# Our Home in Days Gone By: Housing Markets in Advanced Economies in Historical Perspective

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# Contents

# List of Figures

# List of Tables

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Chapter 1

# Introduction

> *Trotzdem finde ich, ich habe nicht schlecht gekauft. Andere sind darüber anderer Ansicht. An einem heissen Sommertag trete ich in eine Wirtschaft der Stadt Bergfeld, ich lasse mir ein Glas Bier geben. Ein paar Leute sitzen da, ich kenne sie nicht, sie kennen mich nicht, ich bin ein Kurgast für sie. Eine Stimme erhebt sich und spricht: "Da hat ja so'n Berliner Dösbartel das Haus von dem Pendel gekauft. Zwölftausend Mark soll er dafür gegeben haben. Daß die Dummen nicht alle werden!" "Dat segg man, Päule!" stimmte der Wirt eifrig zu. "Zwölfdusend Mark – und is doch bloß ne Baracke, die alle Tage einfallen kann! Herrgott, wie groß ist dein Tiergarten!"*
>
> – Hans Fallada, *Heute bei uns zu Haus*

A substantial share of the income of most people is spent on paying for a roof over their heads – be it as rent, paying down a mortgage, or home improvement projects. This is also true for the author Rudolf Ditzen, better known as Hans Fallada. In 1933, he bought a house in Carwitz, a small village in Mecklenburg not too far from Berlin, at the price of 12,000 marks. Built in 1848, the house was in poor condition at the time of his purchase. The roof and windows leaked, the wooden floors were ruined, the rooms full of rats and mice. The surrounding acres had long been laid to waste. His new neighbors thought it a foolish purchase and the property to be overpriced. But Ditzen was convinced he had made a good investment. After some refurbishment, he would spend some of his happiest years in this house.

Like Ditzen, most homeowners view their house not only as a home but also as an investment. The reason is that for most of them, a house is the largest single purchase they will make in their life. At the beginning of the 21st century, about two-thirds of all Europeans and Americans own the homes they live in,[1] and residential property forms the largest component of their wealth. In many countries across the Western world, housing wealth accounts for more than half of total households assets.[2] Given that financial wealth is more unequally distributed than housing wealth, housing wealth generally accounts for an even larger share of the average household's wealth. The majority of households borrow to finance a home purchase. This makes mortgage debt the main financial liability of the household sector, and mortgage loans the main asset of the financial system. In advanced economies, about 60 percent of banks' total lending portfolios are held in form of mortgage loans (Jordà et al., 2016a).

Yet despite its obvious importance, housing has been at the periphery of macroeconomic thinking throughout most of modern history. In one of the earliest contributions to the economics of housing, Needleman (1965) stressed "that there can be few subjects of comparable importance that have been discussed so much and analyzed so little." And little had changed by the end of the 20th century. In the

[1] See also Appendix Table B.4. The population weighted mean home ownership rate for the 16 countries for which data are reported in Appendix Table B.4 is 65.3 Percent.

[2] Housing wealth is defined as the sum of housing structures and the market value of land. Estimate for 2010, based on data for 12 countries for which data on total housing wealth are available. The countries included are Australia, Belgium, Canada, France, Germany, Italy, Japan, the Netherlands, Spain, Switzerland, the U.K., and the U.S. See Appendix A.2 for a description of the sources.

first volume of the *Handbook of Macroeconomics*, published in 1999, housing was completely absent (Taylor and Woodford, 1999). Since the early 2000s, it has gradually moved from the margin of macroeconomic studies to its center. The large housing boom that preceded the financial crisis of 2007/2008 and its aftermath lead to a fundamental reassessment of the importance of housing markets for the macroeconomy. A rapidly growing literature investigates house price trends and fluctuations,[3] their interaction with business and credit cycles,[4] their welfare and distributional consequences,[5] and the nexus between mortgage borrowing and monetary policy.[6]

With few exceptions, most existing empirical studies of house price dynamics and the corresponding economic outcomes focus on the U.S. or on post-1970 developments. They tend to miss the wealth of historical experience and the diversity of housing markets in Europe and elsewhere. My dissertation, *Our Home in Days Gone By*, fills a crucial gap in the literature by providing a historical perspective on housing markets in the Western world. Using the toolkit of quantitative economic history, I analyze long-run trends in house prices and rents in a large sample of advanced economies since the late 19th century, investigate whether house prices in these economies have been excessively volatile and assess how the accumulation of mortgage debt may have impacted the wider economy during the U.S. Great Depression. I generate a wealth of new historical data as a backbone to studying these questions.

This dissertation contributes to three pivotal research areas. The first is the large body of work on how and why developments in housing markets may influence macroeconomic outcomes. This literature offers several vantage points that help to rationalize a close link between housing and the macroeconomy. One focuses on volume or quantity cycles in housing markets. In contrast to most other aspects of housing markets, construction cycles have been a major concern of macroeconomists for a long time (Leser, 1951; Burns and Mitchell, 1945; Long, 1939). In today's advanced economies, the construction sector is relatively small,[7] but highly volatile and closely interconnected with other sectors on the supply side. These intersectoral linkages transmit swings in residential investment to the rest of the economy, amplifying their economic effects and markedly contributing to volatility in the economy as a whole (Piazessi and Schneider, 2016; Boldrin et al., 2013). Swings in construction activity and residential investment also appear to be essential in a predictive sense. In many countries, housing starts and residential investment consistently and substantially contribute to weakness before recessions and to strength before recoveries (Kydland et al., 2016; Leamer, 2015; Alvarez and Cabrero, 2010; Leamer, 2007).

[3]See, for example, Ambrose et al. (2013); Bénétrix et al. (2012); Bracke (2013); Agnello and Schuknecht (2011).

[4]Many macroeconomists have contributed to this area. Among them are Guerrieri and Uhlig (2016); Claessens et al. (2012); Ghent and Owyang (2010); Leamer (2007).

[5]See, for example, Bonnet et al. (2014), Mian and Sufi (2016) and the references therein.

[6]See, for example, Jordà et al. (2015a); Adam and Woodford (2013); Goodhart and Hofmann (2008); Del Negro and Otrok (2007).

[7]In 2011, construction amounted to between 5 and 15 percent of advanced economies' GDP (Sun et al., 2013).

Another vantage point concerns house *price* fluctuations and the macroeconomic implications. House price fluctuations directly influence construction activity through changing Tobin's q and may thus account for part of the volatility in volumes (Goodhart and Hofmann, 2008). More importantly, movements in house prices induce changes in households' financial positions and thus in household consumption. The exact channel and size of this effect have been extensively debated. The two main transmission mechanisms typically considered are the *wealth effect* and the *credit channel* or *collateral effect*. The *wealth effect* is implicit to Friedman's permanent income hypothesis (Friedman, 1957) and Ando and Modigliani's life cycle model (Ando and Modigliani, 1963). Both theories posit that the level of households consumption is determined by the household's permanent income and lifetime resources. In these frameworks, a change in housing wealth that is perceived to be permanent will affect household consumption (Mishkin, 2007). Since housing wealth is a large share of total household wealth, the size of this effect may be non-negligible (Muellbauer, 2007).[8] Similar in spirit, other recent research examines the welfare cost of housing wealth shocks. These studies argue that a negative shock to household net worth stemming from a decrease in house prices is an important factor in determining consumption growth during recessions (Mian and Sufi, 2016; Leigh et al., 2012; Mian et al., 2013; Glick and Lansing, 2010). The *credit channel* focuses on the nexus between credit, house prices, and economic outcomes. Real estate is the single most important collateral for household borrowing across the Western world (Jordà et al., 2016a). Through relaxing (tightening) collateral constraints, a rise (fall) in house prices may alter households' credit demand inducing them to borrow and spend more (less). An increase (decrease) in collateral values may also change credit supply via its effect on the balance sheets of banks. In both cases, the fraction of households that benefit (suffer) from a house price increase (decrease) may be large enough so as to shape the dynamics of aggregate consumption (Iacoviello, 2010; Goodhart and Hofmann, 2008; Bernanke and Gertler, 1995).

Most economists also agree that a strong link exists between house price fluctuations and financial sector stability. As noted above, a considerable share of bank loans are secured by real estate (Jordà et al., 2016a) and financial institutions may face large losses on these mortgage loans in the event of a housing market downturn. This may be particularly problematic for the stability of the financial sector if a certain type of a financial institution, such as the U.S. savings and loan associations or the Japenese jusen companies, concentrates its portfolio in hous-

[8]The question whether the *wealth effect* can be applied in such a standard manner has, however, not been settled. As noted above, a home is not only an asset but owner-occupiers directly value its services. That being the case, in times of rising house prices also the opportunity cost of housing services increases, potentially offsetting the *wealth effect* (Aoki et al., 2008). In a similar vein, Buiter (2010) argues that "housing wealth isn't wealth" alluding to the fact that house price fluctuations do not necessarily increase aggregate wealth but redistribute wealth between households that are long and households that are short in housing. If the marginal propensity to spend differs between the two types of households, aggregate spending may actually decrease when house prices appreciate. Finally, the size of the *wealth effect* has been extensively debated. While some authors find that the effect of housing wealth on consumption is large and greater than the wealth effect on consumption from stock holdings, others do not find any significant effect (Sousa, 2009; Mishkin, 2007; Case et al., 2005).

ing, leaving it highly exposed to property-related risk. A fall in house prices may also undermine financial institutions' capital since many of them hold real estate as assets. Along these lines, several empirical contributions covering different time spans and country samples show that leverage-fuelled house price bubbles substantially raise the risk of a financial crisis (Jordà et al., 2015b; Zhu, 2005; Herring and Wachter, 1999). Monitoring house price developments is therefore a key component of financial stability analysis.

Second, by shedding light on the characteristics of house price fluctuations, long-run returns on housing and on their predictability, this dissertation also adds to the large finance literature concerned with price volatility and the price of risk. Much of the work in this area focuses on the question of whether prices are excessively volatile relative to fundamentals, and tries to understand what factors may account for time-varying risk premia. Another active strand of this literature tries to estimate these risk premia for different types of assets, as they are a central component of every risk-and-return model in finance. Although housing is a more important part of the average household portfolio than stocks or bonds and more households participate in the housing than in the stock market, these studies have largely stayed away from properties of house prices and returns. The observation that prices fluctuate too much compared with what would be expected from their fundamental valuation has been confirmed for equity markets (Golez and Koudijs, 2014; Shiller, 1981; LeRoy and Porter, 1981), bond and treasury markets (Cochrane, 2011; Piazzesi and Swanson, 2008; Campbell and Shiller, 1991) as well as for exchange rates (Obstfeld and Rogoff, 2000). Yet the few contributions that study excess volatility in housing markets, have produced mixed evidence (Engsted and Pedersen, 2015; Ambrose et al., 2013; Ghysels et al., 2013; Plazzi et al., 2010; Campbell et al., 2009; Gallin, 2008), in part because time horizons in these studies are short. Similarly, the limited empirical evidence that exists on the long-run returns on housing and the housing risk premium is almost exclusively based on a short span of U.S. data (Giglio et al., 2016; Flavin and Yamashita, 2002; Ross and Zisler, 1991; Ibbotson and Siegel, 1984). Despite the paucity of empirical evidence on these fundamental questions, the ups and downs in housing markets since the turn of the century have already motivated important research that explores how the double role of housing as collateralizable asset and as a consumption good affects asset pricing and portfolio choices (Piazessi et al., 2007; Lustig and van Nieuwerburgh, 2006, 2005; Flavin and Yamashita, 2002)

Finally, this dissertation contributes to the literature that assesses the role of housing wealth for long-run trends in wealth-to-income ratios. Piketty (2014) argues that wealth-to-income ratios in advanced economies have followed a U-shaped curve over the past century and a half. Subsequent work shows that an increase in housing wealth accounts for a considerable share of the rise in wealth-to-income ratios in the second half of the 20th century suggesting an important role for housing in inequality dynamics (Rognlie, 2015; Bonnet et al., 2014). The rise in housing wealth was accompanied by substantial expansion of homeownership and several recent contributions try to understand the relationship between trends in home ownership and wealth inequality (Kuhn et al., 2017; Kindermann and Kohls, 2016; Kocharkov et al., 2015).

This dissertation consists of three essays that empirically analyze different aspects of housing markets in historical perspective. The first two seek to broaden our understanding of long-run trends and fluctuations in housing markets. The third focuses on the interplay of mortgage debt and macroeconomic fluctuations.

Chapter 2 studies how house prices have evolved over the long-run. Based on extensive historical research, the essay presents annual house price series for 14 advanced economies since 1870. The historical journey into long-run house price trends yields two important new insights. First, it shows that real house prices stayed constant from the 19th to the mid-20th century, but rose strongly in the second half of the 20th century. Second, a decomposition of house prices into the replacement cost of the structure and land prices reveals that rising land prices have been the driving force behind this hockey-stick pattern of house prices. They explain about 80 percent of the global house price boom that has taken place after World War 2. These findings have a number of important implications. They suggest that higher land prices likely played a critical role in the recent increase of housing wealth and hence in the rise of wealth-to-income ratios in Western economies. In addition to these distributional consequences, land prices may also impact economic growth directly through agglomeration effects. Finally, the findings contradict the popular notion that the long-run price elasticity of housing supply is high, because new land for additional construction is still in ample supply and available at constant prices.

Chapter 3 examines house price fluctuations and their sources over the past 140 years to answer the following question: Are house prices excessively volatile relative to fundamentals? To capture changes in fundamentals, macroeconomists typically focus on variables that might shift supply and demand. In this essay, I borrow from the finance literature to take a different approach. Assuming that any asset's fundamental value equals the present value of its future cash flows, rents are one of the most important fundamental determinant of housing value and the rent-price ratio summarizes market expectations of future housing returns and/or rent growth. In this setting, the question about excess volatility translates into asking whether the rent-price ratio predicts returns or rent growth. Most studies examining the rent-price ratio's predictive power for housing returns and rents have focused on relatively recent U.S. data and produced mixed evidence. To conduct a comprehensive study of return predictability in international housing markets, I combine the long-run house price data from Chapter 2 with a novel dataset covering data on housing rents since the late 19th century. I start by providing a comprehensive characterization of house price cycles and show that house prices have deviated from rents for extended periods of time. House price growth in advanced economies particularly outpaced rent growth in the second half of the 20th century, resulting in strongly decreasing rent-price ratios. Based on the dynamic Gordon growth model and using a restricted vector-autoregressive framework, I find that return predictability and thus the excess volatility puzzle have been a pervasive feature of modern housing markets. In this way, housing markets appear to be remarkably similar to stock and bond markets.

The last essay (Chapter 4) investigates the link between the accumulation of debt and the severity and duration of recessions. In the wake of the Great Recession, household debt overhang and the ensuing process of deleveraging have often been cited as factors holding back economic recovery. In this chapter, I zoom in on the years of the Great Depression and use cross-sectional data for U.S. states to examine the connection between state-level variation in household indebtedness and the strength of recovery. The years preceding the Great Depression were a time of great economic prosperity and credit expansion that fostered a significant increase in household debt in general, and mortgage debt in particular. The level of mortgage debt varied substantially across states at the onset of the Depression. I present evidence that the level of indebtedness is an important aspect in explaining the severity and duration of the Great Depression. This relationship is mostly driven by a slower pace of economic recovery, rather than a more severe recession. U.S. states with higher initial debt-to-income ratios recovered considerably slower between 1933 and 1939. The similarity of the results for very different historical episodes suggests a close link between the accumulation of household indebtedness and recovery paths.

In summary, this dissertation provides important new insights about long-run developments in housing markets and the nexus between housing and the macroeconomy. Many open questions remain and there is ample opportunity for future research. I hope that with the data presented in this dissertation, new avenues for empirical and theoretical research in macroeconomics, financial economics and economic history will become possible.

Chapter 2

# No Price Like Home: Global House Prices, 1870–2012

with Moritz Schularick and Thomas Steger

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## 2.1 Introduction

For Dorothy there was no place like home. But despite her ardent desire to get back to Kansas, Dorothy probably had no idea how much her beloved home cost. She was not aware that the price of a standard Kansas house in the late 19th century was around 2,400 dollars (Wickens, 1937) and could not have known whether relocating the house to Munchkin Country would have increased its value or not. For economists there is no price like home – at least not since the global financial crisis: fluctuations in house prices, their impact on the balance sheets of consumers and banks, as well as the deleveraging pressures triggered by house price busts have been a major focus of macroeconomic research in recent years (**?**Mian and Sufi, 2014a; Shiller, 2009). In the context of business cycles, the nexus between monetary policy and the housing market has become a rapidly expanding research field (Adam and Woodford, 2013; Goodhart and Hofmann, 2008; Del Negro and Otrok, 2007; Leamer, 2007). Houses are typically the largest component of household wealth, the key collateral for bank lending and play a central role for long-run trends in wealth-to-income ratios and the size of the financial sector (Jordà et al., 2016a; Piketty and Zucman, 2014). Yet despite their importance to the macroeconomy, surprisingly little is known about long-run trends in house prices. Our paper fills this void.

Based on extensive historical research, we present house price indices for 14 advanced economies since 1870. A considerable part of this paper is devoted to the presentation and discussion of new stylized facts that we unearthed from more than 60 different primary and secondary sources. Houses are heterogeneous assets and when combining data from a variety of sources great care is needed to construct long-run indices that account for quality improvements, shifts in the composition of the type of houses and their location. Controlling for quality changes and shifts in the overall quality-mix of transacted houses is arguably the main challenge for the construction of house price indices over extended periods. We go into considerable detail to corroborate the plausibility and test the robustness of the trends we identify using additional historical sources. However, researchers using our data should be aware of these caveats. In addition to house price data, we have also assembled corresponding long-run data for construction costs and farmland prices.

Using the new dataset, we are able to show that since the 19th century real house prices in advanced economies have taken a particular trajectory that, to the best of our knowledge, has not yet been documented. From the last quarter of the 19th to the mid-20th century, house prices in most industrial economies were largely constant in real (CPI-deflated) terms. By the 1960s, they were, on average, not much higher than they were on the eve of World War I. They have been on a long and pronounced ascent since then, giving rise to a hockey-stick pattern of house prices in the long run.

While house prices have increased in all countries over the past 140 years, we also find considerable cross-country heterogeneity. Australia has seen the strongest, Germany the weakest increase in real house prices since 1870. House prices have broken out of their historical range in almost all countries in the second half of the 20th century. Yet cross-country differences also extend to the timing of the surge of house prices. In most countries, it occurred in the 1960s and 1970s, in some countries the trajectory began to change already shortly after World War II, and in some others only after 1990. Japan is the only country in which house prices fell significantly over the past two decades.

We then study the driving forces of this hockey-stick pattern of house prices. Houses are bundles of the structure and the underlying land. An accounting decomposition of house price dynamics into replacement costs of the structure and land prices demonstrates that rising land prices hold the key to understanding the upward trend in global house prices. While construction costs have flat-lined in the past decades, sharp increases in residential land prices have driven up housing values. Our decomposition shows that more than 80 percent of the increase in house prices between 1950 and 2012 can be attributed to land prices. The results of this decomposition exercise are sensitive to assumptions about the land share in the value of housing. As a baseline, we assume a land share of 50 percent, but even for land shares as low as 25 percent, the land component still accounts for more than 70 percent of the house price increase. The pronounced increase in residential land prices in recent decades contrasts starkly with the period from the late 19th to the mid-20th century. During this period, residential land prices remained, by and large, constant despite substantial population and income growth. We are not the first to note the upward trend in land prices in the second half of the 20th century (Glaeser and Ward, 2009; Case, 2007; Davis and Heathcote, 2007; Gyourko et al., 2013). But to our knowledge, it has not been shown that this is a broad based, cross-country phenomenon that marks a break with the previous era.

This finding challenges the view that in the long run the price elasticity of housing supply is high as additional land for construction may not be readily available at constant cost (Shiller, 2009, 2007; Grebler et al., 1956). Through agglomeration spillovers rising land prices may also have positive effects on economic growth (Davis et al., 2014). Moreover, our findings have important implications for much-debated trends in national wealth and its distribution (Piketty and Zucman, 2014). Bonnet et al. (2014) have stressed that the late 20th century surge in wealth-to-income ratios in Western economies is largely due to increasing housing wealth. Our paper traces the surge in housing wealth in the second half of the 20th century back to land price appreciation. This price channel is conceptually different from the capital accumulation channel stressed by Piketty (2014) as an explanation for rising wealth-to-income ratios. Higher land prices can push up wealth-to-income ratios even if the capital-to-income ratio stays constant. The critical importance of land prices for the trajectory of wealth-to-income ratios evokes Ricardo's famous principle of scarcity: Ricardo (1817) argued that, over the long run, economic growth profits landlords disproportionately, as the owners of the fixed factor. Since land is unequally distributed across the population, Ricardo reasoned that market economies would produce rising inequality (Piketty, 2014).

The structure of the paper is as follows: the next section describes the data sources and the challenges involved in constructing long-run house price indices. The third section distills new stylized facts from the long-run data: real house prices have risen in advanced economies, albeit with considerably cross-country heterogeneity, and virtually all of the increase occurred in the second half of the 20th century. These observations are robust to a number of additional checks relating to quality adjustments and sample composition. In the fourth part, we use a parsimonious model of the housing market to decompose changes in house prices into changes in replacement costs and land prices. We show that land price dynamics are key to understanding the observed long-run house price dynamics. In the fifth section, we discuss the economic implications of our results. The final section concludes and outlines avenues for further research.

## 2.2 Data

This paper presents a novel dataset that covers residential house price indices for 14 advanced economies over the years 1870 to 2012. It is the first systematic attempt to construct house price series for advanced economies since the 19th century on a consistent basis from historical materials. Using more than 60 different sources, we combine existing data and unpublished material. The dataset reaches back to the early 1920s (Canada), the early 1910s (Japan), the early 1900s (Finland, Switzerland), the 1890s (U.K., U.S.), and the 1870s (Australia, Belgium, Denmark, France, Germany, The Netherlands, Norway, Sweden). Building such a comprehensive data set required locating and compiling data from a wide range of scattered primary sources, as detailed below and in the appendix.

### 2.2.1 House price indices

An ideal house price index captures the appreciation of the price of a standard, unchanged house. Yet houses are heterogeneous assets whose characteristics change over time. Houses are also sold infrequently, making it difficult to observe their pricing over time. Four main challenges are involved in constructing consistent long-run house price indices. These relate to differences in the geographic coverage, the type and vintage of the house, the source of pricing, and the method used to adjust for quality and composition changes.

First, house price indices may either be national or cover several cities or regions (Silver, 2014). Whereas rural indices may underestimate house price appreciation, urban indices may be upwardly biased. Second, house prices can either refer to new or existing homes, or a mix of both. Price indices that cover only newly constructed properties may underestimate overall property price appreciation if new construction tends to be located in areas where supply is more elastic (Case and Wachter, 2005). Third, prices can come from sale prices in the market, listing prices or appraised values. Fourth, if the quality of houses improves over time, a simple mean or median of observed prices can be upwardly biased (Case and Shiller, 1987; Bailey et al., 1963). In Appendix A.1.1, we discuss different approaches to construct house price indices and the extent to which they deal with quality and composition changes over time in greater detail.

**Table 2.1:** Overview of house price indices.

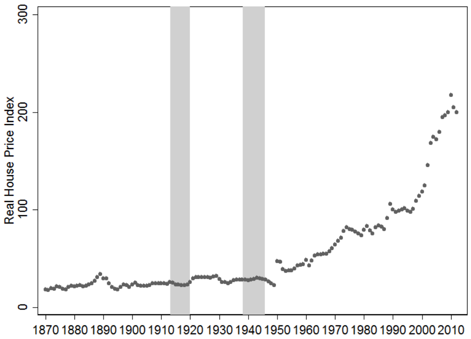
| Country | Years | Geographic Coverage | Property Vintage & Type | Method |
|---|---|---|---|---|
| Australia | 1870–1899 | Urban | Existing Dwellings | Median Price |
| | 1900–2002 | Urban | Existing Dwellings | Median Price |
| | 2003–2012 | Urban | New & Existing Dwellings | Mix-Adjustment |
| Belgium | 1878–1950 | Urban | Existing Dwellings | Median Price |
| | 1951–1985 | Nationwide | Existing Dwellings | Average Price |
| | 1986–2012 | Nationwide | Existing Dwellings | Mix-Adjustment |
| Canada | 1921–1949 | Nationwide | Existing Dwellings | Repl. Values (incl. Land) |
| | 1956–1974 | Nationwide | New & Existing Dwellings | Average Price |
| | 1975–2012 | Urban | Existing Dwellings | Average Price |
| Denmark | 1875–1937 | Rural | Existing Dwellings | Average Price |
| | 1938–1970 | Nationwide | Existing Dwellings | Average Price |
| | 1971–2012 | Nationwide | New & Existing Dwellings | SPAR |
| Finland | 1905–1946 | Urban | Land Only | Average Price |
| | 1947–1969 | Urban | Existing Dwellings | Average Price |
| | 1970–2012 | Nationwide | Existing Dwellings | Mix-Adjustment, Hedonic |
| France | 1870–1935 | Urban | Existing Dwellings | Repeat Sales |
| | 1936–1995 | Nationwide | Existing Dwellings | Repeat Sales |
| | 1996–2012 | Nationwide | Existing Dwellings | Mix-Adjustment |
| Germany | 1870–1902 | Urban | All Existing Real Estate | Average Price |
| | 1903–1922 | Urban | All Existing Real Estate | Average Price |
| | 1923–1938 | Urban | All Existing Real Estate | Average Price |
| | 1962–1969 | Nationwide | Land Only | Average Price |
| | 1970–2012 | Urban | New & Existing Dwellings | Mix-Adjustment |
| Japan | 1913–1930 | Urban | Land only | Average Prices |
| | 1930–1935 | Rural | Land only | Average Price |
| | 1936–1955 | Urban | Land only | Average Price |
| | 1955–2012 | Urban | Land only | Average Price |
| Netherlands | 1870–1969 | Urban | All Existing Real Estate | Repeat Sales |
| | 1970–1996 | Nationwide | Existing Dwellings | Repeat Sales |
| | 1997–2012 | Nationwide | Existing Dwellings | SPAR |
| Norway | 1870–2003 | Urban | Existing Dwellings | Hedonic, Repeat Sales |
| | 2004–2012 | Urban | Existing Dwellings | Hedonic |
| Sweden | 1875–1956 | Urban | New & Existing Dwellings | SPAR |
| | 1957–2012 | Urban | New & Existing Dwellings | Mix-Adjustment, SPAR |
| Switzerland | 1900–1929 | Urban | All Existing Real Estate | Average Price |
| | 1930–1969 | Urban | Existing Dwellings | Hedonic |
| | 1970–2012 | Nationwide | Existing Dwellings | Mix-Adjustment |
| United Kingdom | 1899–1929 | Urban | All Existing Real Estate | Average Price |
| | 1930–1938 | Nationwide | Existing Dwellings | Hypothetical Average Price |
| | 1946–1952 | Nationwide | Existing Dwellings | Average Price |
| | 1953–1965 | Nationwide | New Dwellings | Average Price |
| | 1966–1968 | Nationwide | Existing Dwellings | Average Price |
| | 1969–2012 | Nationwide | Existing Dwellings | Mix-Adjustment |
| United States | 1890–1928 | Urban | New Dwellings | Repeat Sales |
| | 1929–1940 | Urban | Existing Dwellings | Hedonic |
| | 1941–1952 | Urban | Existing Dwellings | Median Price |
| | 1953–1974 | Nationwide | New & Existing Dwellings | Mix-Adjustment |
| | 1975–2012 | Nationwide | New & Existing Dwellings | Repeat Sales |

### 2.2.2 Historical house price data

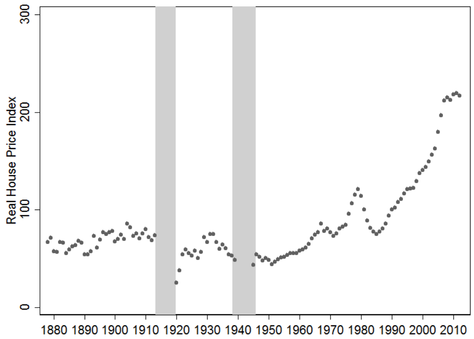
Most countries' statistical offices or central banks began to collect data on house prices in the 1970s. Extending these back to the 19th century involved compromises between the ideal and the available data. We typically had to link different types of indices. As a general rule, we chose constant quality indices where available and opted for longitudinal consistency as well as historical plausibility.

A central challenge for the construction of long-run price indices relates to

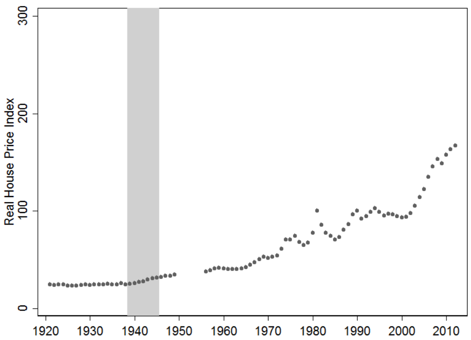
**Figure 2.1:** Historical house prices, 14 countries.



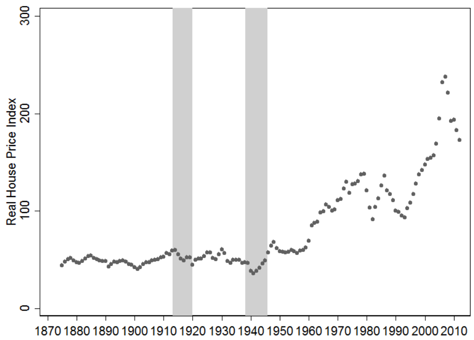

**(a)** Australia, 1870–2012



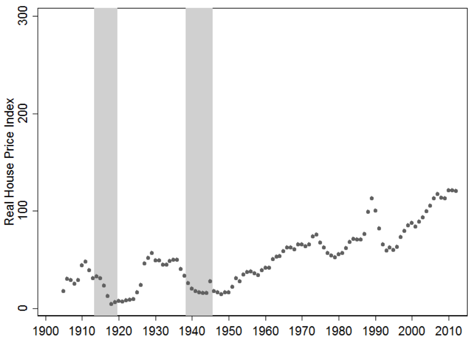

**(b)** Belgium, 1878–2012



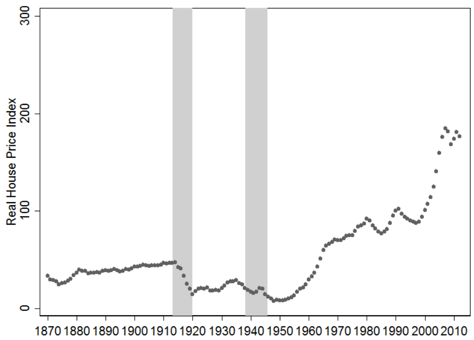

**(c)** Canada, 1921–2012



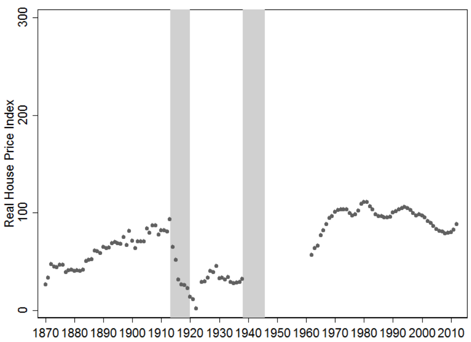

**(d)** Denmark, 1875–2012



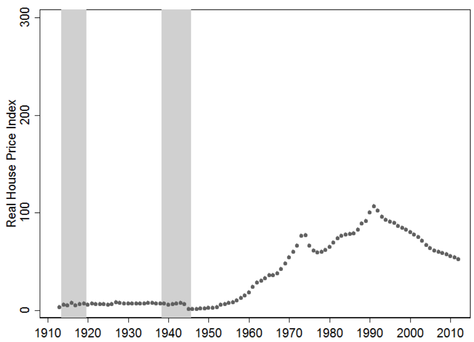

**(e)** Finland, 1905–2012



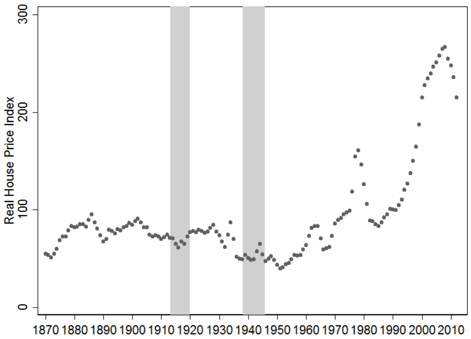

**(f)** France, 1870–2012



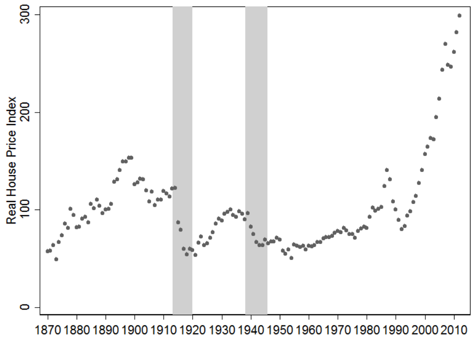

**(g)** Germany, 1870–2012



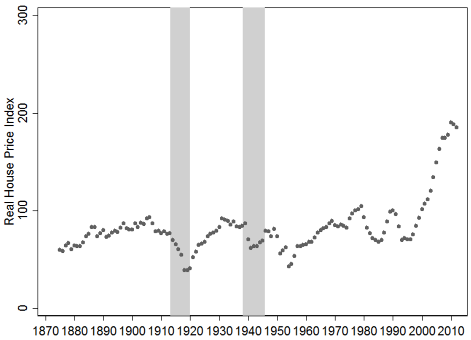

**(h)** Japan, 1913–2012



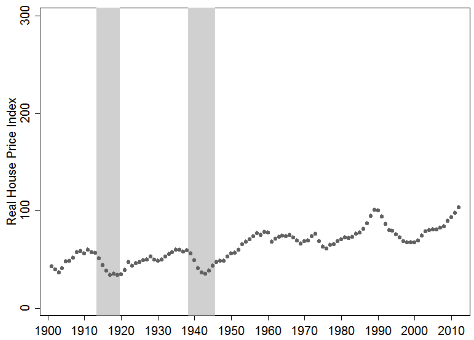

**(i)** The Netherlands, 1870–2012



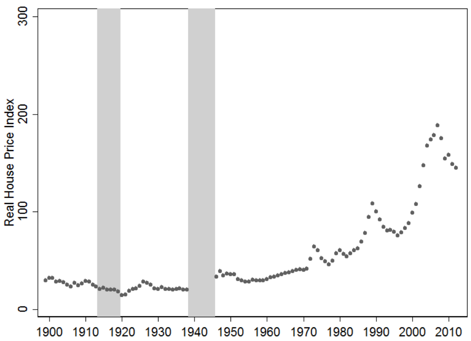

**(j)** Norway, 1870–2012



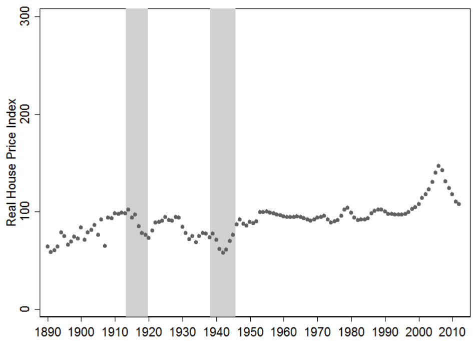

**(k)** Sweden, 1875–2012




**(l)** Switzerland, 1901–2012




**(m)** United Kingdom, 1899–2012




**(n)** United States, 1890–2012

quality changes. While homes today typically feature central heating and hot running water, a standard house in 1870 did not even have electric lighting. We aimed for the broadest possible geographical coverage and, whenever possible, kept the type of house covered constant over time. We normally chose data for the price of existing houses instead of new ones.

We are confident that the indices give a reliable picture of price developments in the 14 housing markets covered in this study. Yet we had to make a number compromises. Some series rely on appraisals, others on list or transaction prices. Despite our efforts to ensure the broadest geographical coverage possible, in a few cases – such as the Netherlands prior to 1970 or the index for France before 1936 –

the country-index is based on a narrow geographical coverage. For certain periods no constant quality indices were available, and we relied on mean or median sales prices. We discuss potential biases arising from these compromises in greater detail below and argue that they do not systematically distort the aggregate trends we uncover.

To construct long-run house price indices for a broad cross-country sample, we partly relied on the work of economic and financial historians. Examples include the index for Amsterdam (Eichholtz, 1997) and the city-indices for Norway (Eitrheim and Erlandsen, 2004). In other cases we took advantage of previously unused sources to construct new series. Some historical data come from dispersed publications of national or regional statistical offices, such as the Helsinki Statistical Yearbook, the publications of the Swiss Federal Statistical Office and the Bank of Japan (1966).

We also drew upon unpublished data from tax authorities such as the U.K. Land Registry or national real estate associations such as the Canadian Real Estate Association (1981). In addition, we collected long-run indices for the price of residential land, the price of agricultural land, and construction costs to proxy for replacement costs.[1]

Table 2.1 provides a comprehensive overview of the house price series, their geographic coverage, the type of dwelling covered, and the method used for price calculation. The paper comes with an extensive data appendix that specifies the sources we consulted and discusses the construction of the individual country indices in greater detail. Figure 2.1 plots the historical house prices country by country.

## 2.3 Aggregate trends

How have house prices evolved over the long run? In this section, we describe the global run-up in house prices in the 20th century and its specific path over time. We show that real house prices in advanced economies have on average risen threefold since 1900 and that the overwhelming share of this increase occurred in the second half of the 20th century. The long-run trajectory of global house prices displays a hockey-stick pattern: real house prices remained broadly stable from the late 19th century to World War II. They trended upwards in the postwar decades and have seen a particularly steep incline since the late 1980s.

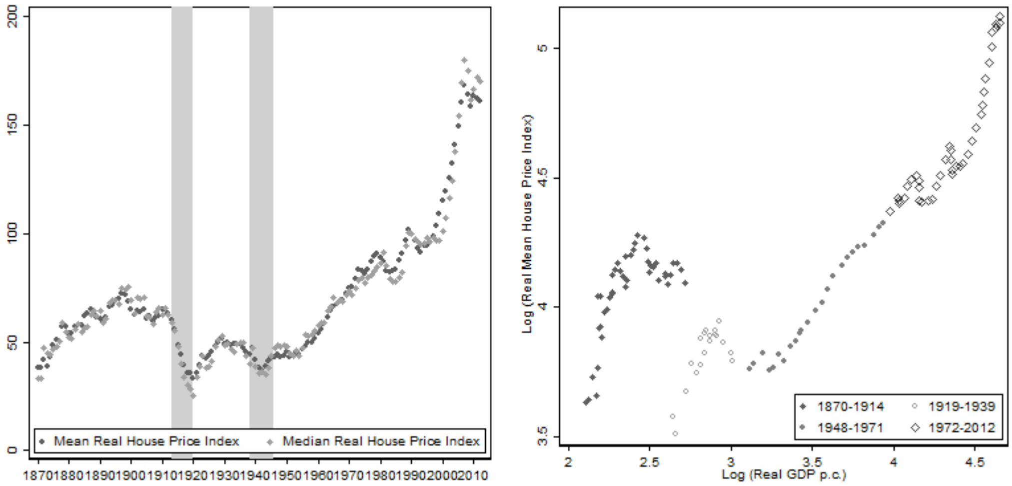
### 2.3.1 A global house price index

The arithmetic mean and the median of the 14 house price series are displayed in the left panel of Figure 2.2. One recognizes that CPI-adjusted house prices stayed within a relatively tight range from the late 19th to the second half of the

[1]For the sources and compilation of these time series, see Appendix A.2. All auxiliary macroeconomic and financial variables come from Jordà et al. (2016a).

20th century.[2] In subsequent decades, house prices have broken out of their long-run range and embarked on a steep incline, resulting in a hockey-stick pattern of long-run real house prices. This specific path of global house prices is robust to different weightings and across regional subsamples and a constant-coverage sample.

**Figure 2.2:** Aggregate trends.




*Notes:* Index, 1990=100. The years of the two world wars are shown with shading.

The relation between house prices and GDP per capita over the past 140 years exhibits a similar hockey-stick pattern. The right panel of Figure 2.2 shows that house prices remained, by and large, stable before World War I despite rising per capita incomes. In the final decades of the 20th century, house price growth outpaced income growth by a substantial margin.

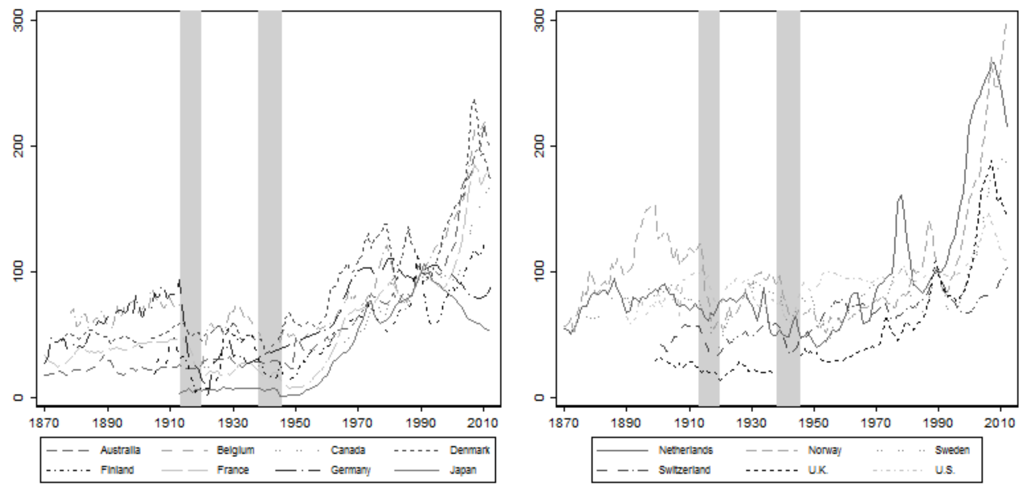
Table A.2 in Appendix A.1.5 puts numbers on these phenomena. It shows average annual growth rates of house prices for all countries and for two sub-periods. House price growth was about 1.5 percent in nominal and below 1 percent in real terms before World War II. After World War II, the average nominal annual rate of growth climbed to above 6 percent and to 2 percent adjusted for inflation.

The path of global house prices displayed in Figure 2.2 is based on an unweighted average of 14 country indices in our sample. Figure 2.3 and Table A.2 in Appendix A.1.5 demonstrate that there is considerable heterogeneity in the cross-country trends. In the long-run, real house prices merely increased by 40 basis points per year in Germany, but by about 2 percent on average in Australia, Belgium, Canada and Finland. U.S. house prices have increased at an annual rate of a little less than 1 percent since the 1890s; both the UK and France have seen somewhat higher house price growth of 1 percent and 1.4 percent, respectively. Figure

[2]Real house prices by construction reflect ex-post returns. We also calculated real house price indices using average inflation in the preceding five years to proxy for adaptive inflation expectations (see Figure A.6 in Appendix A.1.5).

2.3 also shows that Japan has been an important outlier. It is the only country in which house prices significantly fell during the past two decades. It is therefore important to look at both the mean and the median.

**Figure 2.3:** Heterogeneity.




*Notes:* Index, 1990=100. The years of the two world wars are shown with shading.

The cross-country heterogeneity also extends to the timing of the surge of real house prices in the second half of the 20th century. We identified structural breaks in the real house price series for individual countries using the methodology of Bai and Perron (2003). The structural break tests show that virtually all upward breaks occurred in the second half of the 20th century, but the exact year when the heel of the hockey stick is reached differs from country to country (see Table A.1 in Appendix A.1.2). In 8 out of 14 countries, the structural break most likely took place in the 1960s and 1970s. In the U.S. and Switzerland, structural breaks in the series are dated in the 1950s, and in the 1990s or early 2000s in the cases of Belgium, the Netherlands, Norway and Sweden.[3]

### 2.3.2 Robustness checks

Now that we have explored the long-run path of global house prices, we subject it to additional robustness and consistency check. We address four issues: first, we demonstrate the robustness of these aggregate trends across different subsamples; second, we discuss if the aggregate trends could be distorted by a potential mismeasurement of quality improvements in the housing stock; third, the aggregate price developments could be an artifact of a compositional shift of the underlying

[3] Bai and Perron (2003) provide a test for the null hypothesis that the mean of a time series is the same over all time intervals versus one (or more) changes in the mean. In Appendix Table A.1, we flexibly allow for a maximum of three breaks. For some countries, the test signals more than one structural break, typically in the immediate post-World War II decades as well as in the 1990s or early 2000s.

indices from predominantly (cheap) rural to (expensive) urban areas over time; fourth, we ask if the strong rise in house prices was mainly driven by urban areas.

### Subsamples

It is conceivable that small and land-poor European countries have a disproportionate influence on the aggregate trends outlined above. We calculated population and GDP weighted indices (Appendix Figure A.1).[4] It turns out that house price appreciation was somewhat stronger in the small European countries than it was in the large economies in our sample, i.e., the U.S., Japan, and Germany. Yet over the past 140 years, the overall trajectory is comparable. Data coverage starts at different dates for different countries. Appendix Figure A.3 presents average trends for fixed country groups. Again, the aggregate trends discussed above are largely unaffected.

Finally, as our sample is Europe-heavy, the trends – in particular the stagnation of real house prices in the first half of the 20th century – may be driven by the shocks of the two World Wars and the destruction they brought to the European housing stock. However, trends are similar in countries that experienced major war destruction on their own territory and countries that did not (i.e., Australia, Canada, Denmark, and the U.S).

### Quality improvements

A key challenge for the construction of long-run house price indices relates to changes in the quality of the housing stock. First, the quality of homes has risen continuously over the past 140 years. Indices that do not control for quality improvements will overstate the price increase over time.[5] The pre-World War II data warrant particular attention. The reason is that the most significant improvements in housing quality – such as running water and electricity – entered the standard home in the first half of the 20th century and some of our indices in this period are based on mean or median prices.[6] This could induce an upward bias to our house price series *before* World War II. The strong increase of house prices *after* World War II would be largely unaffected as most data for this period are adjusted for quality improvements. In other words, the reliance on mean or median prices prior to World War II likely accentuates the aggregate trends discussed above.

Second, the composition of the housing stock may change in response to secu-

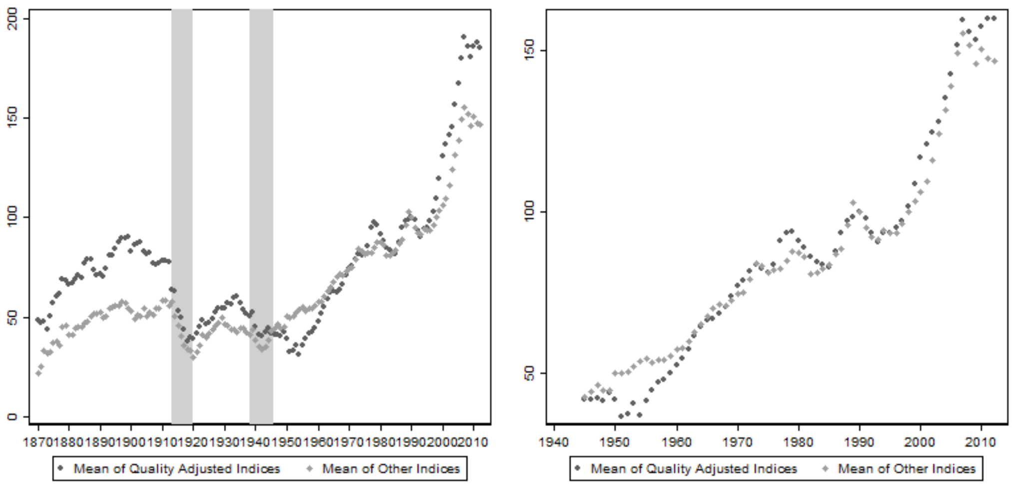
[4] We also tested if border changes systematically influence the picture (see Appendix Figure A.2). Figure A.2 also includes a GDP per capita weighted index.

[5] The speed of the quality improvement varies over time and across countries. Davis and Heathcote (2007) estimate for the U.S. that quality gains amounted to less than 1 percent per year between 1930 and 2000. For Australia, Abelson and Chung (2005) calculate that spending on alterations and additions added about 1 percent per year to the market value of detached housing between 1979/80 and 2002/03. Stapledon (2007) arrives at similar conclusions. For the U.K., Feinstein and Pollard (1988) argue that housing standards rose about 0.22 percent per year between 1875 and 1913.

[6] By 1940, for example, about 70 percent of U.S. homes already had running water, 79 percent electric lighting and 42 percent central heating (Brunsman and Lowery, 1943).

lar trends such as urbanization or the business cycle. While business cycle effects are unlikely to matter much for the long-run trends discussed above, the supply of (comparably cheap) low quality houses in cities could have increased with urbanization. If more low quality houses were transacted, mean or median price indices could understate the price increase that occurred before World War II. Narrative accounts and historical housing statistics offer some support for the idea that the rapid growth of cities initially went hand in hand with deteriorating average urban housing conditions (Porter, 1998; Bernhardt, 1997; Wischermann, 1983; Kelly, 1978).[7] Unfortunately, there is very little information on trends in the overall quality-mix of transacted houses limiting our ability to quantify the effects with greater precision.

**Figure 2.4:** Quality adjustments.




*Notes:* Index, 1990=100. The years of the two world wars are shown with shading. The mean of quality adjusted indices includes the following countries: FRA, NLD, NOR, SWE, JPN (left figure); FRA, NLD, NOR, SWE, JPN, DEU, CHE (right figure).

As an indicative test, we can compare house price trends for countries for which we have reliable quality adjusted price information with country indices for which the constant quality assumption is more doubtful. Figure 2.4 shows that the overall trajectories look similar.

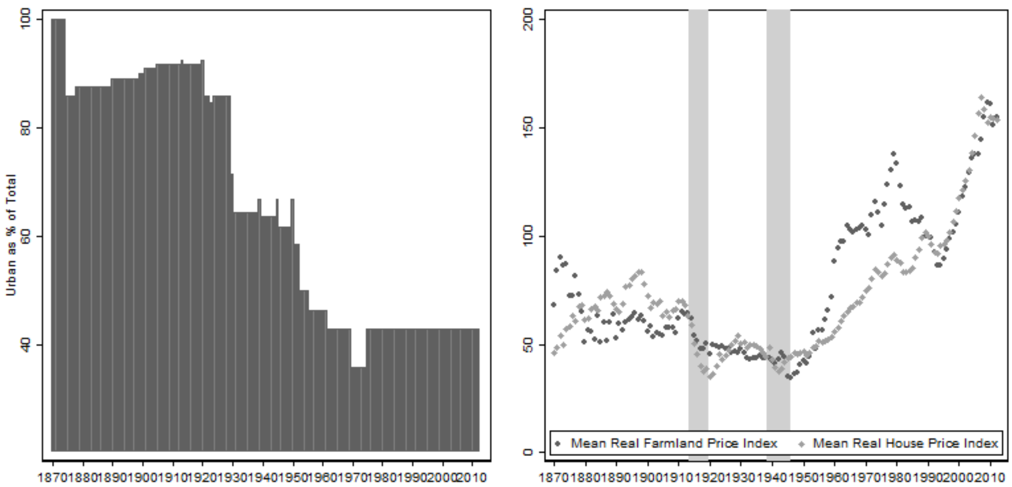
All things considered, some uncertainty remains as to which these two opposing effects dominates in the pre-World War II period. On the one hand, there could be a potential overstatement of price increases because of rapid quality improvements, but on the other hand price increases could also be understated because of a deteriorating quality-mix. Researchers using our dataset in the future should take into account that accurate measurement of quality-adjustments remains a challenge.

[7]This could potentially affect our data for Australia, Germany, Switzerland, and the U.K. as these indices are not adjusted for quality changes and exclusively based on data for urban areas.

### Composition shifts

The world is considerably more urban today than it was in 1900. About 30 percent of Americans lived in cities in 1900. In 2010, the corresponding number was 80 percent. In Germany, 60 percent of the population lived in urban areas in 1910 and 74.5 percent in 2010 (United Nations, Department of Economic and Social Affairs, Population Division, 2015; U.S. Bureau of the Census, 1975). The UK is the only exception as the country was already highly urbanized at the beginning of the 20th century.

**Figure 2.5:** Composition effects.




*Notes:* Left panel: Index, 1990=100. The years of the two world wars are shown with shading.

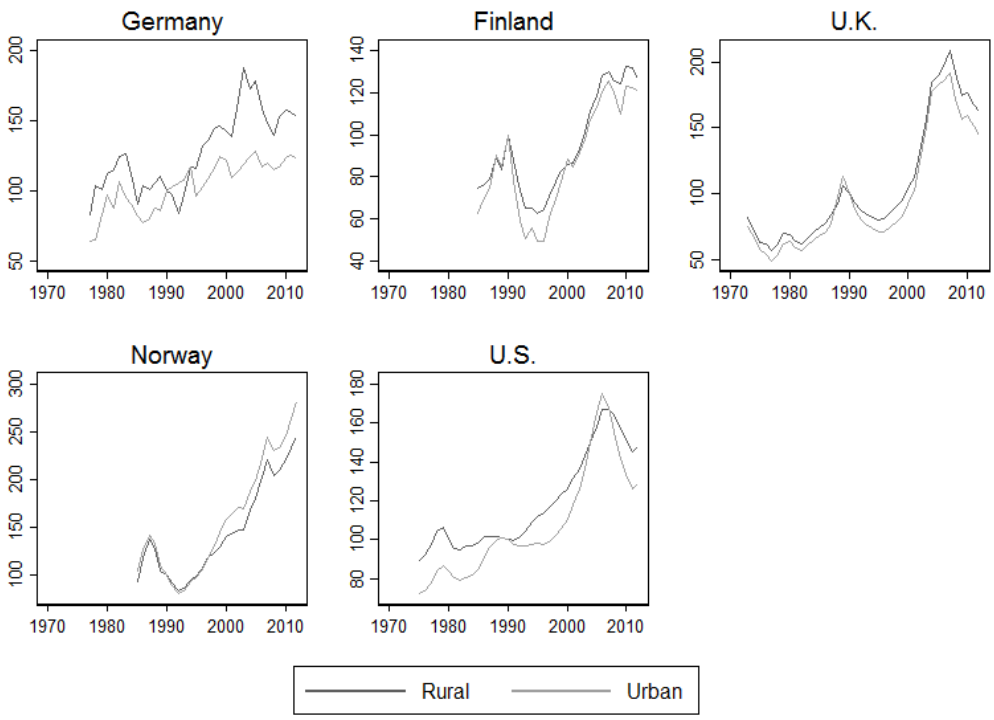
If the statistical coverage of house price data shifted from (cheap) rural to (expensive) urban prices over time, this could mechanically push up the average prices that we observe, even if rural and urban prices remain constant over time. The left panel of Figure 2.5 plots the share of purely urban house price observations for the entire sample. It turns out that the share of urban prices is declining over time, mainly because many of the early house price observations rely on city data only. The indices broaden out over time and cover more and more non-urban prices. Compositional shifts are not responsible for the patterns that we observe.

### Urban and rural price dynamics

It remains, however, a possibility that the strong rise in house prices since the 1960s was predominantly an urban phenomenon, driven by a growing attractiveness of cities. Urban economists have long pointed to the economic advantage of living in cities, explaining high demand for urban land (Glaeser et al., 2012, 2001). It is essential, therefore, to separately examine the evidence we have on price trends in rural vis-a-vis urban areas.

As a first check, we went back to the historical sources and collected data for the price of farmland. Farmland prices can serve as a rough proxy for non-urban prices if the price of rural land used for farming and the price of land used for rural housing move together in the long run. To compare average farmland prices (as a proxy for rural housing) with average house prices we further need to assume that, in the long run, construction costs move together in cities and rural areas.[8] The right panel of Figure 2.5 plots mean farmland prices for 11 countries against the average house price index for the same 11-country sample.[9] Real farmland prices have more than doubled since 1900. This implies that the long-run growth in farmland prices was only slightly below the average growth rate of house prices (by about 0.3 percentage points per year). Clearly, farmland is cheaper than building land per area unit, but the long-run trajectories appear similar.

**Figure 2.6:** Urban and rural house prices since the 1970s, 5 countries.




*Notes:* Index, 1990=100. Data for Germany 1977–2012, Finland 1985–2012, U.K. 1973–1999, Norway 1985–2010, U.S. 1975–2000.

Figure 2.6 plots the development of urban and rural house prices for a sub-sample of five countries for the post-1970 period: Finland, Germany, Norway,

[8]This assumes that land use regulation does not drive a wedge between the price of land used for farming and for residential purposes.

[9]Data on farmland prices are available for Belgium, Canada, Switzerland, Germany, Denmark, Finland, United Kingdom, Japan, the Netherlands, Norway and the United States. See Appendix A.2 for sources and description.

the U.K. and the U.S.[10] Figure 2.6 shows that both rural and urban house prices trended strongly upwards in recent decades. While the increase in house prices has been most pronounced in cities, it is not exclusively an urban phenomenon.

## 2.4 Decomposing long-run house prices

What accounts for the surge of house prices in the second half of the 20th century? As a house is a bundle of the structure and the underlying land, a decomposition of house prices into the replacement value and the value of the underlying land allows us to identify the driving forces of house price changes. If the price of a house rises faster than the cost of building a structure of similar size and quality, the underlying land gains in value. In this section, we introduce long-run data on construction costs (as a proxy for the trend in replacement costs) that we compiled from a wide range of historical sources, discussed in Appendix A.2. Using a stylized model of the housing market, we then study the role of construction costs and land prices as drivers of the increase in house prices over the past 140 years.

Consider a housing sector with a large number of identical firms (real estate developers) who produce houses under perfect competition. Production requires to combine land $Z_t$ and residential structures $X_t$ according to a Cobb-Douglas technology $F(Z, X) = (Z_t)^{\alpha}(X_t)^{1-\alpha}$, where $0 < \alpha < 1$ denotes a constant technology parameter (Hornstein, 2009a,b; Davis and Heathcote, 2005). Profit maximization implies that the house price $p_t^H$ equals the equilibrium unit costs such that $p_t^H = B(p_t^Z)^{\alpha}(p_t^X)^{1-\alpha}$, where $p_t^Z$ denotes the price of land at time $t$, $p_t^X$ the price of (quality-adjusted) residential structures as captured by construction costs, and $B := (\alpha)^{-\alpha}(1-\alpha)^{-(1-\alpha)}$, respectively.[11] The preceding equation describes how the house price depends on the price of land and on construction costs. The implied growth rate of house prices reads

$$\frac{p_{t+1}^H}{p_t^H} = \left(\frac{p_{t+1}^Z}{p_t^Z}\right)^{\alpha} \left(\frac{p_{t+1}^X}{p_t^X}\right)^{1-\alpha} \tag{2.1}$$

and the imputed land price can be traced out by employing

$$\frac{p_{t+1}^Z}{p_t^Z} = \left(\frac{p_{t+1}^H}{p_t^H}\right)^{\frac{1}{\alpha}} \left(\frac{p_{t+1}^X}{p_t^X}\right)^{\frac{\alpha-1}{\alpha}}. \tag{2.2}$$

With information on house prices and construction costs, Equation 2.2 can be applied to impute the price of residential land. The decomposition therefore

[10] We divided regions in these five countries into urban and rural ones based on population shares. Regions with a share of urban population above the country-specific median are labeled predominantly urban.

[11] Diewert (2013) uses a hedonic regression approach relying on micro data to decompose house prices into the price of land and the price of structures. Similar to Hornstein (2009a,b) and Davis and Heathcote (2005), Diewert (2013) applies a supply side analysis of house prices.

allows us to identify the relative importance of construction costs and land prices as drivers of long-run house prices.[12]

### 2.4.1 Construction costs

The left panel of Figure 2.7 displays a cross-country construction cost index side by side with the global house price index.[13] It shows that construction costs, by and large, moved sideways until World War II. Before World War II, costs were likely held down by technological advances such as the invention of the steel frame. Construction costs rose somewhat in the interwar period, but increased substantially between the 1950s and the 1970s in many countries, including the U.S., Germany and Japan. Among other factors, this may reflect solid wage gains (relative to labor productivity) in the construction sector.[14]

Yet what is equally clear from the graph is that since the 1970s, construction cost growth has leveled off. During the past four decades, construction costs in advanced economies have remained broadly stable, while house prices surged. *Prima facie*, changes in replacement costs of the structure do not seem to offer an explanation for the strong increase in house prices in the second half of the 20th century.

### 2.4.2 Land prices

Historical prices for residential land are scarce. We were able to locate price information for residential land for six economies, predominantly for the post-World War II era: Australia, Belgium, Japan, Great Britain, Switzerland, and the U.S. – for the latter we dispose of a derived land price index from Davis and Heathcote (2007). The land price series are displayed in Figure A.8 in Appendix A.1.5 and show a substantial increase of residential land prices in the last decades of the 20th century. But a sample of six countries appears too small to make general inferences.

To obtain a more comprehensive picture and corroborate the trends evident in the primary residential land price series, we use Equation 2.2 to impute long-run land prices combining information on construction cost and the price of houses. For this decomposition, we need to specify $\alpha$, the share of land in the total value of housing. Table 2.2 suggests that a reasonable assumption for $\alpha$ is a value of

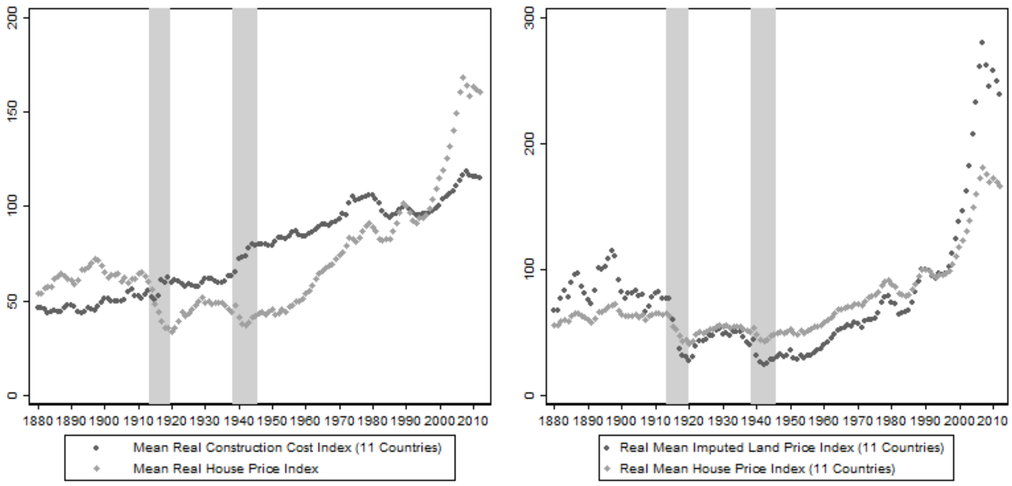
[12] Other factors, such as sales taxes or building permit fees, may also affect equilibrium house prices. The imputed land price series based on Equation 2.2 implicitly assume that the relative importance of these factors does not change over time. We illustrate this point in Appendix A.1.4.

[13] Figure 2.7 starts in 1880 as we only have data for construction costs for two countries for the 1870s. Figure A.7 in Appendix A.1.5 plots historical construction costs for each country. Appendix A.2.1 describes the data sources and discusses the methodological challenges involved in constructing long-run construction cost series.

[14] We calculated real unit labor cost indices for the construction sector based on national accounts data for Canada, France, Finland, Germany, Norway, Sweden, the U.K. and the U.S. (see Appendix A.2.1 for details). In the 8 countries for which data are available, average real unit labor costs rose by 13 percent between 1950 and 1970 compared to an increase in average real construction costs of 15.2 percent.

about 0.5, but there is some variation both across time and countries. Figure A.4 in Appendix A.1.4 demonstrates that our results are robust to changing $\alpha$ within reasonable limits.[15]

**Figure 2.7:** Decomposition - land prices and construction costs.




*Notes:* Index, 1990=100. The years of the two world wars are shown with shading.

The average land price that we back out from this decomposition is shown in the right panel of Figure 2.7 together with global house prices. Real residential land prices appear to have remained constant before World War I and fell substantially in the interwar period. It took until the 1970s before real residential land prices in advanced economies had, on average, recovered their pre-1913 level. Since 1980, residential land prices have approximately doubled.[16]

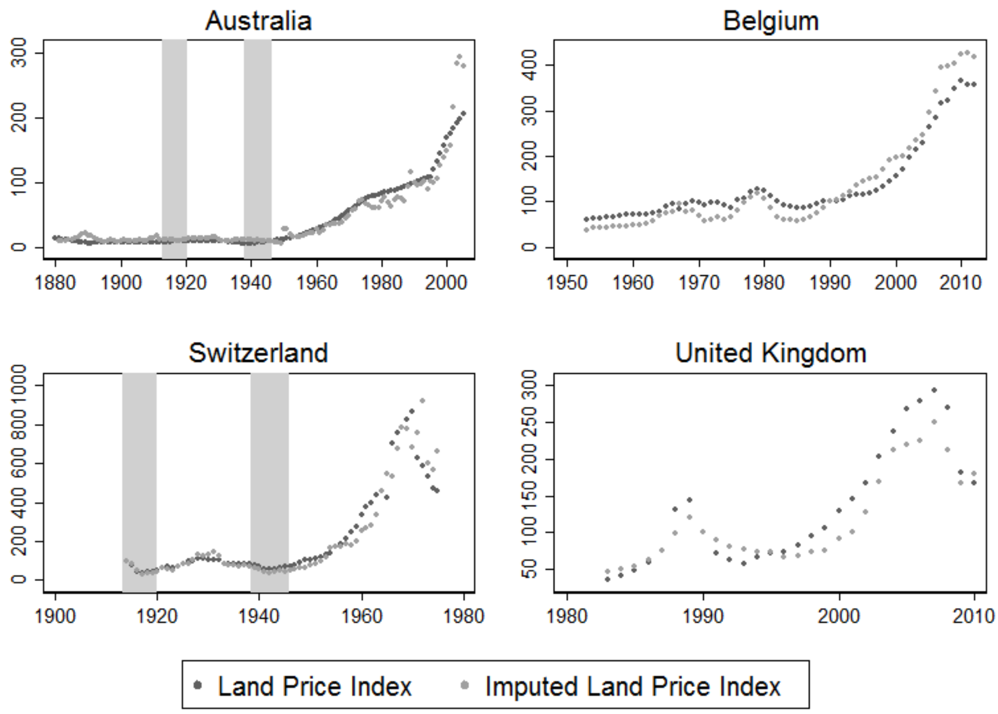
As a plausibility check, we compare imputed land prices with observed land prices for a sub-sample of four countries for which we have independently collected residential land prices.[17] Country by country comparisons of imputed and observed land price data are shown in Figure 2.8. The imputed land price index tracks the empirically observed price data closely and displays virtually identical trends – most importantly a sharp run-up of land prices in the past three decades.

[15]For the decomposition, we exclude Finland, Germany, and Japan since the house price indices for these countries in part rely on residential land prices.

[16]Figure A.5 in Appendix A.1.4 presents the robustness of Figure 2.7 with respect to the underlying production technology. The Cobb-Douglas price index rests on the assumption of an elasticity of substitution between land and construction services in housing production equal to unity. We also consider the case of an elasticity of substitution equal to zero (Leontief technology) in the appendix.

[17]Since our aim is to compare empirical and imputed data, we are forced to exclude the residential land price series for the U.S. (Figure A.8), which itself was imputed in a similar exercise by Davis and Heathcote (2007). We also exclude Japan as the Japanese house price index captures the price change of urban residential land plots (see Appendix A.2). For Switzerland, we rely on an alternative house price series covering house prices in Zurich so as to be able to compare imputed and empirical land prices in Zurich (for details see Appendix A.2.13.)

**Figure 2.8:** Imputed land prices - individual countries.




*Notes:* Index, 1990=100 for Australia, Belgium, and the United Kingdom. Index, 1914=100 for Switzerland. The years of the two world wars are shown with shading.

### 2.4.3 Accounting for the global house price boom

How important is the land price increase relative to construction costs when it comes to explaining the surge in mean house prices during the second half of the 20th century? With data for construction costs and land prices at hand, it is straightforward to determine the contributions of land prices and constructions costs to the late 20th and early 21st century global house price boom. Noting Equation 2.1, the growth in global house prices between 1950 and 2012 may be expressed as follows

$$\frac{p^H_{2012}}{p^H_{1950}} = \left(\frac{p^Z_{2012}}{p^Z_{1950}}\right)^{\alpha} \left(\frac{p^X_{2012}}{p^X_{1950}}\right)^{1-\alpha}, \tag{2.3}$$

where $p^Z_t$ denotes the imputed mean land price in period $t$. During 1950 to 2012 house prices grew by a factor of $\frac{p^H_{2012}}{p^H_{1950}} = 3.3$, land prices increased by $\frac{p^Z_{2012}}{p^Z_{1950}} = 7.5$, while construction costs exhibited $\frac{p^X_{2012}}{p^X_{1950}} = 1.5$. The share of house price growth that can be attributed to land price growth may therefore be expressed as $0.5\frac{\ln(7.5)}{\ln(3.3)}$.[18] The overall result is striking: 84 percent of the rise in house prices dur-

[18] Taking logs on both sides of Equation 2.3 and normalizing house price growth by dividing by

ing 1950 to 2012 can be attributed to rising land prices. The remaining 16 percent can be attributed to the rise in real construction costs, reflecting lower productivity growth in the construction sector as compared to the rest of the economy. Clearly, these results are sensitive to the choice of $\alpha$, the share of land in housing value. Using a lower bound estimate for $\alpha$ of 0.25 and an upper bound estimate of 0.75 gives us a range of 76 to 92 percent of the house price increase between 1950 and 2012 that is accounted for by increasing land prices.

At a country-by-country level we find that the contribution of land prices in explaining house price growth ranges from 73 percent (U.K.) to 96 percent (Finland), while the median is 86 percent. The contribution of land prices to national house price growth is 77 percent for Denmark, 81 percent for Belgium, the Netherlands and Sweden, 83 percent for Switzerland, 89 percent for the U.S., 90 percent for Australia, 92 percent for Norway, 93 percent for France, and 95 percent for Canada.

## 2.5 Implications

Our historical journey into long-run house price trends has yielded two important new insights. First, house prices in advanced economies stayed largely constant until the mid-20th century and have risen strongly in the last decades of the 20th century. Second, the late 20th century surge in house prices was due to sharply rising land prices. About 80 percent of the increase in real house prices in advanced economies in the second half of the 20th century can be explained by higher land values. In this section, we discuss a number of important implications of these findings.

The existing literature offers two opposing views on the long-term evolution of land prices. The classical position emphasizes that land becomes increasingly scarce as the economy grows and land prices rise as a consequence (Walras, 1881; Ricardo, 1817). The opposing view is that land is still in ample supply so that house price increases trigger a supply response which brings prices down again (Shiller, 2009, 2007; Grebler et al., 1956). Davis et al. (2007) as well as Davis and Heathcote (2007) have already taken issue with the data underlying this view and show that U.S. land prices have been on a steady upward trajectory since World War II. Our data add an international dimension to this debate by showing that the cross-country evidence is hard to reconcile with the assumption of constant land prices. The findings indicate the significance of the classical view on the evolution of land prices, at least for the time period after World War II. If both land prices and the cost share of land in housing production are rising over time, the supply response to rising home values may not bring prices down again. Hence, the view that the long-run price elasticity of housing supply is high as new land for additional construction is available at constant prices must be scrutinized.[19]

$\ln\left(\frac{p^H_{2012}}{p^H_{1950}}\right)$ one gets $\alpha \frac{\ln\left(\frac{p^Z_{2012}}{p^Z_{1950}}\right)}{\ln\left(\frac{p^H_{2012}}{p^H_{1950}}\right)} + (1-\alpha)\frac{\ln\left(\frac{p^X_{2012}}{p^X_{1950}}\right)}{\ln\left(\frac{p^H_{2012}}{p^H_{1950}}\right)} = 1.$

[19]Since building additional houses takes time, the price elasticity of housing supply tends to be

A second important implication has to do with much-debated long-run trends in wealth-to-income ratios. Piketty (2014) argued that wealth-to-income ratios in advanced economies have followed a U-shaped curve over the past century and a half. At the end of the 20th century, wealth-to-income ratios – and with them measures of wealth inequality – have returned to pre-World War I levels. Piketty (2014) further hypothesizes that capital-to-income ratios may continue to rise.[20] Bonnet et al. (2014) have stressed that most of the late 20th century increase in wealth-to-income ratios in Western economies can be ascribed to rising housing wealth. They argue that wealth-to-income ratios, excluding housing wealth, have flat-lined or fallen in many countries. Rognlie (2015) established that the (net) capital income share remained largely constant in the economy and only increased in the housing sector.

Our findings suggest that higher land prices likely played a critical role for the increase of housing wealth in the late 20th century. To check if this proposition is borne out by the data, we went back to the historical national wealth data to trace the share of land in the total value of housing over the 20th century. Collecting data for the land share in housing wealth, we mostly relied on the national wealth estimates by Goldsmith (Goldsmith, 1985, 1962; Garland and Goldsmith, 1959) for the pre-World War II period. For the postwar decades, we turned to published and unpublished data from national statistical offices such as the U.K. Office of National Statistics, Statistics Netherlands (1959), and Statistics Japan (2013a). The resulting trends are displayed in Table 2.2. The data show a substantial increase of the land component in total housing wealth. In the U.S., the land share in the total value of housing roughly doubled over the course of the 20th century, rising from 20 percent on the eve of World War I to close to 40 percent today. In line with the land and house price trends we described in this paper, most of the increase occurred over the past 40 years. Even stronger effects can be observed in European countries such as the Netherlands and France.

The implications for the debate about the drivers of rising wealth-to-income ratios are profound. National wealth consists of components that can be accumulated, such as capital goods ($K$), and a land component ($Z$) whose quantity is fixed. Total wealth ($W$) may hence be expressed as $W = K + p^Z Z$.[21] If the land price rises faster than the economy grows, i.e. if $\hat{p}^Z > g$ with $\hat{p}^Z$ denoting the growth rate of $p^Z$, the wealth-to-income ratio increases even if $\frac{K}{Y}$ remains constant. This price channel of rising land valuations therefore differs from the quantity channel of capital accumulation stressed by Piketty (2014). The data presented in Table 2.2 imply that the land price channel played a critical role for wealth dynamics over

low in the short-run. By contrast, assuming that prices of production inputs (i.e., the price of land and construction costs) remain largely constant, the price elasticity should be significantly higher in the long-run. This may no longer be the case if land prices are rising.

[20] Assuming a saving rate $s$ of 10 percent and real GDP growth $g$ of 1.5 percent, Piketty (2014) argues, the capital-to-income ratio $\frac{K}{Y} = \frac{s}{g}$ would rise to 600–700 percent. Provided that $r$ does not adjust, this would result in a rising capital income share ($\frac{rs}{g}$) and, given that capital is unequally distributed, in rising income inequality. These propositions have been debated recently (Krusell and Smith, 2015).

[21] The price of $K$ is normalized to one. Standard theory implies that this price is either equal to unity (Solow model) or constant in the steady state (capital-adjustment-cost model).

**Table 2.2:** Share of land in total housing value.

| | AUS | CAN | DEU | FRA | GBR | JPN | NLD | USA |
|---|---|---|---|---|---|---|---|---|
| 1880 | | | 0.13 | 0.25 | | | | |
| 1890 | | | | | | 0.40 | | |
| 1900 | 0.54 | | 0.18 | | | 0.40 | | 0.21 |
| 1913/1914 | 0.43 | | 0.20 | 0.30 | | 0.43 | | 0.20 |
| 1920 | | | | | | | | 0.20 |
| 1930 | 0.40 | | 0.17 | 0.30 | 0.23 | 0.52 | | 0.20 |
| 1940 | | | 0.17 | | 0.19 | 0.46 | | 0.20 |
| 1950 | 0.49 | | 0.17 | 0.32 | 0.17 | 0.65 | 0.15 | 0.13 |
| 1960 | 0.40 | | 0.17 | 0.30 | 0.12 | 0.85 | | 0.13 |
| 1970 | | 0.48 | 0.25 | 0.30 | 0.15 | 0.86 | | 0.19 |
| 1980 | 0.40 | 0.52 | | 0.41 | 0.11 | 0.81 | | 0.27 |
| 1990 | 0.62 | 0.47 | 0.36 | 0.42 | | 0.90 | | 0.40 |
| 2000 | 0.63 | 0.49 | 0.32 | 0.39 | | 0.81 | 0.57 | 0.36 |
| 2010 | 0.71 | 0.53 | 0.37 | 0.59 | 0.54 | 0.77 | 0.53 | 0.38 |

Note: Dates are approximate. Sources: See Appendix A.2.

the past century.[22] Scholars interested in the driving forces of long-run trends in wealth and its distribution must direct their attention to the striking path of land prices in the modern era.

In addition to distributional effects, land prices may also impact economic growth directly. In a dynamic stochastic general equilibrium model of cities, Davis et al. (2014) specifically point to the role of agglomeration effects. Rising land prices induce firms to economize on land which leads to rising density of production. While agglomeration increases congestion and lowers growth, rising density also fosters total factor productivity growth through technological spillovers. The empirical analysis in Davis et al. (2014) suggests that in the U.S. case, the annual increase in the land price by 1.0 percent between 1978 and 2009 has increased the growth rate of per capita consumption by about 10 percent. Recent research by Liu et al. (2013) further demonstrates real effects of land price changes at the business cycle frequency.

## 2.6 Conclusion

In *The Wizard of Oz*, Dorothy's house is transported by a tornado to a strange new plot of land. The story neatly depicts the fact that a home consists of both the physical structure of the house and the underlying plot of land. A core insight of our study is that the price of land has played the central role for long-run trends in house prices. After a long period of stagnation from 1870 to the mid-20th century, real house prices rose strongly during the second half of the 20th century. The

[22] The importance of land prices for wealth brings Ricardo's famous principle of scarcity to mind. Ricardo (1817) reasoned that economic growth disproportionately benefits the owners of the fixed factor land. Writing in the 19th century, Ricardo was mainly concerned that population growth would push up the price of corn so that the land rent and the land price would continuously increase. In the 21st century, we may be more concerned with the price of residential land, but the underlying mechanism remains the same.

decomposition of house prices into the replacement cost of the structure and land prices revealed that rising land prices have been the driving force for the observed trends. Explanations for the long-run trajectory of house prices must be mapped onto the underlying land price dynamics and the comparatively minor role of changes in the replacement value of the structure.

Research interest in housing markets has surged in the wake of the global financial crisis. Despite its importance for macroeconomics, the study of housing market dynamics has been hampered by the lack of comparable long-run and cross-country data from economic history. We expect that the data presented in this study will open new avenues for empirical and theoretical research on housing market dynamics and their interactions with the macroeconomy.

Chapter 3

# As Volatile As Houses: Return Predictability in International Housing Markets, 1870–2015

## 3.1 Introduction

When, as the story goes, Isaac Newton in the 1600s famously noted that "what goes up, must come down," he was talking about apples. In recent years, this phrase has almost as often been invoked to describe house price dynamics as to illustrate the law of gravity. The great housing downturn following the financial crisis of 2007/2008 proved wrong the old myth that house prices always go up. While real estate had for a long time been perceived as a safer investment than stocks or bonds, today most people would probably agree that houses are no different from other assets in their ability to rapidly increase in value and then crash. In principle, this has long been known. Narratives about booms and busts in real estate prices are remarkably frequent in the economic history of advanced economies. But how can we understand such large swings in house prices? Do house prices mainly respond to information about changes in fundamental values? Or do they also respond to other, non-fundamental, factors? In other words: Are house prices *excessively* volatile?

I offer an empirical answer to this question by investigating the predictive power of the rent-price ratio for future housing returns and rent growth. In essence, fluctuations in asset prices can occur either due to changing expectations of future returns or changing expectations of fundamentals. To capture changes in fundamentals, economists often focus on variables that might shift supply and demand, such as household income, amenities, or regulation of residential building (Glaeser et al., 2008; Glaeser and Gyourko, 2006; Himmelberg et al., 2005). I borrow from the finance literature to take a different approach. The finance paradigm holds that any asset's fundamental value equals the present value of its future cash flows. A house does not provide a cash flow directly but rather a service flow that can be derived either by living in it or by renting it out. The value of this service flow may thus be approximated by the rental value of the house. In this simple setting, the question about excess volatility translates into asking whether valuation ratios such as the rent-price ratio can predict returns.[1] To test this, I combine data on house prices and rents from the late 19th century to 2015 for 16 countries and estimate the joint dynamics of housing returns, rent growth rates, and the rent-price ratio in a restricted vector-autoregressive framework based on the dynamic Gordon growth model (Campbell and Shiller, 1988).

Return predictability is one of the most-researched and controversially debated empirical questions in financial economics. Since the 1980s, the literature has mainly focused on this issue in the context of stock markets. An extensive body of empirical contributions starting with Shiller (1981) and LeRoy and Porter (1981) document that stock prices are excessively volatile and subsequent research confirms that returns are at least partially predictable (Golez and Koudijs, 2014; Cochrane, 2008; Fama and French, 1988; Campbell and Shiller, 1988). Numerous studies suggest that return predictability is also a phenomenon in other asset markets such as treasuries and bonds (Cochrane, 2011). From an economic perspective, understanding the dynamics of housing values is clearly no less important

[1] This approach rests on the assumption that the rent-price ratio is the only conditioning variable, i.e. that it summarizes all other relevant economic factors.

than understanding the pricing dynamics of other assets. In the U.S., the total value of real estate at the end of 2016 amounted to about $39 trillion, of which two thirds was in residential dwellings. By comparison, the capitalization of the U.S. stock market amounted to a little less than $24 trillion.[2] Homeownership rates exceed participation rates in stock markets by a substantial margin across many countries in the Western world (Badarinza et al., 2016) and in most of these countries housing wealth accounts for more than half of total households' assets. But, so far, research on return predictability in housing markets has been complicated by a lack of data. In fact, with few exceptions, existing studies mainly focus on relatively recent U.S. data and produce mixed evidence (Engsted and Pedersen, 2015; Ambrose et al., 2013; Ghysels et al., 2013; Plazzi et al., 2010; Campbell et al., 2009; Gallin, 2008).[3] This raises two key issues. First, how representative are these findings for housing markets in advanced economies in general? And second, is return predictability in housing markets only an occasional phenomenon or is it also historically a pervasive feature?

To conduct a comprehensive international study of return predictability in housing markets, I take advantage of the historical house price dataset compiled in Chapter 2 of this dissertation and construct long-run rent-price ratios and new estimates for total housing returns using a novel dataset covering housing rents. Taken together, the data span 140 years of modern economic history across 16 advanced economies.

I have divided my discussion into three major parts. The next section introduces the two historical datasets and assesses how long-run trends in rents compare to the long-run trajectory of house prices. This preliminary inspection shows that house prices have deviated from rents for extended periods of time, but does not *per se* provide direct evidence for excess volatility of house prices. Another key observation is that the relationship between house prices and rents has changed over the past century and a half. Rents and prices generally moved together prior to World War 2 but house price growth in advanced economies outpaced rent growth by a substantial margin in the second half of the 20th century. As a result, rent-price ratios strongly decreased during the past few decades.

In Section 3.3, I use a definition of turning points typically applied in the business cycle literature to document a rich set of empirical regularities of house price cycles. House price cycles tend to be intense and protracted. At the same time house prices dynamics have changed over the past century and a half. Expansions

[2]Data drawn from the Flow of Funds Accounts and the World Bank.

[3]The results vary with methodology, time period covered and the level of aggregation. For the U.S., Case and Shiller (1990, 1989), find evidence of predictability in excess returns. Ghysels et al. (2013), Plazzi et al. (2010), and Gallin (2008) also provide evidence that real estate returns are at least partially predictable. Campbell et al. (2009) show that the rent-price ratio explains a larger fraction of the variability of expected returns than of expected rent growth. Engsted and Pedersen (2015) find return predictability in housing markets using data for 18 OECD countries since the 1970s. Ambrose et al. (2013) find persistent and substantial deviations of market prices away from market fundamental values relying on Dutch data for 355 years and show that market correction of the mispricing occurs mainly through prices, not rents. By contrast, again focusing on the U.S., findings by Clark (1995), and Meese and Wallace (1994) suggest that prices appear to have significant links to expected future movements in housing rents.

are longer and more pronounced today than they were a 100 years ago. Recent contractions are briefer and less extreme than their historical counterparts. The discussion also provides another piece of evidence that house price fluctuations net of fundamentals are sizable. Although changes in rents are correlated with changes in house prices, rents do not grow on par with house prices over the house price cycle.

Sections 3.4 and 3.5 offer a more formal analysis of the question whether house prices are excessively volatile. Specifically, I study return predictability both across the full country sample as well as on a country-by-country basis. The analysis reveals that housing returns have been predictable since the time my records start. For the entire period covering 140 years, the predictive coefficient on the rent-price ratio is positive and highly significant for all countries in the sample. The results provide strong evidence that excess volatility is a main characteristic of housing markets and accord with the standard notion of time-varying expected returns and risk-premia. In this way, the housing market appears to be remarkably similar to stock and bond markets. Rent growth rates have also been predictable. But while the rent-price ratio in most countries significantly predicts rent growth rates in the pre-World War 2 period, the evidence for the second half of the 20th century is more mixed. The final section concludes and outlines avenues for future research.

## 3.2 The data: 140 years of housing rents

This study relies on two long-run datasets. The first is an updated version of the house price database assembled and documented by Knoll et al. (2017) in the form of an annual panel of 16 countries since the late 19th century. The dataset now extends to the year 2015 and also covers Italy, Spain and Portugal. The second assembles newly unearthed data on housing rents.

To the best of my knowledge, this is the first systematic attempt to construct long-run rent series for advanced economies on a consistent basis from historical materials.[4] The combined dataset covers 16 advanced economies over the years 1870–2015 at annual frequency. Table 3.1 gives an overview of the period coverage of house prices and rents.[5] This section describes the data sources, the challenges involved in constructing long-run rent indices and discusses the long-run evolution of rents and rent-price ratios.

### 3.2.1 Rent indices

Where do the rent data come from? The construction of the dataset was in large part an investigative and assembly operation. All of the series already existed, but most of the historical series had not been used in the past decades, and some

[4]One exception is a recent paper by Korevaar et al. (2016). The authors study 500 years of housing rents in seven cities in four different European countries.

[5]All auxiliary macroeconomic and financial variables come from Jordà et al. (2016b). For a detailed discussion and description of the datasets, see the authors' appendices.

**Table 3.1:** Data coverage.

| Country | House Prices | Rents |
|---|---|---|
| Australia | 1870–2015 | 1901–2015 |
| Belgium | 1878–2015 | 1890–2015 |
| Switzerland | 1901–2015 | 1890–2015 |
| Germany | 1870–2015 | 1870–2015 |
| Denmark | 1875–2015 | 1870–2015 |
| Spain | 1900–2015 | 1870–2015 |
| Finland | 1905–2015 | 1920–2015 |
| France | 1870–2015 | 1870–2015 |
| UK | 1899–2015 | 1874–2015 |
| Italy | 1927–2015 | 1927–2015 |
| Japan | 1913–2015 | 1931–2015 |
| Netherlands | 1870–2015 | 1870–2015 |
| Norway | 1870–2015 | 1871–2015 |
| Portugal | 1931–2015 | 1948–2015 |
| Sweden | 1875–2015 | 1883–2015 |
| USA | 1890–2015 | 1890–2015 |

were unpublished. I consulted a broad range of sources including publications of national statistical offices and central banks, publications of the International Labor Organization, economic and financial history books and journal articles. For most countries, I relied on the rent components of the cost of living or consumer price index as constructed by national statistical offices and combined them with information from other sources to create long-run series reaching back to the late 19th century.

I am confident that the indices give a reliable picture of rent developments in the 16 housing markets covered in this study. Constructing long-run rent series required pragmatic choices between the ideal and the available data. Typically, I had to link multiple index series and the historical rent data vary across countries and time with respect to their coverage and the method used for index construction. The resulting challenges involved fall into two broad categories. The first concerns the construction and coverage of the rent index. The second key challenge relates to the matching of rent and house price indices. To mitigate these issues, I chose indices that control for quality changes where available, that best concurred with the respective house price series, and opted for within-country consistency as well as historical plausibility.

Let me first discuss the main issues that need to be considered when constructing consistent long-run rent indices in more detail. There are three. Most importantly, an ideal rent index captures the increase in the cost of the service a standard, unchanged dwelling provides. Yet, dwellings are heterogeneous assets with changing characteristics over time. Rent contracts are typically long-term contracts making it difficult to observe changes in the actual market rent over time. These specifics are similar to those involved when constructing house price indices and the same standard approaches can be applied to adjust for quality and composition changes.[6] In Appendix B.2.1, I discuss different approaches to construct rent indices in greater detail. On the downside, most rent series available only partially adjust for changes in the composition or increases in the quality of dwellings. As a rule of thumb, while the pre-World War 2 indices are generally based on average rents, the indices for the post-World War 2 period are constructed using somewhat more refined statistical techniques. On the upside, rental units are considered to be less heterogeneous in size at any given time, more homogeneous over time, and experience quality improvements along fewer dimensions than, say, owner-occupied housing units (Gordon and van Goethem, 2007).

The second and third issue relate to the segments of the housing market covered. Apart from market rents of tenant-occupied dwellings, current rent indices typically also reflect changes in the cost of shelter for homeowners. The cost for owner-occupied shelter is an estimate of the *implicit rent* homeowners would have to pay if they were renting their dwellings. Estimating implicit rents of owner-occupiers is a challenging task. Most statistical offices calculate an owner-occupied units' potential rent by matching it with a tenant-occupied unit of similar size, quality and location. Nevertheless, these estimates may be flawed if rent controls and subsidized rents are dominant and/or if rental and owner-occupied housing markets are highly segmented. Moreover, statistical offices began to include data on implicit rents of homeowners in the CPI rent series only in second half of the 20th century.[7] The long-run indices therefore broaden out over time to cover also owner-occupied housing. Unfortunately, there is very little information on long-run trends in implicit rents of homeowners limiting my ability to quantify the effects of this compositional change with greater precision.[8]

Rental markets in all advanced economies have historically been subject to substantial regulations and rent indices typically cover also some regulated tenancies. A well-known example are the rent freezes and controls introduced during the years of the two world wars. While controls were mostly repealed within a couple of years after the end of World War 1, rent regulations became a long-lasting feature of housing markets after World War 2. Appendix Table B.7 briefly summarizes the most important rent control laws. While the effect of rent freezes on the index is straightforward, the effect of more nuanced regulations is less transparent. Due to paucity of data, it is unfortunately not possible to precisely assess the effect of rent regulation on the rent series. Most studies measuring formal regulations provide only a snapshot of cross-country differences at a specific point in time or track the change in regulations for rather short periods.[9] In most general terms, rent regulations will reduce short-term volatility in the rent series.

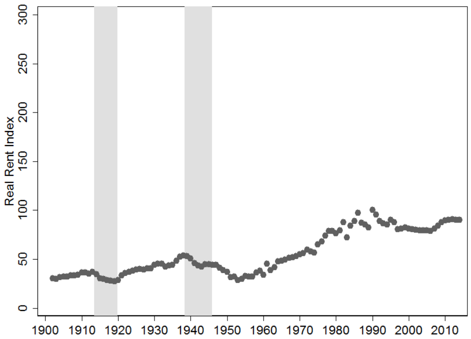
[6] For a brief methodological overview on house price indices, see Appendix A.1.1 to Chapter 2.

[7] In the U.S. case, the costs of owner-occupied housing was instituted in the 1953 CPI revision (Crone and Nakamura, 2006). In Belgium, house rents were added to the CPI basket only in 1983 and do not include implicit rents of owner-occupiers as of today. Also the CPI rent components of France, Italy, Portugal, and Spain, and Switzerland do not cover owner-occupied housing.

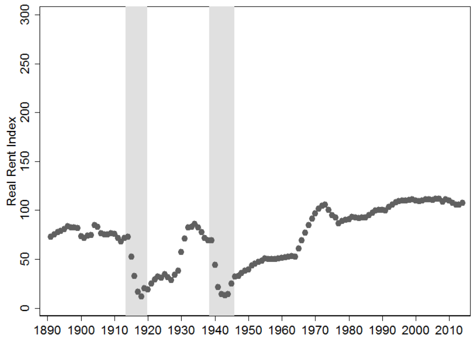
[8] As an indicative test, I can compare trends in country indices which cover owner-occupied housing with country indices reflecting tenants' rents only. The right panel of Appendix Figure B.2 shows that the overall trajectories since 1950 look similar.

[9] The only exception is Kholodilin (2015) who quantifies the strength of rental regulations in Germany between 1913–2015.

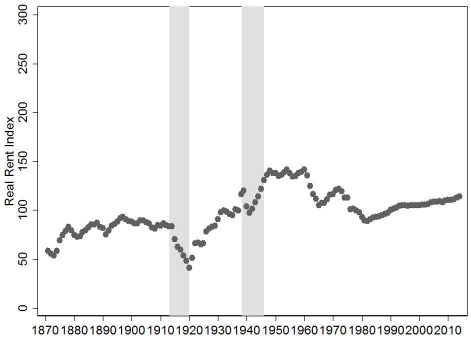
**Figure 3.1:** Historical rents, 16 countries.



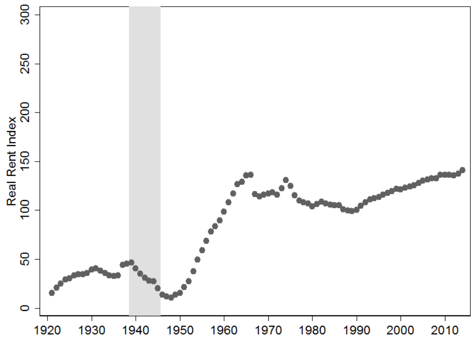

**(a)** Australia, 1901–2015



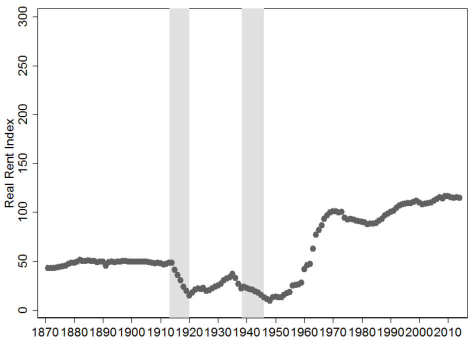

**(b)** Belgium, 1890–2015



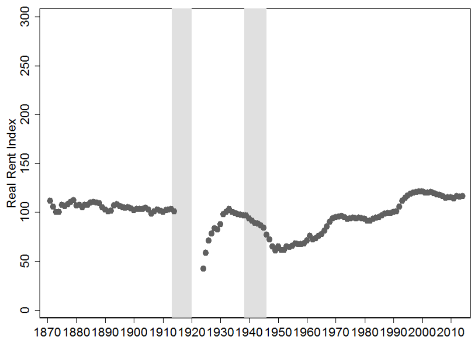

**(c)** Denmark, 1870–2015



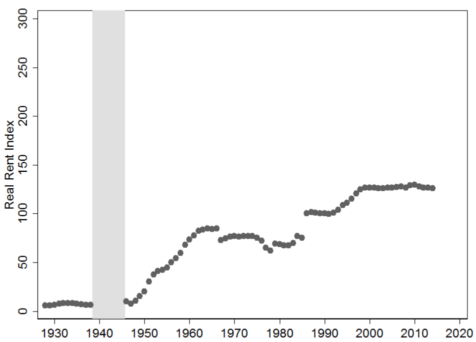

**(d)** Finland, 1920–2015



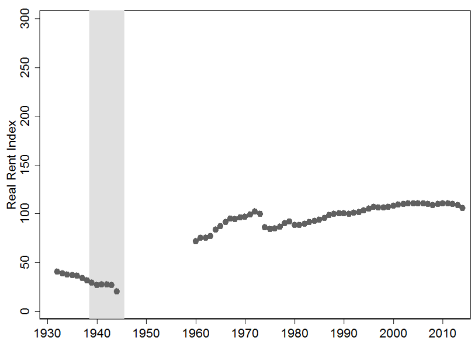

**(e)** France, 1870–2015



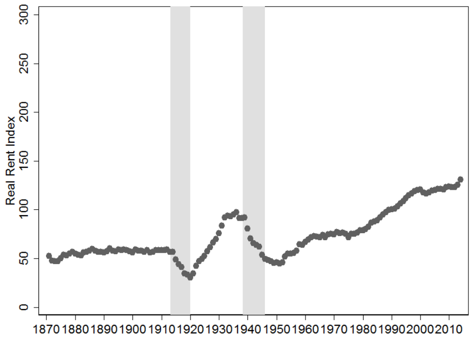

**(f)** Germany, 1870–2015



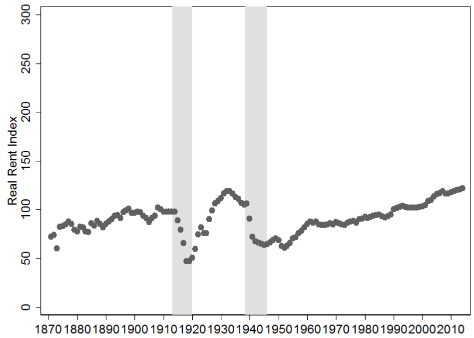

**(g)** Italy, 1927–2015



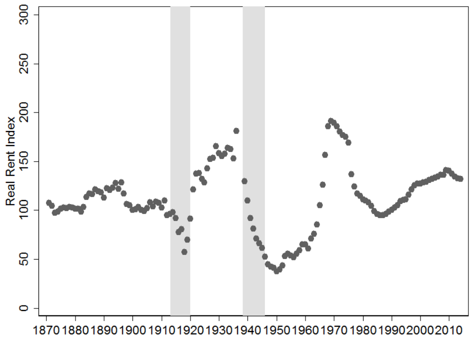

**(h)** Japan, 1927–2015



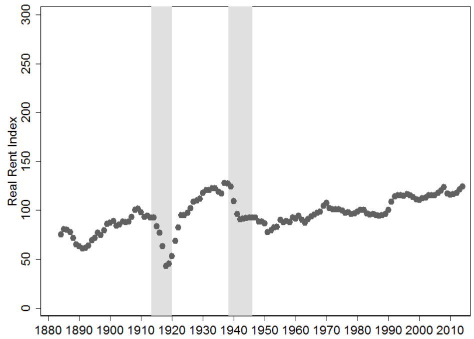

**(i)** The Netherlands, 1870–2015



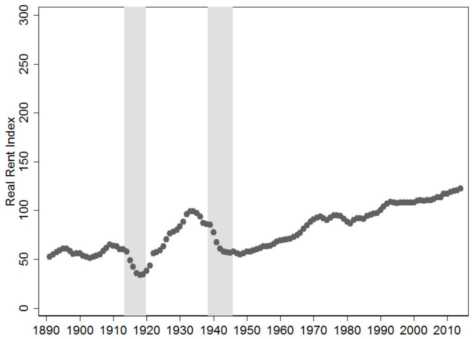

**(j)** Norway, 1870–2015



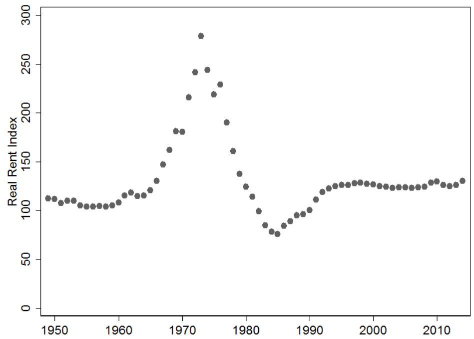

**(k)** Spain, 1870–2015



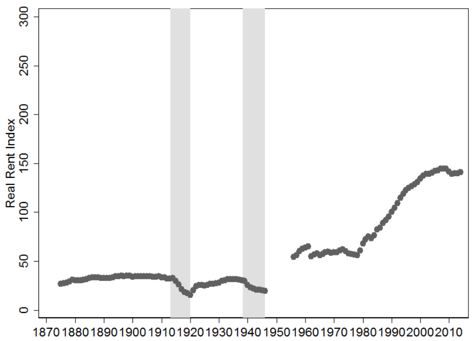

**(l)** Sweden, 1883–2015



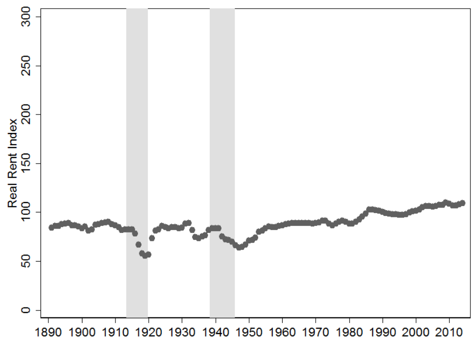

**(m)** Switzerland, 1890–2015




**(n)** Portugal, 1948–2015




**(o)** United States, 1874–2015




**(p)** United States, 1890–2015

*Note*: Index, 1990=100.

It is important to note that the introduction of these regulations may also result in a temporary mis-measurement of rent growth rates. In the majority of cases, rent regulations are only directed to a certain part of the housing market and the extent to which this segment is included in the index is often hard to gauge. Intuitively, if relatively more regulated tenancies were recorded after the introduction of rent regulation, the rent index will temporarily underestimate rent growth rates. For instance, Stapledon (2007) shows that the rent index constructed by the Australian Bureau of Statistics suffers from a downward bias in the immediate post-World War 2 decades. Corroborating the plausibility of the rent data is therefore an important task when constructing long-run indices. As an indicative test, I went back to the historical national wealth and income data to construct rent-price ratios for each country for benchmark years as comparative to a rent-price ratio derived from using the rent-price ratio in a baseline year and combining the rent and price series (see also Section 3.4.1). Additionally, I consulted a broad range of historical sources to obtain independent estimates of rent-price ratios. In most cases, the differences were small. For three countries, the additional estimates suggest that the rent index in the immediate post-World War 2 period is subject to a downward bias. In these cases, I adjust the rent series so that the rent-price ratio corresponds to the independently-obtained estimates.[10]

Also with regard to the matching of rent and house price indices a number of clarifications are necessary. The ideal rent index to accompany a house price index would be based on data for the exact same dwelling as the house price index. The two most important characteristics to match rent and house price indices are therefore i) the type of houses and ii) the geographical area covered by the indices. On the downside, while the historical house price data mostly reflect prices of all kinds of residential dwellings (i.e. new and existing single- and multifamily houses), the historical rent data mostly refer to rents of multifamily dwellings. Relatedly, house price indices generally cover prices of both owner-occupied and tenant-occupied housing. By contrast, as noted above, all rent indices in the pre-World War 2 period and some post-World War 2 series exclusively reflect tenant's rents. Excluding owner-occupied implicit rents when rental and owner-occupied housing markets are segmented may result in an imperfect matching of the rent and house price series. I therefore need to assume that changes in rents of different types of houses are strongly correlated. Matching the house price and rent series in terms of geographical coverage has been – in most cases – possible.

The paper comes with an extensive data appendix that specifies the sources I consulted and discusses the construction of the individual country indices in greater detail. Figure 3.1 plots the historical rent series country by country.

[10]The three countries for which I adjust the long-run rent index are Australia, Finland, and Spain. While long-run rent data for Canada are available from various sources, combining the rent series with the house price series presented in Chapter 2 implausibly high rent-price ratios prior to the 1970s and, to the best of my knowledge, no independent estimates of rent-price ratios for the pre-1970 period are available. I therefore omit data for Canada in this chapter.

### 3.2.2 Long-run trends in rents and the rent-price ratio

The left panel of Figure 3.2 presents the arithmetic mean of the 16 rent series along with an arithmetic mean house price index for the same 16 countries. Both series are adjusted by the consumer price index. The visual impression is striking. The two indices follow each other closely over time, but only until the mid-1970s. Both, real rents and house prices stayed within a relatively tight range until the mid-20th century while experiencing large swings in the interwar period and during the two world wars. After World War 2, rents and house prices embark on a steep incline. But since the 1970s, rent growth has leveled off and remained broadly stable thereafter. The pronounced boom in house prices that preceded the global financial crisis of 2007/2008 is almost absent in rents. This specific path of global rents is robust to different weightings and across regional subsamples and a constant-coverage sample (see Appendix Figures B.1 and B.2).

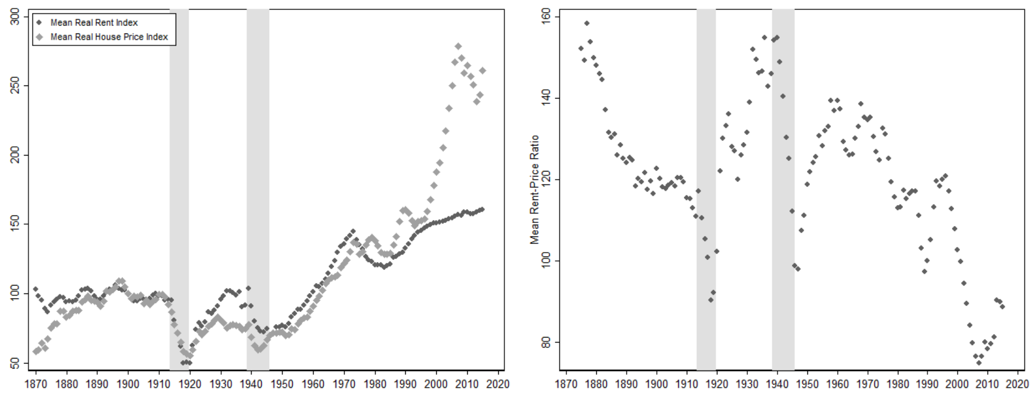
Table B.1 in the appendix puts numbers on these phenomena. It shows average annual growth rates of rents for all countries and for two sub-periods. Rent growth was about 1.9 percent in nominal terms and 1.7 percent in real terms before World War 2. This is even a little higher than the average annual nominal growth rate of house prices of 1.6 percent. After World War 2, the average annual growth rate climbed to 5.4 percent and to 1.3 percent adjusted for inflation. This compares to house price growth of nearly 7 percent in nominal terms and a little more than two percent in real terms. As a result of this divergence, over a period of more than 140 years, real rents have increased by a factor of 1.5 while real house prices have increased by a factor of 4.5. Virtually the entire difference can be accounted for by the rapid rise in house prices in the second half of the 20th century.

Clearly, there is considerable heterogeneity in cross-country trends (see Appendix Table B.1). In the long-run, real rent growth has been a little less than 1 percent in Denmark, Japan, Portugal, and the U.S but about 2 percent on average in Belgium and France. Australian and German rents have increased at an annual rate of a about 1 percent. The Netherlands, Norway, Sweden, Spain and the U.K. have seen somewhat higher rent growth of about 1.5 percent.

The right panel of Figure 3.2 combines the house price and the rent series into an average rent-price ratio. When house prices are high relative to rents, the rent-price ratio is low and vice versa. Two points are noteworthy. As we would have expected from the long-run trajectories of the individual series, the rent-price ratio shows no clear trend between the late 19th century and the 1970s. In the long-run, the series appears stationary. But in the last decades of the 20th century, the rent-price ratio has become increasingly persistent reaching a historic low in the mid-2000s. Figure 3.2 also illustrates that the magnitude of the fall in the rent-price ratio preceding the financial crisis of 2007/2008, i.e. the appreciation of house prices relative to rents, has been unprecedented. On average, between the mid-1990s and the mid-2000s rent-price ratios decreased by nearly 40 percent.

The second important observation is that the average rent-price ratio fluctuated substantially during the past century. Prices significantly deviated from rents for extended periods of time. Moreover, Table B.1 in the Appendix demonstrates

**Figure 3.2:** Aggregate trends.




*Notes:* Left panel: index, 1900=100, right panel: index, 1990=100.

that rents have been significantly less volatile than house prices. On average, the standard deviation of house price growth is nearly twice as large as the standard deviation of rent growth. Put together, this first cut of the data suggests that house price fluctuations may be difficult to explain by changes in fundamentals alone. In many cases, the movements in the house price index seem too big to be attributed to movements in rents. But does that also imply that house prices are *excessively* volatile? Before analyzing this question more formally, the next section examines some key characteristics of house price fluctuations since the late 19th century.

## 3.3 The house price cycle in historical context

### 3.3.1 Identifying house price cycles

The natural way to think about a house price cycle – or just any business or financial cycle for that matter – is as a sequence of turning points. To implement this definition, I use the classical cycle dating approach proposed by Burns and Mitchell (1946) relying on the Bry and Broschan (1971) algorithm to detect local maxima (*peaks*) and minima (*troughs*) in the annual house price data. *Expansions* denote phases from trough to peak (trough excluded); *contractions* denote phases from peak to trough (peak excluded). As this characterization does not depend on any trend modeling, it is well suited to consistently date house price cycles using long-run data and across a large country sample. It also mirrors the definition of peaks and troughs in economic activity issued by business cycle committees, such as the NBER's, and has been used to date house price cycles in a string of papers by Bordo and Landon-Lane (2013); Bracke (2013); Igan and Lougani (2012); Claessens et al. (2012, 2011) and Girouard et al. (2006), among others.[11]

[11]There is no single standard cycle dating methodology. Another commonly applied way of analyzing cyclical behavior is to focus on deviations from a permanent trend component. Widely used tools to filter out these deviation cycles are the Hodrick-Prescott filter or a band pass-filter such as proposed by Baxter and King (1999) and Christiano and Fitzgerald (2003). While the idea of a

In addition to this straightforward identification of local maxima and minima, the Bry and Broschan (1971) algorithm requires peaks and troughs to alternate, constrains phases and requires completed cycles (expansion and contraction) to have a certain minimum duration to avoid spurious cycles. Drehmann et al. (2012) argue that house price cycles are longer than business cycles and hence tend to be best defined focusing on the medium term. I therefore select pairs of adjacent, local absolute maxima and minima requiring a minimal duration for cycles (peak-to-peak) of four years and a minimal duration of phases (trough-to-peak and peak-to-trough) of two years. Appendix Figure B.3 shows the resulting chronology of peaks and troughs. Reassuringly, this approach yields remarkably similar results as studies that use higher frequency data (Bracke, 2013; Agnello and Schuknecht, 2011; Girouard et al., 2006).

### 3.3.2 Expansions, contractions, and comovement

The top panel of Table 3.2 offers a bird's eye view on the universe of more than 100 house price cycles, 113 expansions and 120 contractions in advanced economies since 1870. I explore three main properties of house price expansions and contractions: (1) duration (in years), (2) violence, measured as the average rate of change per year (in percent) and (3) amplitude, i.e. the absolute log level difference between trough (peak) and peak (trough) levels (in percent). The statistics are reported as average for the full sample, and for pre- and post-World War 2 subsamples.

House price cycles tend to be long, much longer than business or credit cycles (Jordà et al., 2016b). Over the past century and a half, the average house price cycle lasted for a little less than 16 years. On average, expansions lasted for nearly ten years whereas contractions persisted for only 6.6 years. House price cycles also tend to be intense. During the average expansion, house prices increased by more than one third. Contractions are a not as extreme with prices falling by about 26 percent. This difference in (absolute) amplitude may, at least to some extent, be accounted for by the difference in duration. Absolute growth rates are nearly identical for expansions (about 5.6 percent p.a.) and contractions (5.4 percent p.a.). Hence, on average, the longer the duration of a phase is, the larger its amplitude (see also Appendix Figure B.4). Overall, over the past 140 years, house price expansions were longer and larger than contractions but not more violent.[12]

Notable differences exist between the first and the second half of the 20th century. House price expansions were about three years longer after World War 2 than in the late 19th and early 20th century. The elongation of house price expansions coincided with a slight increase in growth rates during these episodes, from 5.4 to about 5.7 percent per annum, and a decline in volatility. Consequently,

deviation cycle appears straightforward at first, the dating and thus any stylized facts derived from the data may differ according to the filter technique applied (Canova, 1998). More eclectic methods such as wavelet filtering allow for the analysis of time series across the full frequency spectrum (see for example Schularick and Ward (2014) for an application to credit cycles).

[12]These findings are generally in line with previous studies analyzing house price cycles since the 1970s such as Drehmann et al. (2012), Claessens et al. (2011), and Bracke (2013).

their amplitude was substantially more pronounced in the second half of the 20th century. The average price increase during expansions rose from about 30 percent prior to World War 2 to more than 40 percent post-World War 2. The opposite phenomenon is true for contractions. They tended to be somewhat briefer and less pronounced after World War 2 than during the pre-World War 2 decades. Similar to expansions, growth rates during contractions slightly increased, from -5.8 to about -5.1 percent per annum while volatility declines. Table 3.2 also shows that expansions lasted nearly twice as long and their absolute amplitude was nearly twice as large compared to contractions after World War 2. Prior to World War 2, the duration of phases was about the same, as was their absolute amplitude. These results conform with the main trends documented in Chapter 2 of this dissertation as they imply a stronger upward trend in house prices during the second half of the 20th century when compared to the pre-World War 2 decades. They also complement our understanding of these long-run trends as they suggest that not only house price trajectories have changed over time but also house price dynamics have.

Real rents and real house prices are positively contemporaneously correlated.[13] Historically, rents rose during expansions and fell during contractions. But as we would have expected from Figure 3.2, Table 3.2 shows that rents did not grow on par with house prices. During expansions, rents increased by about 2.5 percent p.a., about 3 percentage points less than prices. For contractions, this difference is even more stark: Rent growth rates were nearly 5 percentage points higher than growth rates of prices. A comparison of the pre- and post-World War 2 period shows that this is true for both subsamples. Yet the percentage point difference between growth rates was much smaller in the late 19th and early 20th century than after World War 2. These statistics provide an additional piece of evidence that house price fluctuations may not be explained by changes in fundamentals alone. And this appears to be particularly true for the second half of the 20th century. Or, put differently, fluctuations in house prices net of fundamentals were sizeable.

The global pattern of house price dynamics masks considerable heterogeneity in the amplitude and duration of cycles across the individual housing markets. The bottom panel of Table 3.2 summarizes the main characteristics of house price cycles country by country. Expansions have been particularly pronounced in the U.K. while Finland has experienced the most severe contractions. Since the time the records start, cycles tended to be comparably long in France and Germany and relatively short in Australia and Belgium. While part of the heterogeneity in the amplitude of expansions and contractions may be accounted for by differences in the length of the episodes (see also Appendix Figure B.4), Table 3.2 also shows that house prices increased (decreased) at significantly different rates during expansions (recessions) across countries. Exploring the causes of these differences is an important object for future research but is beyond the scope of this study.

What can we say about the timing of cycles across the individual markets? In other words, how synchronized are house price cycles *across* countries? The upper

[13] Correlation coefficient of 0.58.

**Table 3.2:** House price cycles, 1870–2015.

| | Period | Number of episodes | | | Duration (years) | | | Rate (% p.a.) | | Amplitude (%) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | coverage | Cycle | Expansion | Contraction | Cycle | Expansion | Contraction | Expansion | Contraction | Expansion | Contraction |
| | | | | | *All countries* | | | | | | |
| *Full sample* | | | | | | | | | | | |
| House prices | | 104 | 110 | 118 | 15.8 | 9.9 | 6.6 | 5.59 | -5.42 | 36.53 | -26.45 |
| | | | | | (7.7) | (6.2) | (3.7) | (3.04) | (4.14) | (18.89) | (17.39) |
| Rents | | | | | | | | 2.46 | -0.54 | 15.27 | -2.76 |
| *Pre-WW2* | | | | | | | | | | | |
| House prices | | 60 | 57 | 58 | 16.0 | 7.8 | 7.0 | 5.43 | -5.81 | 29.11 | -30.09 |
| | | | | | (8.4) | (4.3) | (3.8) | (3.61) | (4.52) | (14.25) | (19.89) |
| Rents | | | | | | | | 3.55 | -2.07 | 17.76 | -12.48 |
| *Post-WW2* | | | | | | | | | | | |
| House prices | | 44 | 53 | 60 | 15.5 | 11.7 | 6.3 | 5.72 | -5.12 | 42.73 | -23.52 |
| | | | | | (6.8) | (6.9) | (3.7) | (2.49) | (3.82) | (20.15) | (14.63) |
| Rents | | | | | | | | 1.64 | 0.69 | 13.39 | 5.05 |
| | | | | | *By country* | | | | | | |
| Australia | 1870–2015 | 9 | 9 | 10 | 13.1 | 10.3 | 5.4 | 4.26 | -3.95 | 33.81 | -17.64 |
| Belgium | 1878–2015 | 9 | 8 | 9 | 13.9 | 10.3 | 5.4 | 5.60 | -5.77 | 36.94 | -25.37 |
| Denmark | 1875–2015 | 8 | 8 | 9 | 16.1 | 10.4 | 6.4 | 4.88 | -5.02 | 34.01 | -24.92 |
| Finland | 1905–2015 | 5 | 5 | 6 | 17.5 | 17.7 | 7.0 | 6.34 | -15.10 | 62.14 | -60.65 |
| France | 1870–2015 | 7 | 8 | 7 | 19.2 | 12.1 | 6.2 | 5.45 | -3.87 | 38.36 | -21.45 |
| Germany | 1870–2015 | 5 | 6 | 6 | 19.8 | 9.2 | 6.2 | 2.79 | -5.39 | 26.62 | -21.39 |
| Italy | 1927–2015 | 5 | 5 | 6 | 15.8 | 6.0 | 7.2 | 7.76 | -3.62 | 33.51 | -21.82 |
| Japan | 1913–2015 | 4 | 4 | 5 | 16.5 | 8.0 | 13.3 | 12.51 | -4.60 | 37.94 | -33.78 |
| Netherlands | 1870–2015 | 7 | 7 | 8 | 17.2 | 12.2 | 5.7 | 5.14 | -6.87 | 43.05 | -31.02 |
| Norway | 1870–2015 | 7 | 7 | 8 | 15.0 | 13.7 | 6.0 | 4.41 | -5.03 | 43.03 | -25.48 |
| Portugal | 1931–2015 | 4 | 5 | 5 | 15.7 | 8.0 | 7.5 | 8.04 | -8.23 | 42.06 | -36.28 |
| Spain | 1900–2015 | 7 | 7 | 8 | 16.2 | 8.5 | 7.0 | 7.49 | -4.28 | 42.73 | -24.80 |
| Sweden | 1875–2015 | 7 | 9 | 8 | 14.9 | 10.1 | 6.3 | 4.90 | -5.98 | 35.86 | -29.08 |
| Switzerland | 1901–2015 | 6 | 8 | 7 | 13.0 | 8.6 | 5.1 | 4.11 | -5.70 | 26.06 | -24.34 |
| United Kingdom | 1899–2015 | 6 | 5 | 7 | 17.8 | 10.2 | 7.9 | 7.73 | -5.05 | 48.67 | -31.03 |
| United States | 1890–2015 | 8 | 9 | 9 | 14.4 | 5.6 | 7.5 | 4.76 | -2.81 | 19.96 | -16.20 |

*Note:* Cycles are defined based on turning points in real house prices. Standard deviations in parentheses. *Duration* refers to the number of years that each phase between turning points last. *Rate* refers to the annual rate of change between turning points, calculated as the overall change during a cyclical phase divided by its duration and expressed in percent change per year. *Amplitude* refers to the absolute log level difference between turning points in percent. Amplitude and rate based on CPI-adjusted data.

panel of Table 3.3 examines the comovement of real house prices across the 16 countries in the sample over the past 140 years. In addition to statistics for the full sample, I also present results for pre- and post-World War 2 subsamples. I refer to synchronization as the degree to which house price comove contemporaneously. Specifically, I measure synchronization using the *concordance index* (Harding and Pagan, 2006). A concordance index of 1 signals perfect alignment of cycles between two countries while a concordance index of 0 signals perfect disalignment. [14]

Table 3.3 shows that house price cycles across countries have been aligned on average about 57 percent of the time. Historically, if house prices in one country were rising, it was almost a coin toss whether other countries experienced a house price expansion or contraction. Such a relatively low level of comovement is certainly unsurprising. Housing markets are much less integrated across borders than, e.g., credit and equity markets. Cross-border trading of real estate is more difficult than trading of other assets such as stocks. Real estate is not portable and services from its ownership are considered to be non-tradable. Comovements of house prices across countries have therefore been interpreted as reflecting business cycle linkages, synchronization of interest rate movements and financial deregulation rather than direct real estate market linkages (Otrok and Terrones, 2005; Case et al., 2000).

At the same time, there is largely consensus in the literature that globalization and financial innovation strengthened the degree of synchronization in both macroeconomic and financial cycles across countries (Hirata et al., 2013). This notion seems to be in line with recent experiences. Prior to the financial crisis of 2007/2008, house prices strongly increased in most advanced economies and subsequently collapsed across the board. But surprisingly, the degree of house price cycle synchronization appears roughly similar before and after World War 2. The concordance index only slightly rises from 0.55 in the first half of the 20th century to 0.57 post-World War 2. After 1985, the index reaches 0.59.[15] In other words, while synchronization has strengthened somewhat in recent years, the evidence suggests that it is not significantly higher than the historical long-run average.

How strong is the interaction between house prices, output, and credit *within* countries? Do house price cycles generally align with credit and business cycles? The lower panel of Table 3.3 shows the mean concordance index between house price and business cycles and between house price and credit cycles.[16] During

[14] The Harding and Pagan (2006) concordance statistic $CI$ determines the number of periods for which country $i$ and country $j$ are in the same phase, i.e. expansions or contractions, and averages out over $T$ periods. The index is hence calculcated as

$$CI_{i,j} = \frac{1}{T}\sum_{t=1}^{T}\left[E_t^i E_t^j + C_t^i C_t^j\right] \tag{3.1}$$

$E$ and $C$ are binary variables taking the value 1 of a country is in an expansion (E) or contraction (C). I calculate the concordance for each country (variable) pair and report the mean of the sample.

[15] Not reported in Table 3.3.

[16] Business cycles are defined using real GDP p.c., credit cycles are defined using data on private credit p.c., i.e. bank lending to the non-financial sector, deflated with the CPI index. I rely on measures per capita to account for the widely varying background rate of population growth both over time as well as across the 16 countries in the sample.

**Table 3.3:** Concordance.

| | Full sample | Pre-WW2 | Post-WW2 |
|---|---|---|---|
| | *Cross-country concordance* | | |
| House price cycles | 0.57 | 0.55 | 0.57 |
| | *Mean within-country concordance* | | |
| House price & business cycles | 0.54 | 0.42 | 0.61 |
| House price & credit cycles | 0.51 | 0.38 | 0.60 |

*Note:* Upper panel reports mean of concordance across countries. Lower panel reports the mean of concordance within countries.

the past 140 years, house price and business cycles aligned in about 54 percent of the time on average suggesting no strong level of synchronization. The average contemporaneous correlation between real house price growth and real GDP p.c. growth is about 0.3. Hence, while house prices and business cycles do not strongly correspond, real house prices are nevertheless (mildly) pro-cyclical, rising in expansions and falling in recessions (Pinheiro et al., 2011; Ahearne et al., 2005). A similar pattern is true for the interaction between real house prices and real credit. Again, the concordance statistic does not suggest a strong comovement but real house price growth and credit growth are positively correlated.[17] Yet, the evidence in Table 3.3 further suggests that the link between house prices and the macroeconomy has become significantly stronger over the past 140 years. Concordance statistics rise from 0.42 in the pre-World War 2 period to 0.61 in the second half of the 20th century for house price and business cycles and from 0.38 to 0.60 for house price and credit cycles. Also correlation coefficients are much higher after World War 2 in both cases.

While the synchronization of house price and business cycles appears relatively weak, recent research shows that particularly large swings in house prices, i.e. bubbles and crashes, matter for real macroeconomic outcomes (Jordà et al., 2015b; Helbling and Terrones, 2003). Determining the presence of these episodes empirically is, however, not unproblematic. So far, there exists no commonly accepted procedure to isolate bubbles from standard expansions and crashes from standard contractions.[18] To illustrate the potential macroeconomic repercussions of house price bubbles but also to shed some light on the question why house prices move as much as they do, the next section highlights some selected historical episodes.

[17] Correlation coefficient of 0.35.

[18] Two main approaches have been suggested in the literature. The first set of methods relies, broadly speaking, on the severity of the episode as measured by amplitude, growth rates, and/or costliness (Alessi and Detken, 2011; Helbling and Terrones, 2003). A second option is to focus on the extent to which house prices deviate from trend **?**Detken and Smets (2004); Borio and Lowe (2002). While both approaches are plausible, they do not necessarily result in identical dating of bubbles and crashes.

### 3.3.3 Selected historical episodes

#### The Australian real estate boom and crash of the 1880s and 1890s

A crash in 1890 marks the end of one of the most famous real estate bubbles of the 19th century. At its center was 'marvellous Melbourne,' Victoria's capital that had turned from a small city to a metropolis within less than two decades. Just before the crash, land values in central parts of the city reached levels equal to those in London. The discovery of gold in many parts of eastern Australia in the 1850s and 1860s had sown the seeds of a sustained economic boom and attracted large numbers of immigrants from Europe and North America (Davison, 1978; Cannon, 1966). Melbourne expanded in all directions along new rail and tram lines which were among the largest and most modern in the world. Thousands of acres of suburban land were subdivided, sold and re-sold. Middle class and working class families embraced the suburban lifestyle in newly built rows of cottages and terraced houses (Cannon, 1966). During the 1880s, the population of Greater Melbourne rose by more than 70 per cent.[19] The stock of dwellings in Victorian cities, towns and boroughs increased in lockstep – by over 50 per cent over the same period – as did real estate values (Simon, 2003). Between 1884 and 1889 alone, house prices surged by about 38 percent. Developers and real estate agents, the so-called 'land boomers,' had successfully established a belief that it was close to impossible to loose money investing in Victorian soil (Cannon, 1966).

Yet, a large share of this belief was financed on credit readily available from a plethora of building societies and land banks.[20] These institutions not only provided ample mortgage credit but also speculated in land on their own account.[21] When the vast amount of developed land at the urban fringe started to depress rental yields by the end of the 1880s and highly leveraged borrowers' cash flows petered out, building societies and land banks were the first institutions to experience problems. At the same time, the pace of economic growth slowed down and general confidence in the bright prospects in 'marvellous Melbourne' stalled. When mortgage defaults and bank runs lead to a number of banks going under, the boom collapsed into a severe economic depression (Ellis, 1893).[22] The six years that followed would see real prices contract by 47 percent and Melbourne would

[19] Between 1851 and 1890, population rose from 30,000 to about 485,000, i.e. on average about 7.5 percent p.a. (Stapledon, 2012b).

[20] Bank credit as share in GDP increased from about 35 percent in 1880 to more than 70 percent just before the crash. The increase in total credit, i.e. including building societies, land banks, and finance companies, can therefore be assumed to be even more pronounced. Yet, data on the exact amount of lending by these institutions are hard to obtain. The growth in their share of total assets may, however, offer some indication: between 1885 and 1892, their share of financial system assets nearly doubled, from 12 to 21 percent. After the crash, their market share contracted significantly (Fisher and Kent, 2011). Already starting in 1887, some of the more reputable banks restricted their mortgage lending activities but particularly land banks' activities supported a further rise of the market (Simon, 2003).

[21] A change in legislation in 1876 allowed building societies to buy and sell land themselves. Land banks, too, invested in real estate on their own account. The financial institutions' speculative operations further fueled the real estate boom (Simon, 2003; Fisher and Kent, 2011).

[22] According to Pope (1991), 54 deposit-taking financial institutions suspended payments between 1891 and 1893, about 60 percent of them permanently.

take decades to recover (Simon, 2003).[23]

### The Danish property boom of the 1900s

Urban areas were also at the center of a Danish property boom in the early 1900s. As Danish industrialization took off in the last decade of the 19th century, the urbanization level jumped to 41 percent in 1901,[24] and large numbers of rural laborers moved to work in town factories. Already by 1905 Greater Copenhagen, where industries concentrated, hosted more than half a million people - nearly a fifth of the Danish population (Statistics Denmark, 1910). Expanding public transportation networks loosened the link between homestead and workplace, and suburbs briskly spilled beyond the old city limits. At the turn of the century, Copenhagen had emerged from a fortified garrison city to a modern metropolis (Hyldtoft, 1978). This structural change notwithstanding, late 19th century Denmark was still a predominantly agricultural society.

Under the stress of the so-called grain invasion from North America and Eastern Europe, Danish farmers responded effectively by moving from grain exports to exports of animal products. Their adjustment strategy proved successful. Starting in the 1880s, the pace of Danish economic growth quickened and even outperformed that of most other European countries at the time. This very export drive of agriculture became a major force in developing other sectors of the economy, notably transport, trade and finance (Henriksen, 2006). It was against this backdrop and in an environment of substantial capital inflows and low interest rates, that competition among financial institutions fueled a rapid credit expansion. Between 1900 and 1908, total outstanding loans of commercial banks doubled (Østrup, 2008; Nielsen, 1933).

Urban housing demand ran particularly high during these boom years of the 1890s and early 1900s. Many newly established small banks therefore concentrated on mortgage lending but also participated in speculation of all kinds (Nielsen, 1933).[25] A large share of lending went into financing new residential building in the suburbs of Copenhagen and other growing cities. Construction surged and housing demand was gradually saturated. Vacancy rates reached 8 percent in 1905. When the building boom crashed in 1907, the three main banks involved in financing the building boom (Kjobenhavns Grundejerbanken, Detailhandlerbanken, and Centralbanken) and some smaller institutions faced bank runs or suspended payments (Østrup, 2008).[26] Although the U.S. financial crisis of 1907 may have contributed to the problems of Danish banks, for many contemporary

[23] While the house price cycle of the 1880s and 1890s was somewhat less dramatic in other colonies, it still stands out (Stapledon, 2012b; Daly, 1982; Ellis, 1893). Sydney house prices, for example, increased by about 32 percent during the 1880s, peaked in 1892 and subsequently fell by about 36 percent.

[24] From 25 percent in 1870.

[25] According to Meyer (1909) speculative activites prior to the crisis of 1907 were rather widespread and included not only real estate but also, for example, industrial and shipbuilding shares.

[26] To alleviate the panic, the National Bank guaranteed the liabilities of the crisis-hit banks. Starting in 1910, Detailhandlerbanken, Grundejerbanken and three smaller institutions were unwound (Østrup, 2008).

observes it was obvious that the Danish crisis was first and foremost a speculation and credit crisis (Gerlach, 1911; Meyer, 1909).[27]

### The American real estate boom of the 1920s

Whereas rural America was in a state of considerable distress throughout most of the 1920s, the roaring twenties were a time of great economic prosperity particularly in urban areas. Amid an overarching atmosphere of optimism, "a period of sensational real estate speculation" (Simpson, 1933) spread from the swamps of Florida to the urban density of Manhattan and Chicago (Nicholas and Scherbina, 2013; George, 1986; Simpson, 1933). Between 1921 and 1925, residential construction more than tripled and, with large regional variation, house prices rose strongly. The magnitude of the price increase ranged from about 19 percent in Seattle to 43 percent in Manhattan.[28] Many Americans took on mortgage debt to become homeowners. The U.S. homeownership rate increased by more than 2 percentage points over the course of the decade.[29] Galbraith (1955), in his well-known account of the Great Depression, even viewed the Florida boom as "the first indication of the mood of the twenties and the conviction that God intended the American middle class to be rich" fueling delusions that even swamps would make for a wonderful real estate investment.[30] The inevitable realization that it was not resulted a crash in the mid-1920, well in advance of the Great Depression. Building starts began declining in 1926 falling to their 1920 level by 1931. Foreclosures, however, rose continuously and created a range of problems not only for the financial sector but for the entire economy. In response to the mounting troubles in the housing sector, the U.S. government during the Great Depression began to institute various mechanisms to support distressed homeowners and revive the flow of credit into housing (Knoll, 2012).

Yet, for most of the 20th century, few economists took note of this boom or its nationwide scope. Only recently, the 1920s real estate boom has been analyzed in great detail (Field, 2014; Gjerstad and Smith, 2014; Brocker and Hanes, 2014; Fishback and Kollmann, 2014; White, 2014). White (2014), for example, notes that the 1920s boom had a number of uncanny parallels with the housing bubble of the 2000s. He argues that not only the dimensions of the booms were similar but also some of the driving factors: easy monetary policy, weak bank supervision, declining bank lending standards, as well as an increase in mortgage securitization.

[27]Since the Danish house price index for that period, however, mainly covers rural areas, it does not perfectly reflect the timing of this boom-bust pattern. There are two possible explanations that may have joint or partial validity: First, since the construction boom was centered in the residential real estate sector, the index for farm prices may not provide an adequate picture of developments in house prices. Second, as the construction boom was concentrated in Copenhagen, the boom and crash may not be visible as strongly on the national level.

[28]For Florida, which is likely to have experienced the biggest boom and bust, no house price index is available for this period.

[29]Mortgage debt increased tremendously as a result, more than doubling from 8 percent of GDP in 1920 to 20 percent of GDP in 1930. In 1920, about 45.6 percent of Americans owned their own home. In 1930, 47.8 percent did (Knoll, 2012).

[30]Already before the 20th century, land bubbles frequently occurred in the U.S. For an account of some of these earlier episodes, see Sakolski (1932).

**European house price booms in the 1980s: Switzerland and Scandinavia**

The 1980s were a decade of strong economic growth in Switzerland. Construction activity was well supported by the strong demand for housing service by the baby boomer generation. House prices increased by 65 percent over the decade and the amount of mortgages held by Swiss banks more than doubled. Loan to value ratios of 80–100 percent were not uncommon (Woitek and Müller, 2012; Agnello and Schuknecht, 2011; Basel Committee on Banking Supervision, 2004). However, the boom ended abruptly in the early 1990s and was followed by a pronounced recession with substantive frictions in the Swiss banking system, and a sharp decline of house prices. By the end of the 1990s, real house prices had fallen back to their 1979 pre-boom level (Woitek and Müller, 2012; Wüest and Partner, 2012).

A similar story can be told from Northern Europe. The Scandinavian real estate boom and bust episodes of the 1980s are often associated with the wave of financial deregulation that swept the region at the beginning of the decade. Mortgage lending surged in Denmark, Norway, Sweden, and Finland (Grytten, 2010; Hjerppe, 2008; Kristensen, 2007; Eitrheim and Erlandsen, 2004). The deregulation of the financial sector as well as the liberalization of capital movements enabled banks to borrow abroad. Foreign funds were used to fund new commercial and residential real estate projects, but also the value of existing houses rose strongly over the decade before collapsing by the end of the decade (Monnery, 2011; Kindleberger, 2000). In the late 1980s and early 1990s the financial sectors in all countries faced severe problems and central banks had to intervene to support failing banks.

**The Japanese bubble of the 1980s**

The Japanese asset price bubble got underway in the 1982 but accelerated strongly after 1985 (Okina et al., 2001). Initially, equity prices posted the strongest gains. Land prices only followed the Nikkei index with a lag of a few years. In the second half of the 1980s, the real estate boom spread from Tokyo to other urban areas across the country. Japanese urban land prices doubled over a few years. The combined capital gains in real estate and stocks equaled 450 percent of GDP. Equity prices peaked in 1989, while the real estate bubble burst in 1991. Stock stock prices had fallen by 60 percent in 1992 already. Yet, land prices deflated more slowly and remained on a downward trajectory for almost two decades after the peak of the bubble (Shiratsuka, 2005; Okina et al., 2001; Kindleberger, 2000). By 2012, the nominal value of real estate was about half its 1991 value.

## 3.4 Methodology: Testing for return predictability

The previous sections have demonstrated that large fluctuations in house prices are nothing new but have occurred with striking regularity. They also provided some evidence that these fluctuations can not be explained by changes in fundamentals alone. The immediate question hence is whether rent-price ratios can predict returns. If that is the case, it would suggest that house prices are excessively volatile. This section describes how I calculate returns on housing and outlines the methodology used to assess the predictability of returns and rent growth.

### 3.4.1 Calculating returns on housing

The most basic requirement to examine the extent to which housing returns are predictable by the rent-price ratio is a time series of returns on housing. As the return on any financial asset, the return on housing consists of two components. The first component is the dividend the owner receives. A house yields a dividend in the form of a service flow that is derived either by living in it or by renting it out. In consequence, the dividend is usually approximated by the rental value of the property. Second, upon selling the asset, the owner makes a capital gain or loss. Let $P$ and $R$ denote the observed price and rental payment of housing, $\delta$ denotes depreciation and maintenance. The one-period return on housing $H$ is then given by

$$H_t = \frac{R_t + P_t - P_{t-1}}{P_{t-1}} - \delta \tag{3.2}$$

To construct estimates of the return to housing for each country, I use the rent-price ratio estimated in a baseline year and compute a time series of returns using the house price and the rent indices introduced in Section 2.2.[31] This approach focuses on a representative portfolio of houses and hence does not need to correct for changes in the housing stock.

For benchmark rent-price ratios in 2013, I rely on rental yields from the Investment Property Database (IPD).[32] IPD rental yields reflect net income (i.e. net of property management costs, ground rent and other irrecoverable expenditure) received for residential real estate as percentage of the capital employed. Assuming that maintenance costs are stable over many years, rental yields calculated using the rent-price approach are net yields.[33] Note also that rental yields drawn from the IPD database are based on asset-level data from a wide variety of professional investors in real estate covering a substantial share of the total institutional investment market in each country. Hence, the rent-price ratios do not suffer from the typical problem of comparing two different sets of properties: those for sale and those for rent.[34]

The resulting estimates of average annual real returns, rental yields, and capital yields are summarized in Table B.2. Note that these estimates are not adjusted

[31] For a detailed description of the *rent-price approach*, see also Appendix B.2.3. A similar approach has been used by Ambrose et al. (2013) and Giglio et al. (2016), for example.

[32] The U.S. is the only exception. In this case, I rely on a rent-price ratio from the real estate portal Trulia for 2012 as suggested by Giglio et al. (2016).

[33] In the case of the U.S., to compute net returns, I subtract maintenance costs and depreciation calibrating their impact at 2.5 percent p.a.

[34] Also the rent-price ratio drawn from Trulia for the U.S. relies on asset-level data.

for taxes and transaction costs. From an investor's perspective deducting these expenses clearly is important to arrive at an estimate of the effective rate of return.[35] Both, taxes and transaction costs, differ substantially across and (in the case of taxes) within countries. They have also changed over the past 140 years, even though theses changes tend to be irregular and non-continuous. Since quantifying the burden of these costs with precision is beyond the scope of this study, I will focus on pre-tax and pre-transaction cost returns. Assuming that these costs are not significantly time-varying and/or the variation is uncorrelated with changes in the rent-price ratio, omitting them will not affect my results below.

### 3.4.2 Present value relations and predictive regressions

Any modern investigation of return predictability starts with the log-linear return approximation by Campbell and Shiller (1988) as guiding framework. Originally developed in the context of the stock market, it has been widely applied and modified to examine return predictability across different markets. To develop intuition for the empirical analysis that follows, I briefly rephrase their framework in terms of housing returns, rent growth rates and rent-price ratios.

Campbell and Shiller (1988) begin by taking a first-order Taylor approximation of Equation 3.2 to derive a linearized expression of log returns by:[36]

$$h_{t+1} \simeq rp_t + \Delta r_{t+1} - \rho rp_{t+1} \tag{3.3}$$

where $h_{t+1} = \log H_{t+1}$, $rp_t = \log(R_t/P_t)$ , $\Delta r_{t+1} = \log R_{t+1} - \log R_t$ and $\rho = \frac{exp(-\overline{rp})}{1+exp(-\overline{rp}}$ is a linearization constant with $\overline{rp}$ denoting the long-run average rent-price ratio ($0 < \rho < 1$). The rent-price ratio is assumed to be stationary for now, but I will return to this issue in Section 3.5.2. Equation 3.3 is often referred to as a dynamic version of the Gordon (1962) growth model since it allows for both returns and rent growth rates to be time-varying (Campbell and Shiller, 1988). As in the case of other assets such as stocks, there are good reasons to believe that also returns on housing and rent growth rates are time-varying (Plazzi et al., 2010). Rewriting Equation 3.3 in terms of the price-rent ratio, I obtain

$$rp_t \simeq h_{t+1} - \Delta r_{t+1} + \rho rp_{t+1} \tag{3.4}$$

Hence a high rent-price ratio is either related to high future housing returns, low future rent growth rates, or a high future rent-price ratio. Note that Equation 3.4 does not predict which variables of the right-hand side should be forecastable; it suggests only that if there is predictable variation in housing returns or rent growth, the rent-price ratio is a good variable for uncovering that variation. This

[35]For rough estimates of the effective housing return, i.e. net of taxes and transaction costs, and a comparison of long-run equity and housing returns, the reader is referred to Jordà et al. (2017).

[36]For convencience, the constant in the approximation is suppressed equivalent to assuming that all variables are demeaned. Moreover, $\delta$ is suppressed equivalent to assuming that $\frac{R_t}{P_{t-1}}$ reflects the adjusted yield, i.e. net of depreciation and maintenance.

implication of the Campbell-Shiller equation motivates predictive regressions of housing returns, rent growth rates, and the rent-price ratio on the lagged rent-price ratio in the form of[37]

$$h_{t+1} = \alpha_h + \beta_h(rp_t) + \epsilon^h_{t+1} \tag{3.5}$$

$$\Delta r_{t+1} = \alpha_r + \beta_r(rp_t) + \epsilon^r_{t+1} \tag{3.6}$$

$$rp_{t+1} = \alpha_{rp} + \beta_{rp}(rp_t) + \epsilon^{rp}_{t+1} \tag{3.7}$$

It is important to note that the Campbell-Shiller relation in Equation 3.4 links the predictive coefficients in Equations 3.5–3.7. To avoid potential bias arising from this interdependence, return and rent growth predictability should best be studied jointly (Cochrane, 2008). To model the joint dynamics of housing returns, rent growth, and the rent-price ratio, I rely on a VAR model. Let $x_t = [h_t, \Delta r_t, rp_t]$ be a column vector consisting of the three variables. All variables are demeaned so that $E[x_t] = 0$. Under the maintained assumption that the rent-price ratio is stationary, the VAR model can be written as

$$x_{t+1} = \phi x_t + \epsilon_{t+1} \tag{3.8}$$

where $\Gamma = E[x_t, x_t']$ denotes the covariance matrix of the variables. The VAR model is thus identified by nine moment conditions

$$E[(x_{t+1} - \phi x_t) \otimes x_t] = 0 \tag{3.9}$$

The coefficients further have to satisfy the linear restrictions implied by Equation 3.4. Let $I$ denote a three by three identity matrix where $e_i$ denotes the $i$-th column of the matrix. The linear restrictions then take the form of

$$(e_1' - e_2' + \rho e_3')\phi = e_3' \tag{3.10}$$

Since the system exhibits nine moment conditions, nine parameters, and three linear restrictions, the VAR model is overidentified. I follow the recent literature and estimate the model using two-step GMM (Golez and Koudijs, 2014; Plazzi et al., 2010; Larrain and Yogo, 2008).[38] Because the VAR is overidentified, I use a J-test to test for the validity of overidentifying restrictions (Hansen, 1982). I report heteroskedasticity and autocorrelation consistent statistics based on Bartlett kernel with optimal bandwith determined by the Newey-West method.

[37]This approach rests on the assumption that the rent-price ratio is the only conditioning variable, i.e. that it summarizes all other relevant economic factors. To the extent to which some factors may remain uncaptured, the model will be misspecified.

[38]Cochrane (2008) and Engsted and Pedersen (2015) use a different approach to exploit the present value relation. They conduct Monte Carlo simulations to analyze the finite-sample joint distribution of the return and dividend predictive coefficients. Specifically, they simulate two systems: under the null of no return predictability ($b_h = 0$) they simulate the rent-price ratio and rent growth and under the null of no rent growth predictability ($b_r = 0$) they simulate the rent-price ratio and returns. They then calculate the third variable based on Equation 3.4.

Apart from assessing the predictive ability of the rent-price ratio for returns and rent growth, the VAR model can shed light on the relative importance of (the predictability of) each variable in driving the variation in the current rent-price ratio. Specifically, the variance of the rent-price ratio can be decomposed into the covariances with future returns and rent growth rates (Cochrane, 1992) :

$$Var(rp_t) = Cov\left(rp_t, \sum_{\tau=1}^{\infty} \rho^{\tau-1}[h_{t+\tau}]\right) + Cov\left(rp_t, -\sum_{\tau=1}^{\infty} \rho^{\tau-1}\left[\Delta r_{t+\tau}\right]\right) \tag{3.11}$$

The expression says that all variation in the rent-price ratio must be accounted for by its covariance with and thus its ability to forecast future returns or future rent growth. The first covariance term captures the variation of the rent-price ratio due to discount rates – or expected returns – whereas the second covariance terms captures variation due to rent growth – or cash flows. Equation 3.11 can be written in terms of the VAR outlined above as

$$Var(rp_t) = e_3'\Gamma e_3 = e_1'\phi(I - \rho\phi)^{-1}\Gamma e_3 - e_2'\phi(I - \rho\phi)^{-1}\Gamma e_3 \tag{3.12}$$

To determine the relative importance of the two components, I divide the covariance terms by the variance of the rent-price ratio and express them in percentages.

## 3.5 Predicting returns and rent growth using the rent-price ratio

Does the rent-price ratio forecast housing returns or rent growth? Recall from Equation 3.4 that if the rent-price ratio forecasts neither of the two, it would be constant over time. But in fact, we know from Figure 3.2 that this is not the case. Rent-price ratios have shown substantial fluctuations over the past 140 years. This section first presents a cross-country and country-by-country analysis of predictability of housing returns and rent growth using the VAR model introduced above. In the remainder of the section, I subject these results to additional robustness and consistency checks.

### 3.5.1 140 years of housing return predictability

Table 3.4 relies on the full country sample and reports results from the three simple predictive regressions 3.5–3.7 in Panel (A) and from the VAR model studying return and rent growth predictability jointly in Panel (B). For convenience, in Panel (B) I do not report the full parameter matrix but focus on the coefficients associated with the lagged rent-price ratio in the return, rent growth, and rent-price ratio regressions. All variables are demeaned by the respective country mean. The estimates are based on annual nominal data.

The long view from history suggests that the rent-price ratio predicts both returns and rent growth rates. Column (1) of Table 3.4 shows that a relatively high rent-price ratio predicts higher next period returns. The coefficient of 0.067 in the first column of Panel (A) implies that when rent-price ratios rise one percentage point, prices rise another 67 basis points on average in the subsequent year, rather than declining one percentage point to offset the extra rental income and render returns unpredictable. The result that housing returns are positively predictable is consistent with the present value framework. It also accords with evidence from previous studies that find return predictability in real estate markets for the post-1970 period (Engsted and Pedersen, 2015; Plazzi et al., 2010; Cochrane, 2011). Column (2) shows that the opposite is true for the predictability of rent growth rates. A high rent-price ratio is generally associated with lower rent growth. Again, the coefficients are highly statistically significant even though they are relatively small when compared to the coefficients in the return regression. This result is noteworthy as it contradicts the prevalent notion that the rent-price ratio predicts returns but not rent growth (Engsted and Pedersen, 2015; Plazzi et al., 2010; Cochrane, 2011).[39]

We know from Sections 3.2 and 3.3 as well as from Chapter 2 of this dissertation that there is considerable heterogeneity in trends of house prices and rents across the 16 countries in the sample. In Table 3.5, I therefore estimate a separate VAR model for each country. Note that data coverage starts at different dates for different countries. The samples span between 66 (Japan and Portugal) and 144 (France and the Netherlands) annual observations. For convenience, I do not report the full parameter matrix for each country but focus on the coefficients associated with the lagged rent-price ratio in the return (column (1)) and rent growth (column (2)) regression. Decomposition results are shown in column (4).[40]

The patterns from the pooled regressions in Table 3.4 are confirmed on a country-by-country basis. The estimated parameter on the rent-price ratio in the return regressions is positive for all 16 countries in the sample. The coefficients range between 0.029 for Italy and 0.193 for the U.S. and are highly statistically significant in all cases. Turning to the rent growth regressions, the results are somewhat more mixed. It shows that rent-price ratios negatively forecast rent growth rates in all countries except for Portugal. Yet, they turn out to be (almost) zero for Denmark, Spain and the Netherlands and are statistically significant only for eight of these countries. In other words, while return predictability appears to be a consistent feature of housing markets in all advanced economies in the sample, the evidence for rent growth predictability is less pervasive. I obtain qualitatively similar results if I focus on excess returns. Results are shown in Panel (B) of Appendix Table B.3.[41]

[39]For the period 1970–2010, Engsted and Pedersen (2015) show that nominal rent growth is predictable for seven out of the 18 countries they study. Cochrane (2011), using U.S. data 1960–2010, finds no evidence of rent growth predictability. Plazzi et al. (2010) show that rent-price ratios marginally forecast office rent growth but not rent growth of apartments, retail properties, and industrial properties.

[40]In column (3), I also report J-statistics from the test of overidentifying restrictions.

[41]The excess return or premium paid above the risk free rate $i_t$ – the long-term rate on government securities, usually five years or more in maturity – is computed as $E_t = H_t - i_t$.

**Table 3.4:** Predictive regressions, 16 countries.

| | | | |
|---|---|---|---|
| | *Panel A: OLS estimates* | | |
| | (1) | (2) | (3) |
| | Returns ($h_{t+1}$) | Rent Growth ($\Delta r_{t+1}$) | Rent-Price Ratio ($rp_{t+1}$) |
| Rent-Price Ratio, $rp_t$ | 0.067*** | -0.022* | 0.972*** |
| | (0.010) | (0.011) | (0.010) |
| N | 1793 | 1793 | 1793 |
| $R^2$ | 0.08 | 0.02 | 0.94 |
| | *Panel B: VAR estimates* | | |
| | Returns ($h_{t+1}$) | Rent Growth ($\Delta r_{t+1}$) | Rent-Price Ratio ($rp_{t+1}$) |
| Rent-Price Ratio, $rp_t$ | 0.066*** | -0.020*** | 0.971*** |
| | (0.006) | (0.004) | (0.001) |
| N | 1793 | | |
| J-test | 5.616 | | |

*Notes to Panel A*: Results from regression 3.5 in column (1), results from regression 3.6 in column (2), results from regression 3.7 in column (3). The data are annual. Country fixed effects. Robust standard errors in parentheses. *** p < 0.01; ** p < 0.05; * p < 0.1.
*Notes to Panel B*: VAR estimates of returns and rent growth rates. The data are annual. The model is estimated by two-step generalized method of moments subject to the present value model constraints. Heteroskedasticity and autocorrelation corrected standard errors based on Bartlett kernel are reported in parentheses below the estimated parameters. The Newey and West method is used for the selection of the optimal bandwidth. *** p < 0.01; ** p < 0.05; * p < 0.1.

This is also reflected in the decomposition results. Note that the decomposition is not a decomposition in orthogonal components but the components can account for more than 100 percent or less than 0 percent of the variation in the rent-price ratio (Cochrane, 2008). For twelve out of the 16 countries, the variability in the rent-price ratio is mostly accounted for by returns, or discount rates. Exceptions are Belgium, Switzerland, Italy and the U.S. where more than half of the variation is driven by rent growth.[42] The finding that rent growth only accounts for a small share of the variability in housing valuations mirrors findings from other asset markets (Golez and Koudijs, 2014; Campbell and Ammer, 1993). In this way, houses again behave like other assets.

[42]While the results from the decomposition are unsurprising given the VAR estimates, for the U.S. they contrast with evidence reported by Campbell et al. (2009). The authors decompose the variation in rent-price ratios in 23 metropolitan areas between 1975 and 2005 into real rent growth and real returns. They find that returns account for more than 50 percent or more in variability. Yet the results displayed in Table 3.5 for the U.S. as a whole 1891–2013 suggest that more than 50 percent in variability can be attributed to rent growth.

**Table 3.5:** Vector autoregression estimates: forecasting returns and rent growth with the rent-price ratio.

| Country | Years | Returns ($h_{t+1}$) | Rent Growth ($\Delta r_{t+1}$) | J-test | Decomposition DR | CF | N |
|---|---|---|---|---|---|---|---|
| | | (1) | (2) | (3) | (4) | | (5) |
| Australia | 1901–2015 | 0.062*** | -0.025** | 6.091 | 0.878 | 0.122 | 113 |
| | | (0.014) | (0.011) | | | | |
| Belgium | 1890–2015 | 0.044*** | -0.071*** | 2.608 | 0.232 | 0.768 | 124 |
| | | (0.017) | (0.026) | | | | |
| Denmark | 1875–2015 | 0.047*** | -0.005 | 1.515 | 0.837 | 0.163 | 139 |
| | | (0.011) | (0.005) | | | | |
| Finland | 1920–2015 | 0.132*** | -0.043** | 3.354 | 0.614 | 0.386 | 94 |
| | | (0.036) | (0.019) | | | | |
| France | 1870–2015 | 0.065*** | -0.018 | 2.545 | 1.586 | -0.586 | 144 |
| | | (0.017) | (0.017) | | | | |
| Germany | 1870–2015 | 0.086*** | -0.023*** | 6.374 | 0.578 | 0.422 | 108 |
| | | (0.024) | (0.004) | | | | |
| Italy | 1927–2015 | 0.029** | -0.060*** | 1.326 | 0.223 | 0.777 | 78 |
| | | (0.013) | (0.014) | | | | |
| Japan | 1931–2015 | 0.053*** | -0.004 | 4.273 | 1.112 | -0.112 | 66 |
| | | (0.015) | (0.003) | | | | |
| Netherlands | 1870–2015 | 0.081*** | -0.000 | 1.443 | 0.999 | 0.001 | 144 |
| | | (0.015) | (0.005) | | | | |
| Norway | 1871–2015 | 0.089*** | -0.031** | 8.111 | 0.699 | 0.301 | 143 |
| | | (0.019) | (0.014) | | | | |
| Portugal | 1948–2015 | 0.113** | 0.005 | 1.013 | 1.374 | -0.374 | 66 |
| | | (0.040) | (0.013) | | | | |
| Spain | 1900–2015 | 0.052*** | -0.007 | 3.027 | 0.910 | 0.090 | 110 |
| | | (0.017) | (0.007) | | | | |
| Sweden | 1883–2015 | 0.075*** | -0.014 | 3.823 | 0.828 | 0.172 | 131 |
| | | (0.024) | (0.013) | | | | |
| Switzerland | 1901–2015 | 0.037* | -0.026*** | 0.704 | 0.308 | 0.692 | 113 |
| | | (0.023) | (0.009) | | | | |
| United Kingdom | 1899–2015 | 0.111*** | -0.020 | 1.792 | 0.835 | 0.165 | 96 |
| | | (0.031) | (0.016) | | | | |
| United States | 1890–2015 | 0.193*** | -0.049*** | 0.756 | 0.400 | 0.600 | 124 |
| | | (0.045) | (0.016) | | | | |

*Note:* This table reports VAR estimates of returns and rent growth rates and decomposition results based on the VAR estimates. The data is annual. The model is estimated by two-step generalized method of moments subject to the present value model constraints. Heteroskedasticity and autocorrelation corrected standard errors based on Bartlett kernel are reported in parentheses below the estimated parameters. The Newey and West method is used for the selection of the optimal bandwidth. *** p < 0.01; ** p < 0.05; * p < 0.1.

### 3.5.2 Robustness checks

#### Subsamples: Return predictability now and then

The results in the previous section suggest that the rent-price ratio is a statistically significant predictor of housing returns and – at least in half of the countries – of rent growth rates. Yet we know that house prices in advanced economies have followed a particular trajectory since the late 19th century. Chapter 2 of this dissertation shows that real house prices in advanced economies stayed within a relatively tight range between the late 19th and the mid-20th century, but rose strongly during the second half of the 20th century. Notably, Figure 3.2 indicates that this hockey-stick pattern is not reflected in real rents. But if the relationship between prices and rents has changed over time as Figure 3.2 suggests, the immediate question is whether the predictability of returns and rent growth differs between the pre- and the post-World War 2 period.

To explore this possibility, Panel (A) of Table 3.6 repeats the VAR regressions of Tables 3.4 and 3.5 for two non-overlapping samples: i) between the time our records start for the respective country and 1945, and ii) between 1946 and 2015. Note that data for Portugal only starts in 1948. I also omit Finland, Italy, and Japan for the pre-World War 2 period because of the small sample size (data only starts after World War 1). Again, I focus on the coefficients associated with the lagged rent-price ratio in the return (column (1)) and the rent growth (column (2)) regression. Decomposition results are shown in column (3).

When separately estimating the forecasting regressions for the two subsamples, the evidence for return predictability holds up. For the pre-World War 2 period, it shows that the rent-price ratio positively predicts returns in the pooled sample as well in each single country. The coefficients are statistically significant in all cases but two (Belgium and Switzerland). For most countries, the coefficient increases compared to the estimates in Table 3.5. Also for the post-World War 2 period, the results confirm the predictability of housing returns. Again the coefficients are highly statistically significant but tend to be somewhat smaller compared to the pre-World War 2 period. While the forecasting relationship between housing returns and the rent-price ratio hence displays some instability across subsamples, the results nevertheless confirm that return predictability has been an important characteristic of housing markets in advanced economies since the late 19th century.

By contrast, considering the results from the rent growth regressions, I observe substantial differences between the two periods. While rent growth is significantly predictable with a negative sign in the pooled sample, the country-by-country analysis tells a different story. Not only the magnitude but also the signs of the rent-price coefficient in these regressions are rather unstable. Whereas the rent-price ratio predicts rent growth with a negative sign for nine out of the twelve countries for which pre-World War 2 data are available, this is only the case for less than a fifth of the 16 countries in the second half of the 20th century. As we would expect, discount rates also explain not only a larger fraction of the variation in the rent-price ratio when compared to the pre-World War 2 period but most of it. Germany, Italy, and Switzerland are the only exceptions.

As my sample is Europe-heavy, the housing return data may underestimate the riskiness of an investment in residential real estate during the years of the two world wars. Particularly in European cities, a substantial part of the housing stock was destroyed during the war years. Incorporating the physical loss of (part of) the asset would lower the return to a representative housing investment. In other words, the data may suffer from a survivorship bias.[43] As additional robustness check, I therefore exclude the years of World War 1 and World War 2. Results are shown in Appendix Table B.3.[44] Again, the results remain robust.

What may explain these differences between the first and the second half of the 20th century? Two points are worth noting. First, differences in rental regulation across countries and time could account for part of these results. Broadly speaking, post-World War 2 regulations often took the form of limiting year-to-year increases in rents (see also Appendix Table B.7). These policies may be reflected in the rent indices in the form of smoother rent growth rates relative to the pre-World War 2 era. If that is the case, this will mechanically imply less predictability of rent growth rates and render housing returns more predictable. Unfortunately, there is very little long-run data measuring the exact extent of rental regulation for the 16 countries in the sample limiting my ability to quantify these effects with greater precision.[45] Second, it is important to note that the partial disappearance of rent growth predictability in the second half of the 20th century is also associated with an increased persistence of the rent-price ratio which would induce a bias to the post-World War 2 estimates. The next subsection will address this feature of the data in more detail.

### Accounting for structural shifts in the mean of the rent-price ratio

The regressions in the previous subsection show that the selection of the sample period matters. This is a first serious concern when discussing the robustness of housing return predictability. A second statistical issue in forecasting regressions relates to potential biases resulting from the persistence in the rent-price ratio. Standard specifications such as the one used in this paper assume that all processes are stationary around a constant mean. Yet we see from Figure 3.2 that the mean of the 16 rent-price ratios does not fluctuate within some historical range over

[43] See Jorion and Goetzmann (1999) for a discussion of the survivorship bias in equity markets.

[44] Moreover, some of the house price indices are based on appraisals. Returns on housing constructed based on such an index will essentially reflect some sort of moving average of the underlying asset performance. Consequently, housing returns will be smoothed and hence exhibit lower volatility over time. For three countries, (part of) the house price index is based on appraised values are Denmark, the Netherlands and Sweden. As Tables 3.5 and 3.6 show, regression results are qualitatively similar for countries for which house price series is based on transaction prices and countries for which (part of the) the house price series is based on appraised values.

[45] Most studies measuring formal regulations provide a snapshot of cross-country differences in the extent of regulation at a specific point in time or provide regulation indices covering a rather short time period. To the best of the author's knowledge, the only exception is Kholodilin (2015) who quantifies the strength of rental regulations in Germany between 1913 and 2015.

the past 140 years but starts to strongly trend downward in the second half of the 20th century. In Table B.6 in the appendix, I report results from Augmented Dickey Fuller (ADF) tests country by country. Unsurprisingly, in most cases, the null hypothesis of a unit root cannot be rejected. It follows that the return forecast regression inherits the near-unit root properties of the rent-price ratio. A large literature has examined the implications of high persistence in financial ratios for forecasting regressions and generally concludes that the statistical evidence of forecastability is weaker once tests are adjusted for high persistence (Ang and Bekaert, 2007; Valkanov, 2003; Stambaugh, 1999). I will use a simple approach to address both challenges. Specifically, I will follow Lettau and van Nieuwerburgh (2007) and adjust the rent-price ratio to account for structural breaks in its mean. Using the adjusted rent-price ratio, I will then re-examine the evidence for return and rent growth predictability.

Means of valuation ratios are determined by the steady state of the economy. Aiming to reconcile the existing stock return predictability evidence, Lettau and van Nieuwerburgh (2007) reason that if the steady-state of the economy has shifted since the early 20th century, so will have the mean dividend-price ratio. The authors argue that in the presence of steady-state shifts, an unadjusted, non-stationary valuation ratio is not a well defined predictor. Modeling the non-stationary component as a constant that is subject to rare structural breaks, they propose to use a regime-specific demeaned ratio as predictor instead. Put differently and applied to housing markets, deviations of the rent-price ratio from steady states are stationary as long as deviations of rent growth and returns from their respective steady states are stationary. The consequently reduced persistence of the appropriately demeaned, stationary ratio alleviates the upward small-sample bias in the return predictability coefficient.

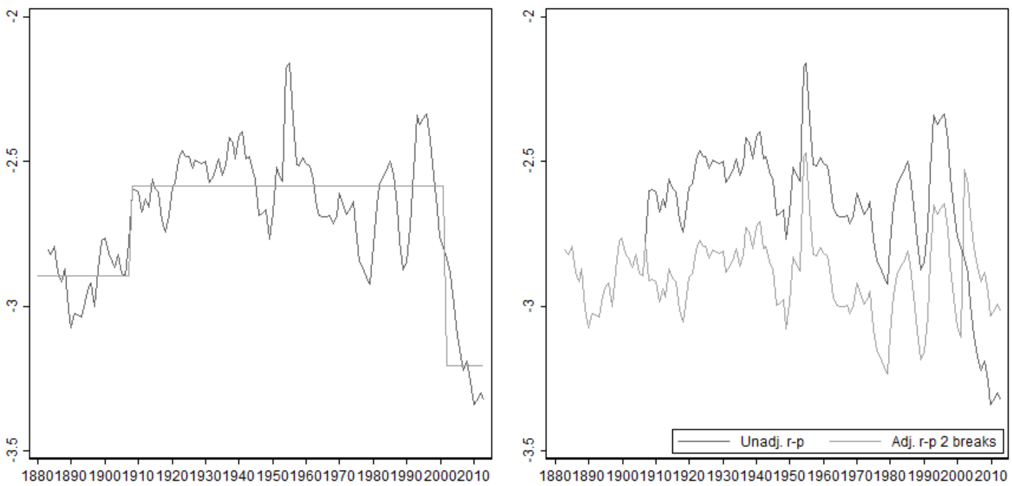
There is reason to believe that the steady-state mean of the rent-price ratio has changed over the course of the past 140 years. While permanent technological innovations may have affected the steady-state growth rate of economic fundamentals, changes in the tax code, lower macroeconomic volatility, and housing policies aimed at increasing homeownership rates[46] may have altered expected returns of houses. Such changes are slow-moving and may mask time variation in expected returns and expected rent growth at higher frequencies. To investigate this possibility, I test the null hypothesis of no break against the alternative hypotheses of one, two, or three breaks with unknown break dates. Structural breaks in the log rent-price ratio for individual countries are identified using the methodology of Bai and Perron (2003). Results are exhibited in Appendix Table B.5. Structural breaks are detected in rent-price ratios of all countries in the sample which motivates me to construct adjusted rent-price ratios. For each country, I simply subtract the mean in the relative subsample(s), i.e. in the one-break case with break date $\tau$, the adjusted ratio is defined as

[46] As a result of these policies, homeownership rates have increased substantially over the past century and a half in all countries in the sample (see Appendix Table B.4).

$$\widetilde{rp_t} = \begin{cases} rp_t - \overline{rp_1} \text{ for } t = 1, ...\tau \\ rp_t - \overline{rp_2} \text{ for } t = \tau + 1, ..., T \end{cases} \tag{3.13}$$

where $\overline{rp_1}$ is the sample mean for the first subsample, i.e. the years before the structural break, and $\overline{rp_2}$ is the sample mean for the second subsample, i.e. the years after the structural break. Figure 3.3 illustrates this procedure in the case of Sweden accounting for two structural breaks. The left panel shows the raw series and the regime-specific means. The right panel shows the raw series along with the adjusted rent-price ratio. The adjusted series are much less persistent and the null of a unit root in the adjusted series is usually rejected (see Table B.6).

**Figure 3.3:** Structural shifts in the mean of the rent-price ratio.




*Notes:* Log rent-price ratio, Sweden 1883–2013. The left panel overlays the subsample means $\overline{rp_1}$ in 1883–1907, $\overline{rp_2}$ in 1908–2001, and $\overline{rp_3}$ in 2002–2013. The right panel plots the unadjusted rent-price ratio and the adjusted rent-price ratio in the two break case.

I revisit the return and dividend predictability estimations for each country from Table 3.5 using the adjusted dividend-price ratios instead of the raw series as predictor variable. The results are shown in Panel B of Table 3.6. I find that the adjusted rent-price ratio significantly predicts returns for all countries in the sample. The coefficients for the full period for which data are available for each country are somewhat higher when compared to the estimates in Table 3.5.[47] Hence, the previous lower point estimates were due to averaging across regimes. Not taking the non-stationarity of the rent-price ratio into account biases the estimate downward. The same is true for rent growth predictability. Taken together, the results suggest that the mean of the rent-price ratio has indeed been subject to structural shifts. Accounting for these shifts confirms the findings from the previous section: the rent-price ratio significantly predicts returns for all countries in the sample. The evidence on the predictability of rent growth rates remains somewhat more

[47] This is consistent with the results presented by Lettau and van Nieuwerburgh (2007) for stock markets.

mixed. Yet the results do not support the notion that the rent-price ratio only predicts returns but not rent growth rates.

**Table 3.6:** Robustness: sub-samples and adjusted rent-price ratios.

| | | (A) Sub-samples | | | | | (B) Adj. rent-price ratio | | |
|---|---|---|---|---|---|---|---|---|---|
| Country | Years | Returns ($h_{t+1}$) | Rent Growth ($\Delta r_{t+1}$) | Decomposition DR | CF | N | Years | Returns ($h_{t+1}$) | Rent Growth ($\Delta r_{t+1}$) |
| | | (1) | (2) | (3) | | (4) | | (5) | (6) |
| All Countries | Pre-1945 | 0.122*** | -0.037*** | - | - | 725 | Full Sample | 0.110*** | -0.042*** |
| | | (0.016) | (0.011) | | | | | (0.012) | (0.007) |
| | Post-1945 | 0.076*** | -0.011* | - | - | 1068 | | | |
| | | (0.009) | (0.005) | | | | | | |
| Australia | 1901–1945 | 0.132*** | -0.042** | 0.794 | 0.206 | 43 | 1901–2015 | 0.171*** | -0.093*** |
| | | (0.030) | (0.018) | | | | | (0.029) | (0.022) |
| | 1946–2015 | 0.100*** | 0.006 | 1.254 | -0.254 | 69 | | | |
| | | (0.032) | (0.011) | | | | | | |
| Belgium | 1890–1945 | 0.040 | -0.197*** | -0.346 | 1.346 | 54 | 1890–2015 | 0.092*** | -0.109*** |
| | | (0.055) | (0.030) | | | | | (0.021) | (0.039) |
| | 1946–2015 | 0.104*** | 0.016 | 0.938 | 0.062 | 69 | | | |
| | | (0.018) | (0.022) | | | | | | |
| Denmark | 1875–1945 | 0.103*** | 0.006 | 1.197 | -0.197 | 69 | 1875–2015 | 0.148*** | -0.041*** |
| | | (0.030) | (0.011) | | | | | (0.024) | (0.009) |
| | 1946–2015 | 0.052*** | -0.002 | 0.816 | 0.184 | 69 | | | |
| | | (0.015) | (0.004) | | | | | | |
| Finland | 1946–2015 | 0.078** | -0.044*** | 0.317 | 0.683 | 69 | 1920–2015 | 0.230*** | -0.046** |
| | | (0.036) | (0.017) | | | | | (0.051) | (0.021) |
| France | 1870–1946 | 0.117** | -0.061** | -0.166 | 1.166 | 74 | 1870–2015 | 0.088*** | -0.072*** |
| | | (0.036) | (0.031) | | | | | (0.020) | (0.019) |
| | 1946–2015 | 0.073*** | 0.006 | 1.502 | -0.502 | 69 | | | |
| | | (0.016) | (0.026) | | | | | | |
| Germany | 1870–1945 | 0.088** | -0.016*** | 0.722 | 0.278 | 56 | 1870–2015 | 0.084*** | -0.020** |
| | | (0.035) | (0.004) | | | | | (0.033) | (0.009) |
| | 1962–2015 | 0.026 | -0.030*** | 0.300 | 0.700 | 52 | | | |
| | | (0.028) | (0.008) | | | | | | |
| Italy | 1945–2015 | 0.059** | -0.121*** | 0.166 | 0.834 | 68 | 1927–2015 | 0.063** | -0.039** |
| | | 0.029 | 0.025 | | | | | (0.029) | (0.017) |
| Japan | 1960–2015 | 0.048* | -0.004 | 1.370 | -0.370 | 54 | 1931–2015 | 0.143*** | -0.106*** |
| | | (0.026) | (0.004) | | | | | (0.031) | (0.014) |
| Netherlands | 1870–1945 | 0.080*** | -0.013** | 0.729 | 0.271 | 74 | 1870–2015 | 0.098*** | -0.001 |
| | | (0.021) | (0.006) | | | | | (0.011) | (0.006) |
| | 1946–2015 | 0.076*** | 0.017 | 1.137 | -0.137 | 69 | | | |
| | | (0.024) | (0.014) | | | | | | |
| Norway | 1871–1945 | 0.132** | -0.089 | 0.516 | 0.484 | 73 | 1871–2015 | 0.171*** | -0.051 |
| | | (0.063) | (0.084) | | | | | (0.038) | (0.037) |
| | 1946–2015 | 0.085*** | 0.009 | 1.319 | -0.319 | 69 | | | |
| | | (0.017) | (0.007) | | | | | | |
| Portugal | 1948–2015 | 0.113*** | 0.005 | 1.374 | -0.374 | 66 | 1948–2015 | 0.171*** | -0.024 |
| | | (0.040) | (0.013) | | | | | (0.049) | (0.020) |
| Spain | 1900–1945 | 0.126*** | -0.019 | 0.860 | 0.140 | 40 | 1900–2015 | 0.077*** | -0.038** |
| | | (0.041) | (0.031) | | | | | (0.029) | (0.019) |
| | 1946–2015 | 0.078*** | 0.014 | 1.381 | -0.381 | 69 | | | |
| | | (0.023) | (0.011) | | | | | | |

*Table continues on the next page.*

**Table 3.6, ctd.:** Robustness: sub-samples and adjusted rent-price ratios.

| | | (A) Sub-samples | | | | | (B) Adj. rent-price ratio | | |
|---|---|---|---|---|---|---|---|---|---|
| Country | Years | Returns | Rent Growth | Decomposition | | N | Years | Returns | Rent Growth |
| | | ($h_{t+1}$) | ($\Delta r_{t+1}$) | DR | CF | | | ($h_{t+1}$) | ($\Delta r_{t+1}$) |
| | | (1) | (2) | (3) | | (4) | | (5) | (6) |
| Sweden | 1883–1945 | 0.094*** | -0.033* | 0.619 | 0.381 | 61 | 1883–2015 | 0.133*** | -0.039 |
| | | (0.019) | (0.022) | | | | | (0.030) | (0.026) |
| | 1946–2015 | 0.058** | 0.007 | 1.244 | -0.244 | 69 | | | |
| | | (0.027) | (0.013) | | | | | | |
| Switzerland | 1901–1945 | 0.047 | -0.035*** | 0.131 | 0.869 | 43 | 1901–2015 | 0.143*** | -0.057*** |
| | | (0.050) | (0.014) | | | | | (0.037) | (0.016) |
| | 1946–2015 | 0.040* | -0.026*** | 0.475 | 0.525 | 69 | | | |
| | | (0.022) | (0.011) | | | | | | |
| United Kingdom | 1899–1938 | 0.277*** | -0.042 | 0.802 | 0.198 | 38 | 1899–2015 | 0.156*** | -0.044* |
| | | (0.068) | (0.035) | | | | | (0.038) | (0.025) |
| | 1956–2015 | 0.070 | -0.024 | 1.014 | -0.014 | 58 | | | |
| | | (0.021) | (0.018) | | | | | | |
| United States | 1890–1945 | 0.200*** | -0.064*** | 0.414 | 0.586 | 54 | 1890–2015 | 0.156*** | -0.049*** |
| | | (0.069) | (0.025) | | | | | (0.044) | (0.017) |
| | 1946–2015 | 0.127*** | -0.004 | 1.231 | -0.231 | 69 | | | |
| | | (0.036) | (0.014) | | | | | | |

*Note:* Estimated by two-step generalized method of moments subject to the present value model constraints. Heteroskedasticity and autocorrelation corrected standard errors based on Bartlett kernel in parentheses. The Newey and West method is used for the selection of the optimal bandwidth. *** p < 0.01; ** p < 0.05; * p < 0.1. Panel (A) reports estimates for sub-samples. Panel (B) reports estimates using the adjusted rent-price ratio.

### Real returns and rent growth

Do these findings carry over to the predictability of real housing returns and real rent growth? By subtracting inflation from both sides, Equations 3.5-3.7 can easily be applied to real returns and real dividend growth. Although inflation does not affect the ratio of rents to prices, any variable that predicts inflation may also predict nominal returns and rent growth rates. Relatedly, previous contributions by Brunnermeier and Julliard (2008) and Engsted and Pedersen (2015) suggest that housing markets may be prone to money illusion.[48] The intuition is simple. People suffering from money illusion will mistake a decrease in inflation for a decrease in real interest rates and therefore underestimate the real cost of future mortgage payments. As a result, house prices will be high relative to rents when inflation declines and the rent-price ratio will be positively correlated with future inflation rates (Modigliani and Cohn, 1979). If that is the case, we would likely observe differences between the predictive regressions above using nominal data and predictive regressions using real data.

[48] Brunnermeier and Julliard (2008) provide evidence for the U.K. and the U.S. (since the late 1960s and 1970). Engsted and Pedersen (2015) offer additional suggestive evidence for a sample of OECD countries (since 1970).

**Table 3.7:** Vector autoregression estimates: forecasting real returns and real rent growth with the rent-price ratio.

| | | (A) | (B) VAR | | (C) VAR - Adj. | |
|---|---|---|---|---|---|---|
| Country | Years | Inflation | Returns ($h_{t+1}$) | Rent Growth ($\Delta r_{t+1}$) | Returns ($h_{t+1}$) | Rent Growth ($\Delta r_{t+1}$) |
| All countries | Full sample | -0.016*** | 0.063*** | 0.001 | 0.141*** | -0.014* |
| | | (0.005) | (0.006) | (0.003) | (0.011) | (0.007) |
| Australia | 1901–2015 | 0.048*** | 0.058*** | -0.019*** | 0.200*** | -0.096*** |
| | | (0.016) | (0.008) | (0.005) | (0.029) | (0.023) |
| Belgium | 1890–2015 | -0.014 | 0.087*** | -0.031* | 0.147*** | -0.088** |
| | | (0.032) | (0.033) | (0.019) | (0.047) | (0.037) |
| Denmark | 1875–2015 | -0.020 | 0.049*** | 0.000 | 0.163*** | -0.061*** |
| | | (0.013) | (0.013) | (0.004) | (0.031) | (0.017) |
| Finland | 1920–2015 | -0.004 | 0.129*** | 0.000 | 0.155*** | -0.009 |
| | | (0.048) | (0.049) | (0.017) | (0.025) | (0.015) |
| France | 1870–2015 | -0.036 | 0.082*** | 0.011 | 0.153*** | 0.031 |
| | | (0.043) | (0.043) | (0.013) | (0.029) | (0.024) |
| Germany | 1870–2015 | -0.037*** | 0.091*** | 0.005 | 0.109*** | -0.001 |
| | | (0.014) | (0.014) | (0.004) | (0.027) | (0.006) |
| Italy | 1927–2015 | -0.060*** | 0.049** | 0.016 | 0.070*** | 0.012 |
| | | (0.020) | (0.020) | (0.017) | (0.025) | (0.017) |
| Japan | 1931–2015 | 0.011 | 0.061*** | 0.012 | 0.192*** | -0.083*** |
| | | (0.020) | (0.020) | (0.013) | (0.032) | (0.031) |
| Netherlands | 1870–2015 | 0.016 | 0.080*** | -0.008 | 0.111*** | -0.013 |
| | | (0.020) | (0.020) | (0.006) | (0.014) | (0.009) |
| Norway | 1871–2015 | -0.020 | 0.119*** | -0.010** | 0.245*** | -0.009 |
| | | (0.020) | (0.020) | (0.005) | (0.030) | (0.017) |
| Portugal | 1948–2015 | 0.077** | 0.099* | -0.014 | 0.208*** | -0.030 |
| | | (0.034) | (0.034) | (0.010) | (0.046) | (0.021) |
| Spain | 1900–2015 | -0.014 | 0.069*** | -0.000 | 0.166*** | -0.033*** |
| | | (0.012) | (0.012) | (0.009) | (0.021) | (0.011) |
| Sweden | 1883–2015 | 0.013 | 0.065** | -0.011 | 0.177*** | -0.010 |
| | | (0.020) | (0.020) | (0.007) | (0.033) | (0.014) |
| Switzerland | 1901–2015 | -0.042 | 0.085*** | -0.022* | 0.214*** | -0.070*** |
| | | (0.040) | (0.040) | (0.013) | (0.044) | (0.024) |
| United Kingdom | 1899–2015 | -0.041* | 0.132*** | -0.007 | 0.152*** | -0.014 |
| | | (0.025) | (0.025) | (0.014) | (0.038) | (0.010) |
| United States | 1890–2015 | -0.106** | 0.249*** | -0.010 | 0.256*** | -0.048*** |
| | | (0.043) | (0.043) | (0.014) | (0.059) | (0.012) |

*Note:* Panel A shows estimates from the forecasting regression $\pi_{t+1} = \alpha_\pi + \beta_{rp}(rp_t) + \epsilon^{\pi}_{t+1}$. Newey-West standard errors in parentheses. Panel B reports VAR estimates of real returns and real rent growth rates. Panel C reports VAR estimates of real returns and real rent growth rates using the adjusted rent-price ratio. The data are annual. The model is estimated by two-step generalized method of moments subject to the present value model constraints. Heteroskedasticity and autocorrelation corrected standard errors based on Bartlett kernel are reported in parentheses below the estimated parameters. The Newey and West method is used for the selection of the optimal bandwidth. *** p < 0.01; ** p < 0.05; * p < 0.1.

As a first step, Panel A of Table 3.7 therefore explores whether the rent-price ratio ($rp_t$) has forecasting power for inflation ($\pi_t$). It shows that the rent-price ratio is negatively correlated with future inflation in twelve of the 16 countries in the sample and positively in the remaining four. Recall from the previous sections that nominal returns are positively predictable in all countries. Intuitively, the consequence of negative inflation predictability will be a reinforcement of return predictability and a reduction of rent growth predictability in real terms. By contrast, positive inflation predictability will reduce real return predictability (or even render returns unpredictable) and strengthen rent growth predictability.

Panel B of Table 3.7 repeats the benchmark regressions from Section 3.5.1 using real returns and real rent growth. Panel C reports results using the adjusted rent-price ratio from the previous subsection. It shows that real housing returns remain positively predictable in the pooled sample as well as in each of the individual countries and all coefficients are highly statistically significant. As expected for countries for which the inflation coefficient is positive (Japan, the Netherlands, Sweden, and Portugal), accounting for inflation reduces return predictability. But the degree of inflation predictability is not strong enough to overturn the conclusions from the previous sections. Turning to the rent growth regressions, the results are again less stable. For the pooled sample, real rent growth is unpredictable using the unadjusted rent-price ratio (Panel B) but still significantly negatively predictable using the adjusted rent-price ratio (Panel C) with the coefficient being numerically smaller compared to the rent growth coefficient in Table 3.6. Moving to the country-by-country analysis, in Panel B (C), the rent-price ratio predicts rent growth with a negative sign in nine (14) countries (significant for four (seven)). Rent growth is positively predictable in four (two) countries (yet insignificant) but becomes unpredictable for the remaining three. In sum, the degree of rent growth predictability has clearly decreased compared to the case using nominal data but the results once again confirm that return predictability appears to be a pervasive feature of housing markets in advanced economies irrespective of the use of nominal or real data.

## 3.6 Conclusion

Are house prices excessively volatile? Recent experience has shown that house prices may fluctuate significantly and that big price changes do not necessarily coincide with similar strong changes in rents. Such episodes seem to conflict with the most simple valuation model at the center of finance theory: prices should equal the present value of expected future cash flows. But it is notoriously difficult to draw reliable conclusions about price volatility from individual episodes or small samples.

In this paper, I turn to economic history for the first comprehensive assessment of return predictability in housing markets of advanced economies. Based on house price and rent data for 16 countries since the late 19th century, I provide robust evidence that the excess volatility puzzle (Shiller, 1981), one of the seminal puzzles of financial economics, also exists in housing markets. Since the time my records start, the rent-price ratio has been a strong predictor of future returns. Rent growth rates are also predictable but the results are less stable. The evidence further suggests that return predictability has become stronger over time and rent growth predictability largely vanished after World War 2. This development coincides with an increased persistence of rent-price ratios in recent years. While real house prices have skyrocketed in the second half of the 20th century, real rents barely increased since the 1970s.

What may account for this excess volatility in house prices? The standard interpretation of return predictability is that risk-premia, i.e. discount rates, and thereby expected returns vary over time. The question remains why expected returns are time-varying. The existing literature offers two main vantage points. The first set of models retains assumptions of rationality and argues that risk premia vary with the state of the economy. In other words, when economic conditions are uncertain, households require higher expected returns to hold risky and less liquid assets. A related category of models focuses on institutional finance or, more precisely, leveraging and deleveraging dynamics. As consumption rises in good times, people slowly take on more debt. When the tide turns, people delever and repair their balance sheets. Both approaches describe a market with time-varying ability to bear risk and are observationally equivalent but have different policy implications (Cochrane, 2016; Koijen and van Nieuwerburgh, 2011; Campbell and Cochrane, 1999). Second, excess volatility of asset prices may also be accounted for by irrational behavior of investors. In good times, overoptimism may lead households to buy real estate despite high prices. In bad times, pessimism may lead households to sell their houses despite low prices. Observationally, such irrational exuberance would also be equivalent to requiring low expected returns in good times and high expected returns in bad times (Shiller, 2014, 1981). How are we to resolve this debate? At this level, we cannot and I leave this as an item for future research. Whatever the relative importance of these two schools of thought in explaining return predictability is, the evidence presented in this paper suggests that time-varying discount rates have been a consistent feature of housing markets in advanced economies and are crucial to understand house price booms and busts.

The post-crisis wisdom has become that large house price corrections tend to be damaging events that create significant economic costs. Neither economists nor policy makers may be able to identify house price bubbles with certainty as they develop. But they still need to make judgments about whether sharp increases in house prices are evidence of mounting financial and economic risks. The finding that housing returns are predictable implies that returns are mean reverting, i.e. above-average returns tend to be followed by below-average returns and vice versa. Or, in the words of Newton, "what goes up, must come down." An important implication of return predictability for policy makers therefore is that rent-price ratios may be a useful indicator of potential subsequent house price reversals. Yet this paper also shows that house price cycles are not only intense but also tend to be long and while prices revert to fundamentals, this reversion make take extended periods of time.

Chapter 4

# Household Debt and Economic Recovery: Evidence from the U.S. Great Depression

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## 4.1 Introduction

Given the slow pace of economic recovery from the Great Recession in the U.S. and elsewhere, economists have begun examining the factors that keep economies depressed in the wake of financial crises. The speed of economic recovery continues to be a much-discussed topic in the media as well as in the economics profession. This debate has typically focused on whether financial crises have been associated with deeper and more prolonged spells of recession than other forms of crisis.

So far, two different interpretations of the historical evidence on recoveries from financial crises have been put forward. The first line of interpretation posits that financial crises are associated with substantially weaker recoveries. Reinhart and Rogoff (2009a), for instance, argue in their widely cited work that declines in output, employment, and asset markets during recessions driven by financial crises are not only more pronounced but also significantly protracted (see also Reinhart and Rogoff (2009b)). Several authors such as Reinhart and Reinhart (2010), Cerra and Saxena (2008), and the International Monetary Fund (2012a) report similar findings, supporting the idea that financial crises have a more adverse effect on economic performance during the period of recovery than 'normal' recessions do.[1] The second line of interpretation, however, contends that there is little evidence for differences in output performance between different types of recession during the recovery period. On the contrary: it is even argued that the economy might bounce back faster from deep recessions triggered by financial crises than recessions in which financial crisis has played no role (Bordo and Haubrich, 2012; Howard et al., 2011).[2] Even though the general consensus is that

[1]Reinhart and Reinhart (2010) take a long-term perspective on financial crisis that incorporates the recovery period by examining the behavior of key macroeconomic indicators during the decade before and the decade after the crisis. They find that financial crisis significantly adversely affect the performance of these indicators, including slower income growth rates and elevated unemployment. Cerra and Saxena (2008), analyzing a sample of 160 countries, argue that financial crises are associated with large output losses that tend to be highly persistent. Based on this previous research, Reinhart and Rogoff (2012) argue that the U.S. has performed better during the current recovery than during previous systemic financial crises and has performed better than other countries that experienced similar systematic financial crises in 2007–2008. Some critics, however, have pointed out that a sample such as used by Reinhart and Reinhart (2010), Reinhart and Rogoff (2009a), and Cerra and Saxena (2008) comprising advanced and developing economies might not offer meaningful evidence. Nevertheless, Schularick and Taylor (2012b), focusing on 14 advanced economies between the years 1870 and 2008, also stress that the recent recovery has been far better than could have been expected given the historical record on recoveries from financial crises. From a sample of 21 advanced economies since 1960, the International Monetary Fund (2009) concluded that financial crisis-based recessions tend to be more severe and longer lasting than recessions associated with other shocks. The subsequent recovery is usually weaker, with tight credit conditions and weak domestic demand being important features of these periods.

[2]Howard et al. (2011) examine 59 advanced and emerging economies since 1970. They define the recovery by indexing the level of GDP to 100 at the date of the recession trough. But they also note that the strength of recovery varies under certain circumstances. For instances, recessions featuring severe housing downturns are associated with slower recoveries, while deep recessions are followed by faster recoveries. Bordo and Haubrich (2012) analyze U.S. recessions since 1880. According to the authors, the weak current recovery is a major departure from historical precedent. Their approach, however, has been criticized by Krugman (2012), who identifies several misattributions and argues that using growth from the recession trough as a measure of recovery success provides a blurred picture. This criticism also applies to the approach used by Howard et al. (2011). Reinhart and

recessions driven by financial crisis are more costly than other recessions (Taylor, 2014; Bordo and Haubrich, 2010; Schularick and Taylor, 2012a; Reinhart and Rogoff, 2009b; Cerra and Saxena, 2005b,a; Kaminsky and Reinhart, 1999), there remains some uncertainty about how recoveries from financial crises differ qualitatively from recoveries associated with standard recessions.[3]

While the explanatory power of the crisis type (financial or not) on the length, strength, and quality of recovery remains debated, recent research suggests that the development of certain macroeconomic variables during the pre-crisis period could be decisive. Schularick and Taylor (2012b) offer an insightful perspective using pre-crisis credit growth instead of a binary approach to identify slumps set off by financial crises. The authors conclude that "all recessions [and recoveries] are not created equal": the more credit intense the expansion years preceding a crisis, the more severe the recession and the slower the recovery. This is particularly interesting because leverage has been identified as playing an important role in financial crises.[4] In a similar vein, one strand of literature that seeks to explain the current sluggish recovery stresses that high and persistent levels of household debt – known as a *debt overhang* – holds back economic recovery, because households continue to deleverage in an attempt to repair their balance sheets (Mian and Sufi, 2014b; Mian et al., 2013).[5]

This paper aims to contribute to this debate. It offers a new perspective by analyzing the link between high household indebtedness and economic performance during the recovery from the Great Depression in the U.S. The Great Depression is an obvious place to look. As in the run-up to the recent crisis, the years preceding the Great Depression were a time of marked credit expansion. Household indebtedness more than doubled in the 1920s, from 15 percent of GDP in 1920 to 32 percent of GDP in 1929.[6] After the Great Crash in 1929, households tried to reduce their debt burdens (Temin, 1976, 171) as incomes fell.[7] Aggregate demand collapsed, with consumer expenditures decreasing by 18 percent between 1929 and 1933 (Temin, 1976, Table 1).[8]

Rogoff (2012) also observe that Bordo and Haubrich (2012) failed to distinguish between systemic financial crises and non-systemic ones. Schularick and Taylor (2012b) note that the implications of financial crises might be hard to identify given the small sample size when only focusing on U.S. experience.

[3]See also Brunnermeier and Sannikov (2012), who state that "[e]mpirically, the profession has not settled the question of how fast recovery occurs after financial recessions."

[4]See for example Tobin (1989), who called it the "Achilles heel of capitalism." Sutherland et al. (2012) argue that high debt in general is associated with more pronounced vulnerabilities and thus can weaken macroeconomic stability.

[5]See Konczal (2012) for an overview of studies discussing this *balance sheet recession view.*

[6]Data drawn from Goldsmith (1955, Table D-1), Grebler et al. (1956, Table N4), James and Sylla (2006, Table 889), Schularick and Taylor (2012a).

[7]Between 1929 and 1933, personal income per capita declined by about 35 percent in real terms (Schwartz and Graham, 1955).

[8]Temin (1976) found that the collapse in aggregate consumption in 1930 was even more pronounced than in 1921 and 1938 and argued that "the fall in consumption must be regarded as truly autonomous" (Temin, 1976, 83). Examining the reasons of the collapse in consumption, Romer (1990) claimed that the 1929 stock market crash created uncertainty about future income causing consumers to decrease spending on durable goods. Olney (1999, 320) notes the significance of consumer debt, writing that "[t]he 1930 drop in consumption resulted from the unique combination of

In this paper, I use cross-sectional data for U.S. states to examine state-level variation in household indebtedness and the strength of recovery during the Great Depression. The level of household debt varied substantially across states at the onset of the Depression. I look for evidence of a correlation between household debt and economic performance during the recovery period. The state-level focus not only allows a more detailed and nuanced study of the Great Depression in the U.S.; it is also helpful in circumventing problems associated with unobserved heterogeneity in cross-country studies. In examining this relationship, I compiled a new dataset containing state-level data on credit, income, employment, and various other control variables for the period 1925–1939.

I am not the first person to study state-level performance during the Depression with the goal of understanding its specific drivers. Previous contributions have pointed out differences in economic structures and in initial prosperity as main factors that produce spatial variation in economic performance (Garrett and Wheelock, 2006; Rosenbloom and Sundstrom, 1997; Wallis, 1989). The role of New Deal spending and regional variation in banking crises has also been discussed in great detail (Fishback et al., 2005, 2003). It is thus important to control for a wide range of other factors. To the best of my knowledge, debt overhang in the household sector has not been examined systematically as a central factor behind the divergence in state-level economic performance in the 1930s. Therefore, this paper hopes not only to make a specific contribution to the aforementioned studies on the role of household debt in the business cycle but also to illuminate an important aspect in the comparative development of U.S. states during the Great Depression.

The main findings of this paper are as follows. First, I demonstrate with a cross-sectional analysis that there was a close relationship between household indebtedness and economic performance during the recovery period. More indebted states showed worse economic performance than less indebted states. Second, I show that this indebtedness/performance relationship was mostly driven by a slower pace of economic recovery, but not by a more severe recession. Thus, state-level data for the U.S. in the 1930s provide strong evidence for the view that household indebtedness shapes the recovery path, a view consistent with studies on debt overhang in the household sector during the current recession. Third, I present some suggestive evidence that deleveraging was an important factor as high debt-to-income states reduced their debts more strongly. My findings are robust to the inclusion of controls for initial income levels, for sector-specific shocks, for bounce-back effects, for effects of fiscal and monetary policy, as well as for the degree of bank distress. Overall, I find that household debt overhang is an important aspect in explaining the severity and duration of the Great Depression in the U.S.

The remainder of this paper is structured as follows. The second section provides a theoretical discussion, reviewing literature on the link between household debt, economic downturns, and subsequent recoveries. After discussing the dataset and the methodology, in the third section I analyze the relationship be-

historically high consumer indebtedness and punitive default consequences."

tween household debt and economic performance during the 1930s. Moreover, I examine deleveraging as a possible transmission mechanism for the adverse effect of high household indebtedness. The final section provides a summary of my findings.

## 4.2 Household debt and the economy: Then and now

In recent academic and political debates, the credit boom that preceded the Great Recession features prominently. This comes as no surprise, as it has been widely noted that countries experiencing particularly pronounced credit booms, such as the U.S. but also the United Kingdom and Spain, have faced more sluggish recoveries than countries like Germany or Canada, which entered the Great Recession with low private credit levels. Using U.S. county level data, Mian and Sufi (2014b) and Mian, Rao, and Sufi (2013) show how the accumulation of household debt affected consumption and employment during the recession. They argue that the substantial accumulation of household debt between 2002 and 2006 in combination with the collapse in home prices at the onset of the economic crisis helps to understand the onset, severity, and the length of the subsequent collapse in consumption (Mian et al., 2013). Faced with the strong decline in housing prices, highly leveraged counties experienced a severe shock to their balance sheets in 2007 and 2008. Affected households started to reduce their debt burdens and rebuild their balance sheets. This, in turn, resulted in a significant drop in household consumption expenditures and pronounced weaknesses in aggregate demand. The researchers conclude that weak household deleveraging and the resulting drop in aggregate demand were major causes of the high and persistent level of unemployment (Mian and Sufi, 2014b).[9] This relationship appears to apply not only to the United States but also to countries globally. Analyzing a sample of advanced economies over the past three decades, the International Monetary Fund (2012a) finds that housing busts and recessions that were preceded by larger run-ups in household debt tended to be deeper and protracted.[10]

How can the close relationship between debt overhang in the household sector and economic performance be rationalized? This question is not entirely new. The role of financial factors in the business cycle was the subject of research as far back as the 1930s. The boom leading up to the Great Depression was associated with a strong increase in household indebtedness.[11] While the literature emphasizes the rapid expansion of consumer credit during the *années folles*, caused by the

[9]Both Mian et al. (2013) and Mian and Sufi (2014b) employ U.S. county-level data for their studies. Using household survey data from the Panel Study of Income Dynamics, Dynan (2012) offers evidence consistent with this argument. Also Glick and Lansing (2009) make a similar point arguing that the deleveraging by U.S. households would act as near-term drag on overall economic activity through a prolonged slowdown in consumer spending.

[10]Already Glick and Lansing (2010) offer evidence that the link between rising leverage and rising house prices since the late 1990s as documented by Mian and Sufi (2010) might be a global phenomenon. The same holds true for the link between household leverage before the crisis and the decline in consumption during the crisis.

[11]This unprecedented credit boom has been emphasized in several accounts of the 1920s, such as Allen (1931, 167 ff.).

*consumer durable revolution* (Vatter, 1967) and the related proliferation of the installment plan (Olney, 1987; Hyman, 2011), mortgage debt as the largest component of total household liabilities increased at an even slightly faster pace between 1920 and 1929.[12] The rise in residential mortgage debt was associated with a nationwide real estate boom. Though prices probably peaked in 1925 – well in advance of the Great Depression – residential housing starts remained strong for the rest of the decade, fueling a continuous rise in household mortgage debt.[13]

High levels of household debt accumulated during the 1920s were the principal ingredient to Irving Fisher's concept of a self-enforcing debt deflationary spiral that reinforces an initial economic shock (Fisher, 1933).[14] According to Fisher, once household debt is perceived as excessive either by creditors or debtors, credit markets tighten and force creditors to consolidate by liquidating asset positions to reduce debt stocks. The subsequent asset price slump increases the value of debt in real terms, enforcing another cycle of distress selling and a debt-deflationary spiral. Accordingly, Fisher concludes that the Great Depression was "an example of a debt-deflation depression of the most serious sort" (Fisher, 1933, 345).

Yet Fisher's insights were largely forgotten in subsequent decades. Not only were there no financial crises in advanced economies in the three decades after the Second World War. Fisher also neglected to discuss why changes in debt levels – which, by definition, go hand in hand with equivalent changes in assets – have macroeconomic consequences. As every debt is an asset for someone else, debt deflation episodes redistribute wealth, though the aggregate asset position of the household sector remains more or less unchanged. In short, the unexpected price level shocks discussed by Fisher would only have redistributive effects within the household sector.

Tobin (1980, 10), focusing on the implications of distributional shocks between debtors and creditors, asserts that "[a]ggregation would not matter if [...] the marginal propensity to spend from wealth were the same for creditors and debtors." Tobin reasons that the borrower and lender status is not randomly distributed among households. Rather, the debtor status indicates a comparably higher marginal propensity to spend. In this case, a redistribution of wealth from borrowers to lenders is not neutral in terms of demand. King (1994) further pursues Tobin's argument, presenting suggestive evidence on the link between the shortfall of consumption in the 1990s and the previous rise in the household-debt-to-income ratio by county and region for the United Kingdom. Another perspective was offered by Mishkin (1978), who argues that household balance sheet adjustments triggered by financial distress lower demand for tangible assets, which

[12] Total consumer credit (i.e. long-term and short-term) increased from $6.07 bn in 1920 to $14.4 bn in 1929 for an average annual growth rate of 9 percent. During the same period, residential mortgage debt rose from $7.2 bn to $18.9 bn, which amounts to an average annual growth rate of about 10 percent (data drawn from Goldsmith (1955, Table D-1), Grebler et al. (1956, Table N4), James and Sylla (2006, Table 889).

[13] For a discussion of the real estate boom and bust of the 1920s, see for example White (2014) and Allen (1931, 270 ff.).

[14] This was the first attempt to account systematically for the role of private debt in business cycle theory.

is to say, for consumer durables and residential housing.[15]

The recent financial crises and the subsequent recession have precipitated renewed interest in these questions. Several recent contributions argue that a shock to household balance sheets results in a significant reduction in consumption (Eggertsson and Krugman, 2012; Guerrieri and Lorenzoni, 2011; Philippon and Midrigan, 2011). Though this research focuses on the state of the household balance sheet, it differs from Mishkin (1978) in two regards: First, most authors define the shock to household balance sheets as a sudden credit tightening. Second, deleveraging is considered the main transmission mechanism linking high household debt to a decrease in consumption. In line with Tobin (1980) and King (1994), these studies assume heterogeneous agents, in other words that some households are borrowers and some are lenders.

Eggertsson and Krugman (2012) model a crisis that results from a deleveraging shock triggered by sudden awareness that assets are overvalued and household collateral constraints too lax, a so-called *Minsky moment*.[16] The authors assume that households are heterogeneous: debtor households are impatient; creditor households are patient. As a consequence of the sudden downward revision of acceptable debt levels, debtors need to cut back on current consumption to adjust to the borrowing constraint.[17] Therefore, to sustain spending by the creditor so as to maintain a certain level of consumption, interest rates have to decrease. However, according to the authors, a nominal interest rate of zero can still be too little to induce sufficient spending; hence, the economy may be stuck in a liquidity trap.[18]

Other models propose similar (if not identical) mechanisms. For instance, the model of Guerrieri and Lorenzoni (2011) and the model of Eggertsson and

[15]In an earlier paper, Mishkin (1977) makes a similar point examining the 1973–1975 recession. In addition to the *liquidity hypothesis*, Mishkin (1978) tested Ando and Modigliani's *life-cycle hypothesis*. Based on this model, he reasons that a drop in a household net wealth has a significant impact on consumption. Accordingly, the large drop in household net wealth between 1929 and 1930, further intensified by price deflation between 1930–32, might have contributed to the decline in aggregate demand. While this model does not distinguish between the effect of assets and the effect of liabilities on the household balance sheet, debt deflation nevertheless partly explains why household net worth decreased substantially during this period.

[16]This term goes back to Hyman Minsky and his financial instability hypothesis. Minsky (1986) argues that the economy is inherently unstable due to "capitalist finance." He characterizes the business cycle upswing as a period of transitory tranquility that expands as economic agents become increasingly optimistic, increasing the willingness to borrow and to engage in speculative and debt finance practices. As balance sheets deteriorate, financial fragility arises. The boom comes to an end when short-and long-term interest rates rise, creating the so-called the Minsky moment. Whether this later leads to a deep recession, a financial crisis, or debt deflation depends mainly on structural characteristics and specific policies, such as overall economic liquidity, government size, and lender-of-last-resort actions by the central bank. The tendencies that precipitate a boom are also determined by institutional structures and policy systems. Though Minsky focuses on corporate debt, his hypothesis, or parts of it, have been applied to cases of household indebtedness by Eggertsson and Krugman (2012) and Palley (1994), among others.

[17]Way back in 1896 Bagehot noted that "[c]redit – the disposition of one man to trust another – is singularly varying. In England, after a great calamity, everybody is suspicious of everybody; as soon as that calamity is forgotten, everybody again confides in everybody."

[18]Hall (2011) makes a similar point, arguing that in an economy with a disabled monetary policy the decline in aggregate demand driven by deleveraging is a major factor in understanding the nature of the contraction.

Krugman (2012) both assume that borrowers deleverage by reducing consumption, but the former also assumes that lenders increase precautionary savings as well. Through the sudden reduction in the demand for, and increase in, the supply of savings, interest rates fall and output declines, with both effects being strongest in the short run.[19] In related work, Philippon and Midrigan (2011) focus on housing as both a consumption good and as a means of providing liquidity via home equity borrowing. When a shock limits the ability of households to extract equity from their houses, leveraged households are forced to reduce their consumption. Applying their model to the Great Recession, they conclude that a reduction in credit at the household level accounts for the decrease in output and employment to a non-negligible extent.

While these theoretical and empirical contributions assume different transmission mechanisms, they all agree that the buildup of debt in the household sector coupled with a shock to household balance sheets can contribute significantly to deep and prolonged economic downturns. The history of the Great Depression provides a fascinating testing ground for these hypotheses. Before turning to the empirical evidence on the relationship between household debt and state-level economic performance during the 1930s, however, I present in the next section the data set and discuss the methodology.

## 4.3 Estimating the effects of household debt on economic recovery in the 1930s

The trajectory of the Great Depression in the U.S. is well known. After the stock market crash in October 1929, the U.S. economy entered a sharp recession. In the second half of 1932, industrial production increased slightly but a wave of banking failures in early 1933 pushed the U.S. back into depression. It was only after the banking holiday in the spring of 1933 that the recovery began in earnest. Until 1937, real GNP grew at an average annual rate of over 8 percent. In the period 1937–1938, the recession within the depression initiated new economic troubles. Despite the high growth rates throughout the recovery, the fall in output was so severe that the U.S. only returned to its pre-Depression growth path around 1942 (Romer, 1990, 1992). The strength of the recovery differed substantially across U.S. states, however.

In this section, I study the role of household debt in the 1930s. The key question to be addressed is whether there is systematic evidence that higher levels of indebtedness were associated with slower recovery. The analysis will focus on state-level economic performance in the recovery period, thus from 1933 to 1939. Economic performance is defined using four different indicators: personal income, wages, employment, and consumption. I also study other sub-periods and perform various robustness tests. The sub-periods that I examine are the Great Depression as a whole (1929–1939), the contraction period (1929–1932), as

[19]Contrary to the findings of Eggertsson and Krugman (2012), borrowing and lending are driven by idiosyncratic income shocks rather than by preferences, though Eggertsson and Krugman (2012) also incorporate a nominal debt deflation mechanism.

well as two periods excluding the recession within the Depression (1929–1937 and 1933–1937). This differentiated approach reveals that the strong relationship between household debt and economic performance is mostly due to a slower pace of economic recovery and not to a more severe slump in the initial years of the Depression recession.

### 4.3.1 Data and methodology

To study the effect of household debt on economic performance during the Great Depression, I compiled a new dataset. The dataset covers 48 U.S. states and the District of Columbia from the years 1929 to 1939 at annual frequency.[20] For each state, it assembles data on household debt, income and wages per capita, employment, New Deal spending, sectoral output composition, discount rates set by the respective regional Federal Reserve Banks, bank failures, and retail sales. I draw on a variety of data sources and the work of other scholars such as Fishback et al. (2005) and Wallis (1989). Below I briefly describe the key variables and introduce the empirical model to be estimated.[21]

For the period of the Great Depression and the subsequent recovery, most standard indicators for economic performance and business cycle activity (such as GDP or consumption) are unavailable due to lack of reliable and consistent state-level data. To circumvent this shortcoming, I use state-level per capita income ($INC_s$) and per capita salaries and wages ($WAGE_s$) as dependent variables. While at the national level, per capita income serves as a good proxy for GDP per capita (correlation coefficient of 0.98 for the period 1929–1939), per capita salaries and wages (the largest share of total household income) are a more sensitive income measure of economic fluctuations.[22] Data on total household income and salaries and wages are drawn from Schwartz and Graham (1956). To study the effects of household debt on employment, I also use the employment index provided by Wallis (1989) ($EMP_s$) as a third dependent variable. The index is calculated from establishment surveys on firms undertaken by the Bureau of Labor Statistics (BLS). Finally, according to Fishback et al. (2005), retail sales serve as a strong proxy for consumption, both for durable and non-durable goods. As a fourth dependent variable, I therefore use data on retail sales supplied by Fishback et al. (2005) to examine effects on consumption ($SALES_s$).

In the empirical literature examining the effects of indebtedness on economic performance, the household debt-to-income ratio is commonly used as key explanatory variable (Olney, 1999; Glick and Lansing, 2010; Mian et al., 2013; Philippon and Midrigan, 2011; International Monetary Fund, 2012a; Mian and Sufi, 2014b). I use the average state-level ratio of household debt-to-income in 1929 ($DEBT_{s,1929}$) to proxy for household leverage.[23]

[20] Alaska and Hawaii did not become U.S. states until 1959.

[21] For a complete description of data, see appendix to this chapter.

[22] Wage and salary disbursements accounted for on average 58.5–65.2 percent of personal income in the 1930s (Creamer and Merwin, 1942).

[23] I use the word leverage in a broader sense to stand for household indebtedness relative to income. Typically, the concept of leverage relates to the ratio of household debt to household assets.

As data on total household debt is unavailable at the state level, average annual debt-to-income ratios are calculated using annual state-level mortgage debt data drawn from the All Bank Statistics (ABS) (Board of Governors of the Federal Reserve System, 1959). In assessing the adequacy of the approximation, I calculated the share of total, i.e. national-level, residential mortgage debt in total household debt.[24] As shown in Figure 4.1, mortgage debt is by far the largest share of household debt during the period 1925–1939, amounting to on average 60 percent of total household debt. Moreover, at the national level, mortgage debt reproduces the trends and fluctuations in total household debt fairly well, with a variable correlation of 0.8.

**Figure 4.1:** Composition of nonfarm private debt, 1925–1939.

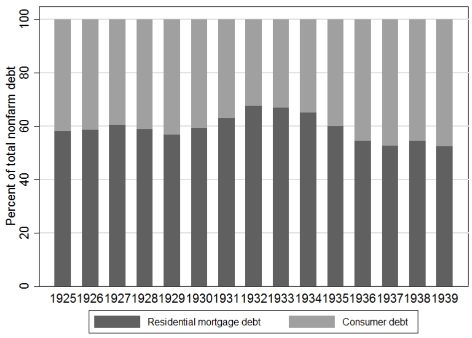
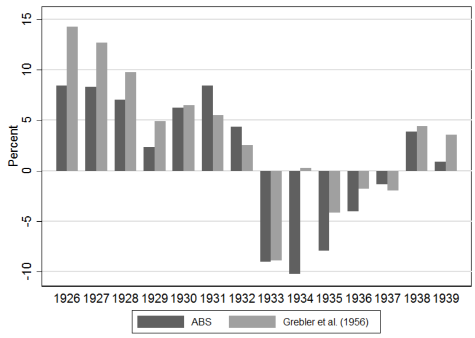



**Figure 4.2:** Year-to-year changes in mortgage debt, 1925–1939.




Yet data from the ABS suffer from two constraints: First, they underestimate total mortgage debt because they do not record household lending by all financial intermediaries. The ABS cover mortgages issued by national banks, chartered state banks, loan and trust companies, stock savings banks, unincorporated private banks, and mutual savings banks. This neglects major lenders for mortgage credit such as building and loan associations and life insurance companies.[25] Second, the data series also comprises loans on farmland and other properties, as well as

In the event of an adverse economic shock, households with an unexpected debt overhang are forced to readjust to their targeted net asset position through deleveraging. By leverage I generally mean the debt-to-income ratio or income leverage. "Debt overhang" also refers to the debt-to-income ratio of households.

[24]Data are drawn from James and Sylla (2006, Tables 889); Goldsmith (1955, Table D-1); Grebler et al. (1956, Table N4).

[25]For 1929, in addition to the data on mortgage debt published in the ABS, the Bureau of Labor Statistics provides annual state-level data on mortgage loans outstanding made by building and loan associations covering 45 states and the District of Columbia (MD, TN, and SC are not reported separately) (U.S. Bureau of Labor Statistics, 1930). Using a measure of aggregate mortgage debt, i.e. combining data from the ABS and the Bureau of Labor Statistics, to calculate alternative average annual debt-to-income ratios ($DEBT2_{s,1929}$) for the analysis in Section 4.3.2 does not affect the economic and/or statistical significance of the results (see Appendix Table C.5). However, since no state-level data on mortgage loans outstanding made by building and loan associations is available for 1932 and the data for 1929 covers only 45 states and the District of Columbia, data drawn from the ABS will be used as principal source.

loans on bonds and mortgages.[26]

Nevertheless, real estate lending as reported by in the ABS appears to be a good indicator for total residential mortgage lending. Figure 4.2 compares annual percentage changes in the ABS data on national level with annual percentage changes in total residential mortgage debt outstanding as reported by Grebler et al. (1956). As is quite evident, the two data series follow the same trend for the national level. Both series are strongly correlated (approx. 0.8) for the period 1925–1939.

Figure 4.2 also confirms the strong increase in mortgage indebtedness during the second half of the 1920s.[27] Data drawn from the ABS suggest a strong positive relationship between the mortgage debt-to-income level in 1929 and the percentage change in mortgage debt per capita from 1925 to 1928.[28] Unsurprisingly, this indicates that households had higher debt-to-income ratios when the boom years came to an end in states with a particularly pronounced credit growth in the 1920s.[29]

The key explanatory variable in the following analysis is the initial average state-level indebtedness of households, $DEBT_{s,1929}$, defined as the mortgage debt-to-income ratio as of 1929 for each state. As a robustness check, I also use the mortgage debt-to-income ratio as of 1932 ($DEBT_{s,1932}$) for each state. Results for these two key variables are reported separately in the analysis, but the results are very similar.[30]

Debt levels are unlikely to be the only drivers of economic performance, however. Hence, it is crucial to account for other factors that may produce spatial inequality in economic performance and propose additional control variables. In selecting variables I follow previous literature (Garrett and Wheelock, 2006; Fishback et al., 2005; Calomiris and Mason, 2003; Romer, 1993). The control variables fall into the following broad categories: income level, fiscal policy, and the effects of the New Deal; sector specific factors; potential regional differences in monetary policy; and bank failures.

Let me now discuss the other factors that may have induced spatial inequality

[26] For instance, the share of farm mortgages was between 20 and 30 percent of total mortgages during the period 1925–1939.

[27] This applies to all loan categories reported in the ABS: real estate loans, loans secured by collateral other than real estate, and all other loans (see Appendix C). The increase in real estate loans and loans on collateral (including loans backed by securities) stands out in particular and provides a suggestive link between the real estate boom and the stock market boom and the growth of credit.

[28] The correlation coefficient is 0.43. The relationship remains strong (correlation coefficient of 0.48) even when omitting influential observations (VT, MA, NH, CT, NY). This also applies when using the change in total loans p.c. as reported in the ABS 1925–1928 (correlation coefficent of 0.40). But because state-level income data is unavailable prior to 1929, it is impossible to determine the extent to which the increase in household debt corresponds to a comparable development in income.

[29] In Oklahoma, households were the lowest income levered (with a mortgage debt-to-income ratio of 0.13). Households were the highest income levered in Vermont (with a mortgage debt-to-income ratio of 0.43).

[30] Moreover, in Appendix Table C.5, I use a measure of aggregate mortgage debt, i.e. combining data from the ABS and the U.S. Bureau of Labor Statistics (1930) to include mortgage loans outstanding made by building and loan associations, to calculate alternative average annual debt-to-income ratios ($DEBT2_{s,1929}$).

and the control variables needed to compensate for them. I have five salient points. First, the depression could have had different effects on states depending on their productivity levels, which is why I include – state-level income per capita in 1933 relative to nation-wide income per capita in 1933 – as a measure of aggregate productivity.

Second, since bank failure rates vary widely across states, $BANKFAIL_s$ controls for the degree of bank distress at the state level between 1929 and 1933 and is defined as the annual average rate of bank suspensions in the period 1929–1933.[31] Although the exact transmission mechanism through which bank failures magnify the extent of economic decline is disputed,[32] bank failures have been identified as a significant factor in explain-ing economic performance during the period of the Great Depression (Calomiris and Mason, 2003; Romer, 1993; Bernanke, 1983; Friedman and Schwartz, 1963). Bank failures might matter particularly as an indicator of credit supply (Calomiris and Mason, 2003).

Third, during the 1930s, particularly as part of the New Deal, the federal government embarked on expansionary fiscal policy and issued substantive volumes of loans and grants throughout the United States to revive economic activity. As a result, federal civilian spending as a share of GNP increased from about one to eight percent during this decade (Rockoff, 1998). Because New Deal spending per capita differed markedly across states (Fishback et al., 2005), I control for cross-sectional level effects with the variable $NEWDEAL_s$, which measures cumulative per capita government spending and lending from 1933 to 1939 for each state.

Fourth, sector-specific shocks might create spatial differences in economic performance depending on the sectoral composition of output in a respective state. Sectors particularly affected by the economic downturn after 1929 were agriculture, mining, construction, and durable manufacturing. By contrast, the services and transportation sector were affected to a lesser extent (Garrett and Wheelock, 2006). Accordingly, states with an initially unfavorable sectoral specialization can be expected to experience larger declines in per capita income than states less dependent on these sectors. I use $AGRIC_{s,1929}$ and $MAN_{s,1929}$ to proxy for sector specific factors. These variables measure salaries and wages received from agriculture and manufacturing as a share of total personal income at the state level in 1929.[33]

Fifth, and finally, I aggregated states into regions based on the Federal Reserve Districts as a control variable. It measures the extent and timing of the monetary policy response by the respective regional Federal Reserve Bank ($MONPOL_s$) to account for possible differences in monetary policy. The variable is calculated

[31] While most northeastern states had low failure rates, several mid-western and southern states faced substantial bank distress, with failure rates exceeding 10 percent in the period 1929–1933.

[32] Friedman and Schwartz (1963), for example, point out the negative impact of banking panics on money supply, which led to a decline in spending, employment, and output. Bernanke (1983), by contrast, argues that the principal conduit for the transmission of shocks is that of disrupted credit flows through the increased cost of financial intermediation.

[33] According to data drawn from Carter (2006), in 1929, about 25 percent of national income came from salaries and wages in the manufacturing sector and about 10 percent from salaries and wages in the agricultural sector.

using data on discount rates set by the respective regional Federal Reserve Banks in the contraction period, 1929–1932. Timing and scale of interest rate cuts are used as weights. Earlier and stronger interest rate cuts are attributed a higher weight than smaller and posterior reductions in discount rates. The results suggest that differences in monetary policy generally did not produce spatial variation in economic outcomes.

Summary statistics for the main variables are presented in Table 4.1.

**Table 4.1:** Summary statistics.

| | Mean | Min | Max | Std. Dev. | N |
|---|---|---|---|---|---|
| $DEBT_{s,1929}$ | 0.097 | 0.013 | 0.426 | 0.095 | 49 |
| $\Delta INC_{s,1929-39}$ | 0.011 | -0.201 | 0.210 | 0.084 | 49 |
| $\Delta WAGE_{s,1929-39}$ | 0.063 | -0.324 | 0.304 | 0.096 | 49 |
| $\Delta EMP_{s,1931-39}$ | 0.162 | 0.081 | 0.018 | 0.391 | 48 |
| $\Delta SALES_{s,1929-39}$ | 0.010 | -0.303 | 0.230 | 0.127 | 48 |
| $DELEV_{s,1933-39}$ | 0.079 | -0.523 | 1.148 | 0.348 | 48 |
| $NEWDEAL_s$ (in 1967 Dollars) | 238.27 | 107.46 | 746.78 | 111.21 | 49 |
| $BANKFAIL_s$ | 0.134 | 0.008 | 0.394 | 0.083 | 49 |

I use a cross-sectional OLS model. The estimation equation for the baseline specification covering the period 1933–1939 is:

$$\begin{aligned}\Delta Y_s = \alpha + \beta_1 DEBT_{s,1929} + \beta_2 INC_{s,1933} + \beta_3 AGRIC_{s,1929} + \beta_4 MAN_{s,1929} \\ + \beta_5 NEWDEAL_s + \beta_6 MONPOL_s + \epsilon_s\end{aligned} \tag{4.1}$$

With $s$ indexing states. The error term is assumed to be well behaved. $\Delta Y_s$ varies in the regressions. I use four different dependent variables: income per capita, salaries and wages per capita, employment, and retail sales. $\Delta Y_s$ is

$$\Delta Y_s = lnY_{s,1937} - lnY_{s,1933} \tag{4.2}$$

In other words, it expresses the observed percentage change of the respective dependent variable during the recovery period. This period also covers the recession within the depression and might thus confuse different effects. For this reason, the specification is estimated to exclude the years 1938 and 1939 as a second measure of the recovery period.

### 4.3.2 Household debt and recovery, 1933–1939

What were the implications of high ex-ante levels of household income leverage for economic performance during the recovery period? The initial visual inspection of the data suggested a notable relationship between the level of household indebtedness as of 1929 and the growth rate in personal income between 1933 and 1939. Figure 4.3 shows the correlation plot for these two variables. The plot indicates that high-debt states showed worse economic performance than lower indebted states.[34] While the relationship in Figure 4.3 is indicative, one also needs to control for other variables, as I stress above. I thus now turn to formal regression analysis using the baseline specification outlined in the previous subsection.

**Figure 4.3:** Debt-to-income in 1929 and economic recovery 1933–1939.

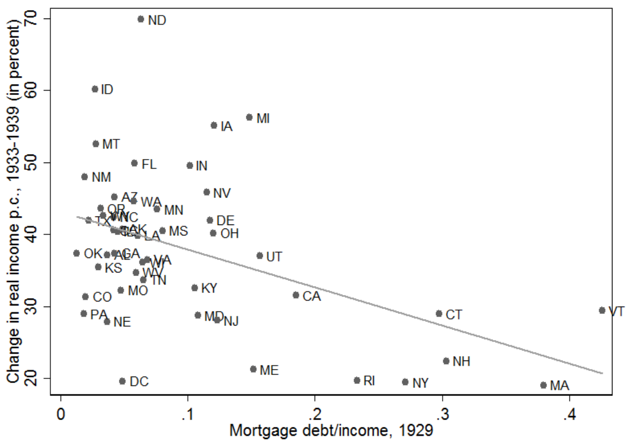



Table 4.2 shows the regression of ex-ante household indebtedness on the percentage change in four indicators for economic performance from 1933 to 1939: income per capita, wages per capita, employment, and retail sales. The model is estimated with heteroskedasticity-robust standard errors.[35] These benchmark results show an interesting picture: regression coefficients on $DEBT_{s,1929}$ are negative and highly significant on the five percent level for all dependent variable specifications. Everything else being equal, the coefficients point toward a decrease in the growth rate of employment, per capita income, and per capita salaries and wages during the recovery between 2.7 and 4.2 percentage points for a debt-to-income ratio ten percentage points above the sample mean. At the very least, these preliminary results suggest that in states where households initially faced relatively high debt balances, economic performance between 1933 and 1939 was markedly weaker.

Figure 4.4 explores this relationship between the level of household indebtedness and the strength of economic recovery in simple graphical form. The graphs present an index with 1933=100 for all four dependent variables distinguishing between the 13 high-debt states and the 12 low-debt states, that is the states in

[34]This negative relationship remains robust even when omitting the influential states VT, MA, NH, NY, CT, and PA.

[35]Standard errors and levels of significance are not distorted by heteroskedasticity because standard test procedures (like the Breusch-Pagan test) do not detect it. This assumption is also supported by the fact that regressions with and without heteroskedasticity-robust standard errors and levels of significance do not differ significantly. All regression results in this paper are reported with heteroskedasticity-robust standard errors and levels of significance. For income p.c., SD has been omitted as an outlier. Wallis does not provide an employment index for DC in any given year (Wallis, 1989).

the top and bottom quartile for the 1929 debt-to-income ratio. It shows a clear divergence of recovery paths in these two groups for all economic performance indicators. Overall, low-debt states appear to recover faster and stronger during the period 1933–1939.[36]

**Table 4.2:** Regression results recovery, 1933–1939.

| | (1) $\Delta\ INC_{s,1933-39}$ | (2) $\Delta\ WAGE_{s,1933-39}$ | (3) $\Delta\ EMP_{s,1933-39}$ | (4) $\Delta\ SALES_{s,1933-39}$ |
|---|---|---|---|---|
| $DEBT_{s,1929}$ | -0.282*** | -0.232*** | -0.388** | -0.321** |
| | (0.086) | (0.079) | (0.151) | (0.136) |
| $INC_{s,1933}$ | -0.112*** | -0.088*** | 0.022 | 0.438 |
| | (0.023) | (0.017) | (0.056) | (0.048) |
| $AGRIC_{s,1929}$ | 2.321*** | -0.0514 | -0.295 | -0.111 |
| | (0.199) | (0.237) | (0.681) | (0.755) |
| $MAN_{s,1929}$ | 0.273* | 0.323*** | -0.283 | -0.106 |
| | (0.156) | (0.127) | (0.251) | (0.183) |
| $NEWDEAL_s$ | 0.000 | 0.000 | 0.002* | 0.002* |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| $MONPOL_s$ | -0.032* | -0.032** | -0.0267 | -0.0148 |
| | (0.017) | (0.014) | (0.029) | (0.024) |
| Constant | 0.343*** | 0.345*** | 0.260*** | 0.394*** |
| N | 48 | 49 | 48 | 48 |
| $R^2$ | 0.648 | 0.4314 | 0.2384 | 0.1765 |

*Notes*: Standard errors in parentheses; *** p<0.01, ** p>0.05, * p<0.1. Standard errors are heteroskedasticity-robust.

According to the regression results in Table 4.2, the level of per capita income in 1933 correlates negatively to economic performance in the recovery period. This means that the initially less prosperous states experienced a stronger recovery. The immediate question, however, is how these less prosperous states performed during the contraction period. If they performed worse than more prosperous states – due to a sectoral composition that made the state economy more vulnerable to shocks, say – the negative effect of income per capita as of 1933 may be due to catch-up or bounce-back effects. In the "plucking model" of business fluctuations, Friedman (1993) argues that the size of the contraction affects the subsequent expansion and thus hypothesizes a bounce-back effect. For this reason, I include an additional control for a bounce-back effect ($BOUNCEBACK_s$) that is calculated as the percentage change (change in natural logs) of the respective dependent variable in the period 1929–1932.[37]

Table 4.3 repeats the benchmark regression of Table 4.2 when controlling for

[36]Accordingly, the 12 low-debt states are CO, ID, KS, MT, NE, NM, OK, OR, PA, SD, TX, and WY. The 13 high-debt states are CA, CT, IA, MA, ME, MI, NH, NJ, NY, OH, RI, UT, and VT.

[37]The respective $BOUNCEBACK_s$ variables are defined as $\Delta INC_{s,1929-1932} = lnINC_{s,1932} - lnINC_{s,1929}$, $\Delta WAGE_{s,1929-1932} = lnWAGE_{s,1932} - lnWAGE_{s,1929}$ and $\Delta EMP_{s,1929-1930} = lnEMP_{s,1930} - lnEMP_{s,1930}$. Since no data is available for retail sales in 1932, $\Delta INC_{s,1929-1932} = lnINC_{s,1932} - lnINC_{s,1929}$ will be used as a proxy for the bounce-back effect in retail sales. The growth rates in retail sales and personal income strongly correlate for the period 1929–1939 (correlation coefficient of 0.64).

**Figure 4.4:** Recovery paths of high- and low- debt states.


*Notes:* Indices, 1933=100. Income p.c., wages p.c., and retail sales p.c. are adjusted for inflation.

a bounce-back effect. Regression coefficients on $DEBT_{s,1929}$ in columns (1) to (4) remain negative and highly significant on the five percent level for all dependent variable specifications.[38] All things being equal, the coefficients suggest a decrease in the growth rate of employment, retail sales, per capita income, and per capita salaries and wages during the recovery between 2.2 and 3.2 percentage points for a debt-to-income ratio ten percentage points above the sample mean for the period 1933–1939. Moreover, the explanatory power of the specification is substantive, explaining up to about 69 percent of the regressand's variation. The null hypothesis of the F-test can clearly be rejected for all specifications except for regression (4).[39] Even though the model has weak explanatory power for $SALES_s$, the results suggest a statistically significant relationship between high initial household indebtedness and the decline in consumption during the period 1933–1939. Yet be-

[38]To test for the robustness of this relationship, I have analyzed other periods of recovery as well: 1933–1936, 1934–1936, and 1934–1937. The negative correlation between initial household debt and economic performance remains robust and significant.

[39]The F-value is 27.53 in column (1), 8.34 in column (2), 5.68 in column (3), 2.48 in column (4), 22.68 in column (5), 4.29 in column (6) and 6.39 in column (7) with respective p-values of about 0.00. (Except for column (4), where the p-value is 0.03.) The F-test is not distorted by multicollinearity because standard test procedures (like Variance Inflation Factors (VIFs) and simple bivariate correlation) do not detect it among explanatory variables. Most importantly, multicollinearity between $MAN_{s,1929}$ and $AGRIC_s$, 1929 is not present. The VIFs for $MAN_{s,1929}$ and $AGRIC_s$, 1929 remain well below any critical threshold.

cause the availability of retail sales data for the period 1929–1939 is insufficient for making reliable conclusions, these findings provide suggestive evidence at best.[40] Nevertheless, the results provide some indication that highly indebted households cut back consumption more strongly than households with lower levels of indebtedness.

The period 1933–1939 includes the effects of the 1937 recession and hence might be confusing different effects. To extend the analysis, I use regressions (5) to (7) to examine the time period 1933–1937 but excluding the effects of the 1937 recession. Since no data on retail sales is available for 1937, $SALES_s$ is omitted as a dependent variable.[41] As can be seen, the results hold up: regression coefficients on $DEBT_{s,1929}$ are negative and statistically significant on the one percent level for (5) and (6).[42] Once again, the model has high explanatory power. These regressions confirm the findings presented in Table 4.2 suggesting that in states where households initially faced comparably high debt balances, economic performance between 1933 and 1937 as well as between 1933 and 1939 was markedly weaker. The results remain significant when including weights for state size, i.e. when measured by state population in 1930 (see Appendix C, Table C.6).

As for the other control variables in Table 4.3, the results indicate that there is indeed a strong bounce-back effect: states that had suffered more pronounced losses in income and employment during the slump experienced a stronger and more rapid recovery.[43] This is in line with previous findings. For instance, Rosenbloom and Sundstrom (1997) attribute the strong recovery in the Mountain region to a strong bounce-back effect. Also, Garrett and Wheelock (2006) showed that low-income states that had suffered larger declines during the recession would gain faster and stronger during the recovery. At the same time, sector-specific shocks were not a significant factor producing variation in economic outcomes.[44] This points toward the fact that the sectoral composition of output is less relevant in explaining scope and speed of recovery, confirming the finding by Garrett and Wheelock (2006) that income growth varied little across sectors during the recovery period. The coefficients on $NEWDEAL_s$ are economically or statistically sig-

[40] Data on retail sales are available for 1929, 1933, 1935, and 1939.

[41] For income p.c., SD has been omitted as an outlier as has been MI for salaries and wages p.c. For employment, AZ and VT have been omitted as outliers. Wallis does not provide an employment index for DC in any given year (Wallis, 1989).

[42] The p-value (0.14) for the coefficient on $DEBT_{s,1929}$ in column (7) still offers suggestive evidence against the null hypothesis.

[43] Coefficients on $BOUNCEBACK_s$ are negative and highly significant for all three economic indicators and both periods of recovery.

[44] Coefficients on $MAN_{s,1929}$ and $AGRIC_{s,1929}$ differ remarkably between income p.c. and salaries and wages p.c. Total personal income p.c. also includes farm and nonfarm proprietor income. (In 1929, proprietor income accounted for about 17 percent of total personal income, with farm proprietor income accounting for 7 percent of total personal income and nonfarm proprietor income accounting for 10 percent of total personal income.) In the agricultural sector, farm proprietor income increases far more during the period of recovery than do salaries and wages in the farm sector. This implies that $AGRIC_{s,1929}$ has a more pronounced effect on income p.c. compared with wages and salaries p.c. For manufacturing, it is impossible to disentangle these dynamics because Schwartz and Graham report salaries and wages in the manufacturing sector but not proprietor income in the manufacturing sector. I assume that comparable dynamics created the differences in magnitude to the coefficients on $MAN_{s,1929}$ (Schwartz and Graham, 1956).

**Table 4.3:** Regression results recovery, 1933–1937 and 1933–1939 (including bounce-back effect).

| | (1) $\Delta\ INC_{s,1933-39}$ | (2) $\Delta\ WAGE_{s,1933-39}$ | (3) $\Delta\ EMP_{s,1933-39}$ | (4) $\Delta\ SALES_{s,1933-39}$ | (5) $\Delta\ INC_{s,1933-37}$ | (6) $\Delta\ WAGE_{s,1933-37}$ | (7) $\Delta\ EMP_{s,1933-37}$ |
|---|---|---|---|---|---|---|---|
| $DEBT_{s,1929}$ | -0.258*** | -0.227*** | -0.315** | -0.303** | -0.271*** | -0.284*** | -0.276 |
| | (0.0834) | (0.075) | (0.152) | (0.138) | (0.098) | (0.076) | (0.185) |
| $INC_{s,1933}$ | -0.041 | -0.060** | -0.014 | 0.080 | 0.007 | 0.024 | -0.032 |
| | (0.036) | (0.024) | (0.056) | (0.054) | (0.039) | (0.0205) | (0.056) |
| $BOUNCEBACK_s$ | -0.323** | -0.175 | -1.488*** | -0.177 | -0.563*** | -0.353*** | -1.651*** |
| | (0.145) | (0.085) | (0.413) | (0.159) | (0.147) | (0.114) | (0.323) |
| $AGRIC_{s,1929}$ | 2.232*** | 0.053 | -0.631 | -0.163 | 1.611*** | 0.383 | -0.433 |
| | (0.255) | (0.224) | (0.547) | (0.789) | (0.312) | (0.388) | (0.444) |
| $MAN_{s,1929}$ | 0.210* | 0.226* | -0.407* | -0.128 | 0.126 | 0.063 | -0.158 |
| | (0.129) | (0.127) | (0.230) | (0.183) | (0.155) | (0.108) | (0.205) |
| $NEWDEAL_s$ | 0.0000 | 0.001 | 0.002 | 0.002* | 0.000 | 0.001 | 0.001 |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| $MONPOL_s$ | -0.291 | -0.027** | -0.043 | -0.013 | -0.011 | -0.012 | -0.029 |
| | (0.018) | (0.013) | (0.027) | (0.025) | (0.016) | (0.012) | (0.021) |
| Constant | 0.202** | 0.300*** | 0.188*** | 0.316 | 0.143* | 0.214*** | 0.181*** |
| N | 48 | 49 | 48 | 48 | 48 | 48 | 46 |
| $R^2$ | 0.695 | 0.486 | 0.471 | 0.197 | 0.682 | 0.554 | 0.497 |

*Notes:* Standard errors in parentheses; *** p<0.01, ** p>0.05, * p<0.1. Standard errors are heteroskedasticity-robust.

nificant in neither specification. Differences in monetary policy generally did not produce statistically significant variation in economic performance. If anything, a slower and weaker countercyclical response to the initial shock was associated with slightly lower growth during the recovery.

Having examined the debt ratios at the onset of the Great Depression, I now turn to the debt overhang households continued to face in 1932. This accounts for possible changes in household debt-to-income ratios that took place during the contraction period 1929–1932. Figure 4.5 summarizes the changes in household debt-to-income ratios in graphical form. Throughout the economic downturn, from 1929 to 1932, the average state-level mortgage debt-to-income ratio slightly increased. This applies both to high-and low-debt states. Yet though income leverage in low-debt states barely increased between 1929 and 1932, income leverage in high-debt states rose by about 11 percentage points. Not surprisingly, this indicates that households were unable to repair their balance sheets during the years of contraction; the truth was they faced persistent high or even significantly increased debt levels at the onset of the recovery.[45]

**Figure 4.5:** Mean mortgage debt-to-income, 1929–1939.

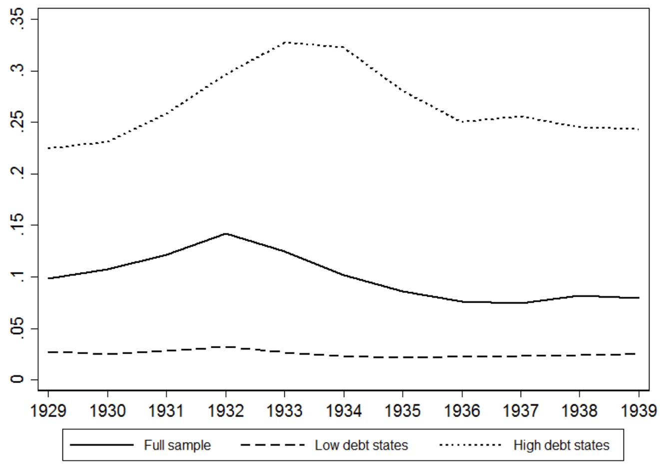



Table 4.4 assesses the implications of the debt overhang with which households entered the period of recovery by regressing the debt-to-income ratio as of 1932 ($DEBT_{s,1932}$) on the percentage change in economic indicators from 1933 to 1937 and from 1933 to 1939. The results are consistent with patterns seen previously when using debt levels as of 1929. The coefficients on income leverage remain negative and highly significant, which suggests a decrease in the growth rate of employment, per capita income, and per capita salaries and wages between 1.6 and 2.3 percentage points for a debt-to-income ratio ten percentage points above the sample mean.[46] Moreover, the explanatory power of the specification remains substantive, explaining up to about 71 percent of the variation of the dependent variable. Finally, the null hypothesis of the F-test can clearly be rejected for all

[45]As can be expected, there is a strong correlation (correlation coefficent of 0.99) between the mortgage debt-to-income ratio in 1929 and in 1932.

[46]The p-value for the coefficient on income leverage in column (7) is 0.26.

specifications.[47]

The results imply that states in which households faced higher income leverage at the onset of the recovery period experienced a weaker economic performance in the period 1933–1937/1939, everything else being equal. On balance, these regressions confirm the earlier results from Table 4.3, which indicate that high levels of household debt acted as a drag on economic recovery during the 1930s.

### 4.3.3 Robustness tests

**Factor analysis** The regressions presented above aim to measure a latent concept of state economic performance using four different observables: personal income per capita, wages per capita, employment, and retail sales. This is because the 'ideal' measure of economic performance – state-level real GDP, i.e. value added on the territory of the individual state – is unavailable. While all four indicators are strongly correlated (bivariate correlation coefficients between 0.82 and 0.94), there are certain conceptual limitations that may dilute their quality as proxies for real state-level GDP. Personal income per capita and wages per capita might be biased because they include out-of-state wage earnings as well as property income from out-of-state assets. The retail sales indicator measures changes of consumption at the state level. Hence, it reflects changes in personal income as well as changes in the propensity to consume. A further bias might result because retail sales include both sales of tradable as well as non-tradable goods, which means they also include goods that have been produced out of state. The employment indicator is only fully consistent if we assume that state-level demand for labor derives entirely from the demand for goods produced within the state. Despite these limitations, however, a substantive share of the variance for all four variables can be attributed to state-level fluctuations of economic performance.

One way to estimate how well these indicators record state-level economic performance is to undertake an explanatory factor analysis. This method identifies the extent to which the variance of these four measures is caused by a set of common, underlying (or unobservable) factors. The analysis suggests that one dominant factor – state economic performance – drives 90 percent of existing cross-state variance in personal income per capita, wages per capita, employment, and retail sales in the period 1929–1939.[48] The loading patterns in Appendix Table C.3 confirm the substantive influence of this factor on all four indicators. Hence, using the factor scores calculated from this analysis as a dependent variable offers an additional way to scrutinize the effect of high levels of household debt on economic performance so as to examine the robustness of earlier findings.[49]

[47] The F-value is 30.02 in column (1), 8.71 in column (2), 5.31 in column (3), 2.6 in column (4), 23.42 in column (5), 4.12 in column (6), and 6.23 in column (7), with respective p-values of about 0.00. The F-test is not distorted by multicollinearity.

[48] As data for retail sales is only available for the years 1929, 1933, 1935, and 1939, the analysis is based on observations for these years. (At that time there were only 48 states.) The corresponding eigenvalue of this factor is 3.6, compared with 0.2 for the second (see Appendix Table C.1). For the respective scoring coefficients, see Table C.2 (see Appendix C).

[49] Summary statistics for factor scores are presented in Appendix Table C.4.

**Table 4.4:** Regression results recovery, 1933–1937 and 1933–1939 (using debt levels as of 1932).

| | (1) $\Delta\ INC_{s,1933-39}$ | (2) $\Delta\ WAGE_{s,1933-39}$ | (3) $\Delta\ EMP_{s,1933-39}$ | (4) $\Delta\ SALES_{s,1933-39}$ | (5) $\Delta\ INC_{s,1933-37}$ | (6) $\Delta\ WAGE_{s,1933-37}$ | (7) $\Delta\ EMP_{s,1933-37}$ |
|---|---|---|---|---|---|---|---|
| $DEBT_{s,1932}$ | -0.197*** | -0.156*** | -0.201** | -0.224** | -0.203*** | -0.193*** | -0.157 |
| | (0.055) | (0.050) | (0.102) | (0.092) | (0.058) | (0.053 | (0.135) |
| $INC_{s,1933}$ | -0.032 | -0.057** | -0.012 | 0.092* | 0.015 | 0.027 | -0.036 |
| | (0.033) | (0.024) | (0.057) | (0.053) | (0.038) | (0.021) | (0.060) |
| $BOUNCEBACK_s$ | -0.333** | -0.178 | -1.479*** | -0.190 | -0.574*** | -0.357*** | -1.646*** |
| | (0.141) | (0.133) | (0.416) | (0.158) | (0.143) | (0.116) | (0.330) |
| $AGRIC_{s,1929}$ | 2.247*** | 0.070 | -0.618 | -0.157 | 1.626*** | 0.404 | -0.417 |
| | (0.247) | (0.221) | (0.556) | (0.773) | (0.319) | (0.385) | (0.457) |
| $MAN_{s,1929}$ | 0.236* | 0.236* | -0.405* | -0.116 | 0.151 | 0.074 | -0.162 |
| | (0.124) | (0.126) | (0.232) | (0.177) | (0.151) | (0.106) | (0.209) |
| $NEWDEAL_s$ | 0.000 | 0.000 | 0.002 | 0.002* | 0.000 | 0.001 | 0.001 |
| | (0.000) | (0.000) | (0.0001) | (0.001) | (0.001) | (0.001) | (0.001) |
| $MONPOL_s$ | -0.028 | -0.027** | -0.043 | -0.011 | -0.010 | -0.011 | -0.029 |
| | (0.018) | (0.013) | (0.026) | (0.025) | (0.016) | (0.012) | (0.022) |
| Constant | 0.191*** | 0.295*** | 0.182*** | 0.303*** | 0.131** | 0.207*** | 0.178*** |
| N | 48 | 49 | 48 | 48 | 48 | 48 | 46 |
| $R^2$ | 0.708 | 0.493 | 0.468 | 0.214 | 0.694 | 0.564 | 0.497 |

*Notes:* Standard errors in parentheses; *** p<0.01, ** p>0.05, * p<0.1. Standard errors are heteroskedasticity-robust.

Table 4.5 presents the regression results using the percentage change in the calculated factor score between 1933 and 1939 and the specifications applied earlier. Thus, three separate estimations ((1)–(3)) are reported: (1) uses the baseline specification, (2) includes a bounce-back effect, and (3) examines the effect of the debt levels as of 1932. The negative effect of high household indebtedness in the period 1933 to 1939 remains robust. The debt variable is again negative and statistically significant on the five to ten percent level for all specifications.

**Table 4.5:** Regression results recovery, 1933–1939 (using factor score).

| | (1) | (2) | (3) |
|---|---|---|---|
| $DEBT_{s,1929}$ | -0.324** | -0.235* | |
| | (0.134) | (0.121) | |
| $DEBT_{s,1932}$ | | | -0.186** |
| | | | (0.082) |
| $INC_{s,1933}$ | 0.061 | 0.090** | 0.101** |
| | (0.048) | (0.044) | (0.043) |
| $BOUNCEBACK_s$ | | -0.381*** | -0.383*** |
| | | (0.085) | (0.084) |
| $AGRIC_{s,1929}$ | 0.026 | -0.040 | -0.033 |
| | (0.772) | (0.694) | (0.674) |
| $MAN_{s,1929}$ | -0.116 | 0.005 | 0.022 |
| | (0.193) | (0.160) | (0.155) |
| $NEWDEAL_s$ | 0.002* | 0.001** | 0.002** |
| | (0.001) | (0.001) | (0.001) |
| $MONPOL_s$ | -0.017 | -0.008 | -0.007 |
| | (0.024) | (0.024) | (0.023) |
| Constant | 0.351*** | 0.161** | 0.154*** |
| N | 48 | 48 | 48 |
| $R^2$ | 0.1780 | 0.3675 | 0.3835 |

Note: Standard errors in parentheses; *** p<0.01, ** p>0.05, * p<0.1. Standard errors are heteroskedasticity-robust.

**Dynamics in recession and recovery** The results presented above suggest a statistically significant negative relationship between household indebtedness and economic performance during the period of recovery, from 1933 to 1937 and from 1933 to 1939, respectively. Yet it is possible that dynamics differ when it comes to recession and recovery. Previous contributions (Garrett and Wheelock, 2006; Wallis, 1989) point out the important role of industrial structure variation in determining differences in economic performances during the 1930s. According to their findings, adverse economic effects of high levels of household indebtedness may vary in recession and recovery depending on the significance of other shocks, such as those affecting the agricultural sector or manufacturing industries. Hence, I use a more differentiated approach that addresses these issues in two steps. First, I examine whether the impact of household debt differs for the contraction period – from 1929 to 1932 – to account for these effects and magnitudes. Second, I study the Great Depression as a whole – from 1929 to 1939 – to analyze whether differences in the levels of household debt still matter for state-level economic performance when viewed in the long term. This sensitivity analysis might provide additional insights as it explores the question whether or not the negative effect of household indebtedness applies only to the medium term, which is to say, only to the recovery.

*The 1929–1932 slump.* Eggertsson and Krugman (2012) assume that households deleverage immediately to the new borrowing constraint after a Minsky moment. The deleveraging households cut back consumption, which in turn decreases output as aggregate demand falls.

But if household leverage is the dominant driver of the slump, we should find a close relationship between levels of household debt and the change in economic indicators for the period 1929–1932. The empirical literature dealing with regional variation during the most severe years of the contraction (from 1929 to 1932) most often uses differences in economic structure – particularly in industrial composition – for explaining differences in economic performance (Wallis, 1989). According to Garrett and Wheelock (2006), for example, states that derived a high percentage of personal income from sectors facing severe shocks during the contraction years experienced larger declines in per capita income than did more diversified states or states depending mainly on sectors that performed comparably well during the slump.

For the contraction phase, the specification is slightly altered. $NEWDEAL_s$ was omitted because New Deal spending did not start until 1933. Instead, the specification includes $BANKFAIL_s$ because the series of four banking panics identified by Friedman and Schwartz (1963) began in fall 1930 and only ended with Roosevelt's banking holiday in March 1933. The initial prosperity is defined as state-level income per capita as a share of total U.S. income p.c. in 1929 ($INC_{s,1929}$).[50]

When estimating this model for the recession period in Table 4.6, the degree of ex-ante household indebtedness does not have significant explanatory power for state-level economic performance in the first years of the Depression. In light of the research cited as well as the noisy data, this is certainly not surprising. It is likely that any negative effect of relatively high household indebtedness on economic performance was offset by lower vulnerability to adverse macroeconomic shocks due to higher diversification (Rosenbloom and Sundstrom, 1997). This dynamic is also suggested by the evidence presented in Table 4.6: the coefficients on $MAN_{s,1929}$ and $AGRIC_{s,1929}$ are negative for all dependent variable specifications. Both the manufacturing and the agricultural sector were particularly affected by the economic downturn starting in 1929. Interestingly, states with relatively high debt-to-income ratios were primarily concentrated on the East Coast. These states were both more diversified and less dependent on heavy industry compared with states in other regions. By contrast, states in the Mountain region – even though among the lowest income levered states – were highly dependent on the mining and lumber industry and thus faced among the most severe decline in employment and income. In addition, states in the northeast also had generally higher

[50] Note that data on retail sales are only available for 1929, 1933, 1935, and 1939.

per capita incomes than states in other regions.[51] Garrett and Wheelock (2006) show that states entering the economic contraction with relatively high per capita incomes tended to suffer smaller contractions in per capita income than did low-income states. This relationship is also apparent in column (1) and (2). The results suggest that states with high per capita incomes as of 1929 performed better when compared with states that had lower levels of per capita income.

**Table 4.6:** Regression results contraction, 1929–1932.

| | (1) $\Delta\ INC_{s,1929-32}$ | (2) $\Delta\ WAGE_{s,1929-32}$ | (3) $\Delta\ EMP_{s,1931-32}$ |
|---|---|---|---|
| $DEBT_{s,1929}$ | 0.098 | 0.062 | 0.159 |
| | (0.151) | (0.124) | (0.096) |
| $INC_{s,1929}$ | 0.151** | 0.094* | -0.016 |
| | (0.061) | (0.055) | (0.028) |
| $AGRIC_{s,1929}$ | -0.767* | -0.021 | -0.444 |
| | (0.460) | (0.467) | (0.499) |
| $MAN_{s,1929}$ | -0.201 | -0.563** | -0.024 |
| | (0.226) | (0.226) | (0.134) |
| $BANKFAIL_s$ | -0.300* | -0.060 | 0.165 |
| | (0.176) | (0.164) | (0.120) |
| $MONPOL_s$ | -0.004 | 0.013 | 0.012 |
| | (0.024) | (0.022) | (0.017) |
| Constant | -0.391*** | -0.242*** | -0.101*** |
| N | 49 | 48 | 47 |
| $R^2$ | 0.431 | 0.258 | 0.136 |

*Notes:* Standard errors in parentheses; *** p<0.01, ** p>0.05, * p<0.1. Standard errors are heteroskedasticity-robust.

*The Great Depression, 1929–1939.* The results so far indicate the important role of debt overhang in the recovery, but not in the slump period. Highly indebted states recovered more slowly but did not suffer from a worse recession. The natural next step is to look at the entire Great Depression episode. Reassuringly, the detrimental effects of a debt overhang in the household sector become clearly visible once the time frame is enlarged.

Table 4.7 regresses $DEBT_{s,1929}$ on the percentage change in the four indicators of economic performance: income per capita, salaries and wages per capita, employment, and consumption on ex-ante household indebtedness.[52] Seven separate

[51] The lumber industry depended heavily on demand in the construction sector and thus was particularly vulnerable to the collapse in construction during the economic downturn. The heavily industrialized East North Central region, together with the Mountain region, experienced significant difficulties during the slump (Rosenbloom and Sundstrom, 1997).

[52] The model controls both for $BANKFAIL_s$ and $NEWDEAL_s$ since the period covers the series of banking panics between 1930 and 1933 as well as the years of the New Deal. Just as in Table 4.6 for the contraction phase, initial prosperity is defined as income per capita at the state level in 1929 as the share of total U.S. income p.c. in 1929 ($INC_{s,1929}$). For percentage change in employment, the model is slightly altered due to data specifics (see column (3)). The employment index by Wallis (1989), though it starts in 1929, uses only state-level data from 1931 on. Before 1931, the indices are

estimations ((1)-(7)) are reported. Regressions over 1929–1939 and 1929–1937 produce essentially similar results. In all cases, the coefficients on the key regressor of interest – household debt – show the expected negative signs. Furthermore, they are economically meaningful and statistically significant at the five percent level for estimations (3), (5), and (6). Assuming we control for other determinants, this implies that for the period from 1929 to 1937 a mortgage debt-to-income ratio ten percentage points above the sample mean is associated with a growth rate drop in income per capita of 2.3 percentage points (from 6 percent to about 3.7 percent) and a growth rate drop in real salaries and wages per capita of two percentage points (from about 4.5 percent to 2.3 percent). For the period 1929–1939, a mortgage debt-to-income ratio ten percentage points above the sample mean is associated with a growth rate drop in employment of 2.6 percentage points.[53] Hence, the results suggest that higher levels of household debt acted as a drag on the economy throughout the entire Great Depression.

The coefficients on agriculture mostly imply what we would expect: states that were highly dependent on agriculture experienced larger economic declines. The evidence on manufacturing is more mixed.[54] The coefficients on bank failures and New Deal lending and spending and monetary policy are instable and insignificant. The explanatory power of the model for the period 1929 to 1937 and for the period 1929 to 1939 is comparably weak, however.[55]

Summing up, the adverse effects of debt overhang are most strongly visible in the recovery, but are also present over the entire 1929–1939 period. During the slump years, the relationship is harder to prove. In light of the various shocks that hit the regional economies during the slump period, this is not particularly surprising.

**Deleveraging in the 1930s** The previous subsections have revealed an important feature of the recovery from the U.S. Great Depression. High debt balances in

based on regional data. This means that state-level estimates reflect differences in the composition of employment regarding the share of nonmanufacturing and manufacturing employment; they do not reflect specific state-level trends.

[53]For salaries and wages p.c., WV was omitted as an outlier. For employment, MI and NC were omitted as outliers. Wallis does not provide an employment index for DC in any given year (Wallis, 1989).

[54]Again, coefficients on $MAN_{s,1929}$ and $AGRIC_{s,1929}$ differ remarkably between income p.c. and salaries and wages p.c. For the farm sector, there are substantial differences during the Great Depression between the percentage change in proprietor income and the percentage change in salaries and wages received in the farm sector. While proprietor income decreased by about 4 percent in real terms on a national level in the period 1929–1937, wages in the agricultural sector decreased by more than 8 percent. As a result, the effect of $AGRIC_{s,1929}$ on income per capita as a dependent variable is much smaller than on salaries and wages per capita. For manufacturing, I again assume that comparable dynamics created the substantial differences in the magnitude of coefficients on $MAN_{s,1929}$.

[55]The specifications account for between 11 and 32 percent of the variation in the economic performance proxies. The null hypothesis of the F-test (regressors are jointly equal to zero) cannot be rejected. The F-value for the specification in column (1) is 2.65 (p-value of 0.02). For the specification in column (2), the F-value is 2.55 (p-value of 0.03), 4.94 in column (3) (p-value of 0.00), 1.77 in column (4) (p-value of 0.12), 2.34 in column (4) (p-value of 0.04), 1.74 in column (5) (p-value of 0.13), and 0.89 in column (7) (p-value) of 0.52). Here again, the F-test is not distorted by multicollinearity.

**Table 4.7:** Regression results Great Depression, 1929–1937 and 1929–1939.

| | (1) $\Delta\ INC_{s,1929-39}$ | (2) $\Delta\ WAGE_{s,1929-39}$ | (3) $\Delta\ EMP_{s,1929-39}$ | (4) $\Delta\ SALES_{s,1929-39}$ | (5) $\Delta\ INC_{s,1929-37}$ | (6) $\Delta\ WAGE_{s,1929-37}$ | (7) $\Delta\ EMP_{s,1929-37}$ |
|---|---|---|---|---|---|---|---|
| $DEBT_{s,1929}$ | -0.194 | -0.131 | -0.260** | -0.033 | -0.231** | -0.202** | -0.130 |
| | (0.124) | (0.107) | (0.126) | (0.185) | (0.108) | (0.101) | (0.125) |
| $INC_{s,1929}$ | -0.007 | -0.055 | -0.004 | 0.081 | 0.004 | 0.001 | 0.001 |
| | (0.049) | (0.048) | (0.036) | (0.072) | (0.042) | (0.042) | (0.033) |
| $AGRIC_{s,1929}$ | 0.568 | -0.615* | -0.554 | -0.054 | -0.048 | -0.405 | -0.216 |
| | (0.461) | (0.364) | (0.383) | (0.848) | (0.357) | (0.404) | (0.410) |
| $MAN_{s,1929}$ | 0.108 | -0.087 | -0.093 | -0.336 | 0.064 | -0.075 | -0.099 |
| | (0.189) | (0.180) | (0.168) | (0.271) | (0.158) | (0.152) | (0.153) |
| $BANKFAIL_s$ | -0.127 | 0.014 | 0.152 | -0.226 | -0.067 | 0.011 | 0.019 |
| | (0.149) | (0.121) | (0.164) | (0.211) | (0.129) | (0.133) | (0.173) |
| $NEWDEAL_s$ | 0.001 | 0.002* | 0.003*** | 0.001 | 0.001 | 0.001 | 0.001 |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| $MONPOL_s$ | -0.016 | -0.020 | 0.010 | 0.005 | 0.005 | -0.003 | 0.000 |
| | (0.025) | (0.189) | (0.019) | (0.036) | (0.020) | 0.017 | 0.019 |
| Constant | -0.017 | 0.104* | 0.124** | -0.111 | -0.008 | 0.055 | 0.152*** |
| N | 49 | 48 | 48 | 48 | 49 | 48 | 46 |
| $R^2$ | 0.114 | 0.247 | 0.315 | 0.197 | 0.128 | 0.167 | 0.132 |

*Notes:* Standard errors in parentheses; *** p<0.01, ** p>0.05, * p<0.1. Standard errors are heteroskedasticity-robust.

the household sector had an adverse effect on state economic performance. This was predominantly a recovery effect. Can we say something about the particular channels through which high household debt held back the economy?

Eggertsson and Krugman (2012) and Guerrieri and Lorenzoni (2011) propose that in response to the deleveraging shock – the sudden downward revision of acceptable debt levels – households decrease indebtedness to arrive at the new borrowing constraint. According to the theoretical and empirical studies discussed in the second section, an important aspect in the process of deleveraging is a decline in consumption, as households are forced to cut back on expenditures to repair their balance sheets (Mian et al., 2013). For the period of the Great Depression, several authors documented a strong decrease in consumption (Romer, 1993; Olney, 1999). Moreover, Mishkin (1978) argued that household debt had an important role in explaining the consumption collapse during the 1930s. The evidence presented in the previous subsections also provides suggestive evidence for a negative relationship between high initial debt levels and the growth rates in retail sales between 1933 and 1939. This negative relationship suggests that consumption was weaker in high-income leveraged households during this period. In this section, I explore deleveraging as a potential channel in greater detail.

The immediate question is whether high debt-to-income states reduced their indebtedness more during the period of recovery. The assumption that deleveraging may be an important transmission mechanism implies that states with higher pre-recession debt ratios deleverage more when adjusting to their targeted net debt position in response to an economic crisis. Figure 4.5 already provides a first indication. Between 1933 and 1937, the average state-level mortgage debt-to-income ratio dropped by about 50 percent. Yet the dynamics were substantively different between states with high household debt ratios and states with lower household debt ratios, particularly during the recovery, Between 1932 and 1937, the mortgage debt-to-income ratio fell by 13 percentage points in the 13 states with the highest debt-to-income ratios in the sample but only by two percentage points in the 13 states with the lowest debt-to-income ratios in the sample.

**Table 4.8:** Debt and deleveraging.

| | (1) | (2) |
|---|---|---|
| | $\Delta$ $DELEV_{s,1933-37}$ | $\Delta$ $DELEV_{s,1933-39}$ |
| $DEBT_{s,1932}$ | -0.551** | -1.051*** |
| | (0.228) | (0.305) |
| Constant | -0.021 | 0.229*** |
| N | 49 | 49 |
| $R^2$ | 0.110 | 0.202 |

*Notes:* Standard errors in parentheses; *** p<0.01, ** p>0.05, * p<0.1. Standard errors are heteroskedasticity-robust.

Table 4.8 takes a more formal approach by regressing $DEBT_{s,1932}$ on the change in real mortgage debt per capita ($DELEV_s$) for the two periods of recovery examined earlier, 1933–1937 and 1933–1939.[56] The results confirm what Figure 5 intimates: highly indebted households reduced debt more aggressively than low-income levered households. Regression coefficients on debt to income are negative and statistically significant on the five (column (1)) and one percent level (column (2)), respectively. For the period 1933 to 1937, the coefficient in column (1) implies a 5.5 percentage point lower growth rate of per capita mortgage debt (from -9 percent to about -15 percent) for a 1932 debt-to-income ratio ten percentage points above the sample mean. This variation across states in the reduction of debt is pronounced. Between 1933 and 1937, the 13 states with the highest debt-to-income ratios significantly reduced their per capita mortgage debt stock in real terms by 30 percent. By contrast, the amount of per capita mortgage debt only decreased by about 6 percent in the 13 states that had the lowest debt-to-income ratios at the on-set of the recovery. On balance, the findings provide some support for the theory that indebted households need to deleverage significantly if they are to repair their balance sheets.[57]

## 4.4 Conclusion

Using U.S. state-level data, this paper examines the relationship between variation in levels of household debt and economic performance during the 1930s. The evidence suggests that high debt levels were associated with worse economic performance, as recovery was considerably weaker in states with high initial debt-to-income ratios. Everything else being equal, the total growth rate of per capita income, per capita wages, and employment was between 2.2 and 3.2 percentage points lower when the household debt-to-income ratios were ten percentage points higher than the U.S. average. These results are robust to the inclusion of various controls as well as for different time periods. I interpret this as evidence that debt overhang created a significant drag for the recovery. Deleveraging of households appears to be an important force driving this trend, as states with higher initial debt-to-income levels reduced debt at a higher rate. Moreover, though the adverse effects of high household indebtedness are strongest for the recovery years, they are also present over the entire Depression period 1929–1939.

These findings for the Great Depression in the U.S. are consistent with other studies relying on cross-sectional variation in household leverage such as Mian et al. (2013) for the U.S. or King (1994) and the International Monetary Fund (2012a) for international contexts. The similarity of the results for very different periods of crisis suggests a close link between the accumulation of household indebtedness and economic recovery paths.

[56] $DELEV_s$ is defined as $lnDEBT_{s,1937} - lnDEBT_{s,1933}$ or $lnDEBT_{s,1939} - lnDEBT_{s,1933}$ respectively.

[57] Appendix Table C.7 shows the regression results for the period 1933–1937 and 1933–1939 when substituting $DEBT_{s,1929}$ and $DEBT_{s,1932}$ with $DELEV_s$ as the key explanatory variable. The coefficients on deleveraging are positive and statistically significant except for employment in column (7). The model has relatively high explanatory power. It explains between 23 and 69 percent of the variation in real outcomes. These regressions provide suggestive evidence for the fact that the more households in a state reduced their p.c. debt burdens, the weaker the state performed economically.

# Appendix

Appendix A

# Appendix to Chapter 2

## No Price Like Home: Global House Prices, 1870–2012

## A.1 Supplementary material

### A.1.1 House price indices: methodology

Different approaches exist to construct house price indices that adjust for quality and composition changes over time. *Stratification* splits the sample into several strata with specific price determining characteristics. A mean or median price index is calculated for each sub-sample and the aggregate index is computed as a weighted average of these sub-indices. A stratified index with $M$ different sub-samples can be written as

$$\Delta P_T^h = \sum_{m=1}^{M} (w_t^m \Delta P_T^m), \tag{A.1}$$

where $\Delta P_T^h$ denotes the aggregate house price change in period $T$, $\Delta P_T^m$ the price change in sub-sample $m$ in period $T$, and $w_t^m$ the weight of sub-sample $m$ at time $t$. The weights used to aggregate the sub-sample indices are either based on stocks or on transactions and on quantities or values (European Commission, 2013; Silver, 2014). Since stratification neither controls for changes in the mix of houses that are not related to the sub-samples nor for changes within each sub-sample, the choice of the stratification variables determines the index' properties. If the stratification controls for quality change, the method is known as *mix-adjustment* (Mack and Martínez-García, 2012).

A complementary approach to stratification is the *hedonic regression* method. Here, the intercept of a regression of the house price on a set of characteristics – such as the number of rooms, the lot size or whether the house has a garage or not – is converted into a house price index (Case and Shiller, 1987). If the set of variables is comprehensive, the *hedonic regression* method adjusts for changes in the composition and changes in quality. The most commonly employed hedonic specification is a linear model in the form of

$$P_t = \beta_t^0 + \sum_{k=1}^{K} (\beta_t^k z^{n,k}) + \epsilon_t^n, \tag{A.2}$$

where $\beta_t^0$ is the intercept term and $\beta_t^k$ the parameter for characteristic variable $k$ and $z^{n,k}$ the characteristic variable $k$ measured in quantities $n$.

The *repeat sales* method circumvents the problem of unobserved heterogeneity as it is based on repeated transactions of individual houses (Bailey et al., 1963). A method similar to the idea of repeat sales is the *sales price appraisal (SPAR)* method which, instead of using two transaction prices, matches an appraised value and a transaction price. Because of depreciation and new investments, the constant-quality assumption becomes more problematic the longer the time span between two transactions (Case and Wachter, 2005). The *weighted repeat sales method* (Case and Shiller, 1987) therefore assigns less weight to transaction pairs of long time intervals. Since the *hedonic regression* is complementary to the *repeat sales* approach, several studies propose hybrid methods (Shiller, 1993; Case et al., 1991; Case and Quigley, 1991), which may reduce the quality bias. Yet despite differences in the way house price indices are constructed, different methods tend to deliver similar overall results (Nagarja and Wachter, 2014; Pollakowski, 1995).

### A.1.2 Structural break tests

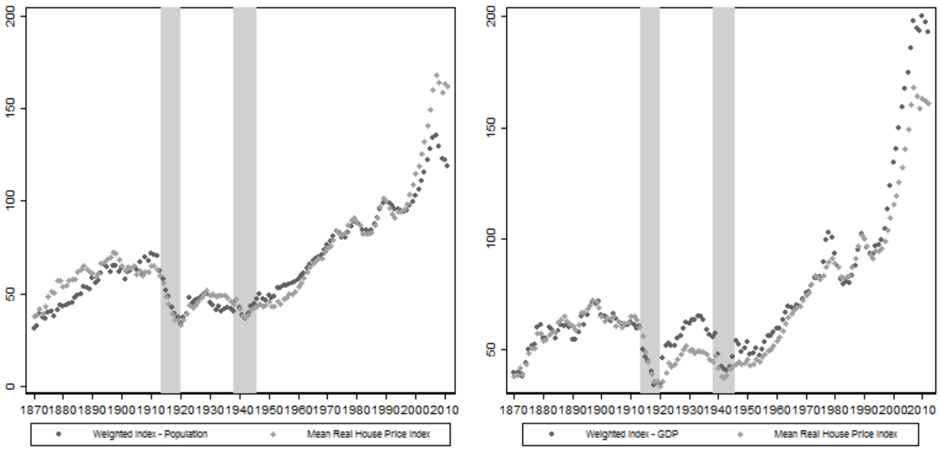
**Table A.1:** Structural break tests by country

| Country | k=1 | k=2 | k=3 |
|---|---|---|---|
| Australia | 1963 | 1950, 1988 | 1950, 1970, 1999 |
| Belgium | 1991 | 1966, 1998 | 1966, 1998 |
| Canada | 1973 | 1949, 1974 | 1947, 1973, 2004 |
| Denmark | 1961 | 1961, 2000 | 1961, 2000 |
| Finland | 1962 | 1962 | 1962 |
| France | 1964 | 1964 | 1964 |
| Germany | 1964 | 1964 | 1887, *1916*, 1963 |
| Great Britain | 1972 | 1963, 1987 | 1946, 1977, 2001 |
| Japan | 1960 | 1960 | *1945*, 1955, 1965 |
| Netherlands | 1995 | 1970, 1998 | 1970, 1998 |
| Norway | 1999 | 1999 | 1999 |
| Sweden | 2000 | 2000 | 2000 |
| Switzerland | 1952 | 1952 | 1952 |
| USA | 1953 | 1953 | 1953 |

Note: $k$ is the maximum number of structural breaks in the log-level of the real house price index determined using the Bai and Perron (2003) methodology with a trimming parameter of 10 percent and a significance level of 0.05, using White heteroskedasticity-consistent standard errors and heterogeneous error distributions across breaks. Break dates shown correspond to first date of new regime. Sample 1870–2012. Italics denote years of downward breaks in the real house price.

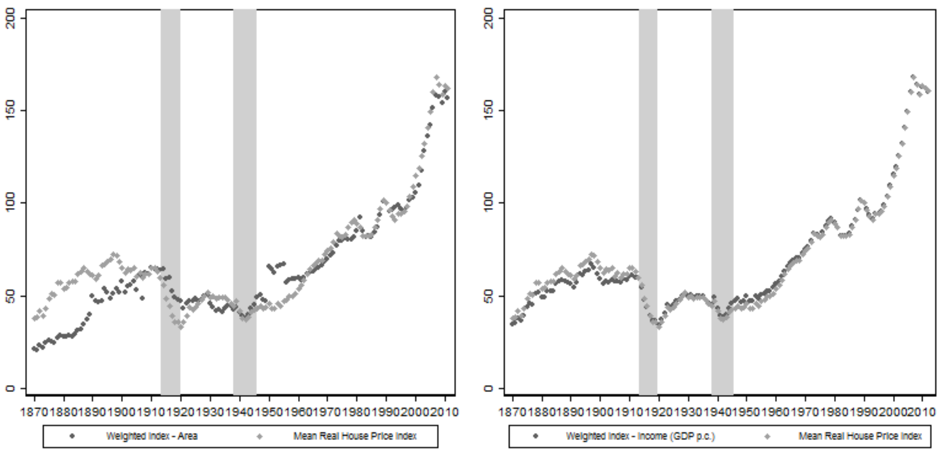
### A.1.3 Robustness

**Figure A.1:** Population and GDP weighted mean real house price indices, 14 countries.



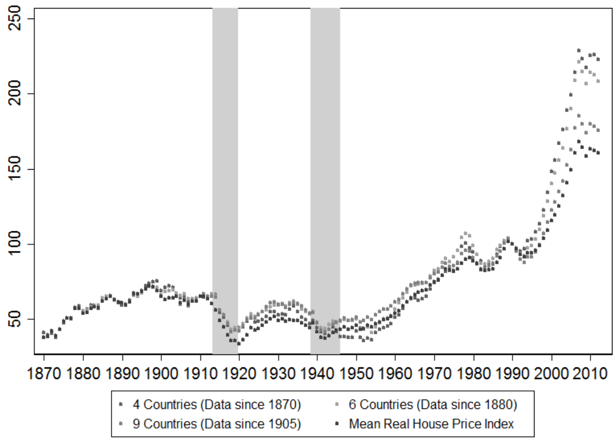

*Notes:* Index, 1990=100. The years of the two world wars are shown with shading.

**Figure A.2:** Area and GDP p.c. weighted mean real house prices, 14 countries.




*Notes:* Index, 1990=100. The years of the two world wars are shown with shading. Note that most border changes were relative minor. Exceptions include the changes for Germany in the interwar period, after World War II and after reunification in 1990, and the change for the U.K. after the Irish Free State seceded in 1922.

**Figure A.3:** Mean of all available data, fixed samples.




*Notes:* Index, 1990=100. The years of the two world wars are shown with shading. 4-, 6-, and 9-country indices include only continuous series. The 4-country sample includes Australia, France, the Netherlands, and Norway. The 6-country sample includes Australia, Denmark, France, the Netherlands, Norway, and Sweden. The 9-country sample includes Australia, Denmark, France, the Netherlands, Norway, Sweden, Switzerland, and the U.S.

### A.1.4 Alternative decompositions

The decomposition in Section 2.4 rests on the assumption of an elasticity of substitution between land and construction services in housing production equal to unity (Cobb-Douglas technology). However, it is quite plausible to argue that this elasticity of substitution is much smaller than unity. Let us consider the extreme case of an elasticity of substitution equal to zero. The production technology then reads $F(Z, H) = \min\{\frac{Z}{a}, \frac{X}{b}\}$, where $a, b > 0$. In this case, the equilibrium house price is given by $p^H = a \cdot p^Z + b \cdot p^X$ such that its (gross) growth rate, noting $\frac{Z}{F(.)} = a$ and $\frac{X}{F(.)} = b$, may be expressed as

$$\frac{p_{t+1}^H}{p_t^H} = w_t \frac{p_{t+1}^Z}{p_t^Z} + (1 - w_t) \frac{p_{t+1}^X}{p_t^X}, \tag{A.3}$$

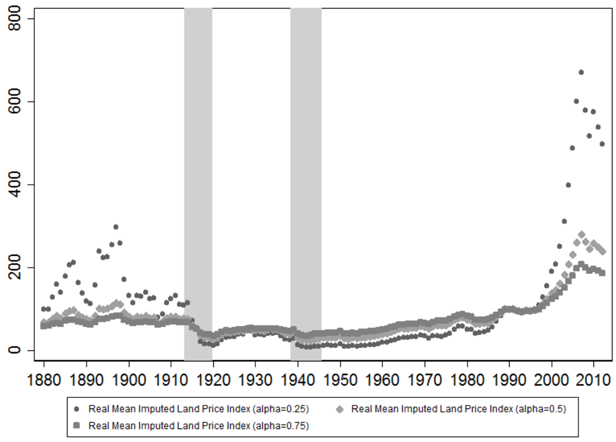
where $w_t := \frac{p_t^Z Z_t}{p_t^H F(.)}$. The index for imputed land prices can hence be traced out by applying

$$\frac{p_{t+1}^Z}{p_t^Z} = \frac{1}{w_t} \frac{p_{t+1}^H}{p_t^H} - \frac{(1 - w_t)}{w_t} \frac{p_{t+1}^X}{p_t^X}. \tag{A.4}$$

It should also be noticed that Davis and Heathcote (2007) start from the definition $p_t^Z Z_t = p_t^H H_t - p_t^X X_t$ which implies $\frac{p_{t+1}^H H_{t+1}}{p_t^H H_t} = \frac{p_{t+1}^Z Z_{t+1}}{p_t^H H_t} + \frac{p_{t+1}^X X_{t+1}}{p_t^H H_t}$. Employing $H_{t+1} = H_t$, $Z_{t+1} = Z_t$ and $X_{t+1} = X_t$, they receive

$$\frac{p_{t+1}^H}{p_t^H} = w_t \frac{p_{t+1}^Z}{p_t^Z} + (1 - w_t) \frac{p_{t+1}^X}{p_t^X}. \tag{A.5}$$

**Figure A.4:** Imputed land prices - sensitivity analysis w.r.t. $\alpha$, 14 countries.

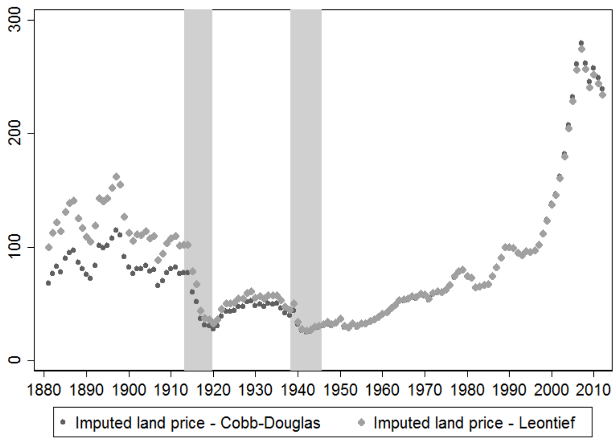



*Notes:* Index, 1990=100. The years of the two world wars are shown with shading.

This expression is, not surprisingly, the same accounting equation as resulting from the Leontief case.

In the main text we discussed imputed land price series assuming an elasticity of substitution between $Z$ and $X$ of unity (Cobb Douglas) and $\alpha = 0.5$. How does the imputed land price series change if one deviates from either of these assumptions? Figure A.4 shows the imputed land price as resulting from Equation 2.2 (Cobb-Douglas) assuming alternative values for $\alpha$. Moreover, Figure A.5 compares the imputed land price employing Equation 2.2 (Cobb-Douglas case, $\alpha = 0.5$) and Equation A.4 (Leontief, $w_t = 0.5$).

**Figure A.5:** Imputed land prices - sensitivity analysis w.r.t. technology, 14 countries.




*Notes:* Index, 1990=100. The years of the two world wars are shown with shading.

Finally, we consider how other factors (besides land prices and construction costs) may affect equilibrium house prices and hence imputed land prices. Let $0 \leq v_t \leq 1$ denote a cost term that is proportional to the value of newly built houses, such as an ad valorem sales tax or building permit fees. The profit function of the representative firm may then be written as $(1 - v_t) p_t^H F(Z_t, X_t) - p_t^Z Z_t - p_t^X X_t$, implying that the equilibrium house price reads

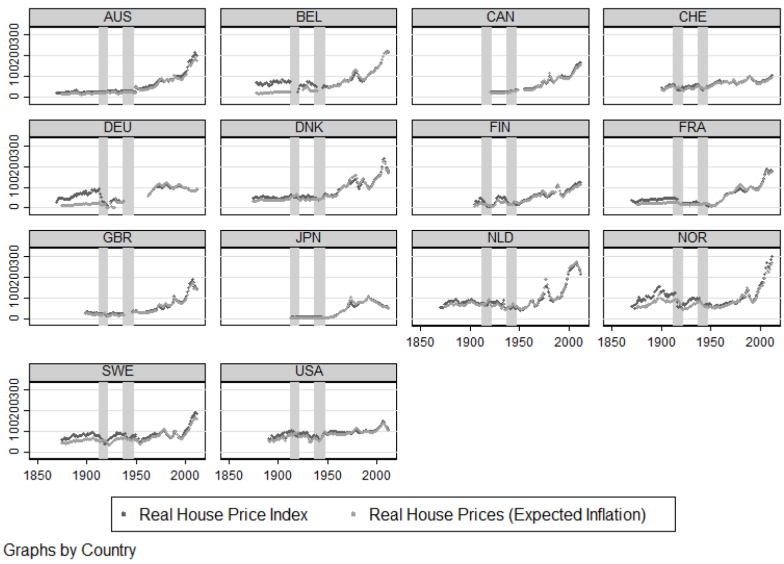
$$p_t^H = \frac{B}{1 - v_t} (p_t^Z)^\alpha (p_t^X)^{(1-\alpha)}, \tag{A.6}$$

where $B := \alpha^{-\alpha}(1-\alpha)^{-(1-\alpha)}$.

Solving Equation A.6 for $p_t^Z$ shows that imputed real land prices now depend on real house prices $p_t^H$, real construction costs $p_t^X$ and the cost term $v_t$. Yet Figure 2.8 indicates that such additional factors do not systematically bias the results.

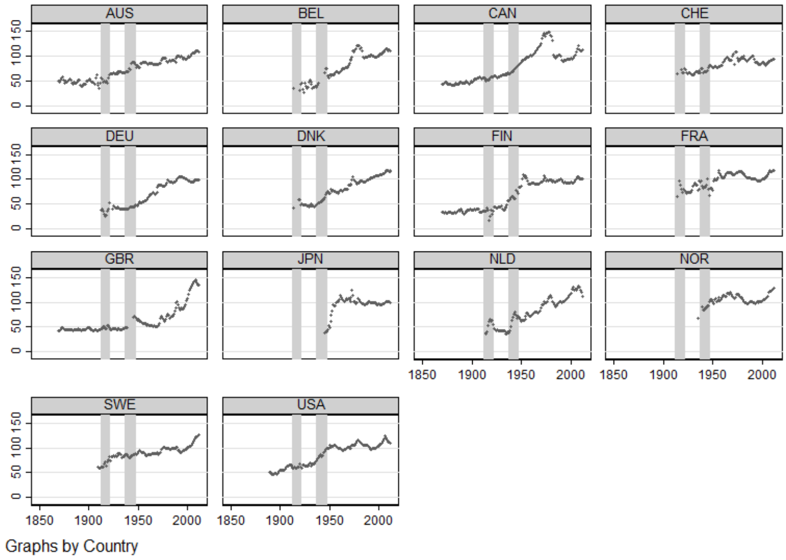
### A.1.5 Additional tables and figures

**Figure A.6:** Real house prices, 14 countries.



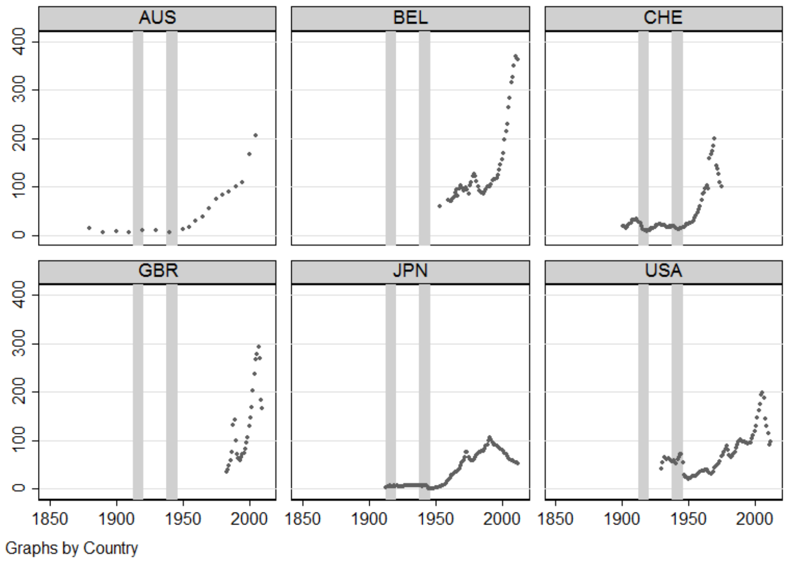

*Notes:* Index, 1990=100. The years of the two world wars are shown with shading. Nominal house prices deflated by average inflation over preceding 5 years

**Figure A.7:** Real construction costs, 14 countries.




*Notes:* Index, 1990=100. The years of the two world wars are shown with shading.

**Figure A.8:** Real residential land prices, 6 countries.




*Notes:* Index, 1990=100 for AUS, BEL, GBR, JPN, USA. Index, 1975=100 for CHE. The years of the two world wars are shown with shading.

**Table A.2:** Annual summary statistics by country and by period.

| | Δ log Nominal House Price Index | | | Δ log CPI | | | Δ log Real GDP p.c. | | |
|---|---|---|---|---|---|---|---|---|---|
| | N | mean | s.d. | N | mean | s.d. | N | mean | s.d. |
| *Australia* | | | | | | | | | |
| Full Sample | 127 | 0.047 | 0.106 | 127 | 0.027 | 0.047 | 127 | 0.016 | 0.040 |
| Pre-World War II | 62 | 0.009 | 0.083 | 62 | 0.001 | 0.037 | 62 | 0.011 | 0.054 |
| Post-World War II | 65 | 0.083 | 0.114 | 65 | 0.052 | 0.041 | 65 | 0.021 | 0.019 |
| *Belgium* | | | | | | | | | |
| Full Sample | 119 | 0.043 | 0.094 | 126 | 0.021 | 0.054 | 127 | 0.021 | 0.041 |
| Pre-World War II | 54 | 0.029 | 0.126 | 61 | 0.008 | 0.069 | 62 | 0.019 | 0.055 |
| Post-World War II | 65 | 0.056 | 0.054 | 65 | 0.034 | 0.031 | 65 | 0.023 | 0.020 |
| *Canada* | | | | | | | | | |
| Full Sample | 75 | 0.048 | 0.078 | 127 | 0.019 | 0.044 | 127 | 0.018 | 0.046 |
| Pre-World War II | 17 | -0.014 | 0.048 | 62 | -0.001 | 0.048 | 62 | 0.017 | 0.062 |
| Post-World War II | 58 | 0.066 | 0.076 | 65 | 0.038 | 0.032 | 65 | 0.019 | 0.023 |
| *Denmark* | | | | | | | | | |
| Full Sample | 122 | 0.032 | 0.074 | 127 | 0.021 | 0.053 | 127 | 0.019 | 0.024 |
| Pre-World War II | 57 | -0.002 | 0.060 | 62 | -0.004 | 0.058 | 62 | 0.017 | 0.025 |
| Post-World War II | 65 | 0.061 | 0.074 | 65 | 0.046 | 0.032 | 65 | 0.020 | 0.024 |
| *Finland* | | | | | | | | | |
| Full Sample | 92 | 0.088 | 0.156 | 127 | 0.031 | 0.059 | 127 | 0.026 | 0.034 |
| Pre-World War II | 27 | 0.094 | 0.244 | 62 | 0.006 | 0.055 | 62 | 0.023 | 0.036 |
| Post-World War II | 65 | 0.085 | 0.105 | 65 | 0.054 | 0.053 | 65 | 0.028 | 0.031 |
| *France* | | | | | | | | | |
| Full Sample | 127 | 0.062 | 0.075 | 127 | 0.036 | 0.071 | 127 | 0.020 | 0.038 |
| Pre-World War II | 62 | 0.023 | 0.055 | 62 | 0.017 | 0.73 | 62 | 0.013 | 0.049 |
| Post-World War II | 65 | 0.099 | 0.072 | 65 | 0.054 | 0.065 | 65 | 0.027 | 0.022 |
| *Germany* | | | | | | | | | |
| Full Sample | 110 | 0.040 | 0.108 | 123 | 0.025 | 0.097 | 127 | 0.027 | 0.043 |
| Pre-World War II | 60 | 0.043 | 0.140 | 58 | 0.022 | 0.139 | 62 | 0.019 | 0.049 |
| Post-World War II | 50 | 0.037 | 0.046 | 65 | 0.027 | 0.026 | 65 | 0.034 | 0.035 |
| *Japan* | | | | | | | | | |
| Full Sample | 84 | 0.078 | 0.155 | 127 | 0.027 | 0.120 | 127 | 0.029 | 0.046 |
| Pre-World War II | 19 | -0.006 | 0.093 | 62 | 0.011 | 0.150 | 62 | 0.015 | 0.049 |
| Post-World War II | 65 | 0.103 | 0.162 | 65 | 0.043 | 0.081 | 65 | 0.042 | 0.038 |
| *The Netherlands* | | | | | | | | | |
| Full Sample | 127 | 0.026 | 0.091 | 127 | 0.015 | 0.044 | 127 | 0.019 | 0.031 |
| Pre-World War II | 62 | -0.009 | 0.086 | 62 | -0.007 | 0.049 | 62 | 0.014 | 0.036 |
| Post-World War II | 65 | 0.059 | 0.084 | 65 | 0.036 | 0.026 | 65 | 0.024 | 0.023 |
| *Norway* | | | | | | | | | |
| Full Sample | 127 | 0.041 | 0.087 | 127 | 0.020 | 0.058 | 127 | 0.023 | 0.027 |
| Pre-World War II | 62 | 0.013 | 0.085 | 62 | -0.007 | 0.066 | 62 | 0.018 | 0.033 |
| Post-World War II | 65 | 0.068 | 0.080 | 65 | 0.045 | 0.035 | 65 | 0.027 | 0.018 |
| *Sweden* | | | | | | | | | |
| Full Sample | 122 | 0.036 | 0.077 | 127 | 0.021 | 0.047 | 127 | 0.022 | 0.029 |
| Pre-World War II | 57 | 0.010 | 0.052 | 62 | -0.004 | 0.045 | 62 | 0.022 | 0.036 |
| Post-World War II | 65 | 0.059 | 0.089 | 65 | 0.045 | 0.035 | 65 | 0.022 | 0.021 |
| *Switzerland* | | | | | | | | | |
| Full Sample | 96 | 0.030 | 0.051 | 127 | 0.008 | 0.048 | 127 | 0.019 | 0.035 |
| Pre-World War II | 31 | 0.019 | 0.062 | 62 | -0.008 | 0.061 | 62 | 0.016 | 0.044 |
| Post-World War II | 65 | 0.036 | 0.044 | 65 | 0.024 | 0.022 | 65 | 0.016 | 0.024 |
| *United Kingdom* | | | | | | | | | |
| Full Sample | 98 | 0.044 | 0.089 | 127 | 0.024 | 0.047 | 127 | 0.015 | 0.025 |
| Pre-World War II | 33 | -0.008 | 0.088 | 62 | -0.004 | 0.035 | 62 | 0.011 | 0.030 |
| Post-World War II | 65 | 0.070 | 0.080 | 65 | 0.050 | 0.042 | 65 | 0.019 | 0.019 |
| *United States* | | | | | | | | | |
| Full Sample | 107 | 0.026 | 0.078 | 127 | 0.015 | 0.040 | 127 | 0.017 | 0.041 |
| Pre-World War II | 42 | 0.006 | 0.115 | 62 | -0.007 | 0.040 | 62 | 0.015 | 0.053 |
| Post-World War II | 65 | 0.038 | 0.039 | 65 | 0.036 | 0.027 | 65 | 0.020 | 0.023 |
| *All Countries* | | | | | | | | | |
| Full Sample | 1557 | 0.044 | 0.097 | 1900 | 0.024 | 0.069 | 1905 | 0.021 | 0.037 |
| Pre-World War II | 645 | 0.016 | 0.102 | 925 | 0.004 | 0.082 | 930 | 0.016 | 0.048 |
| Post-World War II | 912 | 0.066 | 0.087 | 975 | 0.043 | 0.046 | 975 | 0.025 | 0.027 |

Note: World wars (1914–1919 and 1939–1947) omitted.

## A.2 Data appendix

This data appendix supplements the paper, "No Price Like Home: Global House Prices" by Knoll, Schularick and Steger that introduces residential house price indices for 14 advanced economies for the period 1870 to 2012. It details and discusses the sources for constructing long-run house price indices.

We wish to thank Paul de Wael, Christopher Warisse, Willy Biesemann, Guy Lambrechts, Els Demuynck, and Erik Vloeberghs (Belgium); Debra Conner, Gregory Klump, Marvin McInnis (Canada); Kim Abildgren, Finn Østrup, and Tina Saaby Hvolbøl (Denmark); Riitta Hjerppe, Kari Leväinen, Juhani Väänänen, and Petri Kettunen (Finland); Jacques Friggit (France); Carl-Ludwig Holtfrerich, Petra Hauck, Alexander Nützenadel, Ulrich Weber, and Nikolaus Wolf (Germany); Alfredo Gigliobianco (Italy); Makoto Kasuya, and Ryoji Koike (Japan); Alfred Moest and Marjan Peppelmann (The Netherlands); Roger Bjornstad, and Trond Amund Steinset (Norway); Daniel Waldenström (Sweden); Annika Steiner, Robert Weinert, Joel Floris, Franz Murbach, Iso Schmid, and Christoph Enzler (Switzerland); Peter Mayer, Neil Monnery, Joshua Miller, Amanda Bell, Colin Beattie, and Niels Krieghoff (United Kingdom); Jonathan D. Rose, Kenneth Snowden and Alan M. Taylor (United States). Magdalena Korb and Katharina Mühlhoff helped with translation.

### A.2.1 Description of the methodological approach

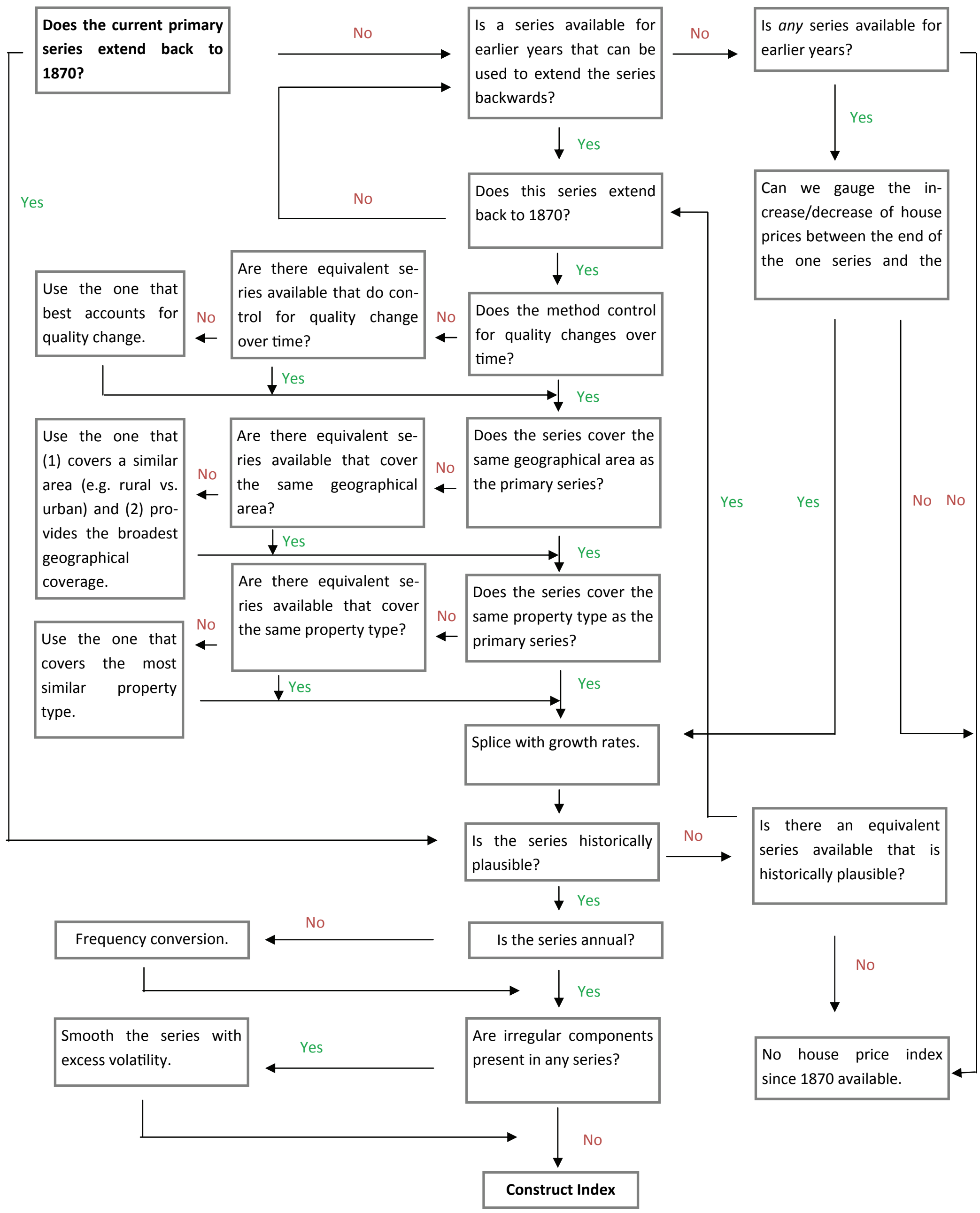
#### House price data

**Data sources** Most countries' statistical offices or central banks began only recently to collect data on house prices. For the 14 countries covered in our sample, data from the early 1970s to the present can be accessed through three principal repositories: the databases maintained by the Bank for International Settlements (2013), the OECD, and the Federal Reserve Bank of Dallas (2013). To extend these back to the 19th century, we used three principal types of country specific data.

First, we turned to national official statistical publications, such as the Helsinki Statistical Yearbook or the annual publications of the Swiss Federal Statistical office, and collections of data based on official statistical abstracts. Typically, such official statistics publications contained raw data on the number and value of real estate transactions and in some cases price indices. A second key source were published and unpublished data gathered by legal or tax authorities (e.g., the U.K. Land Registry ) or national real estate associations (e.g., the Canadian Real Estate Association). Third, we could also draw on the previous work of financial historians and commercial data providers.

**Selection of house price series** Constructing long-run data series usually involved a good many compromises between the ideal and the available data. We often found series spanning short time periods and had to splice them to arrive

**Figure A.9:** Methodological decision tree.



at a long-run index. The historical data we have at our disposal vary across countries and time with respect to key characteristics (area covered, property type, frequency, etc.) and in the method used for index construction. In choosing the best available country-year-series we followed three guiding principles: constant quality, longitudinal consistency, and historical plausibility.

We selected a primary series that is available up to 2012, refers to existing dwellings, and is constructed using a method that reflects the pure price change, i.e. controls for changes in composition and quality. When extending the series, we concentrated on within-country consistency to avoid principal structural breaks that may arise from changes in the market segment a country index covers. We aimed to ensure the broadest geographical coverage for each of the 14 country indices. Likewise we tried to keep the type of house covered constant over time, be it single-family houses, terraced houses, or apartments. We examined the historical plausibility of our long-run indices. We heavily draw on country specific economic and social history literature as well as primary sources such as newspaper accounts or contemporary studies on the housing market to scrutinize the general trends and short-term fluctuations in the indices. Based on extensive historical research, we are confident that the indices offer an accurate picture of house price developments in each of our 14 countries.

**Construction of the country indices** The methodological decision tree in Figure A.9 describes the steps we follow to construct consistent series by combining the available sources for each country in the panel. By following this procedure we aimed to maintain consistency within countries while limiting data distortions. In all cases, the primary series does not extend back to 1870 but has to be complemented with other series.

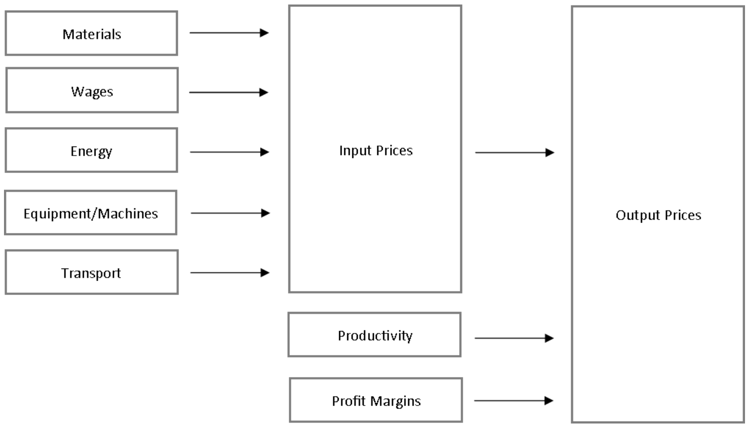
### Construction cost data

**Data sources** To decompose house prices into replacement costs and the value of the underlying land, a replacement cost index would ideally capture the change in the cost of replacing the structure covered by the house price index with a structure of similar size and quality. Data on replacement costs that perfectly matches our long-run house prices series, however, are not available. For the U.S., estimates of changes in replacement values exist for 1930–2012 (Davis and Heathcote, 2007). In all other cases, we use long-run price indices for construction costs to proxy for replacement costs of residential buildings. This choice rests on the assumption that the cost of constructing new (residential) buildings and the cost of replacing the structures covered by our house price indices move together in the long-run since both are primarily a function of the price of materials and wages.

For data on construction costs we mostly draw on publications by national statistical offices. In some cases, we also rely on the work of other scholars such as Stapledon (2012a), Maiwald (1954), and Fleming (1966), national associations of builders or surveyors (Belgian Association of Surveyors, 2013) or journals specializing in the building industry (Engineering News Record, 2013).

**Construction cost indices: methodology** Two main types of construction cost indices exist: input cost indices and output price indices. Input cost indices (or: factor price indices) cover the change in the price of a bundle of factors used to construct a certain type of building (or components thereof). They measure the evolution of wages in the construction sector, the prices paid by contractors to their suppliers of construction materials, equipment hire, and transport and energy costs. By contrast, output price indices decompose construction activity into a bundle of standardized operations covering both structural works (e.g. excavating a building pit) and finishing works (e.g. carpentry works such as doors and windows).[1] They hence reflect the change in the prices contractors charge their customers. Figure A.10 summarizes the coverage of input costs and output price indices. The main difference is that output price indices also reflect changes in contractors' profit margins, productivity, and overhead costs (Eurostat, 1996; OECD and European Community, 1996) whereas input cost indices do not.[2] Conceptually, architect fees, legal fees, VAT, and the cost of land are included neither in input cost nor in output price indices (see also Figure A.10). Whenever possible, we therefore rely on output price indices as estimates of replacement costs.

**Figure A.10:** Construction costs: input prices and output prices




Data on the price of materials used to construct input cost indices typically come from price lists, wholesale price indices as calculated by statistical offices or specific price survey. For wages, input cost indices mainly rely on wages indices for the construction sector. For output price indices, price data comes from price surveys or invoice records. Typically, weights of factors or operations are determined according to a representative construction project. An input cost index is thus calculated as

[1]The decomposition can be made a priori (component cost method) or a posteriori (schedule of prices method) (Eurostat, 1996). Sometimes also hedonic methods are used to calculate output price indices.

[2]This may particularly matter for short-term fluctuations. Dechent (2006b), for examples, notes that during the first half of the 2000s German output prices did were weighed down by declining profit margins. In times of depressed building activity, construction firms' may not be able to fully pass on material price increases to customers resulting in a wedge between input costs and output prices.

$$ICI = \sum_{i=1}^{n} \left( \sum_{k=1}^{n} \left( I^{m}_{c,k} w^{m}_{c,k} \right) + I^{w} w^{w}_{c} \right) w_c \tag{A.7}$$

,

where $ICI$ is the input cost index, $I^{m}_{c,k}$ is the price index for the material $k$ used to construct component $c$, $w^{m}_{c,k}$ is the weight of that particular material $k$ in constructing component $c$, $I^{w}$ is the wage index for the construction cost sector and $w^{w}_{k}$ is the weight of wages in constructing the component $c$ and $w_c$ is the weight of the component $c$ in constructing the representative building.

An output price index is calculated as

$$OPI = \sum_{i=1}^{n} \left( I^{c} w^{c} \right) \tag{A.8}$$

where $OPI$ is the output price index, $I^{c}$ is the price index for component $c$ and $w^{c}$ is the weight of component $c$ in constructing the representative building.

**Construction of the country indices** As in the case of house prices indices, we often found series spanning short time periods and had to splice them to arrive at a long-run index. Due to variation in building norms and standards, the historical data we have at our disposal differ across countries and time with respect to the factors or operations included, the sources of price data, and the weighting scheme used to arrive at an aggregate index. Typically, construction cost indices do not adjust for quality changes. By contrast, they aim to reflect the cost of erecting a structure according to current norms and standards. As a result, construction cost indices are regularly rebased which typically also involves an update of the coverage and the weighting scheme. Whenever possible, we rely on construction cost series covering the same or a similar type of house and area as covered by our long-run house price indices. It remains a possibility that the difference between the house price indices and the construction cost indices with respect to coverage and quality adjustment may bias the results of our decomposition exercise in Section 2.4. While we cannot gauge the exact size and direction of the bias, it is unlikely to systematically distort the long-run trends we uncover. Robustness checks such as in Figure 2.8 support the assumption that the cost of building a new residential structure and replacement costs of the structures covered by our long-run house price indices move together in the long-run.

We also construct real unit labor cost indices for the construction sector between 1950 and 1970 using national accounts data for Canada, France, Finland, Germany, Norway, Sweden, the U.K., and the U.S. Sources are detailed in the respective country sections below. Unit labor costs $ULC_t$ are calculated as labor compensation per worker $C_t$ divided by output per worker $O_t$,

$$ULC_t = \frac{C_t}{O_t}. \tag{A.9}$$

We measure compensation based on salaries and wages (per worker) in the construction sector. Salaries and wages are deflated by the CPI. Output (per worker) in the construction sector is deflated by the construction cost index (Bosworth and Perry, 1994).

#### Other housing statistics

We complement the house price data with additional housing related data series: prices of farmland and estimates for the total value of the housing stock. For prices of farmland we again rely on official statistical publications and series constructed by other researchers. For benchmark data on the total market value of housing and its components (i.e. structures and land) we turn to the OECD database of national account statistics for the most recent period (with different starting points depending on the country). We consult the work of Goldsmith (1981, 1985) and also build on more recent contributions, such as Piketty and Zucman (2014) (for Australia, Canada, France, Germany, Italy, Japan, the U.S., and UK) and Davis and Heathcote (2007) (for the U.S.) to cover earlier years. For macroeconomic and financial variables, we rely on the long-run macroeconomic dataset from Jordà et al. (2016a). Note also that historical CPI series are often confined to urban areas. Due to limited data availability, changes in the quality of commodities and the timing of the introduction of new commodities are not always adequately captured by the historical CPI data. See Grytten (2004) and Officer (2007) for a discussion of the challenges involved in constructing long-run CPI series.

### A.2.2 Australia

#### House price data

Historical data on house prices in Australia are available for 1870–2012.

The most comprehensive source for house prices for the Sydney and Melbourne area is Stapledon (2012c). His indices cover the years 1880–2011. For the sub-period 1880–1943, they are computed from the median asking price for all residential buildings, indiscriminate of their characteristics and specifics; for 1943–1949, Stapledon (2012c) estimates a fixed prices;[3] for 1950–1970, he uses the median sales price.[4] For the sub-period 1970–1985, Stapledon (2012c) relies on estimates of median house prices by Abelson and Chung (2005) (see below); for 1986–2011, he uses the Australian Bureau of Statistics (2013) (see below) index for established houses.

The median house price series compiled by Abelson and Chung (2005)[5] for

[3] Price controls on houses and land were imposed in 1942 and were only removed in 1948 (Stapledon, 2007, 23 f.).

[4] The ask price series for residential houses (1880–1943) and the sales price series (1948–1970) are compiled from weekly property market reports in the *Sydney Morning Herald* and the *Melbourne Age*. The reports are for auction sales and private treaty sales.

[5] Abelson and Chung (2005) also present series for Brisbane (1973–2003), Adelaide (1971–2003),

Sydney and Melbourne are constructed from various data sources: for the Sydney series they rely on i) a 1991 study by Applied Economics and Travers Morgan which draws on sales price data from the Land Title Offices (for 1970–1989); and ii) on sales price data from the Department of Housing, i.e. the North South Wales Valuer-General Office (for 1990–2003). For the Melbourne series the authors rely on previously unpublished sales price data from the Productivity Commission drawing, in turn, on Valuer-General Office (for 1970–1979) and Victorian Valuer-General Office sales price data (for 1980–2003).

Besides the Sydney and Melbourne house price indices (see above), Stapledon (2007, 64 ff.) provides aggregate median price series for detached houses for the six Australian state capitals (Adelaide, Brisbane, Hobart, Melbourne, Perth, Sydney) for the years 1880–2006. As house price data are – with the exception of Melbourne and Sydney – not available for the time prior to 1973, the author uses census data on weekly average rents to estimate rent-to-rent ratios.[6] The rent-to-rent-ratios are then used to estimate mean and median price data for detached houses in the four state capitals (Adelaide, Brisbane, Hobart, Perth), based on the weighted mean price series for Sydney–Melbourne for the time 1901–1973.[7] For the years after 1972, Stapledon (2007, 234 f.) uses the Abelson and Chung (2005) series for the period 1973–1985 and the Australian Bureau of Statistics (2013) series for 1986–2006 (see below).

In addition to Stapledon (2012c, 2007) and Abelson and Chung (2005), four early additional house price data series and indices for Sydney and Melbourne are available: i) Abelson (1985) provides an index for Sydney for 1925–1970[8]; ii) Neutze (1972) presents house price indices for four areas in Sydney (1949–1967)[9]; iii) Butlin (1964) presents data for Melbourne (1861–1890)[10]; and iv) Fisher and Kent (2011) compute series of the aggregate capital value of ratable properties covering the 1880s and 1890s for Melbourne and Sydney.

For 1986–2012 the Australian Bureau of Statistics (2013) publishes quarterly

Perth (1970–2003), Hobart (1971–2003), Darwin (1986–2003), and Canberra (1971–2003). For details on the data sources used for these cities, see Abelson and Chung (2005, 10).

[6]The ratios are computed from average weekly rents for detached houses in the four state capitals (numerators) and a weighted weekly rent calculated from data for Sydney and Melbourne (denominators). Data are available for the years 1911, 1921, 1933, 1947, and 1954.

[7]The same method is applied to extend the series backwards, i.e. to the period 1880–1900. Each city's share of houses is applied for weighting.

[8]Abelson (1985) collects sales and valuation prices from the N.S.W. Valuer-General's records for about 200 residential lots in each of the 23 local government areas. He calculates a mean, a median, and a repeat valuation index.

[9]These areas are Redfern (1949–1969), Randwick (1948–1967), Bankstown (1948–1967) and Liverpool (1952–1967). He also calculates an average of these four for 1952–1967 (Neutze, 1972, 361). These areas are low to medium income areas. He relies on sales prices. In none of the years there are less than ten sales, in most years he includes data on more than 40 sales (Neutze, 1972, 363). Neutze does not further discuss the method he used. He argues, however, that his price series can be taken as being typical of all housing.

[10]According to Stapledon (2007), this series gives a general impression of house price movements after 1860. The series is based on advertisements of houses for sale in the newspapers *Melbourne Age* and *Argus*. Stapledon (2007, 16) reasons that by measuring the asking price in terms of rooms rather than houses, Butlin partially adjusted for quality changes and differences as the average amount of rooms per dwelling rose considerably between 1861 and 1890.

indices for eight cities for i) established detached dwellings and ii) project homes. The indices are calculated using a mix-adjusted method.[11] Sales price data comes from the State Valuer-General offices and is supplemented by data on property loan applications from major mortgage lenders (Australian Bureau of Statistics, 2009).[12]

Figure A.11 compares the nominal indices for 1860–1900, i.e. an index for Melbourne calculated from Butlin (1964), the Melbourne and Sydney indices by Stapledon (2012c), and the six capital index (Stapledon, 2007). For the years they overlap (1880–1890) the four indices provide considerable indication of a boom-bust scenario, albeit with peaks and troughs staggered between two to three years. For the 1890s the indices generally show a positive trend, which culminates between 1888 (Butlin, 1964, Melbourne) and 1891 (Stapledon, 2012c, Sydney). The six-capitals-index follows a pattern that is somewhat disjoint and inconsistent with that picture: While from 1880 to 1887 prices are stagnant, the boom period is limited to mere three years (1888–1891) during which the index reports a nominal increase of house prices in the six capitals amounting to 25 percent. This trajectory, however, not only differs from the Melbourne and Sydney indices but is also at odds with various accounts (Daly, 1982; Stapledon, 2012c).[13] Against this background, the stagnation of the six-capital-index during most of the 1880s appears rather implausible.

[11]The eight cities are Sydney, Melbourne, Brisbane, Adelaide, Perth, Hobart, Darwin, Canberra. 'Project homes' are dwellings that are not yet completed. In contrast, the concept of 'established dwellings' refers to both new and existing dwellings. Locational, structural and neighborhood characteristics are used to mix-adjust the index, i.e. to control for compositional change in the sample of houses. The series are constructed as Laspeyre-type indices. The ABS commenced a review of its house price indices in 2004 and 2007. Prior to the 2004 review, the index was designed as a price measure for mortgage interest charges to be included in the CPI. The weights used to calculate the index were thus housing finance commitments. As part of the 2004 review, the pricing point has been changed, the stratification method improved, and the relative value of each capital city's housing stock used as weights. In 2007 the stratification was again refined and the housing stock weights were updated. Due to the substantive methodological changes of 2004, the ABS publishes two separate sets of indices: 1986–2005 and 2002–2012 (Australian Bureau of Statistics, 2009). They move, however, closely together in the years they overlap.

[12]For 1960–2004, there also exists an unpublished index calculated by the Australian Treasury (Abelson and Chung, 2005). The index moves closely together with the one calculated by Abelson and Chung (2005) (correlation coefficient of 0.995 for the period 1986–2003 and 0.774 for 1970–1985). For the period 1970–2012, an index is available from the OECD based on the house price index covering eight capital cities published by the Australian Bureau of Statistics. For the period 1975–2012, the Federal Reserve Bank of Dallas splices together the index published by the Australian Bureau of Statistics (2013) and the Treasury house price index.

[13]Daly (1982) provides a graphical analysis of land and housing prices in Sydney for the period 1860–1940 drawing on data from business records by Richardson and Wrench (at the time one of the largest real estate agents in Sydney), newspaper reports of sales, and advertisements. Daly (1982, 150) and Stapledon (2012c) describe a pronounced property price boom during the 1880s, followed by a bust in the 1890s. The surge in real estate prices was primarily spurred by a prolonged period of economic growth during the 1870s and 1880s following the gold rushes of the 1850s and 1860s. Also, the time from 1850–1880 was marked by substantial immigration and thus a significant increase in population particularly in the urban areas. For the case of Melbourne, where the house boom was most pronounced, the extensions of mortgage credit through thriving building societies during the 1870s and 1880s appears to have played a major role.

**Figure A.11:** Australia: nominal house price indices, 1870–1900 (1890=100).

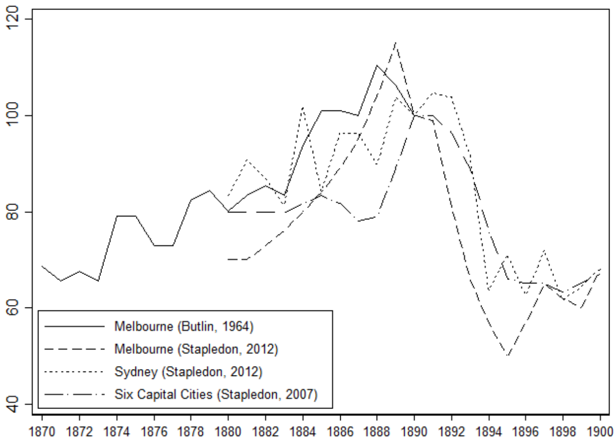
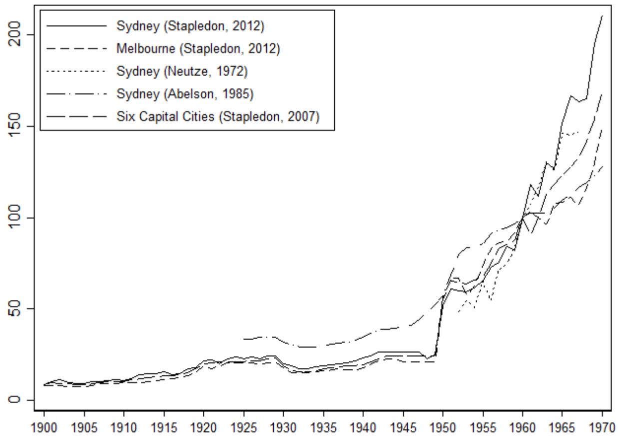



Figure A.12 compares the nominal indices for 1900–1970, i.e. the Melbourne and Sydney indices by Stapledon (2012c), the Sydney indices by Neutze (1972) and Abelson (1985), and the six capital index (Stapledon, 2007). Stapledon (2007) discusses the differences between his six-capital-index and the indices by Neutze (1972) and Abelson (1985) and concludes that they either almost fully correspond (in the case of Neutze (1972)) or at least show a very similar trend (in the case of Abelson (1985)) when compared to that of the six-capital-index. Reassuringly, these trends are also in line with narrative evidence on house price developments.[14]

Figure A.13 shows the indices which are available for the period 1970–2012: the Sydney and Melbourne indices by Stapledon (2012c), indices calculated from the Sydney and Melbourne series by Abelson and Chung (2005), the six-capitals-

[14]The only very moderate rise in nominal house prices between the beginning of the 20th century and 1950 is striking. According to Stapledon (2012c, 305), this long period of weak house price growth may at least to some extent have been a result of the large volume of new urban land lots developed in the boom years of the 1880s). After a consolidation period following the depression of the 1890s that lasted to 1907, nominal property prices slowly but constantly increased. While house prices reached a high plateau during the 1920s, the consolidation that can be ascribed to the adverse effects of the Great Depression of the 1930s appears to have been only minor in size, particularly in comparison to the substantive house price slumps experienced in other countries. Daly (1982, 169) reasons that this soft landing was mainly due to the fact that prices had been less elevated at the onset of the recession, particularly when compared to the boom and bust cycle of the 1880s and 1890s. The post-World War II surge in house prices has been primarily explained with the lifting of wartime price controls in 1949 that had been introduced for houses and land in 1942. The low construction activity during the war years had also led to a substantive housing shortage in the post-war years. A surge in construction activity was the result (Stapledon, 2012c, 294). While postwar Australia began to prosper, entering a phase of low levels of unemployment and rising real wages, the government aimed to raise the level of homeownership by various means, for example, through the provision of tax incentives (Daly, 1982, 133). By the end of the 1950s, however, the federal government became increasingly uncomfortable with the expansion of consumer credit and the strong increase in property values. As a response, measures to restrict credit expansion were introduced in 1960. The resulting credit squeeze had an immediate and sizable impact on both the real estate market and the economy as whole (Stapledon, 2007, 56). The recovery from this brief interruption was rapid and property prices continued to boom.

**Figure A.12:** Australia: nominal house price indices ,1900–1970 (1960=100).



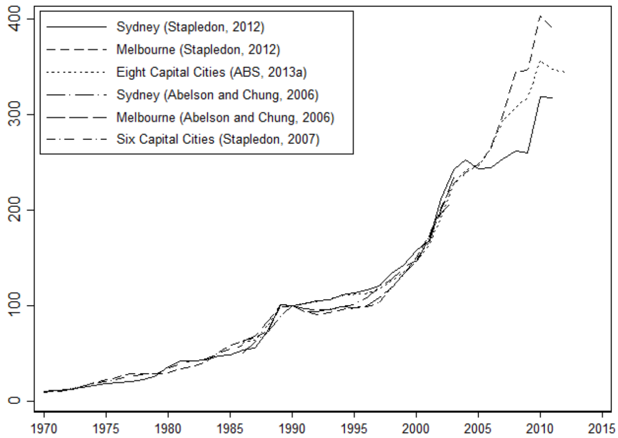

index by Stapledon (2007), and the weighted index for eight cities for 1986–2012 by the Australian Bureau of Statistics (2013).[15] Despite their different geographical coverage, all indices for the years from 1970–2012 follow a joint, almost identical path. It is only after 2004 that the increase in Melbourne property prices shows to be more pronounced compared to Sydney or the Eight Capital Index.

As we aim to provide house price indices with the most comprehensive coverage possible, the series constructed by Stapledon (2007) for the six capitals constitutes the basis for the long-run index. Due to the above mentioned possible deficiencies of the index for the time of the 1880s boom and subsequent contraction, the Stapledon (2012c) index for Melbourne is used for 1880-1899. Therefore, the index may be biased upward to some extent since the boom of the 1880s was particularly pronounced in Melbourne when compared to, for example, Sydney. The index is extended backwards to 1870 using the index calculated from the Melbourne series by Butlin (1964). Hence, prior to 1900, our index only refers to Melbourne. Although we can say little about the extent to which house prices in the Melbourne area prior to 1900 are representative of house prices in the other Australian state capitals, the graphical evidence provided by Daly (1981) at least suggests that during the time prior to 1880 Sydney house prices showed a comparable upward trend. Beginning in 2003, the index is spliced with the Australian Bureau of Statistics (2013) eight-cities-index.

The resulting index may suffer from three weaknesses: first, prior to 1943, the index is based on asking prices. These may differ from actual transaction prices and thus result in a bias of unknown size and direction. Second, the index does not explicitly control for quality changes, i.e. depreciation or improvement. Third, only after 1986 the index controls for quality changes. To gauge the extent of the

[15]The ABS series is spliced in 2003. As Stapledon (2012c) draws upon Abelson and Chung (2005) for 1970–1985, these series should therefore be identical for this period. As Stapledon (2012c) uses the Australian Bureau of Statistics (2013) series for Sydney and Melbourne for 1986–2012, these, again, should be identical for this period. In addition, since Stapledon (2007) uses the Australian Bureau of Statistics (2013) series for eight capital cities, these two indices are identical for post-1986. The Australian Bureau of Statistics (2013) index only starts in 1986.

**Figure A.13:** Australia: nominal house price indices, 1970–2012 (1990=100).




quality bias we can rely on estimates provided by Stapledon (2007) according to which improvements, i.e. capital spending, adds an average of 0.95 percent per annum to the value of housing and changing composition of the stock subtracted 0.35 percent per annum from the median price. For the war years of 1914–1918 and 1940–1945 and the depression periods 1891–1895 and 1930–1935, Stapledon (2007) assumes 0.55 percent per annum. These estimates are in line with Abelson and Chung (2005). If we adjust the growth rates of our long-run series downward accordingly, the average annual real growth rate over the period 1870–2012 of 1.68 percent becomes 1.11 percent in constant quality terms. As this is a rather crude adjustment, we use the unadjusted index (see Table A.3) for our analysis.

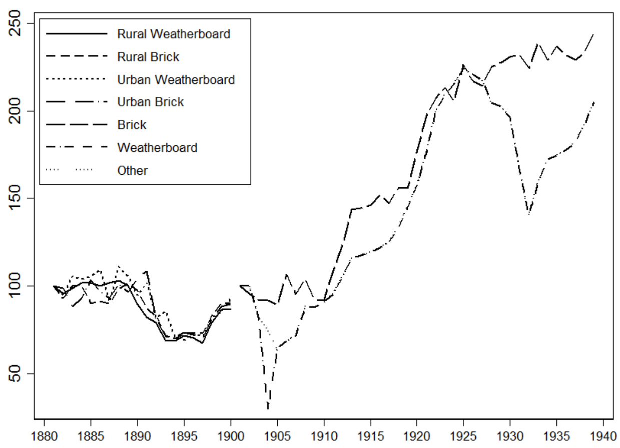
### Construction cost data

Historical data on construction costs in Australia are available for 1870–2012. The most comprehensive source is Stapledon (2012a, Table 2). Stapledon (2012a) reports an index for construction costs of new dwellings for 1881–2012. To arrive at a long-run series, the author combines data drawn from Butlin (1962) for 1870–1938, Butlin (1977) for 1939–1949, and the Australian Bureau of Statistics (2015) for the years thereafter. The series computed by Butlin (1962) refers to construction costs per room in Victoria and is based on loan applications for 1870–1890 and 1900–1939 and tender prices for the 1890s. Loan applications come from the records of the Modern Permanent Building Society and the County of Bourke Building Society. Tender prices are drawn from the *Australasian Builder and Contractors' News*. As price data in both sources include profit margins etc., the series can be interpreted as an output price index. To extend the series to cover the 1870s, Butlin (1962) relies on indices for the cost of building materials and of carpenters' and bricklayers' wages. For 1870–1879, the series are thus constructed as input cost indices. The series are smoothed with a three-year moving average. In addition to the aggregate series for all types of dwellings, several series for different types of dwellings and locations for shorter time periods are available. Reassuringly,

**Table A.3:** Australia: sources of house price index, 1870–2012.

| Period | Series ID | Source | Details |
|---|---|---|---|
| 1870–1880 | AUS1 | Butlin (1964) | *Geographic Coverage*: Melbourne; *Type(s) of Dwellings*: All kinds of existing dwellings; *Data*: Advertisements in newspapers; *Method*: Median asking prices. |
| 1881–1899 | AUS2 | Stapledon (2012c) | *Geographic Coverage*: Melbourne; *Type(s) of Dwellings*: All kinds of existing dwellings; *Data*: Advertisements in newspapers; *Method*: Median asking prices. |
| 1900–1942 | AUS3 | Stapledon (2007) | *Geographic Coverage*: Six capital cities; *Type(s) of Dwellings*: All kinds of existing dwellings; *Data*: Advertisements in newspapers and Census estimates of average rents; *Method*: Median asking prices. |
| 1943–1949 | AUS4 | Stapledon (2007) | *Geographic Coverage*: Six capital cities; *Type(s) of Dwellings*: All kinds of existing dwellings; *Data*: Estimate of the fixed price; *Method*: Estimate of fixed price. |
| 1950-1972 | AUS5 | Stapledon (2007) | *Geographic Coverage*: Six capital cities; *Type(s) of Dwellings*: All kinds of existing dwellings; *Data*: Weekly property reports in newspapers and Census estimates of average rents; *Method*: Median sales prices. |
| 1973–1985 | AUS6 | Abelson and Chung (2005), as used in Stapledon (2007) | *Geographic Coverage*: Six capital cities; *Type(s) of Dwellings*: All kinds of existing dwellings; *Data*: Data from Land Title Offices (LTOs); Productivity Commission data; Valuer-General Offices; *Method*: Weighted average of median prices. |
| 1986–2002 | AUS7 | Australian Bureau of Statistics (2013) as used in Stapledon (2007) | *Geographic Coverage*: Six capital cities; *Type(s) of Dwellings*: New and existing detached houses; *Data*: Data from State Valuer-General Offices, supplemented by data on property loan applications from major mortgage lenders; *Method*: Weighted average of mix-adjusted house price indices. |
| 2003–2012 | AUS8 | Australian Bureau of Statistics (2013) | *Geographic Coverage*: Eight capital cities; *Type(s) of Dwellings*: New and existing detached houses; *Data*: Data from State Valuer-General Offices, supplemented by data on property loan applications from major mortgage lenders; *Method*: Mix adjustment. |

**Figure A.14:** Australia: nominal construction cost indices, 1881–1939 (1881=100).




they generally follow the same trends (see Figure A.14). For the years 1939–1949, Butlin (1977) constructs an input cost index but provides no further details on the characteristics of the series. As part of the Australian National Accounts, the Australian Bureau of Statistics (2015) for the years since 1949 calculates an implicit price deflator for private residential construction, alterations and additions. The series is obtained by dividing the current value of residential structures by a volume estimate. The index therefore reflects the replacement value of all types of residential dwellings.

Our long-run construction cost index for Australia 1881–2012 splices the available series as shown in Table A.4.

### Land price data

Data on residential land prices for the period 1880–2005 comes from Stapledon (2007). Stapledon (2007) reports decennial data on median land prices in Sydney and Melbourne for 1880–1940 and quinquennial data for 1950–2005. Observations are calculated as period averages of median prices for 1880–1990 and as period averages of average prices thereafter. Note that the series is not adjusted for the size of the lot. For 1880–1970, the series is based on data on the price of land for sale and sold from newspaper advertisements (see above). The lots included are located in all segments of the urban areas but are predominantly new allotments in outer suburbs. Therefore, Stapledon (2007) argues that the sample reflects the value of land lots at the urban fringe rather than the value of urban land in general. For 1970–1989, he relies on a series of median residential land prices in Melbourne and Sydney constructed by BIS-Schrapnel using data from two newspapers, the *Sydney Morning Herald* and *Age*. For the years since 1990, he relies on data on the value of residential land by state collected by the Australian Bureau of Statistics and calculates an index of average land value per dwelling (see Stapledon (2007, 196f.) for further details). We use an unweighted average of the resulting long-run series for Melbourne and Sydney.

**Table A.4:** Australia: sources of construction cost index, 1870–2012.

| Period | Source | Details |
|---|---|---|
| 1870–1880 | Butlin (1962) | *Geographic Coverage*: Victoria; *Type(s) of Dwellings*: All types of buildings; *Type of Index*: Input cost index. |
| 1881–1900 | Butlin (1962) as published in Stapledon (2012a) | *Geographic Coverage*: Victoria; *Type(s) of Dwellings*: All types of dwellings; *Type of Index*: Output price index. |
| 1901–1939 | Butlin (1962) as published in Stapledon (2012a) | *Geographic Coverage*: Victoria; *Type(s) of Dwellings*: All types of dwellings; *Type of Index*: Output price index. |
| 1940–1948 | Butlin (1977) as published in Stapledon (2012a) | *Geographic Coverage*: no information available; *Type(s) of Dwellings*: no information available; *Type of Index*: Input index. |
| 1949–2012 | Australian Bureau of Statistics (2015) as published in Stapledon (2012a) | *Geographic Coverage*: Nationwide; *Type(s) of Dwellings*: All types of dwellings; *Type of Index*: Replacement values. |

#### Other housing related and macroeconomic data

*Value of housing stock*: Goldsmith (1985) and Garland and Goldsmith (1959) provide estimates of the value of total housing stock, dwellings, and land for the following benchmark years: 1903, 1915, 1929, 1947, 1956, 1978. Data for 1988–2011 is drawn from OECD (2013). Piketty and Zucman (2014) present data on the value of household wealth in land and dwellings for 1959–2011.

*CPI*: 1870–2007: Taylor (2002); 2008–2012: International Monetary Fund (2012b).

### A.2.3 Belgium

#### House price data

Historical data on house prices in Belgium are available for 1878–2012.

The earliest available data on house prices in Belgium is provided by De Bruyne (1956). It covers the greater Brussels area for the period 1878–1952 and is reported as the annual median price per square meter of the interquartile range for four real estate categories: i) residential property[16] in the center of Brussels, ii) maisons

[16]'Maisons d'habitation' are defined as houses of rather inferior quality. Some of them may be 'maisons de rentier' (see below) that have been downgraded because of the neighborhood or the age of the building. They are usually inhabited by workers or employees, small, and do not have electricity, central heating, gas or water (De Bruyne, 1956, 62).

de rentier,[17] iii) building sites (since 1885), and iv) commercial properties[18] (since 1879).[19]

A second extensive source comprising two house price indices - one for 1919–1960 and the other for 1960–2003 - is Janssens and de Wael (2005). The first index, i.e. for 1919–1960, is based on two data sources: for 1919–1950 the index relies on a property price index for Brussels published by the Antwerpsche Hypotheekkas (1961) using sales price data for maisons de rentier. The AHK-index is computed as the annual median price of the interquartile range. For 1950–1960, the index is based on nationwide data for all public housing sales subject to registration rights gathered by Statistics Belgium. For these years the index reflects the development of the weighted mean sales price; weights are constructed from the share of total national sales in each of the 43 Belgian arrondissements (districts). The computational method for the second index from Janssens and de Wael (2005), covering the years 1960–2003, is identical to that applied to the sub-period 1950–1960. The sole difference lies in the coverage of the data provided by Statistics Belgium. While for the period 1950–1960 sales information is limited to public sales, the index for the time 1960–2003 is computed using price information for both public and private housing sales that were subject to registration rights.

In addition to these two principal sources, for the years since 1986, Statistics Belgium (2013a) on a quarterly basis publishes price indices for the following four types of real estate: i) building lots; ii) apartments; iii) villas; and iv) single-family dwellings. The indices are constructed using stratification and are available for the national, regional, district (arrondissements), and communal level.[20]

Figure A.15 shows the nominal indices for the different property types (maisons d'habitation, maisons des rentier, commercial buildings, and building sites) based on the data from De Bruyne (1956). Three indices (maison d' habitation, maison de rentier, and maison de commerce) move closely together throughout the 1878–1913 period; only the building sites index shows a comparably higher degree of volatility particularly during the 1880s and 1890s. Nevertheless, all four indices

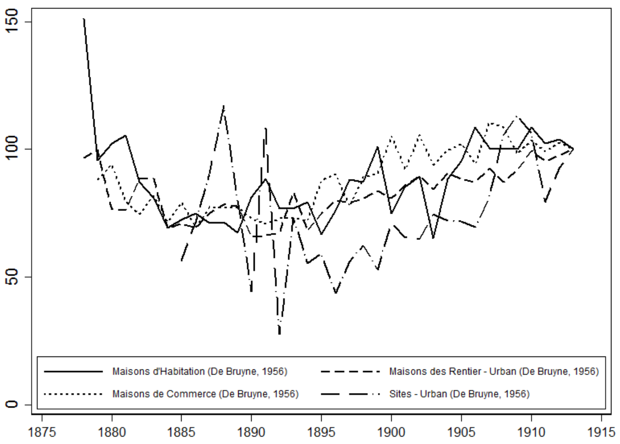
[17]'Maisons de rentier' are defined as properties that are located in a good neighborhood, have usually more than one story, are well maintained, and serve as a single-family dwelling (De Bruyne, 1956, 61 f.).

[18]Commercial properties are defined as all buildings for commercial use, i.e. hotels, restaurants, retail stores, warehouses, etc. (De Bruyne, 1956, 63).

[19]Data are drawn from accounts of public real estate sales published in the *Guide de l'Expert en Immeubles* (Real Estate Agents' Catalogue), a periodical of the Union des Géomètres-Experts de Bruxelles (Union of Surveyors of Brussels). The records include the more urban parts of the Brussels district, such as Brussels itself, Etterbeek, Ixelles, Molenbeek, Saint-Gilles, Saint-Josse, Schaerbeek, Koekelberg, and Laeken. De Bruyne (1956) also publishes separate house price series for the more rural areas, such as Anderlecht, Auderghem, Forest, Ganshoren, Jette, Uccle, Watermael-Boitsfort, Berchem-Ste-Agathe, Woluwe-St-Lambert, Woluwe-St-Pierre, Evere, Haeren, Neder over-Heembeck.

[20]Dwellings are stratified according to type and location. The stratification was refined in 2005 so that single-family dwellings are categorized according to their size (small, average, large) causing a break in the series between 2004 and 2005. The index is computed as a chain Laspeyre-type price index. It does not control for quality changes. Districts are aggregated according to the number of dwellings in the base period (2005). For the period 1970–2012, an index is available from the OECD based on the index compiled by the Bank of Belgium, which in turn is based on the data from Statistics Belgium (European Central Bank, 2013). For the period 1975–2012, the Federal Reserve Bank of Dallas also uses the data from Statistics Belgium (2013a) and Stadim (2013).

**Figure A.15:** Belgium: nominal house price indices, 1878–1913 (1913=100).




depict a similar trend: nominal house prices trend downwards until the late 1880s and slowly recover afterwards. De Bruyne (1956) suggests that these trends are generally in line with the fundamental macroeconomic trends and narrative evidence on house price developments in Belgium.[21]

Figure A.16 displays the nominal indices available for 1919–1960; i.e. the index calculated from the data by De Bruyne (1956) for the Brussels area, the indices from Janssens and de Wael (2005) for the Brussels area, and an index for Antwerp by Antwerpsche Hypotheekkas (1961). As Figure A.16 shows, these nominal indices move closely together during the years they overlap, i.e. 1919–1952.[22] The indices accord with accounts of house price developments during this period.[23] Although all three indices only gauge price developments for maisons de rentier,

[21]Since the 1880s, the Belgian economy had been in a recession. Recovery only began to take hold in the mid-1890s (Van der Wee, 1997). The housing act of 1899 through promoting reduced-rate loans and extending tax exemptions and tax reduction for homeowners may have further contributed to the slow upward trend in house prices (Van den Eeckhout, 1992). Following the economic resurgence in 1906, Belgium until the eve of World War I experienced years of prospering economic activity. De Bruyne (1956) notes that during this period the gap between prices for property in urban and more peripheral parts of the Brussels area began to close. He ascribes this convergence largely to improvements in transportation and communication systems during that time (Janssens and de Wael, 2005; Antwerpsche Hypotheekkas, 1961).

[22]Correlation coefficient of 0.995 for the two Brussels indices; correlation coefficient of 0.993 for the Antwerpen-index (Antwerpsche Hypotheekkas, 1961) and the Brussels index (De Bruyne, 1956).

[23]De Bruyne (1956) reasons that the increase in property prices between 1919 and 1922 was to a large extent caused by a general shortage of housing in the postwar years. While De Bruyne (1956) in this context diagnoses the house price boom to be primarily driven by speculation, the Antwerpsche Hypotheekkas (1961) attributes the price rise to the rapid economic growth during these years. House prices substantially decreased throughout the economic crisis of the 1930s. De Bruyne (1956), however, argues that the decrease was less pronounced in less expensive property categories, i.e. maisons d'habitation as opposed to maisons de rentier since with declining incomes many people were forced to relocate to either areas in which housing is less expensive or to lower quality housing. Prices appear to slightly recover in the end of the 1930s. Yet, the advent of World War II puts the property market back into decline. After the end of World War II, the Belgian economy entered three decades of substantive though non-linear growth which is clearly reflected in house prices. Also, as a result of the wartime destruction, Belgium faced a substantial housing shortage which further drove up prices (Antwerpsche Hypotheekkas, 1961).

we know from Figure A.15 that their value should not develop in a fundamentally different way than the value of other property types. We may also assume that price trends across Belgian cities did not differ significantly. Figure A.16 includes an index for maisons de rentier for Antwerp.[24] When comparing the index for Antwerp and the indices for Brussels, the latter seems not to show a singular development in house prices. Summary statistics of the indices by decade clearly confirm the similarity of general statistical characteristics of the series. This finding can be reinforced from another direction. Leeman (1955, 67) examines house prices in Brussels, Antwerp, Mechelen, Leuven, Bruges, Dinant, and Lier using records of a mortgage bank for the years 1914–1943. He, too, concludes that the trends in Brussels' house prices generally mirror the trends in other regions of Belgium during the interwar period.

**Figure A.16:** Belgium: nominal house price indices, 1919–1960 (1919=100).


For the years 1986–2003 also the index by Janssens and de Wael (2005) for 1960–2003 and the one by Statistics Belgium (2013a) show the same statistical characteristics.[25] Our long-run house price index for Belgium for 1878–2012 splices the available series as shown in Table A.5.

The most important limitation of the long-run series is the lack of correction for changing qualitative characteristics of and quality differences between the dwellings in the sample. To some extent the latter aspect may be less of a problem for 1878–1950 since for that period the index is confined to a certain market segment, i.e. maisons de rentier. Prior to 1950, the series is also adjusted for the size of the dwelling as it is based on price data per square meter. Moreover, despite the fact that the movements in prices for maisons de rentier closely mirror fluctuations in prices of other property types prior to 1913 (cf. Figure A.15), it is of course possible that this particular market segment is not perfectly representative of fluctuations in prices of other residential property types for the whole 1878–

[24]To the best of our knowledge, no other index for this property type is available for other parts of Belgium.

[25]This, however, is unsurprising since Stadim cooperated with Statistics Belgium in the creation of its index. Both, Janssens and De Wael are founding members of Stadim.

**Table A.5:** Belgium: sources of house price index, 1878–2012.

| Period | Series ID | Source | Details |
|---|---|---|---|
| 1878–1913 | BEL1 | De Bruyne (1956) | *Geographic Coverage*: Brussels area; *Type(s) of Dwellings*: Existing maisons de rentier; *Data*: Guide de l'Export en Immeubles; *Method*: Median sales prices. |
| 1919–1950 | BEL2 | Janssens and de Wael (2005); based on Antwerpsche Hypotheekkas (1961) | *Geographic Coverage*: Brussels area; *Type(s) of Dwellings*: Maisons de Rentier; *Data*: Antwerpsche Hypotheekkas (1961); *Method*: Median sales prices. |
| 1951–1959 | BEL3 | Janssens and de Wael (2005) | *Geographic Coverage*: Nationwide; *Type(s) of Dwellings*: Small & medium-sized existing houses; *Data*: Transaction prices (public sales; gathered by Statistics Belgium); *Method*: Weighted average of mean sales prices. |
| 1960–1985 | BEL4 | Janssens and de Wael (2005) | *Geographic Coverage*: Nationwide; *Type(s) of Dwellings*: 1960–1970: Small & medium-sized existing houses; 1971 onwards: all kinds of existing dwellings (villas & mansions included); *Data*: Transaction prices (public and private sales) gathered by Statistics Belgium); *Method*: Weighted average of mean sales prices. |
| 1986-2012 | BEL5 | Statistics Belgium (2013a) | *Geographic Coverage*: Nationwide; *Type(s) of Dwellings*: Existing, single-family dwellings; *Data*: Transaction prices; *Method*: Weighted mix-adjusted index. |

**Table A.6:** Belgium: sources of construction cost index, 1914–2012.

| Period | Source | Details |
|---|---|---|
| 1914–2012 | Belgian Association of Surveyors (2013) | *Geographic Coverage*: Nationwide; *Type(s) of Dwellings*: All types of buildings; *Type of Index*: Output price index. |

1950 period. In an effort to gauge the size of the upward bias stemming from quality improvements we calculate the value of expenditures on alterations and additions as percentage in total housing value for benchmark years. If we downward adjust the real annual growth rates of our long-run index accordingly, the average annual real growth rate over the period 1878–2012 of 1.96 percent becomes 1.77 percent in constant quality terms. Yet, as this is a rather crude adjustment, we use the unadjusted index (see Table A.5) for our analysis.

#### Construction cost data

Historical data on construction costs in Belgium are available for 1914–2012.

Two main sources for construction costs in Belgium exist. First, the Belgian Association of Surveyors (2013) publishes an output price index (ABEX-index) for all types of new buildings (residential and commercial) covering the period 1914–2012. The index is constructed as an output price index and is based on data collected by members of an ABEX commission. The index is published twice a year, in March and November. We calculate an unweighted average of March and November values to arrive at an annual series.

Second, Buyst (1992) graphically reports real building cost indices for 1890–1913, 1920–1939, and 1946–1961. The indices are constructed as input cost indices using data on prices of building materials reported in Buyst (1992) and data on wages in the construction sector from Scholliers (1982), the *Arbeidsblad*, and the *Statistisch Bulletin* published by Statistics Belgium. This graphical analysis of real building costs can be used as a comparative to the index published by the Belgian Association of Surveyors (2013). Reassuringly, the series follows a trend similar to the index calculated by Belgian Association of Surveyors (2013). Our long-run construction cost index for Belgium therefore relies on the ABEX-index for the whole 1914–2012 period (see Table A.6).

#### Land price data

Data on residential land prices for the period 1953–2012 comes from Stadim (2013). The annual index refers to prices of building lots per square meter and is calculated based on transactions of land registered by the Dutch land registry (Kadaster). The national series is calculated as a weighted average of prices of building lots per square meter in the Flemish and the Walloon region.[26]

#### Other housing related and macroeconomic data

*Farmland prices*: 1980–2007: Vlaamse Overheid[27] - Price index for farmland; 2008–2009: Bergen (2011) - Sales prices for farmland in Vlaanderen per square meter.[28]

[26]Number of transactions are used as weights.
[27]Series sent by email, contact person is Els Demuynck, Vlaamse Overheid
[28]No data are available for 2010–2012.

*Value of housing stock*: Goldsmith (1985) provides estimates of the value of total housing stock, dwellings, and land for 1950 and 1978. Data for 2005–2011 is drawn from Poullet (2013).

*CPI*: 1870–2007: National Bank of Belgium (2012)[29]; 2008–2012: International Monetary Fund (2012b).

### A.2.4 Canada

#### House price data

Historical data on house prices in Canada are scarce even though real estate boards were already established in the early 20th century. Data on house prices in Canada is available for 1921–2012.

The first available series is presented by Firestone (1951) and covers the years 1921–1949. The index is calculated using data on the average value of residential real estate (including land) and the number of existing dwellings and hence reflects the average replacement value of existing dwellings rather than prices realized in transactions.[30]

A dataset published by the Canadian Real Estate Association (1981, (CREA)) covers the time 1956–1981. It contains annual data on the average value and the number of transactions recorded in the Canadian Multiple Listing System (MLS) for all properties, i.e. it includes both residential and non-residential real estate. In addition, Subocz (1977) presents a mean price index for new and existing single-family detached houses covering an earlier period, i.e. 1949–1976. The index is based on price data collected from the records of the Vancouver and New Westminster Registry offices serving the Greater Vancouver Regional District.

CREA also publishes a second house price data series that solely draws on price data from secondary market residential properties transactions through MLS

[29]Table "Indice des prix à la Consommation en Belgique," series received from Daisy Dillen, National Bank of Belgium

[30]Firestone (1951, 431 ff.) calculates the value of residential capital, i.e. the value of all existent dwellings, in 1921 by computing the average construction cost per dwelling, adjusting it for the proportion of the life of the dwelling already consumed and multiplying it with the number of available dwellings. The adjustment was made by subtracting 22/75 of the average cost of a non-farm home (the average age of a non-farm home in 1921 was 22 years, Firestone (1951) assumes an average life expectancy of a dwelling of 75 years) and 18/60 for farm homes (the average age of a farm home in 1921 was 18 years, Firestone (1951) assumes an average life expectancy of a farm dwelling of 60 years). The resulting value for 1921 may thus underestimate the value of an average residential structure in 1921 as it is not adjusted for improvements or alterations of the existing housing stock. Using these estimates of the value of structures and data on the ratio of land cost to construction costs, Firestone (1951) calculates the value of residential land in 1921. For the years 1922–1949, the 1921 value is revalued using average construction costs, deducting depreciation, deducting the value of destroyed and damaged dwellings, and adding gross residential capital formation in the respective year. The value of land put in use for residential use in the respective year is added and the value of land removed from residential use is deducted. The series for the total value of residential real estate is calculated as the sum of the series for the value of structures and the series for the value of land.

covering the years 1980–2012.[31] The series is computed as average of all sales prices in the residential property market.

The University of British Columbia index constitutes another source for the development of house prices in Canada. It covers the period 1975–2012 and is computed from price information for existing bungalows and two story executive detached houses in ten main metropolitan areas of Canada (Centre for Urban Economics and Real Estate, University of British Columbia, 2013, UBC Sauder).[32] For each of the cities, UBC Sauder uses a population weighted average of the price change in each neighborhood for which data are available. Subsequently, the index is weighted on changes in the price level of different housing types, i.e. detached bungalows and executive detached houses, according to their share in total units sold. The aim is to capture the within-metro-variation in house prices in proportion to the size of the housing stock and variation across housing types. Data are drawn from the Royal LePage house price survey.[33]

In addition to that, Statistics Canada issues three house price indices for new developments. Data are disaggregated to the provincial level and currently cover the period 1981–2012. They measure price developments for i) buildings; ii) land; and iii) real estate (land and buildings) and are aggregated to nationwide indices and a separate index for the Atlantic region (Statistics Canada, 2013c). The indices are computed from sales prices of new real estate constructed by contractors based on a survey that is conducted in 21 metropolitan areas with the number of builders in the sample representing at least 15 percent of the total building permit value of the respective city and year. The construction firms covered mainly develop single unit houses. The survey data includes information on various characteristics of the units constructed and sold. The index is a matched-model index, i.e. a constant-quality index in the sense that the characteristics of the structures and the lots are identical between successive periods.

The index produced by Firestone (1951) is hence the only available source for house prices in Canada prior to the 1950s. We therefore have to rely on accounts of housing market developments as plausibility check. The nominal index suggests that house prices are fairly stable throughout the 1920s, fall in the wake of the Great Depression, and increase after 1935. Anderson (1992), discussing Canadian housing policies in the interwar period, also suggests that house prices fall during the early 1930s. He furthermore points toward policy measures introduced during the second half of the 1930s that aimed at stimulating housing construction which may explain a demand-driven increase in house prices during these years.[34] Overall, the trajectory of the Firestone (1951) appears plausible.

[31]Series sent by email, contact person is Gregory Klump, Canadian Real Estate Association (CREA).

[32]Bungalows are defined as detached, one-story, three-bedroom dwellings with living space of about 111 square meters.

[33]The way the house price survey is conducted ensures some degree of constant quality as Royal LePage standardizes each housing type according to several criteria, such as square footage, the number of rooms, etc. (European Commission, 2013, 119).

[34]Anderson (1992) lists the 1935 Dominion Housing Act, the 1937 Home Improvement Loan Guarantee Act, and the 1938 National Housing Act.

**Figure A.17:** Canada: nominal house price indices, 1956–2012 (1981=100).

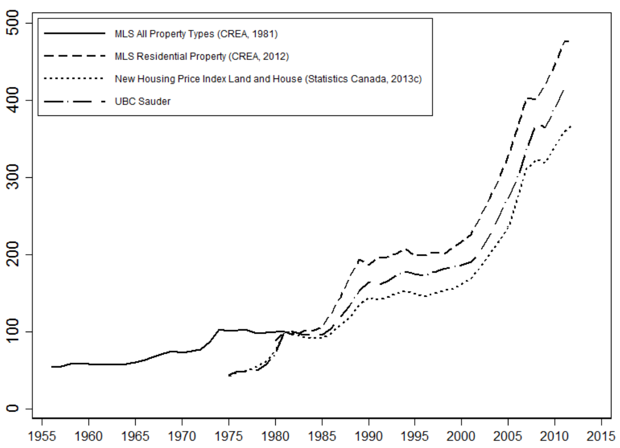



Figure A.17 compares the nominal house price indices available for 1956–2012, i.e. the UBC Sauder index, the price index for new houses (including land) by Statistics Canada, and an index computed from the two CREA datasets (i.e. 1956–1981, and 1980–2012). As the graph suggests, all indices show a marked positive trend in the post-1980 period. However, the magnitude of the price increase varies between the four measures. The European Commission (2013, 120) suggests that the more pronounced growth of the CREA index since the mid-1980s is due to the fact that the series is calculated from a simple average of real estate secondary market prices. Hence, it is biased with respect to the composition (e.g. size, standard, quality, etc.) of the overall volume of secondary market transactions. As this second CREA index, due to the substantive coverage of MLS, includes about 70 percent of all marketed residential properties (European Commission, 2013, 119), it can despite these conceptual limitations be considered a fairly reliable measure for the overall evolution of house prices in Canada for the time from 1980 to present. In comparison to the CREA index, the Statistics Canada index for new houses points toward a less pronounced increase in house prices. However, this Statistics Canada index - as it is solely calculated from price information on new developments - may also be subject to some degree of bias. New residential developments are primarily built in the suburban areas of larger agglomerations where prices and price fluctuations tend to be lower than in city centers (Statistics Canada, 2013a; European Commission, 2013). This may also be the reason for the different magnitude between the UBC Sauder index and the index by Statistics Canada. For the years since 1975 we use the UBC Sauder index as it is confined to a certain market segment (bungalows and existing two-story executive buildings) and thus should be less prone to composition bias than the CREA series.[35]

[35]Figure A.17 suggests that the CREA index for the time 1975–1980 follows a trend different from that of the UBC and Statistics Canada indices. While the latter for the period under consideration show a considerable positive trend, the former appears to be fairly stagnant. We therefore also use the UBC Sauder index for the years 1975–1980.

**Figure A.18:** Canada: nominal house price indices, 1949–1981 (1971=100).

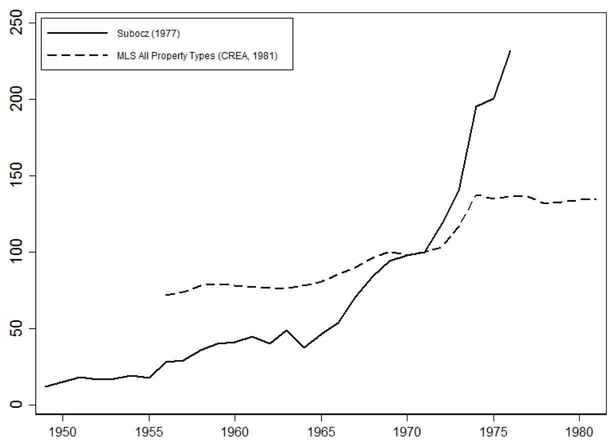



Figure A.18 compares the CREA index for 1956–1981 with the one presented by Subocz (1977). CREA argues that the MLS statistics covering residential and non-residential real estate for the time from 1956–1981 can be used to reliably proxy residential house price development. In addition to the CREA index and the Subocz index, two other sources discuss the development of Canadian house prices prior to the 1980s. The first is a report by Miron and Clayton (1987) which is commissioned by the Canada Mortgage and Housing Corporation and the housing agency of the Canadian government. The authors use scattered data from Statistics Canada to discuss developments in house prices in Canada between 1945 and 1986.[36] Their narrative suggests that house prices in the postwar period generally followed the development of the Canadian economy as a whole. According to the authors, postwar social policy schemes - even though not directly linked to housing policy - generated additional demand side effects as they enabled particularly low-income families to devote a larger disposable income to housing consumption. House prices strongly increased during postwar years, i.e. until the late 1950s, when economic growth declined creating a decline in house prices. In the economic resurgence starting in the mid-1960s, house prices also picked-up and "increased at a frantic pace in the 1970s before tailing off again in the recession of the 1980s" (Miron and Clayton, 1987, 10).[37] A second source is Poterba (1991) who also identifies a run-up in house prices during the 1970s that coincided with the recession of 1982. With the pattern of pronounced variation in the growth rates of real estate prices over time as diagnosed by Miron and Clayton (1987) and Poterba (1991), the first CREA index must be treated with caution. It shows that, different to the CREA-index, the Sobocz-index appears more consistent with narratives by Miron and Clayton (1987) and Poterba (1991) for the period 1949–1976. Yet, the Sobocz-index relies only on a rather small sample size and is confined to property sales in the Greater Vancouver area. Another sign of partial inconsistency is the

[36]Years included: 1941, 1946, 1951, 1956, 1961, 1966, 1971, 1976, 1981, 1984.

[37]Miron and Clayton (1987) argue that the house price surge during the 1970s was also associated with the baby boomers starting to buy residential properties. They also suggest that tax policies made homeownership more attractive after the tax reforms of 1972 introducing tax exemption of capital gains from sales of principal residences.

fact that the Sobocz-index reports an increase in average real house prices of an astonishing 280 percent between 1956 and 1974. The CREA index for the same time reports an increase of approximately 87 percent. Therefore, despite its potential weaknesses, we rely on the CREA index to construct the long-run house price index for Canada.

Data on residential house prices is available for 1921–1949 and for 1956 onwards. For 1921–1949, the series on average value of existing farm and existing non-farm dwellings including land are highly correlated (Firestone, 1951, Tables 69 & 80).[38] Since no data on residential house prices is available for 1949–1956, we use the percentage change in the value of farm real estate per acre to link the 1921–1949 and the 1956–1974 series (Urquhart and Buckley, 1965). Our long-run house price index for Canada 1921–2012 splices the available series as shown in Table A.7.

**Table A.7:** Canada: sources of house price index, 1921–2012.

| Period | Series ID | Source | Details |
|---|---|---|---|
| 1921-1949 | CAN1 | Firestone (1951) | *Geographic Coverage*: Nationwide; *Type(s) of Dwellings*: All kinds of existing dwellings (farm and non-farm) ; *Data*: Estimates of the value of residential structures and the value of residential land as well as data on all available residential dwellings; *Method*: Average replacement values. |
| 1949-1956 | | Urquhart and Buckley (1965) | *Geographic Coverage*: Nationwide; *Type(s) of Dwellings*: Farm real estate; *Method*: Value of farm real estate per acre. |
| 1956-1974 | CAN2 | Canadian Real Estate Association (1981) | *Geographic Coverage*: Nationwide; *Type(s) of Dwellings*: All kinds of real estate (residential and non-residential); *Data*: Transactions registered in the MLS system; *Method*: Average sales prices. |
| 1975-2012 | CAN3 | Centre for Urban Economics and Real Estate, University of British Columbia (2013) | *Geographic Coverage*: Five cities; *Type(s) of Dwellings*: Existing bungalows and two story executive dwellings; *Data*: Royal LePage real estate experts; *Method*: Average prices. |

The resulting long-run index has three drawbacks: first, data prior to 1949 is not based on actual list or transaction prices but calculated as the average replacement value of existing dwellings including land value (see data description above). This approach may result in a bias of unknown size and direction. Second, for 1956–1974, the index refers to both residential and non-residential real estate and is not adjusted for compositional changes. Third, the index is not adjusted for

[38]Correlation coefficient of 0.856.

quality improvements for the years after 1956. The bias should be mitigated for the post-1975 years due to the way the Royal LePage survey is set up (see above). As a way to gauge the potential effect of quality changes, we calculate the value of expenditures on alterations and additions as percentage in total housing value for benchmark years and adjust the annual growth rates of the series downward for the years 1956–1974 using these estimates. The average annual real growth rate over the period 1921–2012 of 2.21 percent becomes 1.67 percent in constant quality terms. As this is a rather crude adjustment, we use the unadjusted index (see Table A.7) for our analysis.

### Construction cost data

Historical data on construction costs in Canada are available for 1870–2012.

The earliest available data on construction costs has been collected by Urquhart (1993). Urquhart (1993) reports a construction cost index for 1870–1921. The index is calculated as an input cost index by combining the following series: i) a building material index calculated as unweighted average of the building materials index constructed by Rymes (1967) and the price index for wood and wood products published by Statistics Canada (1983, K38), and ii) a wage index calculated as weighted average of backward percentage changes of various series of construction sector wages (see Urquhart (1993, p.545) for details). Weights to construct the aggregate construction cost index for 1870–1921 are as follows: wages 0.387 and materials 0.613.

For 1921–1949, a construction cost index for new dwellings is available from Firestone (1951). The series is constructed as an input cost index by combining a wholesale price index for house-building materials prepared by the Dominion Bureau of Statistics and an index of wage rates in building trades published by the Canadian Department of Labor. Weights are chosen based on a 1946 survey of contractors and builders.

For 1926–1976, Statistics Canada (1983, Series S327, K136) publishes an input cost index for new residential construction. Prices of materials and equipment are manufacturers' new order selling prices of about 90 different commodities. For 1935–1970, wage rates are base rates in selected cities across Canada for eight construction trades. The composite wage index is computed as a weighted average of these sub-indices. Weights come from a survey of labor requirements in about 100 buildings conducted by the Department of Labor immediately after World War II. Since 1970, wage rates are basic union wage rates for building trades in major cities and weights are labor requirements based on studies published by the Central Mortgage and Housing Corporation.[39] For 1977–1985, we rely on the continuation of this input cost index for new residential construction as published in Statistics Canada (various years,b).

For 1986–2012, Statistics Canada (2013b) constructs an output price index for

[39] Weights are: wages 0.359 and materials 0.641.

apartment buildings in metropolitan areas.[40] In addition to the main construction items, the index also covers the price of kitchen cupboards and carpets. Architects' fees, engineers' fees, goods and services taxes are excluded. Data are collected through telephone surveys and personal visits as well as from producer price index sources. Weights are based on a cost analysis of an index house. The index house is a concrete apartment building built in 1981 with 53 units on 7 stories, basement parking facility and a penthouse unit.

Our long-run construction cost index for Canada 1870–2012 splices the available series as shown in Table A.8. In addition, we calculate real unit labor costs in the construction sector for 1950–1970 based on national accounts data published by Statistics Canada (2014). Between 1950 and 1970, real unit labor in Canada increased by 33 percent.

**Table A.8:** Canada: sources of construction cost index, 1870–2012.

| Period | Source | Details |
|---|---|---|
| 1870–1920 | Urquhart (1993) | *Geographic Coverage*: Nationwide; *Type(s) of Dwellings*: All types of buildings; *Type of Index*: Input cost index. |
| 1921–1925 | Firestone (1951) | *Geographic Coverage*: Nationwide; *Type(s) of Dwellings*: Single-family houses; *Type of Index*: Input cost index. |
| 1926–1985 | Statistics Canada (1983, various years,b) | *Geographic Coverage*: Urban areas; *Type(s) of Dwellings*: Single-family houses; *Type of Index*: Input cost index. |
| 1986–2012 | Statistics Canada (2013b) | *Geographic Coverage*: Metropolitan areas; *Type(s) of Dwellings*: Apartment buildings; *Type of Index*: Output price index. |

### Other housing related and macroeconomic data

*Farmland prices*: 1901–1956: Urquhart and Buckley (1965) - Value of farm capital (land and buildings) per acre; 1965–2009: Manitoba Agriculture, Food and Rural Initiatives (2010) - Value of farm real estate (land and buildings) per acre; 2010–2011: Province of Manitoba (2012) - Value of farm real estate (land and buildings) per acre.

*Value of housing stock*: Goldsmith (1985) provides estimates of the value of total housing stock, dwellings, and land for the following benchmark years: 1950 and 1978. Data on the value of household wealth including the value of total housing stock, dwellings, and land for 1970-2011 is drawn from OECD (2013). Piketty and Zucman (2014) also present data on real estate wealth for benchmark years in the period 1895–1955.

[40] Seven metropolitan areas are included: Halifax, Montréal, Toronto, Calgary, Edmonton, Vancouver and Ontario.

*CPI*: 1870–2007: Taylor (2002); 2008–2012: International Monetary Fund (2012b).

### A.2.5 Denmark

#### House price data

Historical data on house prices in Denmark are available for 1875–2012.

The most comprehensive source for house prices in Denmark is Abildgren (2006). Abildgren (2006) provides a price index for single-family houses in Denmark for the period 1938–2005 and a price index for farms covering the time 1875–2005. The index for single-family houses reflects annual average sales prices and is computed using data from Økonomiministeret (1966, 1938–1965)[41], Danmarks Nationalbank (various years) and Statistics Denmark (various years,a, 1966–2005). The index for farms reflects the sales price per unit of land valuation based on estimated productivity[42] for 1875–1959, and average sales prices per farm for 1960–2005.[43]

A second important source for property price development in Denmark is provided by the Danish Central Bank.[44] Drawing on data from the Ministry of Taxation (SKAT) and using the Sale-Price-Appraisal-Ratio (SPAR) as computational method, the bank publishes a quarterly house price series covering data for new and existing, single-family dwellings since 1971 (Danmarks Nationalbank, 2003).

A third source is Statistics Denmark (2013a). The agency publishes a nationwide house price index for single-family houses as well as for several types of multifamily structures for the time 1992–2012. As in the case of the index by the Danish Central Bank, the index by Statistics Denmark is computed using the SPAR method (Mack and Martínez-García, 2012).

As shown in Figure A.19, the property price indices for farms and for single-family houses are strongly correlated for the years they overlap, i.e. for the years since 1938.[45] Kristensen (2007, 12) estimates that at the end of World War II, about 50 percent of the Danish population lived in rural areas. Thus, farm property accounted for a significant share of total Danish property and may be used as a proxy for Danish house prices prior to 1938. Nevertheless, the series for 1875–

[41] Økonomiministeret (1966) publishes an index on the average sales price of single-family houses for five different geographical areas: i) Copenhagen and Frederiksberg; ii) provincial towns; iii) Copenhagen area; iv) towns with more than 1500 inhabitants; and v) other rural communities. Until 1950 the indices refer to properties with a value of 20,000 Danish crowns or less. From 1951 onwards they are based on the average purchase price of properties containing one apartment. According to Økonomiministeret (1966), the break in the series may cause an upward bias for 1950–1951.

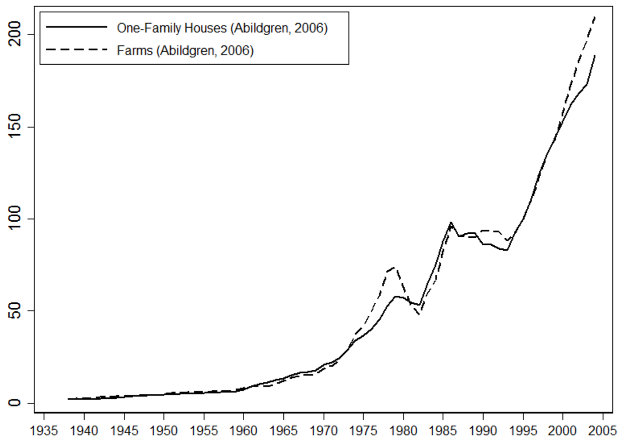
[42] Land was valued according to barrel of *hartkorn*, i.e. barley and rye, produced. Thus, the data refers to the price paid per barrel of *hartkorn*.

[43] The index is computed using sales price data for all farms for 1960–1967; for farms between 10 and 100 hectare for 1968–1975; and for farms between 15 and 60 hectare for 1976–2005. Data are drawn from Statistics Denmark (various years,a), Statistics Denmark (various years,b), Hansen and Svendsen (1968), and Statistics Denmark (1958).

[44] Series sent by email, contact person is Tina Saaby Hvolbøl, Danish Central Bank.

[45] Correlation coefficient of 0.996 for 1938–2005. See also Abildgren (2006, 31).

**Figure A.19:** Denmark: nominal house and farm price indices, 1938–2005 (1995=100).




1937 must be treated with caution when analyzing house price fluctuations in Denmark in this period.[46] Reassuringly, the farm price index for the time prior to World War I appears to coherently mirror the general development of the Danish economy during that period (Nielsen, 1933) and generally accords with accounts of developments in the housing market (Hyldtoft, 1992). Finally, as shown in Figure A.20, when comparing the single-family house price indices for 1938–1965, the development of house prices in urban areas does not seem to systematically differ from house prices in rural areas. It is only in the 1960s that urban areas show substantively stronger house price growth compared to rural areas.

The index for single-family houses by Abildgren (2006) and the index by Statistics Denmark (2013a) show to be highly correlated for the years they overlap (1992–2010).[47] This is also the case for the index by Danmarks Nationalbanken, the index by Statistics Denmark (2013a) and the one by Abildgren (2006).[48] To keep the number of data sources to construct an aggregate index to the minimum, the here composed long-run index relies on Danmarks Nationalbanken index for the period since 1971. Our long-run house price index for Denmark 1875–2012 splices the available series as shown in Table A.9.

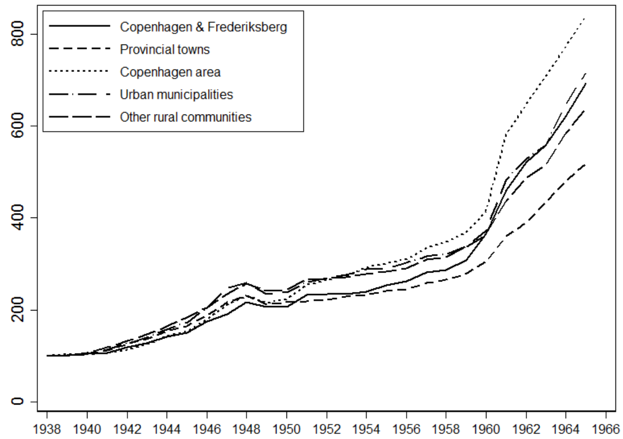
The resulting long-run index has two weaknesses: first, the series used for

[46] In 1895 the Danish economy entered a ten year long boom period. During the boom years, many newly established banks extended credit to finance a building boom in Copenhagen that developed into a price bubble in the market for residential property. The optimism started to wane in 1905 and prices substantially contracted during the financial crisis of 1907 (Østrup, 2008; Nielsen, 1933; Hyldtoft, 1992). The price index for farms does, however, not reflect such a boom-bust pattern. There are two possible explanations that may have joint or partial validity: First, since the construction boom was centered in the residential real estate sector, the index for farm prices may not provide an adequate picture of developments in house prices. Second, as the construction boom was concentrated in Copenhagen, the boom and bust may not be visible on the national level.

[47] Correlation coefficient of 0.971 for 1992–2010.

[48] The series constructed by Statistics Denmark (2013a) and Danmarks Nationalbanken have a correlation coefficient of 0.999 for 1992–2012. The series constructed by Abildgren (2006) and Danmarks Nationalbanken have a correlation coefficient of 0.999 for 1971–2005.

**Figure A.20:** Denmark: nominal single-family house price indices, 1938–1965 (1938=100).

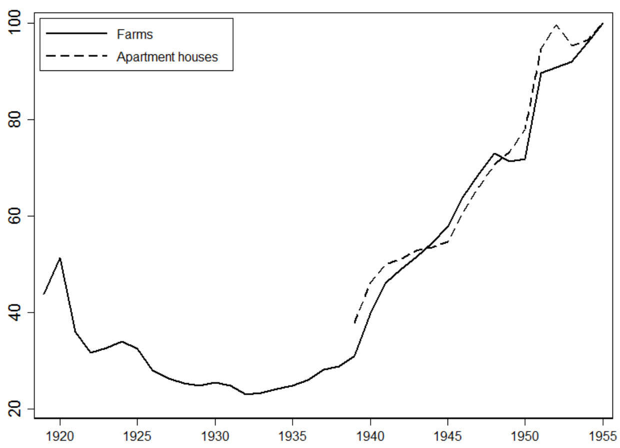



1875–1938 only reflects the price development of farm property which may deviate to some extent from price developments of other residential properties. Second, the series used for 1875–1970 is adjusted neither for compositional changes nor for quality changes. To gauge the extent of the quality bias we can rely on estimates of the quality effect by Lunde et al. (2013). If we adjust the real annual growth rates of our long-run index downward accordingly, the average annual real growth rate over the period 1875–2012 of 0.99 percent becomes 0.57 percent in constant quality terms. Yet, as this is a rather crude adjustment, we use the unadjusted index (see Table A.9) for our analysis.

**Table A.9:** Denmark: sources of house price index, 1875–2012.

| Period | Series ID | Source | Details |
|---|---|---|---|
| 1875–1938 | DNK1 | Abildgren (2006) | *Geographic Coverage*: Nationwide; *Type(s) of Dwellings*: Existing farms; *Data*: Data from various sources (see text); *Method*: Average prices. |
| 1939–1971 | DNK2 | Abildgren (2006) | *Geographic Coverage*: Nationwide; *Type(s) of Dwellings*: Existing single-family houses; *Data*: Data drawn from various sources (see text); *Method*: Average prices. |
| 1972–2012 | DNK3 | Danmarks National-banken | *Geographic Coverage*: Nationwide; *Type(s) of Dwellings*: New and existing single-family houses; *Data*: Ministry of Taxation (SKAT) *Method*: SPAR method. |

**Figure A.21:** Denmark: nominal construction cost indices, 1918–1955 (1955=100).




### Construction cost data

Historical data on construction costs in Denmark are available for 1914–2012.

The first construction cost index for Denmark was published by Statistics Denmark in 1920 as an input cost index for small farms (Statistics Copenhagen, 1937; Statistics Denmark, various years,b).[49] It includes transport costs but excludes electrical installations. Combined, the series on construction costs of rural dwellings cover the period 1914–1970.

For 1940–1970, Statistics Denmark reports an input cost index for apartment houses in Denmark as a whole (Statistics Denmark, various years,b).[50] The series was succeeded in 1969 by input indices for three types of residential dwellings: one-family houses, apartment houses, and an aggregate index covering both types of dwellings (Statistics Denmark, 2015b). The index for small farms and the index for apartment houses are strongly correlated for the years they overlap (see Figure A.21).[51] Note that there is also no significant difference between the index for apartment houses and the index for one-family houses.[52]

Our long-run construction cost index for Denmark splices the available series as shown in Table A.10. To trace construction costs of the type of houses covered by our long-run house price index, we rely on the index for small farms until 1939. Starting 1940 we use the index for apartment houses so as to cover also construction costs of non-rural dwellings. From 1969, we use the construction cost index for single-family houses.

[49] A small farm is defined as consisting of 3 rooms, kitchen, laundry and stable. The definition of the index house was further refined in 1926 and 1959.

[50] More specifically, the index house is a three story apartment house with 6 staircases and 36 apartments.

[51] Correlation coefficient of 0.98 for 1939–1955.

[52] Correlation coefficient of 0.99 for 1986–2012.

**Table A.10:** Denmark: sources of construction cost index, 1914–2012.

| Period | Source | Details |
|---|---|---|
| 1914–1939 | Statistics Denmark (various years,b) | *Geographic Coverage*: Rural areas; *Type(s) of Dwellings*: Small farms; *Type of Index*: Input cost index. |
| 1940–1968 | Statistics Denmark (various years,b) | *Geographic Coverage*: Nationwide; *Type(s) of Dwellings*: Apartment houses; *Type of Index*: Input cost index. |
| 1969–2012 | Statistics Denmark (various years,b) | *Geographic Coverage*: Nationwide; *Type(s) of Dwellings*: Single-family houses; *Type of Index*: Input cost index. |

#### Other housing related and macroeconomic data

*Farmland prices*: 1875–2005: Abildgren (2006) - Index for farm property prices; 1870–1912: O'Rourke et al. (1996) - Index for agricultural land values.

*Value of housing stock*: Goldsmith (1985) provides estimates of the value of total housing stock, dwellings, and land for the following benchmark years: 1880, 1900, 1913, 1929, 1938, 1948, 1960, 1965, 1973, 1978.

*CPI*: 1870–2007: Taylor (2002); 2008–2012: International Monetary Fund (2012b).

### A.2.6 Finland

#### House price data

Historical data on house prices in Finland are available for 1905–2012.

The earliest series at our disposal covers the period 1904–1962. It reports average annual prices of building sites for dwellings per square meter offered for sale by the city of Helsinki (Statistics Helsinki, various years). Drawing on this data source, we construct a three-year-average price index for residential building sites for 1905–1961 to smooth out some of the year-to-year fluctuations stemming from variation in the number of transactions.

A second important source for property price development is Leväinen (1991). Leväinen (1991, 39) using data from different sources computes a building site price index comprising the period 1909–1989.[53] The index is primarily calculated from price data for sites for detached and terraced houses in Southern Finland, particularly in the Helsinki area. Recently, Leväinen (2013) has been able to update his original index such that it now covers the years 1910–2011. Data for the more recent period, 1989–2011, is taken from the National Land Survey of Finland statistics.

[53] The index is a chain index constructed from several indices for shorter sub-periods. He then calculates the ratios of every two successive years. The resulting index is calculated based on all the ratios between the years. For years for which several data sources are available, Leväinen uses a simple average.

A third source that covers the more recent development of residential property prices (1985–2012) is Statistics Finland. The agency constructs a nationwide house price index for existing single-family dwellings and single-family house plots using a combination of hedonic regression and a mix-adjusted method.[54] Statistics Finland uses data from the real estate register of the National Land Survey containing all real estate transactions (Saarnio, 2006; Statistics Finland, 2013b). A second Statistics Finland index based on the same computational procedure (hedonic regression and mix-adjusted method) and covering the same time period (1985–2012) reports price development for existing dwellings in so-called housing companies, that is block of flats and terraced houses. The index is estimated from asset transfer tax statements of the Tax Administration (Saarnio, 2006; Statistics Finland, 2011).[55]

As one component of its index for dwellings in housing companies, Statistics Finland provides estimates for average prices per square meter of dwellings in old blocks of flats[56] in the center of Helsinki for the period 1947–2012 and for greater Helsinki[57] and Finland as a whole for the period 1970–2012.[58] For the years prior to 1987 Statistics Finland relies on data provided by real estate agencies. For the years since 1987 data are drawn from the asset transfer tax statements of the national Tax Administration.[59]

Figure A.22 depicts the nominal HSY site price index and the site price index from Leväinen (2013) for the period 1904–1945 (1920=100). Both indices consistently show two major boom periods: the first occurs during the second half of the 1900s, peaking around 1910; the second, more dynamic one, begins in the early 1920s. Between the first and the second boom period, i.e. during World War I, residential construction declined rapidly; particularly in urban areas (Heikkonen, 1971, 289), as did real house prices. For the second boom period, i.e. for the time during the 1920s, the two indices provide a disjoint and inconsistent picture with respect to duration and turning points. While the Leväinen index insinuates a more than tenfold increase in real terms from trough to peak (1920–1931), the one

[54]Dwellings are stratified by type, number of rooms and location. A hedonic regression is then applied to estimate the price index for each stratum. The strata are combined using the value of the dwelling stock as weights. For details on the classification and the regression model see Saarnio (2006).

[55]Before February 2013 this price series was named 'Prices of Dwellings.' In Finland, dwellings are not classified as real estate but detached houses are. That is the reason there are two different series: one for dwellings and the other one for real estate.

[56]'Old' refers to blocks of flats that are not built in the year of the statistics and the year before (i.e. in the statistics for 2012, old dwellings are all dwellings built before 2011).

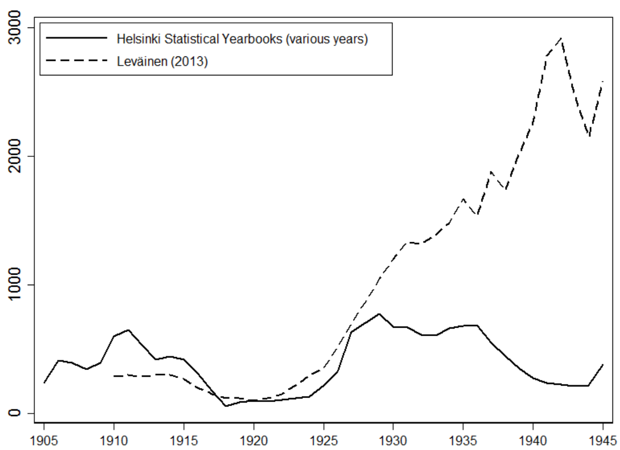
[57]Greater Helsinki includes the cities Helsinki, Espoo, Vantaa and Kauniainen. Series sent by email, contact person is Petri Kettunen, Statistics Finland.

[58]According to Statistics Finland, the data for the center of Helsinki quite well represents prices of dwellings in Finland before 1970 (email conversation with Petri Kettunen, Statistics Finland). Subsequently, however, the prices in Helsinki increased stronger than in the rest of the country.

[59]The structural break observable between 1986 and 1987 is not only due to the above described adjustment of the database but is also, at least in parts, caused by methodological changes, where the year 1987 marks the transition from the fixed weighted Laspeyres-type unit value to the above mentioned combined hedonic and mix-adjusted computation method. For the period 1975–2012 the Federal Reserve Bank of Dallas splices together the nationwide house price index for existing, single-family dwellings (1985–2012) and the price series for existing flats (1975–1985).

based on the data in the Helsinki Statistical Yearbook (HSY) reports a sevenfold rise between the trough in 1921 and the peak in 1929. An even more pronounced divergence between the two indices can be identified for the post-Depression period: While the Leväinen-index continues to rise throughout the years of the Great Depression and the first years of World War II, the HSY-index declines by about 20 percent between 1929 and 1933, and only recovers around 1936 before collapsing again throughout the years of World War II. Against the background of partly inconsistent information the question arises, which of the two indices reflects a more plausible development of real estate prices in Finland between the mid-1920s and the end of World War II. In this context it is important to note that neither indicator covers Finland as a whole; instead both indices solely focus on the Helsinki area. While one may argue that a boom in site prices is unlikely to occur in a period of depression such as during the early 1930s, there are examples of stagnant (UK) or even increasing (Switzerland) house prices during that period. In Switzerland the positive trend in house prices and construction activity was primarily driven by low building costs and easy credit (cp. Section A.2.13). For the example of Britain, a quick recovery in construction activity after an initial fall in the early years of the depression is observable while house prices remained very stable (see Section A.2.14). In the case of Finland, construction activity - as indicated above - strongly re-bounced after 1933 and thus may have also contributed towards a stabilization of site prices. Construction activity peaked in 1937/38 and contracted thereafter making a continued increase in site prices until 1942, also in the wake of World War II, appearing unreasonable. Therefore, the empirical analysis undertaken here relies on the HSY-index for the period prior to 1947.

**Figure A.22:** Finland: nominal house price indices, 1905–1945 (1920=100).




Thus far, the present survey of Finnish property prices has focused on site prices in the Helsinki area, rather than house prices, since information on the latter is not available for the years prior to 1947. Yet, building site prices can be considered to be a good proxy for house prices as they tend to show similar developments. For example, the series for old blocks of flats in the center of Helsinki as published by Statistics Finland for 1947–2012 is highly correlated with

Leväinen's site price index.[60] Nevertheless, there may be minor differences with regard to amplitudes and timing of house price cycles.

**Figure A.23:** Finland: real house price indices, 1945–2012 (1990=100).

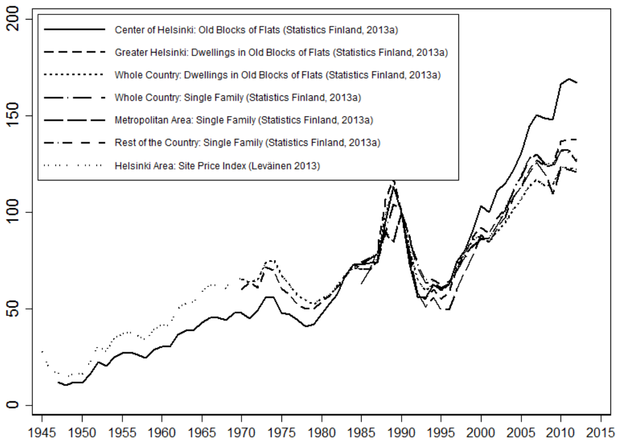



Figure A.23 compares the nominal house price indices available for 1947–2012, i.e. the indices for dwellings in old blocks of flats (Helsinki, Greater Helsinki, Whole Country) and the indices for single-family dwellings (Helsinki, Greater Helsinki, Whole Country). All indices are available from Statistics Finland. Figure A.23 indicates that all indices follow the same pattern for the period under consideration: a house prices boom that peaks in the early 1970s and is followed by a slump; a boom during the late 1980s with a subsequent recovery; a third contraction in the early 1990s followed by a strong rise from the mid-1990s until the onset of the Great Recession. The data only shows minor divergence in amplitudes and timing of house price cycles between old blocks of flats and single-family houses. For the sake of coherence with respect to property types, the long-run index uses the data for old blocks of apartments also for the post-1970 period. The index covering the center of Helsinki depicts the boom of the 1990s/2000s to be stronger than when considering Finland as a whole. Hence, for the years since 1970 we use the nationwide series for old blocks of flats. Our long-run house price index for Finland for 1905–2012 splices the available series as shown in Table A.11.

In sum, the long-run index controls for quality changes only after 1970. For 1905–1947, the index refers to building sites and should not be diluted by unobserved changes in quality. In contrast, since for 1947–1969 the index is only based on simple average prices, it may be biased due to quality changes in the structures that are not controlled for. Since the series is restricted to one very specific market segment (i.e. existing apartments in the center of Helsinki), compositional bias should not play a major role.

[60]Correlation coefficient of 0.96.

**Table A.11:** Finland: sources of house price index, 1905–2012.

| Period | Series ID | Source | Details |
|---|---|---|---|
| 1905–1946 | FIN1 | Statistics Helsinki (various years) | *Geographic Coverage*: Helsinki; *Type(s) of Dwellings:* Residential building sites; *Data*: Sales prices; *Method*: Three year moving average of average prices. |
| 1947–1969 | FIN2 | Statistics Finland | *Geographic Coverage*: Center of Helsinki; *Type(s) of Dwellings*: Dwellings in existing blocks of flats; *Data*: Data from Statistics Finland; *Method*: Average prices. |
| 1970–2012 | FIN3 | Statistics Finland (2011) | *Geographic Coverage*: Nationwide; *Type(s) of Dwellings*: Dwellings in existing blocks of flats; *Data*: Data from Statistics Finland; *Method*: Hedonic mix-adjusted method. |

### Construction cost data

Historical data on construction costs in Finland are available for 1870–2012.

The most comprehensive series on building costs in Finland is provided by Hjerppe (1989, Appendix Table 13) and covers 1870–1984. Hjerppe (1989) uses three main sources to construct the series: First, she relies on Heikkonen (1971) for 1870–1934. The index published by Heikkonen (1971) is constructed as an input cost index using data on average wages in the construction sector and the price of three main building materials (timber, stone, and metal). While the data on prices and wages cover Finland as a whole, the weights are identical to the weights applied by Bank of Finland (1946) (see below) and hence are based on the construction of apartment houses in Helsinki.

Second, Hjerppe (1989) relies on the building cost index calculated by the Bank of Finland for 1935–1955. The series is based on construction cost data for apartment houses in Helsinki[61] and is constructed as an input cost index. It is adjusted to include architect fees and contractors' overhead costs and profits (Bank of Finland, 1946).[62]

Third, for 1955–1984, Hjerppe (1989) uses the construction cost index calculated by Statistics Finland (various years). The series is calculated as an input cost index and covers apartment buildings. Wage data comes from collective agreements, prices of materials are collected from manufacturers and wholesale deal-

[61]For 1935–1951, the aggregate index is a weighted average of factor prices with the weighting scheme being constructed based on data for three representative houses built 1930-1933 (Bank of Finland, 1946). In 1951, the index was re-weighted based on construction cost of five representative houses built 1948–1950 (Bank of Finland, 1952).

[62]The Bank of Finland assumes that contractors' overhead costs (depreciation of machines, rents, wages of office staff and management) and firms profits amounts to 10 percent of booked costs.

**Table A.12:** Finland: sources of construction cost index, 1870–2012.

| Period | Source | Details |
|---|---|---|
| 1870–1934 | Heikkonen (1971) as published in Hjerppe (1989) | *Geographic Coverage*: Helsinki; *Type(s) of Dwellings*: Apartment buildings; *Type of Index*: Input cost index. |
| 1935–1955 | Bank of Finland (1946, 1952, 1955) | *Geographic Coverage*: Helsinki ; *Type(s) of Dwellings*: Apartment buildings; *Type of Index*: Input cost index. |
| 1956–2012 | Statistics Finland (various years) | *Geographic Coverage*: Nationwide; *Type(s) of Dwellings*: Apartment buildings; *Type of Index*: Input cost index. |

ers.[63] Weights and the range of materials included are updated at five or ten-year intervals (Statistics Finland, 2001). We extend the index reported by Hjerppe (1989) to cover the years until 2012 using the continuation of the series reported in Statistics Finland (various years).

Our long-run construction cost index for Finland 1870–2012 splices the available series as shown in Table A.12. In addition, we calculate real unit labor costs in the construction sector for 1950–1970 based on national accounts data published by Hjerppe (1989). Between 1950 and 1970, real construction costs and real unit labor costs decreased by a little more 7 percent.

#### Other housing related and macroeconomic data

*Farmland prices*: 1985–2012: National Land Survey of Finland[64] - Median transaction price of agricultural land per hectare.

*CPI*: 1870–1996: Taylor (2002); 1997–2012: International Monetary Fund (2012b).

### A.2.7 France

#### House price data

Historical data on house prices in France are available for 1870–2012

The most comprehensive single source for French house price data is the dataset provided by the Conseil General de l'Environnement et du Developpement Durable (2013b, CGEDD). It contains a national repeat sales index for all categories of existing residential dwellings, i.e. apartments and single-family houses, for the period 1936–2013.[65] Prior to 1999, the index is based on data drawn from

[63]The construction cost index 2000=100 covers the change in prices of more than 50 building materials.

[64]Series sent by email, contact person is Juhani Väänänen, National Land Survey of Finland

[65]For more information, see Conseil General de l'Environnement et du Developpement Durable (2013b).

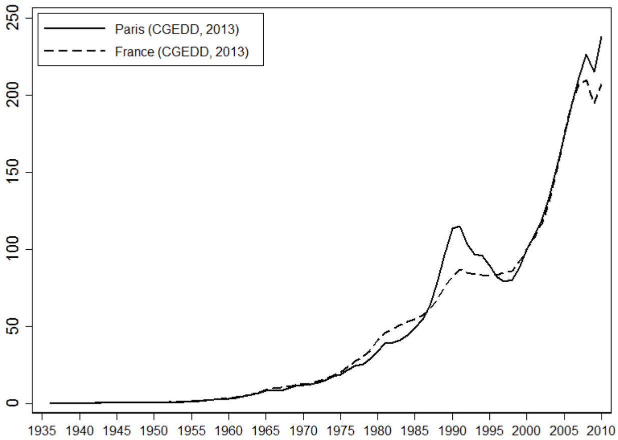



**Figure A.24:** France: nominal house price indices, 1936–2012 (1990=100).

two national notarial databases.[66]

Even though these databases were only established in the 1980s, they also include information on earlier real estate transactions (Friggit, 2002). For the post-1999 period, CGEDD splices this index with a mix-adjusted hedonic index by the Statistics France (2012, INSEE) for existing detached houses and apartments in France (see below).

In addition to the national index, Conseil General de l'Environnement et du Developpement Durable (2013b) also publishes a price index for residential property in the greater Paris area. Combining several different data sources the index has been extended back to 1200. For the time period analyzed in this paper (1870–2012), the Paris index has been composed from three different data series. The first part of the index (1840–1944) is based on a repeat sales index by Duon (1946) using data gathered from property registers of the national Tax Department. It covers apartment buildings such that commercial properties, single-family houses, or apartments sold by the unit remain excluded.[67] The second part of the index (1944–1999) is based on price data for apartments sold by the unit compiled by CGEDD from the notaries' database and calculated using the repeat sales method. As raw data, however, is only available for the time 1950–1999, the gap between the index by Duon (1946) and the one calculated by CGEED, i.e. the years 1945–1949, has been filled applying simple linear interpolation (Friggit, 2002). For the post-1999 period, the index is again spliced with an index by Statistics France (2012) for existing apartments in Paris (Beauvois et al., 2005).

A second important source for French house prices is the Statistics France (2012, INSEE). For the years since 1996, INSEE publishes a mix-adjusted hedonic

[66]The two databases are: The *BIEN base*, managed by the Chambre Interdépartmentale des Notaires de Paris (CINP) that covers the Paris region and the *Perval France base*, which is managed by Perval, a Conseil Supérieur du Notariat (CSN) subsidiary, that covers the provinces. For a detailed discussion of the notarial databases the reader is referred to Beauvois et al. (2005, 25 ff.).

[67]Prior to World War I, apartments could not be sold by the unit. There were few such transactions in the interwar period.

nationwide house price index for all types of existing dwellings as well as two sub-indices for existing detached houses and apartments (Beauvois et al., 2005). In addition, the agency provides regional sub-indices for Paris, Provence-Alpes-Cote d'Azur, Rhone-Alpes, Mord-Pas-de-Calais, and Provence.[68] As CGEDD, also INSEE draws on sales price data from the two national notarial databases.

Figure A.24 compares the nominal indices available for 1936–2012, i.e. the indices for France and Paris published by Conseil General de l'Environnement et du Developpement Durable (2013b), and the nationwide house price index published by Statistics France (2012). It shows that throughout the years 1936–1976 the Paris index is in cadence with the CGEDD France and the INSEE national indices. Considering also the broad macroeconomic trends prior to 1936 and narrative evidence on developments in the French housing market, the Paris index may serve as a fairly reliable measure for the trends in national house prices.[69] We have to keep in mind, however, that Parisian house prices may for some years not be a reliable proxy for house prices in France as a whole.[70] Friggit, for example, suggests that real house prices in Paris were more devalued during World War I than in other parts of France.[71] According to Friggit (2002), also the national index for the time prior to 1950 can only serve as a rough estimate of the true development of

[68]For the period 1975–2012, the Federal Reserve Bank of Dallas splices together the CGEDD nationwide house price index for existing, single-family dwellings (1975–1995) and the INSEE price index for all types of existing dwelling (1996–2012).

[69]The second half of the 19th century, particularly the time during the second phase of the industrial revolution, featured rapid population growth and urbanization that lead to an increase in rents, property prices, and construction activity (Price, 1981; Caron, 1979). In the wake of the Franco-Prussian war of 1870, this trend came to a temporary halt. To service its reparation obligations France heavily relied on domestic borrowing with adverse effects on interest rates: While the yield for government security substantively increased, the return from real estate due to higher financing cost declined, making it a relatively less attractive investment (Price, 1981; Friggit, 2002). In the second half of the 1870s building activity resumed despite the continuing Long Depression. An important factor in this building boom, according to Caron (1979, 66 f.), was what he calls *"rural exodus"* and the associated ongoing urbanization. The increase in the demand for housing in urban areas resulted in a substantive increase in the price of building land and rents (Lescure, 1992). The national rent index increased by 14 percent between 1876 and 1900, clearly outperforming the trend in general cost of living during that time. The boom that peaked in the years 1876–1882 was further fueled by optimistic expectations of investors. Following the Paris Bourse market crash and the failure of the Union General Bank in 1882, France went into the deepest and longest recession and financial crisis in the 19th century. With France's national income declining from 1882 to 1892 and less people leaving the rural areas to move into cities, construction activity stagnated until about 1906 (Caron, 1979, 66 f.). The effects of World War I on real house prices were quite severe and long-lasting. Wartime rent controls remained in place throughout the interwar period dampening the profitability of property investments (Lescure, 1992; Duclaud-Williams, 1978). Only by the mid-1920s, real house prices started to recover and subsequently also fared comparably well after the stock market crash in 1929. According to Friggit (2002), investors were – distrusting any kind of financial instrument – eager to substitute their stock and bond holdings for real estate.

[70]The house price index for Paris only refers to apartment buildings. Apartment buildings were, however, the most important part of the Parisian property market at the time since prior to World War I only about 3.3 percent of houses in Paris were owner occupied. As noted before, apartments could not be sold by the unit before World War I and there were only few such transactions in the interwar period.

[71]Email conversation with Jacques Friggit. Rent controls introduced during the war years reduced real returns from investment in residential real estate and hence its value (Friggit, 2002). Rent controls were not abandoned in the interwar period but alternately relaxed and tightened which may have depressed the value of apartment buildings vis-à-vis other real estate.

house prices in France. Moreover, the index may be biased upwards in the 1950s as there may be a substantial price difference between rented and vacant properties with rented properties having a lower price than vacant houses. Friggit (2002) emphasizes that the share of vacant properties sold particularly increased in the 1950s, thus diluting the quality of the index by overestimating the price increase during this decade (Friggit, 2002).

When examining the three indices during the second half of the 20th century in Figure A.24, it shows that the Paris index is lower than the national index for 1976–1986 but then surpasses the national index increasing strongly until 1991 before reverting to the national level. According to Friggit (2002), this boom and bust pattern was primarily a feature of the Paris region and a few other areas such that it is barely detectable in the national index. For the period 1996–2012, the INSEE and the CGEDD index show an almost identical development. Overall, French house prices rapidly increased since the late 1990s. The CGEDD Paris index moves in lock-step with the two national indices until 2008 and subsequently shows a comparably stronger increase.

**Table A.13:** France: sources of house price index, 1870–2012.

| **Period** | **Series ID** | **Source** | **Details** |
|---|---|---|---|
| 1870–1935 | FRA1 | Conseil General de l'Environnement et du Developpement Durable (2013b) | *Geographic Coverage*: Paris; *Type(s) of Dwellings*: Apartment buildings; *Data*: Data from property registers of the Tax Department; *Method*: Repeat sales method. |
| 1936–1996 | FRA2 | Conseil General de l'Environnement et du Developpement Durable (2013b) | *Geographic Coverage*: Nationwide; *Type(s) of Dwellings*: All types of existing dwellings; *Data*: Notarial database; *Method*: Repeat sales method. |
| 1997–2012 | FRA3 | Statistics France (2012) | *Geographic Coverage*: Nationwide; *Type(s) of Dwellings*: All types of existing dwellings; *Method*: Hedonic, mix-adjusted index. |

Given the data availability, our long-run house price index for France 1870–2012 splices the indices as shown in Table A.13. The long-run index has two major drawbacks: First, as no house price series for France as a whole is available for the years prior to 1936, we rely on the CGEDD Paris index instead. Second, despite the fact that by using the repeat sales method the effect of quality differences between houses is somewhat reduced, it does not control for all potential changes in the quality and standards of dwellings over time.

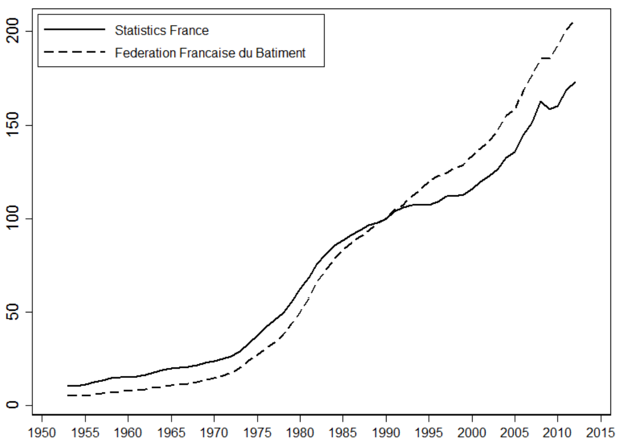
### Construction cost data

Historical data on construction costs in France are available for 1914–2012.

The earliest available data on construction costs in France are published by the Conseil General de l'Environnement et du Developpement Durable (2013a). The input cost index is originally constructed by the Société Centrale des Architectes[72] and covers construction costs of apartment buildings the Paris region for the period 1914–1953 (Duon, 1946; Guet, 1969). For the years since 1942, an additional input cost index for apartment buildings in Paris is available from Federation Francaise du Batiment (2015). Since 1953, Statistics France (2015c) publishes an output price index for all kinds of residential dwellings (excluding public housing) in France (Statistics France, 2015b). The output price index and the input cost index constructed by Federation Francaise du Batiment (2015) are highly correlated for the years they overlap.[73].

Our long-run construction cost index for France 1870–2012 splices the available series as shown in Table A.14. In addition, we calculate real unit labor costs in the construction sector for 1950–1970 based on national accounts data published by OECD (2016). Between 1950 and 1970, real unit labor costs increased by 19 percent.

**Figure A.25:** France: nominal construction cost indices, 1953–2012 (1990=100).




### Other housing related and macroeconomic data

*Value of housing stock*: Goldsmith (1985) provides estimates of the value of total housing stock, dwellings, and land for the following benchmark years: 1880, 1913, 1929, 1950, 1960, 1972, 1977. Data on the value of household wealth including the value of total housing stock, dwellings, and land for 1978–2011 is drawn from

[72]The Société Centrale des Architectes was renamed in 1953 as Académie d'Architecture.

[73]Correlation coefficient of 0.99 for 1953–2012. Yet, the input cost index by Federation Francaise du Batiment (2015) shows a comparably stronger increase over the whole 1953–2012 period (see Figure A.25)

OECD (2013). Piketty and Zucman (2014) also present data on real estate wealth for benchmark years in the period 1870–1954 and for 1970–2011.

*CPI*: 1870–1965: Mitchell (2013); 1966–2012: International Monetary Fund (2015).

**Table A.14:** France: sources of construction cost index, 1914–2012.

| Period | Source | Details |
|---|---|---|
| 1914–1953 | Conseil General de l'Environnement et du Developpement Durable (2013a) | *Geographic Coverage*: Paris region; *Type(s) of Dwellings*: Apartment houses; *Type of Index*: Input cost index. |
| 1954–2012 | Statistics France (2015c) | *Geographic Coverage*: Nationwide; *Type(s) of Dwellings*: All types of residential dwellings; *Type of Index*: Output price index. |

### A.2.8 Germany

#### House price data

Historical data on house prices in Germany are available for 1870–1938 and 1962–2012.

Statistics Berlin (various years) in its yearbooks reports data on transactions of developed lots, i.e. lots including structures, in the city of Berlin for 1870–1918.[74] We compute an annual index from average transaction prices. As the source does not provide details on the lots sold, it is impossible to control for size, number of structures erected on the lot, and type or use of buildings (commercial or residential).

A second source for German house prices is Matti (1963). Matti (1963) presents data on the price of developed lots (number of transactions, average sales price per square meter in German Mark) for the city of Hamburg for 1903–1935.[75] While it is, as in the case of the data for Berlin, impossible to account for the number of structures on the lot and the type or use of buildings in computing the index, we can at least control for the size of the lot. In addition to this series, Matti (1963) for 1955–1962 computed a lot price index for Hamburg using data on average sakes prices per square meter.

As a third source, the Statistical Yearbooks of German Cities (Association of German Municipal Statisticians, various years)[76] reports transaction data for developed lots for 1924–1935 and for building sites for 1935–1939.[77] For each year, information is available on the number of lots sold, the total size of lots sold, and

[74]The yearbooks include the number of lots sold and the total value of all transactions. No data are available for 1911 and 1914.

[75]Data for the years of the German hyperinflation, i.e. 1923 and 1924, are missing.

[76]The Statistical Yearbook of German Cities was published until 1935 and succeeded by the Statistical Yearbook of German Municipalities.

[77]The series includes data on public and private transactions.

the total value of all transactions in the city or municipality. No information on the type or use of property (residential or commercial) is included.[78]

A fourth source for real estate prices is Statistics Germany (various years,b). The agency publishes nationwide data on average building site sales prices per square meter for the years since 1962.[79] For the years since 2000 the Federal Statistics Office produces a hedonic national house price index for new owner-occupied dwellings as well as three sub-indices for i) turnkey homes; ii) built to order homes; and iii) prefabricated homes (Dechent, 2006a).[80] In addition, for the years since 2000, the Federal Statistics Office produces house price indices comprising both owner-occupied and rental properties for i) new and existing dwellings; ii) existing dwellings; and iii) new dwellings (Dechent and Ritzheim, 2012). The indices are computed using data compiled from the local Expert Committees for Property Valuation (Gutachterausschüsse für Grundstückswerte).

Finally, the German Central Bank produces two sets of house price indices: i) a set of indices covering 100 West- and 25 East-German agglomerations with a population above 100,000 since 1995; and ii) a set of indices covering only Western German agglomerations for 1975–2010. The first set includes house price indices for the following building types: i) all types of existing dwellings; ii) all types of new dwellings; iii) existing terraced single-family houses;[81] iv) new terraced single-family houses; v) existing flats; and vi) new flats (Deutsche Bundesbank, 2014).[82] The indices are computed using data collected by BulwienGesa AG.[83] Population is used as weights (Bank for International Settlements, 2013; Mack and Martínez-García, 2012). The indices do not control for quality differences between houses or quality changes over time but only cover properties that provide *"comfortable living conditions"* and are located in *"average to good locations."* By confining the indices to this market segment, the effect of quality differences may be somewhat reduced (Bank for International Settlements, 2013; Deutsche Bundesbank, 2014). The second set of indices, for West-German agglomerations 1975–2012, also draws on data provided by BulwienGesa.[84] They cover 100 Western German towns since 1990 and 50 Western German towns in the years 1975–1989. Indices are available for the following types of property: i) all kinds of new dwellings; ii) new terraced houses; iii) new flats; and iv) building sites for detached single-family dwellings.[85]

[78]Wagemann (1935) publishes an index computed from this data for 'representative cities' for 1925–1935.

[79]For years prior to 1991, the data only covers West-Germany. Since 1992 it includes all German federal states (Statistics Germany, various years,b).

[80]The hedonic regression controls for a variety of characteristics such as the size of the lot, living space, detached house, basement, parking space, and location (Dechent, 2006a, 1292 f.). The aggregate index is weighted by the market share of the respective property type in a certain period (Dechent, 2006a, 1294).

[81]Terraced houses are single-family dwellings with a living space of about 100 square meters (Bank for International Settlements, 2013).

[82]Series available from the Bank for International Settlements (2013, BIS).

[83]Data sources include the Association of German Real Estate Agents (Immobilienverband Deutschland); Chambers of Industry and Commerce, Building & Loan Associations, research institutions, own surveys, newspaper advertisements, and mystery shoppings (Bank for International Settlements, 2013).

[84]Series available from Bank for International Settlements (2013).

[85]The indices for flats and building sites for detached single-family dwellings are adjusted for

The indices are also weighted by population (Bank for International Settlements, 2013; Mack and Martínez-García, 2012), do not control for quality differences but are again confined to dwellings providing *"comfortable living conditions"* located in *"average to good locations"* (Bank for International Settlements, 2013; Deutsche Bundesbank, 2014). The index for new terraced houses (ii) has been extended back to 1970 (cf. OECD Database).[86]

Figure A.26 depicts the nominal indices calculated from the data for Berlin and for Hamburg for 1870–1935. While the Berlin index is the only one available for 1870–1903, its development accords with narrative and scattered quantitative evidence on other German housing markets for the years prior to World War I, such as Carthaus (1917), Führer (1995), Rothkegel (1920), and Ensgraber (1913).[87] In the most general terms, these accounts describe the years of the German Empire as a period of a considerable, yet non-linear, upward trend. All urban areas discussed experienced boom years as well as years of crises that emanated from the macro-economic volatilities of the time (Führer, 1995). While the exact timing of troughs and peaks differed across cities, the local house price cycles nevertheless correspond.

During the years of World War I and the German hyperinflation, nominal house prices increase across the board but significantly lag inflation. As we see in Figure A.26, the indices for Berlin and Hamburg depict a similar trend for the years they overlap. The collapse in real house prices may appear surprising at first given the severe housing shortage in the immediate postwar years. Moreover, in light of rapidly rising building costs and scarce building capital, building activity remained depressed well into the 1920s (Deutsche Bauzeitung, 1923, 1921). Yet returns on existing residential real estate were low or even negative in the immediate post-World War I years. Real estate owners struggled with low rental income due to persistent rent controls,[88] often even too low to cover tax expenses, insurance, and rising utility and maintenance costs (Hausbesitzer-Zeitung für die Rheinprovinz, 1922b; Deutsche Bauzeitung, 1922). In 1921, the *Wall Street Journal* noted that *"[n]o matter what you pay for an apartment house you can not make money at present, and the future prospect is not much better"* (Wall Street Journal, 1921). Despite depressed real estate values, many homeowners therefore had to sell their properties. Particularly in large cities, foreign investors spent large sums buying up real estate knowing that the property may not cover costs for a few years to come but presuming that their investment will be profitable once Germany returns to normal economic conditions and the value of the mark stabilizes (Deutsche Bauzeitung, 1923; Hausbesitzer-Zeitung für die Rheinprovinz, 1922a). In the mid-1920s, real house prices start slowly to recover but are still substantially below their pre-World

size, i.e. refer to prices per square meter. The indices for all kinds of new dwellings and terraced houses refer to prices per dwelling (Bank for International Settlements, 2013).

[86] Mack and Martínez-García (2012) stress, however, that this index may also include existing dwellings.

[87] Rothkegel (1920) focuses on Mariendorf, a suburbian part of Berlin; Ensgraber (1913) on Darmstadt. Carthaus (1917) presents a more comprehensive description and covers developments in Dresden, Munich, and Berlin. Führer (1995) focuses in housing policy.

[88] State control of rents and legal protection of tenants became permanent law during the 1920s (Teuteberg, 1992).

**Figure A.26:** Germany: nominal house price indices, 1870–1935 (1903=100).


War I level. Contemporary newspapers confirm the significant fall in German real house prices during the interwar period. In 1921, the *Wall Street Journal* for example noted that *"an apartment house valued at $100,000 before the war can be bought for $5,000"* (Wall Street Journal, 1921). *The New York Times* reported in 1923, *"[o]ne building [in Berlin], now held at $6,500 in American money, cost $250,000 before the war"* but that *"the buyer would realize probably not more than $2.50 a year on this investment"* (The New York Times, April 10, 1923). In 1927, according to the *Wall Street Journal*, *"[p]rices of apartment houses in general were but 25 percent to 40 percent of pre-war at the beginning of 1926"* (Wall Street Journal, 1927).

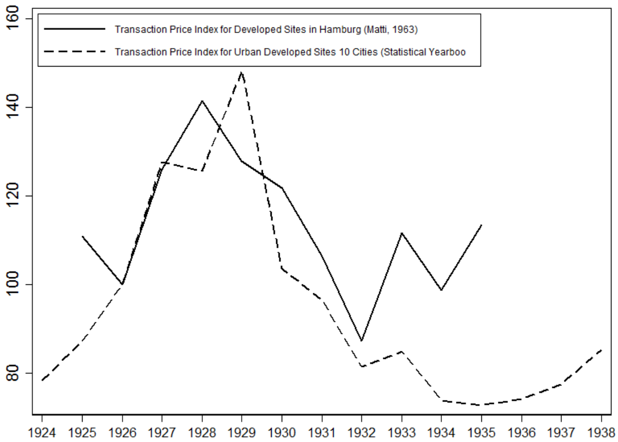
Figure A.27 compares the indices that are available for 1924–1938. For these years, the Statistical Yearbooks of German Cities and the Statistical Yearbooks of German Municipalities provide property price data with a wider geographic coverage (see above). With the information available, it is possible to calculate average transaction prices in German Mark per square meter of developed lots. Based on data for ten cities and municipalities for which data coverage is complete in the years from 1924–1938, we compute a weighted 10-cities index.[89] When comparing the index computed from data published by Matti (1963) and the index computed from average transaction prices for the ten German cities, it shows that - while far away from perfect lockstep - they generally follow the same trend.[90] This observation is somewhat reassuring as it supports the assumption that the index by Matti (1963) may also for the earlier years (i.e. 1903–1922) serve as a more or less reliable proxy for urban property prices in Germany in general. The two indices show that lot prices substantively increased after 1924 and peaked in 1928 (Matti, 1963) and 1929 (10 cities), respectively. During the first years of the Great Depression nominal property prices contracted and only started to recover in 1936.

For the years they overlap and only cover Western Germany, i.e. 1970–1991, the index computed from building site prices (Statistics Germany, various years,b)

[89] The number of transactions is used as weights.

[90] Correlation coefficient of 0.73.

**Figure A.27:** Germany: nominal house price indices, 1924–1938 (1926=100).




and the urban index for new terraced dwellings produced by the German Central Bank[91] are highly correlated.[92] Hence, we assume that prices for building land may serve a good approximation for house prices prior to 1970.

Our long-run index for Germany splices the available series as shown in Table A.15. For 1870–1902 we use the index for Berlin but rely on the index for Hamburg for 1903–1923 mainly for two reasons: first, in contrast to the Berlin index, the Hamburg index controls for the size of the lots sold and may hence be considered a more reliable indicator of price developments. Second, the boom in Berlin between 1902 and 1906 was stronger and the recession preceding World War I started earlier than in most other German urban housing markets (Carthaus, 1917). For 1924–1938 we use the index for 10 cities due to its wider geographical coverage.

Unfortunately, price data for houses or building lots to the authors knowledge are not available for the period 1939–1954 such that a complete index for house prices can only be constructed for the period since 1955. For the years 1955–1962 the development of real estate prices could be approximated using the building site index for Hamburg (Matti, 1963). This index, however, reports a quintupling of prices between 1955–1962 (Matti, 1963). Although the 1950s and 1960s are generally described as a time of rising house and land prices (see below) such a tremendous price spike has not been acknowledged in the literature and therefore must be considered to either have been specific to the city of Hamburg or to have resulted from measurement errors. Accordingly, the index by Matti (1963) is not used for the construction of the long-run real estate price index for Germany. Instead, the here constructed index only starts in 1962 and for the period from 1962 to 1970 relies on price data of building sites per square meter.[93] To obtain our long-run index, we link the two sub-indices, i.e. 1870–1938 and 1962–2012, assuming an average increase in prices of building sites of 300 percent based on the results of a survey conducted by Deutsches Volksheimstättenwerk (1959).

[91] Bank for International Settlements (2013); extended to 1970 as reported in the OECD database.
[92] Correlation coefficient of 0.992.
[93] Actual coverage: 1962—2012; Statistics Germany (various years,b).

The index suggests that real estate prices more than doubled during the 1960s. Overall, a strong increasing trend in property values during the 1960s seems plausible for the following reasons: first, during the 1950s and 1960s, Germany experienced strong economic growth, also referred to as the 'Wirtschaftswunder' (economic miracle). Second and more importantly, price controls for building sites which had been introduced in 1936 were only fully abolished in the Bundesbaugesetz of 1960. Building site prices had, however, already increased tremendously during the years preceding the repeal of the price control. At the time this development was vividly discussed (DER SPIEGEL, 1961; Koch, 1961). According to Deutsches Volksheimstättenwerk (1959), building site prices in 1959, i.e. a year before the price controls had been officially repealed, stood at a level of 250 to 300 percent of the officially still binding price ceiling price established in 1936. After the repeal of the price controls, building site prices surged. Third, rent control and tenant protection laws were gradually relaxed in the 1950s and 1960s. By 1965, rent control had been with the exception of some larger cities been fully abolished. As a result, rents strongly increased during the 1960s making investment in new housing more profitable. For the time since 1971, we use the urban index for new terraced dwellings produced by the German Central Bank (as reported by the Bank for International Settlements (2013)).

The index has, however, three flaws: First, while the Hamburg and Berlin indices appear to well reflect the developments in housing markets as discussed in the literature, it - due to the limited availability of property price data – remains uncertain to what extent they can be considered a fully reliable image of the national trend. A second limitation of the index prior to 1938 remains the lack of correction for changing structural characteristics of and quality differences between the developed lots as well as quality change in the structures built on these lots over time. Third, for 1970–2012, the extent to which the effect of quality differences are indeed reduced through confining the index to a certain market segment remains difficult to determine.

### Construction cost data

Historical data on construction costs in Germany are available for 1913–2012.

The standard reference for German construction costs is the monthly construction cost report published by the Statistics Germany (2012). The series covers the period 1913–2012 and has been calculated as input cost index for 1913–1958 and as output price index thereafter (Horstmann, 1959). Data are collected through price surveys. Note that the area covered by the index varies over time.[94] Yet changes in territory are unlikely to bias the index given the high level of standardization in the German residential construction sector (Vorholt, 1995).

In addition, since 1968, the Statistics Germany (2012) publishes an output price index for prefabricated one-family dwellings. In the long run, the indices for

[94] 1913–1944 territory of the German Reich; 1945–1959 former federal territory, excluding Berlin and Saarland; 1960–1965 former federal territory excluding Berlin; 1966–1990 former federal territory; since 1991 Germany.

**Table A.15:** Germany: sources of house price index, 1870–2012.

| Period | Series ID | Source | Details |
|---|---|---|---|
| 1870–1902 | DEU1 | Statistics Berlin (various years) | *Geographic Coverage*: Berlin; *Type(s) of Dwellings*: All kinds of existing dwellings; *Data*: Sales prices collected by Statistics Berlin; *Method*: Average transaction prices. |
| 1903–1923 | DEU2 | Matti (1963) | *Geographic Coverage*: Hamburg; *Type(s) of Dwellings*: All kinds of existing dwellings; *Data*: Sales prices collected by Statistics Hamburg; *Method*: Average transaction prices. |
| 1924–1938 | DEU3 | Association of German Municipal Statisticians (various years) | *Geographic Coverage*: Ten cities; *Type(s) of Dwellings*: All kinds of existing dwellings; *Data*: Sales prices collected by the city's statistical offices; *Method*: Weighted average transaction price index. |
| 1939–1961 | | Deutsches Volksheimstättenwerk (1959) | *Geographic Coverage*: Western Germany; *Type(s) of Dwellings*: Building sites; *Data*: Data collected through survey; *Method*: Estimated increase in sales prices. |
| 1962–1970 | DEU4 | Statistics Germany (various years,b) | *Geographic Coverage*: Western Germany; *Type(s) of Dwellings*: Building sites; *Data*: Sales prices collected by the Federal Statistical Office of Germany; *Method*: Average sales prices. |
| 1971–1995 | DEU5 | Bundesbank as reported by OECD | *Geographic Coverage*: Urban areas in Western Germany; *Type(s) of Dwellings*: New terraced homes; *Data*: Various data sources collected by BulwienGesa *Method*: Weighted average sales price index. |
| 1995–2012 | DEU6 | Bundesbank as reported by OECD | *Geographic Coverage*: Urban areas in Western Germany; *Type(s) of Dwellings*:New and existing terraced homes; *Data*: Various data sources assembled by BulwienGesa *Method*: Weighted average sales price index. |

all types of residential dwellings and for prefabricated dwellings move closely together (Vorholt, 1995). For the years since 2000, the Statistics Germany (2012) reports an input cost index for residential dwellings (Dechent, 2006a).

The main characteristics of the long-run construction cost index for Germany 1913–2012 are summarized in Table A.16. In addition, we calculate real unit labor costs in the construction sector for 1950–1970 based on national accounts data published by the Statistics Germany (1991). Between 1950 and 1970, real unit labor costs increased by 59 percent.

**Table A.16:** Germany: sources of construction cost index, 1913–2012.

| Period | Source | Details |
|---|---|---|
| 1913–1958 | Statistics Germany (2012) | *Geographic Coverage*: Nationwide; *Type(s) of Dwellings*: All types of residential dwellings; *Type of Index*: Input cost index. . |
| 1959–2012 | Statistics Germany (2012) | *Geographic Coverage*: Nationwide; *Type(s) of Dwellings*: All types of residential dwellings; *Type of Index*: Output price index. . |

#### Other housing related and macroeconomic data

*Farmland prices*: 1961–2012: Statistics Germany (various years,a,v) - Selling price for agricultural land per hectare.

*Value of housing stock*: Goldsmith (1985) provides estimates of the value of total housing stock, dwellings, and land for the following benchmark years: 1875, 1913, 1929, 1950, 1978. Data on the value of household wealth including the value of dwellings, and underlying land for 1991-2011 is drawn from OECD (2013). Piketty and Zucman (2014) also present data on real estate wealth for benchmark years in the period 1870–2011.

*CPI*: 1870–1996: Taylor (2002); 1997–2012: International Monetary Fund (2012b).

### A.2.9 Japan

#### House price data

Historical data on house prices in Japan are available for the time 1881–2012.

The earliest data are provided by the Bank of Japan (1970a). Bank of Japan (1970a) reports prices for rural residential land (measured in Yen/10 are) for selected years during the period 1880–1915 in the Tokyo prefecture (today referred to as greater Tokyo metropolitan area) and for Japan as a whole (national average). The data are based on public surveys conducted for the purpose of land taxation assessments. Average prices at the national level and for the greater Tokyo area were originally published in the Teikoku Statistics Annual. The data indicates a structural break in prices for residential sites in 1913. Presumably, this break has been caused by the 1910 Residential Land Price Revision Law that was associated with a

sharp increase in the valuation price of residential lots (Bank of Japan, 1970a).

For 1913–1930 the Bank of Japan (1986a) using data from the division of statistics of the city of Tokyo reports a land price index for urban land covering six cities.[95] The database also contains a paddy field price index for 1897–1942.

For 1936–1965 the Bank of Japan (1986b) reports four indices; i.e. an urban average land price index, an urban commercial land price index, an urban residential land price index, and an urban industrial land price index calculated from the all-cities and the-six-largest-cities sample, respectively. Furthermore, the database (Bank of Japan, 1986b) contains farm land prices for paddy fields for the period 1913–1965. The land prices are measured in Yen/10 are and are available for eleven districts and as average of all districts. These prices are prices realized in transactions where the farm land remained owner-operated (i.e. transactions in which the land was sold, for example, for road construction are excluded) and were collected through land assessors' surveys .(Bank of Japan, 1970b).

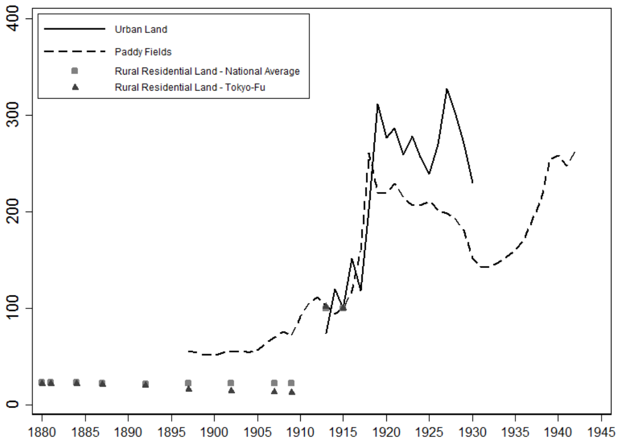
For the periods 1955–2004 and 1969–2012 urban land price indices are available from the Japan Real Estate Institute (Statistics Japan, 2012b, 2013b). Each of the two indices is disaggregated by the form of land utilization (commercial, residential, and industrial use; as well as an average of these) and by location (nationwide, i.e. referring to 233 cities, six largest cities, and nationwide excluding the six largest cities). Data for index calculation is drawn from appraisals.

For the period 1974–2009 the Land Appraisal Committee of the Japanese Ministry of Land, Infrastructure, Transport, and Tourism (MLIT) publishes data on annual growth rates of appraised real estate prices for "standard" commercial and residential properties. The property is valued assuming a free market transaction (Ministry of Land, Infrastructure, Transport, and Tourism, 2009). In addition to the national price growth data MLIT provides sub-series for the following five geographic categories: i) three largest metropolitan regions, ii) the Tokyo region, iii) the Osaka region, iv) the Nagoya region, and v) other regions.

Figure A.28 shows the nominal indices available for 1880–1942, i.e. the paddy field index, the rural residential land index, and the urban residential land index (Bank of Japan, 1970a, 1986a). The rural residential land index (Bank of Japan, 1970a) suggests that land prices continuously decreased between 1881 and 1913. The Meiji-era (1868–1912), however, was a time of considerable economic growth which makes the decrease in land values seem rather surprising. We can offer two explanations for this puzzle which may have joint or partial validity: first, data quality may be poor. The data are based on property valuation by public assessors and not on actual sales prices (Bank of Japan, 1970a). The taxable amount of land seems also not to be changed frequently or not adequately adjusted to the

[95] Tokyo, Kyoto, Osaka, Yokohama, Kobe, and Nagoya (Nanjo, 2002).

**Figure A.28:** Japan: nominal house price indices, 1880–1942 (1915=100).




'real' value.[96] There may hence be differences between trends in assessed values and actual sales prices. Second, the index is based on residential land values for rural areas. Since the last decades of the 19th century were a period of ongoing industrialization and urbanization, trends in rural land values may differ from trends in urban land values and thus not adequately reflect the general national trend during these years.

For the immediate post-World War II decades there are two indices available for urban residential land indices: i) a nationwide index produced by the Bank of Japan (1986b) and ii) a nationwide index by Statistics Japan (2012b, 2013b). For the years they overlap (1955–1965), they are perfect substitutes as they follow exactly the same trend.[97]

Figure A.29 shows the indices produced by Ministry of Land, Infrastructure, Transport, and Tourism (2009) and Statistics Japan (2013b) for 1970–2012. The graphs indicate that both series closely follow the same trend during the period in which they overlap, i.e. 1975–2009.

Since the land price trend as suggested by Bank of Japan (1970a) seems partially implausible considering the economic environment, our long-run index for Japan only starts in 1913. No data for urban residential land prices, however, is available for 1931–1935.[98] The paddy field index and the urban residential land index, however, are strongly correlated for the years they overlap.[99] To obtain our long-run index we thus link the two sub-indices, i.e. 1913–1930 and 1936–2012 using the growth rate of the paddy field index 1930–1936. For 1936–1954 we rely on the urban land price index for all cities by Bank of Japan (1986b). The long-run index uses the Statistics Japan (2013b, 2012b) index for the whole 1955–2012

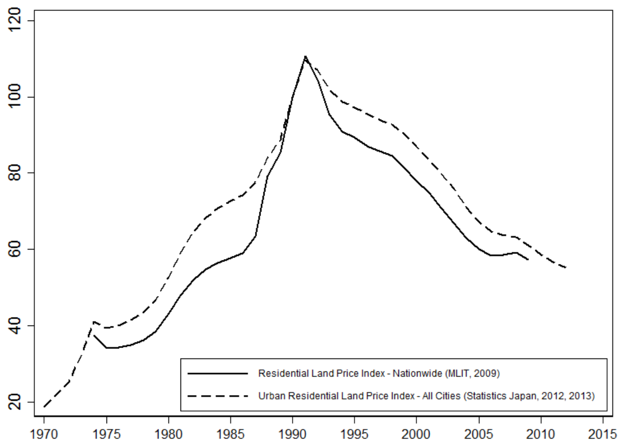
[96] Email conversation with Makoto Kasuya, Tokyo University.

[97] Correlation coefficient of 0.998.

[98] Nanjo (2002) estimates that urban land prices decreased by more than 20 percent in 1931 but were stable 1932–1933.

[99] Correlation coefficient of 0.778 for 1913–1930 (Bank of Japan, 1986a) and correlation coefficient of 0.934 for 1936–1965 (Bank of Japan, 1986b).

**Figure A.29:** Japan: nominal house price indices, 1970–2012 (1990=100).




period for two reasons: first, the index produced by Statistics Japan (2012b) reflects appraised values rather than actual sales prices. Hence, the Statistics Japan (2013b, 2012b) may better reflect real price trends. Second, to keep the number of data sources to construct an aggregate index to the minimum, we do not use the Ministry of Land, Infrastructure, Transport, and Tourism (2009) for the post-1970 period but rely on Statistics Japan (2013b, 2012b) instead. Our long-run house price index for Japan 1880–2012 splices the available series as shown in Table A.17.

**Table A.17:** Japan: sources of house price index, 1880–2012.

| Period | Series ID | Source | Details |
|---|---|---|---|
| 1913–1930 | JPN1 | Bank of Japan (1986a) | *Geographic Coverage*: Tokyo; *Type(s) of Dwellings*: Urban residential land; *Method*: Average price index. |
| 1931–1935 | | Bank of Japan (1986b) | *Geographic Coverage*: Kanto district; *Type(s) of Dwellings*: Paddy Fields; *Data*: Transaction data obtained through surveys; *Method*: Average price index. |
| 1936–1954 | JPN2 | Statistics Japan (2012b) | *Geographic Coverage*: Urban areas; *Type(s) of Dwellings*: Residential land; *Data*: Appraisal of land value as if vacant; *Method*: Average price index. |
| 1955–2012 | JPN3 | Statistics Japan (2013b) | *Geographic Coverage*: Urban areas; *Type(s) of Dwellings*: Residential land; *Data*: Appraisal of land value as if vacant; *Method*: Average price index. |

Three aspects have to be considered when using the series on urban residential sites. First, the index only refers to sites for residential use, and thus does not include the value of the structures. However, as discussed above, particularly in urban areas the land price constitutes a large share of the overall real estate value. Fluctuations in property prices in such densely populated areas are often driven by changes in site prices (Möckel, 2007, 142). Second, Nakamura and Saita (2007) suggest that the land price series, i.e. the Urban Land Price Index published by the Japan Real Estate Institute and the series published by Ministry of Land, Infrastructure, Transport, and Tourism (2009) may actually underestimate the general development in site prices. Both indices are calculated as simple averages thus assigning the same weight to high priced plots and low priced lots. The authors, however, argue that the more pronounced fluctuations were particularly symptomatic for the high priced neighborhoods such as the Tokyo metropolitan area. Simple averages may hence underestimate the magnitude of these movements. Third, for 1936–1954, the index reflects appraised land values which may deviate from actual sales prices.

### Construction cost data

Historical data on construction costs in Japan are available for 1938–2012.

Two main sources for construction costs in Japan exist. First, Statistics Japan (2012b) reports data on the construction costs of wooden houses in 46 cities for 1938–2004.[100] The index is computed by the Japan Real Estate Institute based on surveys of the per square meter market value of medium quality wooden frame houses (building only). The index thus captures changes in replacement values.

Second, the Ministry of Land, Infrastructure, Transport, and Tourism (MLIT) reports a construction cost deflator for 1960–2006 and sub-indices for various types of buildings, including residential buildings (Ministry of Land, Infrastructure, Transport, and Tourism, 2015). The index is calculated as an input cost index and reflects the changes in the costs of materials and labor, installation costs for water, gas, electricity, bathroom, kitchen, and outside fittings. Prices of materials are list prices, data on wages come from surveys of employers. The index is based on data for Greater Tokyo for 1960–1990 and on data for 10 cities (including Greater Tokyo) thereafter. The series covers all types of wooden and non-wooden residential dwellings.

To obtain a long-run index, we rely on the construction cost index published by the Ministry of Land, Infrastructure, Transport, and Tourism (2015) for 1960–2012 and the index for constructed by Statistics Japan (2012b) for 1955–1959. Note that the two series are highly correlated for the years they overlap.[101] Table A.18 summarizes the main characteristics of our long-run construction cost index.

[100] These include all prefectural capitals except for Naha. The index for 1938–1954 is reported in Toyo Keizai Shinposha (1991).

[101] Correlation coefficient of 0.99.

**Table A.18:** Japan: sources of construction cost index, 1955–2012.

| Period | Source | Details |
|---|---|---|
| 1955–1959 | Statistics Japan (2012b) | *Geographic Coverage*: Urban areas; *Type(s) of Dwellings*: Wooden houses; *Type of Index*: Replacement costs. |
| 1981–2012 | Ministry of Land, Infrastructure, Transport, and Tourism (2015) | *Geographic Coverage*: Urban areas; *Type(s) of Dwellings*: All types of residential dwellings; *Type of Index*: Input cost index. |

#### Other housing related and macroeconomic data

*Farmland prices*: 1880–1954: Bank of Japan (1966) - Land price index for paddy fields; 1955-2012: Statistics Japan (2012b, 2013b) - Land price index for paddy fields.

*Value of housing stock*: Goldsmith (1985) provides estimates of the value of total housing stock, dwellings, and land for the following benchmark years: 1885, 1900, 1913, 1930, 1940, 1955, 1965, 1970, 1977. Data for 1954–1998 is drawn from Statistics Japan (2013a). Data on the value of dwellings and land for 2001–2011 is drawn from OECD (2013).

*CPI*: 1870–2000: Van Leeuwen (2004); 2001–2012: International Monetary Fund (2012b).

### A.2.10 Netherlands

#### House price data

Historical data on house prices in the Netherlands are available for the time 1870–2012.

The most comprehensive source is provided by Eichholtz (1997). Using transaction data for buildings at the Herengracht in Amsterdam, Eichholtz computes a biannual hedonic repeat sales index for the period 1628–1973.[102]

A second index covering the development of prices for all types of existing dwellings in the Netherlands during 1970–1994 is constructed by the Dutch land registry (Kadaster).[103] Though the index is not directly available, it is included in

[102]Eichholtz (1997) notes that the buildings in his sample are of constant high quality as well as relatively homogeneous. For his hedonic regression he only includes one explanatory variable to control for changes in the buildings between transactions, that is use of the buildings. Most of the buildings had been built for residential use. Since the early 20th century, however, many of the properties along the Herengracht were converted into offices which, in turn, increased the value of the buildings. The data he uses to compute the index was published as part of a publication, *Vier eeuwen Herengracht*, at the occasion of Amsterdam's 750th anniversary in 1975. It contains the complete history of about 200 buildings along the Herengracht including all recorded transactions and transaction prices.

[103]The original index as published by the Dutch land registry is only available since 1976. However,

the international house price database maintained by the Federal Reserve Bank of Dallas (Mack and Martínez-García, 2012) and the OECD database. For the time 1970–1992 the index is computed from the median sales price of dwellings as reported by the Dutch Association of Real Estate Agents (Nederlandse Vereniging van Makelaars; NVM). For the years since 1992 the index is based on the Land Registry's records of sales prices of existing residential dwellings and computed using the repeat sales method (De Haan et al., 2009).

Besides the indices by Eichholtz (1997) and Kadaster (Mack and Martínez-García, 2012), a third source is available from Statistics Netherlands (2013d). The agency since 1995 on a monthly basis has published price indices for several types of property, such as all types of dwellings, single-family houses, and flats. The indices are computed using the Sales Price Appraisal Ratio (SPAR) method and rely on two separate sources of data: the Dutch land registry (Kadaster) records of sales prices and the municipalities' official value appraisals conducted for residential property taxation.

As indicated above, the only available source that covers the time prior to 1970 is the index by Eichholtz (1997). Even though the index only refers to real estate on one street in the city of Amsterdam (Herengracht), the series appears to be in line with the general trends in house prices as discussed in the literature (Elsinga, 2003; Van Zanden, 1997; Van Zanden and van Riel, 2000; Van der Heijden et al., 2006; Vandevyvere and Zenthöfer, 2012; Van der Schaar, 1987; De Vries, 1980).[104] To obtain an annual index we apply linear interpolation.

Figure A.30 covers the development of real estate prices in the Netherlands

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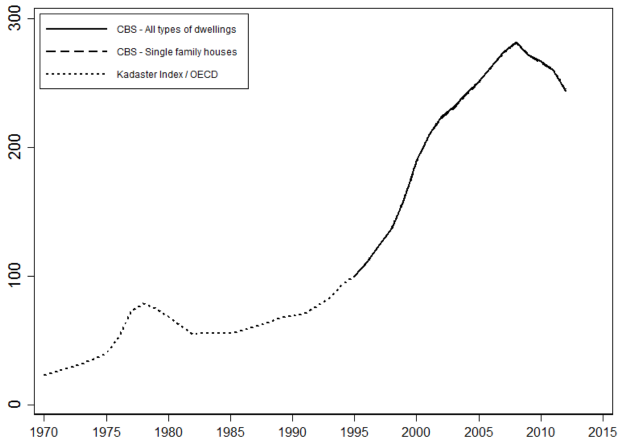
a backcasted version of the index which covers the period 1970–2012 is available from the OECD.

[104]Real house prices are reported to have increased by about 70 percent between 1870 and 1886. According to Glaesz (1935) and Van Zanden and van Riel (2000), urbanization at the time fueled construction activity in the cities. The ensuing construction boom between 1866–1886 induced a substantive increase in residential investment (Prak and Primus, 1992). The boom faltered in the second half of the 1880s and only resumed in the 1890s. This second boom in house prices and construction activity continued until the crisis of 1907 (Glaesz, 1935; Van Zanden and van Riel, 2000). The enactment of a new housing law in 1901 to set structural and design standard requirements in the field of health, sanitation and safety at the same time fostered the improvement of the dwellings stock and hence further contributed to the construction boom (Prak and Primus, 1992; Van der Heijden et al., 2006). During World War I the Netherlands remained neutral. While the war nevertheless adversely affected Dutch economic development, real house prices remain fairly stable between 1914 and 1918. After years of economic growth in the 1920s, in 1929, the Dutch economy entered what Van Zanden (1997) calls the "long stagnation" that lasted until 1949. In line with the dire state of the Dutch economy, real house prices fell by 30 percent between 1930 and 1936 and remained depressed throughout the years of World War II. The German occupation from 1940 to 1945 had devastating effects on the Dutch economy. As many other countries, the Netherlands due to a virtual halt in construction and large scale destruction faced a severe housing shortage after 1945. The housing shortage was further aggravated by rapid population growth and family formation during the 1950s. Rent controls that had already been introduced during the German occupation remained in place until the end of the 1950s, but proved counterproductive to investment in residential real estate (Vandevyvere and Zenthöfer, 2012; Van Zanden, 1997; Van der Schaar, 1987). Not surprisingly considering the strict housing regulation, house price growth remains weak during the late 1940s and 1950s. It was only in 1959 that the government under Prime Minister Jan de Quay (1959–1963) began to liberalize the housing market, i.e. removed the rent controls and cut back social housing subsidization (Van Zanden, 1997; Van der Schaar, 1987). By the 1960s a high rate of homeownership had become a widely supported objective of Dutch housing policy (Elsinga, 2003).

**Figure A.30:** Netherlands: nominal house price indices, 1970–2012 (1995=100).




for the more recent period and shows the Kadaster-index (available since 1970), the CBS-indices for all types of properties and for single-family houses (available since 1995). For the period in which the three indices overlap, i.e. the time from 1995–2012, the indices are perfect substitutes as they follow exactly the same trend and accord with the house price trends discussed in the literature (Vandevyvere and Zenthöfer, 2012).

**Table A.19:** Netherlands: sources of house price index, 1870–2012.

| Period | Source | Details | |
|---|---|---|---|
| 1870–1969 | NLD1 | Eichholtz (1997) | *Geographic Coverage*: Amsterdam; *Type(s) of Dwellings*: All types of existing dwellings; *Data*: Sales prices published in *Vier eeuwen Herengracht*; *Method*: Hedonic repeat sales method. |
| 1970–1994 | NLD2 | Kadaster Index, as published by OECD | *Geographic Coverage*: Nationwide; *Type(s) of Dwellings*: All types of existing dwellings; *Data*: Nederlandse Vereniging van Makelaars, Kadaster; *Method*: 1970–1991: median sales price; 1992–1994: repeat sales method. |
| 1997–2012 | NLD3 | Statistics Netherlands (2013d) | *Geographic Coverage*: Nationwide; *Type(s) of Dwellings*: All types of existing dwellings; *Data*: Kadaster, officially appraised values determined by municipalities as basis for the residential property tax; *Method*: SPAR method. |

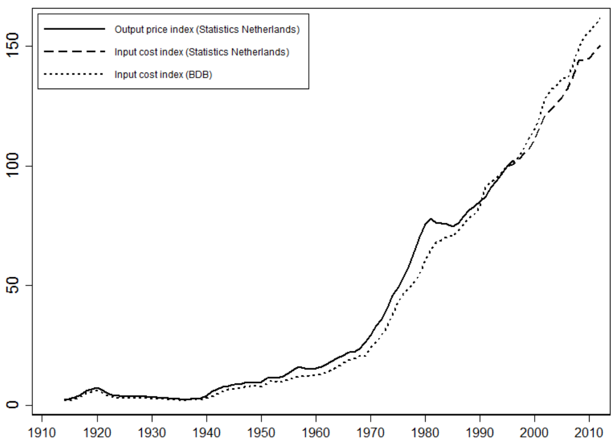
Our long-run house price index for the Netherlands 1870–2012 splices the available series as shown in Table A.19. The long-run index has two weaknesses: first, as no house price series for the Netherlands as a whole is available for the years prior to 1970, we rely on the Herengracht index instead. The extent to which house prices at the Herengracht are representative of house prices in other urban areas or the Netherlands as a whole remains, however, difficult to determine. Second, despite the fact that by using the repeat sales method the effect of quality differences between houses is somewhat reduced, it does not control for all potential changes in the quality and standards of dwellings over time.

### Construction cost data

Historical data on construction costs in the Netherlands are available for 1914–2012.

Statistics Netherlands publishes an output price index for new dwellings since 1914 (Statistics Netherlands, 2013a). For 1914–1999, the index is based on construction costs for council houses[105] including VAT and is adjusted to control for quality changes of dwellings using a hedonic regression. Since the production of council houses declined significantly over time, Statistics Netherlands since 1995 calculates a new construction cost series based on data for all types of dwellings (Statistics Netherlands, 2009b, 2000). Two versions of the post-1995 series are available: including and excluding VAT.

**Figure A.31:** Netherlands: nominal construction cost indices, 1914–2012 (1995=100).




A second source for construction costs for the period 1914–2012 is an input cost index constructed by the Bureau Documentatie Bouwwezen (BDB), an independent research institute for the construction sector. The index for single-family houses is based on list prices of building materials and surveys on wages in the construction sector.[106]

In addition, since 1995, Statistics Netherlands, also calculates an input cost index for residential dwellings (Statistics Netherlands, 2013c). For 1995–1998, the

[105]Public rental housing built by local municipalities.
[106]Series sent by email. Contact person is Marjan Peppelmann, BDB.

**Table A.20:** Netherlands: sources of construction cost index, 1914–2012.

| Period | Source | Details |
|---|---|---|
| 1914–1994 | Statistics Netherlands (2013a) | *Geographic Coverage*: Nationwide; *Type(s) of Dwellings*: Council houses; *Type of Index*: Output price index. |
| 1995–2012 | Statistics Netherlands (2013a) | *Geographic Coverage*: Nationwide; *Type(s) of Dwellings*: All types of dwellings; *Type of Index*: Output price index. |

index is an average construction cost index for detached houses, apartments, and terraced houses. For 1998–2012, the index is based on eight representative construction projects.[107] The input cost index and the output price index are highly correlated for the years they overlap (1995–2012).[108]

Figure A.31 depicts the nominal construction cost indices available for 1914–2012, i.e. the output price index published by Statistics Netherlands (2013a) (1914–2012), the input cost index constructed by BDB (1914–2012), and the input cost index calculated by (Statistics Netherlands, 2013c) (1995–2012). As it shows, the indices generally move together. Nevertheless, in the immediate post-World War II decades, the long-run index by Statistics Netherlands (2013a) follows an upward trend that is slightly more pronounced compared to the BDB-index. In the late 1970s, the series suggests a modest decline in construction costs whereas the BDB-index continues to increase.

To arrive at a long-run construction cost series for 1914–2012, we rely on the output price index (incl. VAT) as shown in Table A.20.

### Other housing related and macroeconomic data

*Farmland prices*: 1963–1989: Statistics Netherlands (2013b) - Sales price index for farmland (without lease); 1990–2001: Statistics Netherlands (2009a) - Sales price index for farmland (without lease).

*Value of housing stock*: The Statistics Netherlands (1959) provides estimates of the total value of land and the total value of dwellings for 1952. Data on the value of dwellings and land for 1996–2011 is drawn from OECD (2013).

*CPI*: 1870–2007: Taylor (2002); 2008–2012: International Monetary Fund (2012b).

[107]The projects are: apartments and detached houses (for rent) in northern and eastern provinces, apartments and detached houses (to buy) in middle and southern provinces, apartments and detached houses (for rent and to buy) in western provinces.

[108]Correlation coefficient of 0.91.

### A.2.11 Norway

#### House price data

Historical data on house prices in Norway are available for the time 1870–2012.

The most comprehensive source for historical data on real estate price in Norway is presented by Eitrheim and Erlandsen (2004). Their data set contains five house price indices; four for urban areas, i.e. for the inner city of Oslo, Bergen, Trondheim and Kristiansand as well as an aggregate index. With the exception of Trondheim, for which data are only available since 1897, the indices cover the period 1819–2003. The indices are constructed from two different sources:

For the years 1819–1985 the indices are computed from nominal transaction prices of real estate property (mostly residential). The data has been compiled from real property registers of the four cities and refers to property in city centers. The four city indices are computed using the weighted repeat sales method, for the aggregate index the hedonic repeat sales method is applied. However, the hedonic regression only controls for location (Eitrheim and Erlandsen, 2004, 358 ff.).

For the years since 1986 Eitrheim and Erlandsen (2004) rely on a monthly index jointly published by the Norwegian Association of Real Estate Agents (Norges Eiendomsmeglerforbund, 2012, NEF) and the Norwegian Real Estate Association (EFF), Finn.no, and Pöyry, a consulting firm. For the years 1986–2001 the index is based on sales price data voluntarily reported by NEF members. Since 2002 the index is based on all transactions managed by NEF and EFF member real estate agents. Reported NEF/EFF raw data are in prices per square meter. There are several sub-series available for various types of properties: all residential dwellings, detached houses, semi-detached houses, and apartments. The data series are disaggregated to county level. NEF/EFF use a hedonic regression method controlling for location and square meters (Eiendomsverdi, Eiendomsmeglerforetakenes Forening, and Finn.no, 2013). Since 1986 the share of total property transactions covered by the NEF/EFF database has been steadily increasing and currently stands at about 70 percent.

Besides the indices by Eitrheim and Erlandsen (2004) and NEF/EFF, a third source that covers the more recent development of residential property prices (1991–2012) is provided by Statistics Norway (2013b). Statistics Norway (2013b) publishes house price indices on a quarterly basis for i) all houses; ii) detached houses; iii) row houses; and iv) multi-family dwellings. The indices are based on house sales registered with FINN.no AS. Statistics Norway follows the approach of a mix-adjusted hedonic index.[109]

Figure A.32 shows the real house price indices based on the deflated nominal indices for Bergen, Kristiansand, Oslo, and Trondheim and the aggregate four-

[109] While the hedonic regression specification as currently applied by Statistics Norway controls for dwelling size and location, it ignores other important characteristics such as age of the property or other distinct quality characteristics. Statistics Norway uses mix-adjustment techniques to account for this limitation (Mack and Martínez-García, 2012).

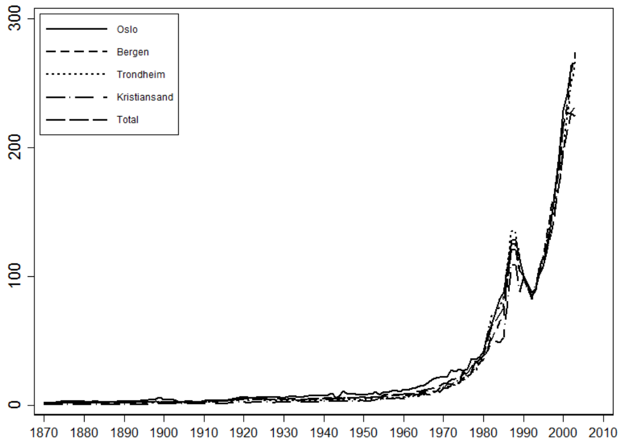
cities-index by Eitrheim and Erlandsen (2004) for 1870–2002. The four city indices appear to follow the same trends throughout the observation period and are in line with developments in the Norwegian housing market as discussed in the literature.[110]

Figure A.33 compares the following four indices for the post-1985 period: the index by Eitrheim and Erlandsen (2004), the national NEF-index (all houses), a four-cities index calculated by averaging the NEF data for Bergen, Kristiansand, Oslo, and Trondheim (all houses), and the national index by Statistics Norway (all houses).[111] It shows that the four indices move in almost perfect lock-step. An analysis by Statistics Norway (2013) suggests that the minor differences between

[110]Norwegian house prices strongly increased throughout the last decade of the 19th century. While the underlying macroeconomics were not particularly favorable, strong population growth, and ongoing urbanization substantively fostered the demand for urban housing and thus put upward pressure on house prices. During those years, construction activity increased considerably (Grytten, 2010; Eitrheim and Erlandsen, 2004). The boom period abruptly came to an end in 1899 when the Norwegian building industry crashed causing a financial collapse. The following consolidation period lasted until 1905 (Grytten, 2010; Eitrheim and Erlandsen, 2004). Although Norway remained neutral during World War I, the war had a strong and depressing effect on the Norwegian economy, particularly due to the disruption in trade. While house prices substantially increased in nominal terms, they considerably lacked behind inflation. Rent controls introduced in 1916 lowered the rates of return from rented residential property and put additional downward pressure on house prices (Eitrheim and Erlandsen, 2004). Only after the war house prices begun to recover. During the 1920s the continuous rise in real estate prices was only briefly interrupted during the international postwar recession which in Norway was associated with a banking crisis. Interestingly, the literature provides different and partly contradictory explanations for the massive rise in real estate prices during the 1920s and the first half of the 1930s. Grytten (2010) reasons that the house price hike was primarily driven by relative changes in the nominal house prices and the general price level: while Norway during that time experienced a phase of general price deflation, nominal house prices remained relatively stable. Husbanken (2011) instead diagnoses a supply shortage to have been a principal price driver. During the years of German occupation (1940–1945) house prices collapsed. Although destructions were limited in comparison to most other European countries there was a perceptible housing shortage after the war. In response, the government in 1946 established the Norwegian State Housing Bank (*Husbanken*) to provide the required liquidity for residential construction (Husbanken, 2011). Throughout the years 1940–1969, however, strict housing market regulations were in place, with house prices essentially fixed until 1954. This may explain why real house prices continued to decrease after the war until mid-1950. In subsequent years (1955–1960) regulations were gradually relaxed and house price started to rise (Eitrheim and Erlandsen, 2004). Liberalization of the tightly regulated banking sector which began in the late 1970s allowed for more flexibility in bank lending rates but also increased the cost of housing credit such that access to housing finance became more restricted. During these years the significance of the State Housing Bank decreased and private sector finance played an increasingly important role in Norwegian housing finance. In 1976 the State Housing Bank had financed about 87 percent of new dwellings. In 1984 its share had shrunk to about 53 percent (Pugh, 1987). The contractive monetary policy pursued by the Federal Reserve since 1979 and the subsequent global surge in interest rates also effected the Norwegian economy, particularly with respect to capital formation and thus also housing (Pugh, 1987). Starting in the mid-1980s a pronounced increase in house prices emerges fueled by credit liberalization and a considerable credit boom (Grytten, 2010). However, when oil prices declined at the end of the 1980s economic activity slowed considerably and Norway entered a recession that continued until 1991. During these years the private banking system entered a severe crisis during which borrowing activities remained restricted. House prices sharply contracted before in 1993 again entering a period of strong expansion (Eitrheim and Erlandsen, 2004).

[111]Since the index by Eitrheim and Erlandsen (2004) refers to all kinds of existing dwellings, the respective series for all houses from Norges Eiendomsmeglerforbund (2012) and Statistics Norway (2013b) are included.

**Figure A.32:** Norway: nominal house price indices, 1870–2003 (1990=100).




the nationwide index by Statistics Norway and the one by NEF primarily originate from the application of different weights for aggregation. Nevertheless, both the national NEF and the four-cities-index after 2000 follow an upward trend that is slightly more pronounced relative to the Statistics Norway-index. A comparison of the index specific summary statistics suggests that the index by Eitrheim and Erlandsen (2004) perfectly mirrors the level, trend, and volatility of the national NEF index for the time in which they overlap (1990–1999). In an effort to construct a coherent index for the period 1870–2012, splicing the Eitrheim and Erlandsen (2004) and the NEF index appears recommendable. Nevertheless, this approach may result in slightly overestimating the increase in house prices in Norway as a whole in the years after 2000 as the NEF index for the whole of Norway indicates a more pronounced rise in house prices when compared to the other indices available (cf. Figure A.33).

**Figure A.33:** Norway: nominal house price indices, 1985–2012 (1990=100).

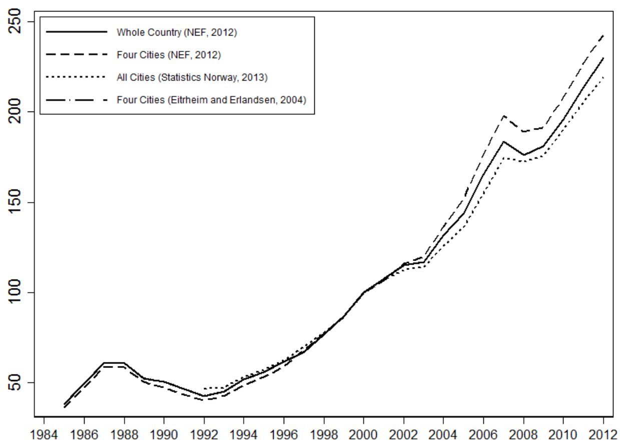
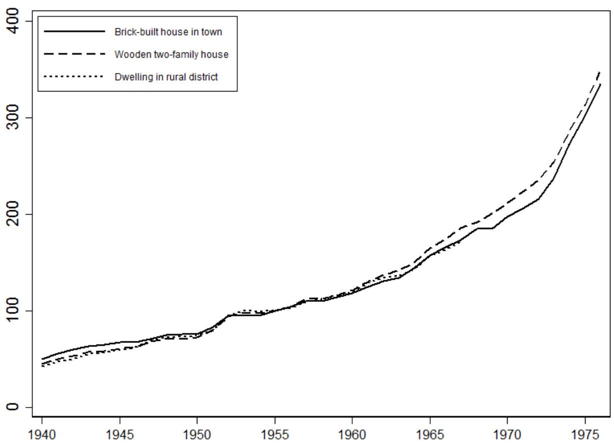


**Table A.21:** Norway: sources of house price index, 1870–2012.

| Period | Series ID | Source | Details |
|---|---|---|---|
| 1870–2003 | NOR1 | Eitrheim and Erlandsen (2004) | *Geographic Coverage*: Four cities; *Type(s) of Dwellings*: All types of existing dwellings; *Data*: Real Property Registers; *Method*: Hedonic weighted repeat sales method. |
| 2004–2012 | NOR2 | Norges Eiendomsmegler-forbund (2012) | *Geographic Coverage*: Four cities; *Type(s) of Dwellings*: All types of existing dwellings; *Data*: Voluntary reports of real estate agents regarding sales of dwellings; *Method*: Hedonic regression. |

Our long-run house price index for Norway 1870-2012 splices the available series as shown in Table A.21. A drawback of the long-run index is that prior to 1986 it accounts for quality changes only to some extent. By using the repeat sales method the effect of quality differences between houses is somewhat reduced, but not all potential changes in the quality and standards of dwellings over time are controlled for.

**Figure A.34:** Norway: nominal construction cost indices, 1940–1977 (1955=100).




### Construction cost data

Historical data on construction costs in Norway are available for the time 1935–2012. The most comprehensive source for construction costs is published by Statistics Norway (2013a). For the years 1935–1977 Statistics Norway (2013a) relies on data by Aspelin-Stormbull – a company producing steel, iron and building materials – for the Oslo area. The dataset contains two construction cost indices for 1935–1977: for brick-built houses and for wooden two-family houses. The two series move closely together (see Figure A.34). For 1935–1967 an additional series for dwellings in rural districts is available. For the years since 1978, Statistics Norway (2013a) calculates two nationwide construction cost series: for multifamily houses and for detached houses of wood. The two series are highly correlated.[112] The long-run construction cost index is based on the data series for wooden houses and splices the available series as shown in Table A.22. In addition, we calculate real unit labor costs in the construction sector for 1950–1970 based on national accounts data published by Statistics Norway (1981, 1979, 1965). Between 1950 and 1970, real unit labor costs rose by a little less than 3 percent.

**Table A.22:** Norway: sources of construction cost index, 1935–2012.

| Period | Source | Details |
|---|---|---|
| 1935–1977 | Statistics Norway (2013a) | *Geographic Coverage*: Oslo area; *Type(s) of Dwellings*: Wooden two-family houses; *Type of Index*: Input cost index. |
| 1978–2012 | Statistics Norway (2013a) | *Geographic Coverage*: Nationwide; *Type(s) of Dwellings*: Detached houses of wood; *Type of Index*: Input cost index. |

#### Other housing related and macroeconomic data

*Value of housing stock*: Goldsmith (1985) provides estimates of the value of total housing stock, dwellings, and land for the following benchmark years: 1880, 1899, 1913, 1930, 1939, 1953, 1965, 1972, 1978.

*Farmland prices*: 1985–2005: Statistics Norway[113] - Average purchase price of agricultural and forestry properties sold on the free market; 2006-2010: Statistics Norway (2011) - Average purchase price of agricultural and forestry properties sold on the free market.

*CPI*: 1870–2012: Bank of Norway (2015).

### A.2.12 Sweden

#### House price data

Historical data on house prices in Sweden are available for the time 1875–2012.

The most comprehensive sources for historical data on real estate price in Sweden are presented by Söderberg et al. (2014) and Bohlin (2014). Bohlin (2014) presents an index for multifamily dwellings in Gothenburg for 1875–1957. The index is based on sales price data and tax assessments and constructed using the SPAR method (Söderberg et al., 2014; Bohlin, 2014). Söderberg et al. (2014) also uses the SPAR method to construct an index for multifamily dwellings in inner

[112] Correlation coefficient of 0.99.
[113] Series sent by email, contact person is Trond Amund Steinset, Statistics Norway.

Stockholm 1875–1957.[114]

In addition, the authors present indices gathered from different sources for Stockholm, Gothenburg, and Sweden for i) single- to two-family houses, and ii) multi-family dwellings for 1957–2012.[115]

A second major source for house prices is available from Statistics Sweden (2014c). The dataset contains a set of annual indices for new and existing one- and two-family dwellings for 12 geographical ares for 1975–2012.[116] The index is constructed combining mix-adjustment techniques and the SPAR method using data from the Swedish real property register (Lantmäteriet).[117]

**Figure A.35:** Sweden: nominal house price indices, 1875–1957 (1912=100).

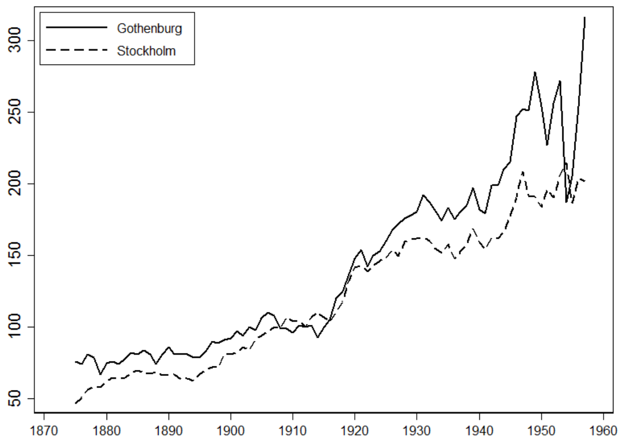



Figure A.35 depicts the nominal indices available for 1875–1957, i.e. the index for Gothenburg (Bohlin, 2014) and the index for inner Stockholm (Söderberg et al., 2014). As it shows, the two indices generally move together.[118] The main difference between the two series is the comparably stronger increase in the Gothenburg index after the 1920s and more pronounced fluctuations during the 1950s.[119] The indices appear to by and large be in line with the fundamental macroeconomic trends and developments in the Swedish housing market (Söderberg et al., 2014;

[114]Both, Söderberg et al. (2014) and Bohlin (2014), also present a repeat sales index which depicts a similar increase in house prices in the long-run. Because the repeat sales analysis still requires further scrutiny, the authors regard the SPAR index as preferable.

[115]The authors combine price information presented by Sandelin (1977) and data collected by Statistics Sweden. For the years since 1975 they rely on Statistics Sweden (2014c).

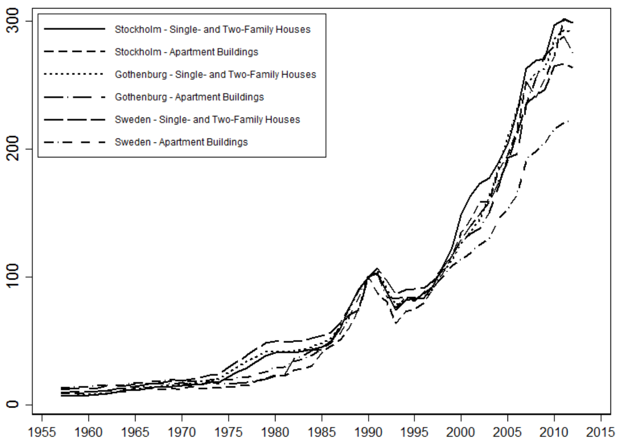
[116]These areas are: Sweden as a whole, Greater Stockholm, Greater Gothenburg, Greater Malmö, Stockholm production county, Eastern Central Sweden, Småland with the islands, South Sweden, West Sweden, Northern Central Sweden, Central Norrland, Upper Norrland.

[117]For the period 1970–2012 an index is available from the OECD based on Statistics Sweden (2014c). For the period 1975–2012 the Federal Reserve Bank of Dallas also relies on the index for single- and two-family dwellings by Statistics Sweden (2014c).

[118]Correlation coefficient of 0.954.

[119]The Stockholm index increases at an average annual nominal growth rate of 0.95 percent between 1920 and 1957 while the Gothenburg index increases at an average annual nominal growth rate of 2.05 percent.

**Figure A.36:** Sweden: nominal house price indices, 1975–2012 (1990=100).




Bohlin, 2014; Magnusson, 2000).[120]

Figure A.36 shows the nominal indices available for 1957–2012. Again, the indices for Gothenburg and Stockholm follow the same trajectory. The comparison nevertheless suggests that prices for apartment buildings increased less than prices for single- and two-family houses. According to Söderberg et al. (2014), it was rent regulation introduced during the years of World War II that held down the prices for apartment buildings. Hence, they argue, the indices for single- and two-family houses better reflect market prices. The extent to which the increase in prices of apartment houses were already dampened in earlier years when compared to single-family houses, i.e. prior to 1957, however, cannot be determined (Söderberg et al., 2014).[121]

Our long-run house price index for Sweden 1875–2012 splices the available series as shown in Table A.23. As we aim to provide house price indices with the most comprehensive coverage possible, we use a simple average of the index for Gothenburg and the index for Stockholm. While the index prior to 1957 refers to multifamily dwellings only, we nevertheless use the index for single- to two-family dwellings for 1957–2012 as the index for multifamily dwellings may underestimate the increase in house prices particularly during the 1960s and 1970s (see above).

[120] Söderberg et al. (2014), however, also reason that the index may not adequately depict the exact extent of the crises and their aftermaths in 1885–1893 and 1907.

[121] Rent controls were already introduced during World War I, but abolished in 1923. The 1917 law did not freeze rents at certain levels, but was mainly intended to prevent them from increasing in leaps and bounds (Stromberg, 1992). Rent regulation was re-introduced in 1942. Rents were frozen, detailed rent-controls for newly built dwellings introduced, and tenants protected. Tenant protection was further strengthened in the 1968 Rent Act. While the 1942 measures were initially planned to be effective until 1943, they were only fully abolished in 1975 (Magnusson, 2000; Rydenfeldt, 1981; Söderberg et al., 2014).

**Table A.23:** Sweden: sources of house price index, 1875–2012.

| Period | Series ID | Source | Details |
|---|---|---|---|
| 1875–1956 | SWE1 | Söderberg et al. (2014); Bohlin (2014) | *Geographic Coverage*: Stockholm and Gothenburg; *Type(s) of Dwellings*: Existing multifamily dwellings; *Data*: Tax assessment values from *Stockholms adresskalender* and *Göteborgs adresskalender*, sales price data from register of certificates of title to properties and other archival sources; *Method*: SPAR method. |
| 1957–2012 | SWE2 | Söderberg et al. (2014) | *Geographic Coverage*: Stockholm and Gothenburg; *Type(s) of Dwellings*: New and existing single- and two-family houses; *Data*: Swedish real property register, Statistics Sweden; *Method*: Mix-adjusted SPAR index. |

### Construction cost data

Historical data on construction costs in Sweden are available for 1910–2012.

Statistics Sweden (2014a) reports a construction cost index for multifamily dwellings for 1910–2012. The series is based on four main sources. For 1910–1935, Statistics Sweden (2014a) relies on an input cost index constructed by Dickson (1946) for apartment buildings in Stockholm. Dickson (1946), in turn, relies on data collected by Johansson (1944) and the *Svenska Handelsbanken*. For 1936–1949, Statistics Sweden (2014a) uses an input index for apartment buildings in Stockholm constructed by the Royal Housing Board (*Kungl. Bostadsstyrelsen*). For 1950–1968, Statistics Sweden (2014a) uses an input index for apartment buildings in Stockholm constructed by the Royal Board of Social Affairs (*Kungl. Socialstyrelsen*). For 1968–2012, the index is identical to the input price index for apartment buildings in Sweden calculated by Statistics Sweden (Statistics Sweden, 2014a).

The main characteristics of the long-run construction cost index for Sweden 1910–2012 are summarized in Table A.24. In addition, we calculate real unit labor costs in the construction sector for 1950–1970 based on national accounts data published by Edvinsson (2005). Between 1950 and 1970, real unit labor costs increased by about 30 percent.

### Other housing related and macroeconomic data

*Value of housing stock*: Waldenström (2016).

*Farmland prices*: 1870–1930: Bagge et al. (1933); 1967–1987: Statistics Sweden (various years); 1988–2012: Statistics Sweden (2014b).

*CPI*: 1870–2012: Statistics Sweden (2015).

**Table A.24:** Sweden: sources of construction cost index, 1910–2012.

| Period | Source | Details |
|---|---|---|
| 1910–1935 | Dickson (1946) | *Geographic Coverage*: Stockholm; *Type(s) of Dwellings*: Apartment buildings; *Type of Index*: Input cost index. |
| 1936–1949 | Royal Board of Housing as reported in Statistics Sweden (2014a) | *Geographic Coverage*: Stockholm; *Type(s) of Dwellings*: Apartment buildings; *Type of Index*: Input cost index. |
| 1950–1967 | Royal Board of Social Affairs as reported in Statistics Sweden (2014a) | *Geographic Coverage*: Stockholm; *Type(s) of Dwellings*: Apartment buildings; *Type of Index*: Input cost index. |
| 1968–2012 | Statistics Sweden (2014a) | *Geographic Coverage*: Nationwide; *Type(s) of Dwellings*: Apartment buildings; *Type of Index*: Input cost index. |

### A.2.13 Switzerland

#### House price data

Historical data on house prices in Switzerland are available for the time 1901–2012.

For Switzerland, there are three principal sources for historical real estate price data. The first source is Statistics Switzerland (2013b) which inter alia reports average sales prices per square meter for developed lots and building sites in several urban areas since the early 20th century. The most comprehensive coverage is available for the city of Zurich (1899–1990) due to extensive documentation of land transactions in the annual Statistical Abstracts of the city of Zurich. We compute an index based on the five year moving average of the average sales price per square meter of building sites and developed lots in Zurich to smooth out some of the fluctuation stemming from year-to-year variation in the number transaction.

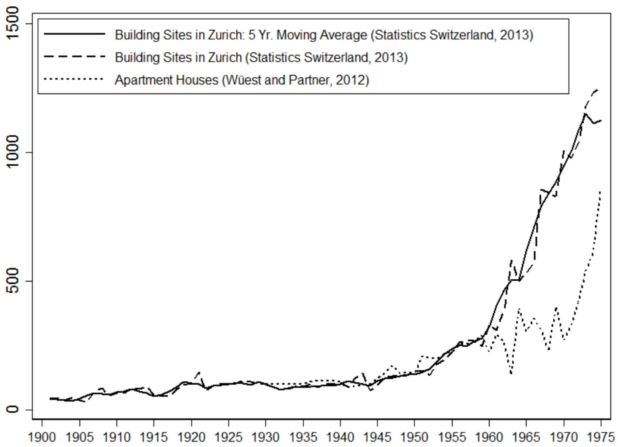
The second source is provided by Wüest and Partner (2012, 40 ff.). The consulting firm produces two price indices - one for multi-family houses and one for commercial property - covering the years since 1930. The index is computed applying a hedonic regression[122] on cross-sectional pooled data.[123] Data are pooled as the number of observations per years varies substantively and hence particularly in years of strong market frictions the single year sample size would be too small

[122]The specification controls for quality of the local community (size, agglomeration, purchasing power, etc.), year of construction, square footage, and volume.

[123]The data are pooled such that the estimation for year N also includes the data on transaction of the two previous (N-1, and N-2) and two subsequent years (N+1, N+2).

to generate reliable price estimates. For the years prior to 2011 the two indices by Wüest and Partner (2012) are constructed from a dataset containing information on 2900 arm's-length transactions of commercial and residential property that took place mostly in large and medium-sized urban centers. The raw data are collected from various insurance companies.[124]

**Figure A.37:** Switzerland: nominal house price indices, 1901–1975 (1930=100).




A third important source on real estate prices covering the period 1970–2012 is provided by the Swiss National Bank (SNB) which on a quarterly basis publishes two mix-adjusted real estate price indices: an index for single-family houses and an index for apartments (sold by the unit). The indices are produced by Wüest and Partner using price information on new and existing properties (Swiss National Bank, 2013). Wüest and Partner rely on a database containing approximately 100,000 entries per year. Each entry provides information on the list prices (not sales prices), location, the size of the respective properties (number of rooms), and whether it at the time was newly constructed or existing stock (Wüest and Partner, 2013).[125]

Figure A.37 depicts the nominal indices available for 1901–1975. For the time prior to 1930, it shows that the index computed using the data published by Statistics Switzerland (2013a) accords with the general macroeconomic developments and accounts of housing market developments (Böhi, 1964; Woitek and Müller, 2012; Werczberger, 1997; Michel, 1927).[126] Reassuringly, the index by Wüest and

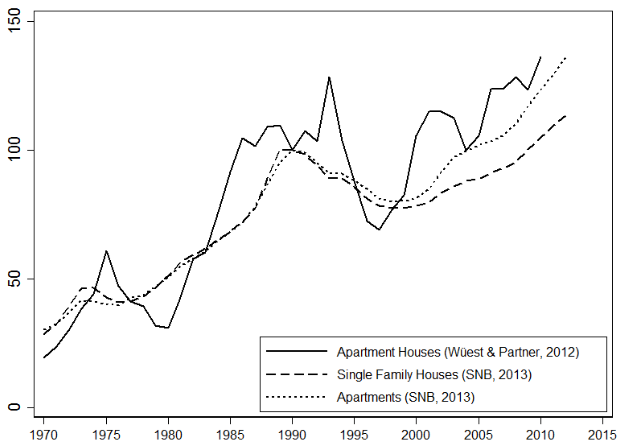
[124]Such as Generali, Mobiliar, Nationale Suisse, Swiss Life and Zurich Insurance.

[125]For the period 1975–2012, the Federal Reserve Bank of Dallas also uses the Swiss National Banks' index, thus the one developed by Wüest and Partner (Mack and Martínez-García, 2012). The OECD also relies on this index.

[126]Several episodes are noteworthy: first, Switzerland experienced a pronounced building boom during the 1920s, a period of general economic expansion. Wartime rent controls were abolished in 1924. The subsequent increase in rents made homeownership or ownership of rented residential property become more attractive while low mortgage rates further spurred investment in housing (Werczberger, 1997; Böhi, 1964). Between 1930 and 1936 the Swiss economy contracted. While the recession was comparably mild it was rather long-lasting: recovery only began after the devaluation of the Swiss Franc in 1936/37 (Böhi, 1964). Strong private domestic consumption and the continuously

Partner (2012) for multifamily properties and the site price index for Zurich (Statistics Switzerland, 2013a) consistently move together for the period 1930–1975 and are strongly correlated.[127]

**Figure A.38:** Switzerland: nominal house price indices, 1970–2012 (1990=100).




For the 1960s, however, the two indices provide a disjoint and inconsistent picture. In the light of pronounced and uninterrupted economic growth during the 1960s (Woitek and Müller, 2012), the strong fluctuations of house prices as suggested by the Wüest and Partner (2012)-index are rather surprising. One explanation may be poor data quality. A second explanation may be that the index is based on price data for multifamily houses. In 1965, apartment ownership (i.e. purchased by the unit) was legalized for the first time. This, in turn, may have made rental arrangements less attractive and caused uncertainties about the future value of apartment houses as investment property (Werczberger, 1997). Hence, for the years after 1965 the index should not be viewed as depicting boom-bust developments in house prices in general but fluctuations specific to apartment houses. This hypothesis is supported by Statistics Switzerland (2013a) index which for the years since 1965 shows and steady positive development for the broader residential property market. However, the index by Statistics Switzerland (2013a) may be problematic for another reason: It appears that the index depicts an exaggerated

high demand for residential housing played an important role to cushion the effect of the recession. While nominal wage rates declined between 1924 and 1933, the drop was less pronounced (minus 6 percent) than the decrease in the cost of living (minus 20 percent) hence increasing the purchasing power of workers. At the same time, building costs were low and credit was easy to obtain since Switzerland was considered a safe haven for capital from countries with unstable currencies (Böhi, 1964; Woitek and Müller, 2012). The outbreak of World War II constituted another major rupture to economic activity in Switzerland. Private investment in housing slumped while construction costs increased. Growth only resumed after the end of the war. During the war years construction activity had remained low. Consequently, the immediate post-war period was characterized by a housing shortage that was further intensified by increasing family formation, high levels of immigration, and generally rising incomes (Böhi, 1964; Werczberger, 1997). Rent controls introduced during the war were gradually abolished until 1954. As a result, rents increased by an impressive 160 percent between 1954 and 1972 and construction activity intensified. A housing shortage persisted, however, until the mid-1970s (Böhi, 1964; Werczberger, 1997).

[127]Correlation coefficient of 0.85.

growth trend as house prices are reported to have roughly tripled between 1960 and 1970. As there is no evidence, discussion or narrative in the literature that reflects such an extreme price development the reported increases appear implausible. While we cannot identify the exact magnitude of house price growth, we can nevertheless assume that Swiss house prices rose during the 1960s. For constructing our long-run index, we therefore rely on the index produced by Wüest and Partner (2012). To smooth out some of the irregular fluctuation, we use a five year moving average of the index.

Figure A.38 compares the indices available for 1970–2012, i.e. the index for apartment houses (Wüest and Partner, 2012), the index for single-family houses, and the index for apartments (Swiss National Bank, 2013). As it shows, the three indices generally follow the same trend. For our long-run index, we rely on the index for apartments (Swiss National Bank, 2013) mainly for two reasons: First, the index for apartment houses fluctuates more widely when compared to the indices published by Swiss National Bank (2013). This may be ascribed to the fact that the index is based on a smaller number of observations than the indices by Swiss National Bank (2013). The indices published by Swiss National Bank (2013) may hence be a more reliable indicator of property price fluctuations. Second, we aim to provide house price indices that are consistent over time with respect to property type. As the index for 1930–1969 refers to apartment houses only, we also use the index for apartments for 1970–2012. Our long-run house price index for Switzerland 1901–2012 splices the available series as shown in Table A.25.

**Table A.25:** Switzerland: sources of house price index, 1901–2012.

| Period | Series ID | Source | Details |
|---|---|---|---|
| 1901–1929 | CHE1 | Statistics Switzerland (2013b) | *Geographic Coverage* Zurich; *Type(s) of Dwellings*: Developed lots and building sites; *Data*: Sales prices collected by Statistics Zurich; *Method*: Five year moving average of average prices. |
| 1930–1969 | CHE2 | Wüest and Partner (2012) | *Geographic Coverage*: Nationwide (predominantly large & medium-sized urban centers); *Type(s) of Dwellings*: Apartment houses; *Data*: Insurance Companies; *Method*: Hedonic index. |
| 1970–2012 | CHE3 | Swiss National Bank (2013) | *Geographic Coverage*: Nationwide; *Type(s) of Dwellings*: Apartments; *Data*: List prices; *Method*: Mix-adjustment. |

**Construction cost data**

Historical data on construction costs in Switzerland are available for 1874–2012.

The earliest data on construction costs in Switzerland is published by Michel (1927). The authors uses data from fire insurance appraisals of newly built residential dwellings in the city of Basel.[128] The appraisals contain information on the size of a building (measured in cubic meter) and the total value of construction. Michel (1927) constructs an index of average construction costs per cubic meter. Relying on more than 125 appraisals per year on average, he reports biannual data for 1874–1916 and annual data for 1916–1924. To obtain an annual index we apply linear interpolation.

A second source for construction costs in Switzerland is the output price index published by Statistics Zurich for 1914–2012 (Statistics Zurich, 2012). The index covers apartment houses in the city of Zurich[129] and is constructed based on quoted prices collected by Statistics Zurich from a sample of building firms (Statistics Zurich, 2014, 1958).[130] For the years they overlap (1914–1924), the two series generally follow a similar trend. Yet the index for Basel shows a comparably larger increase than the index for Zurich.[131]

We use the index (Michel, 1927) for Basel for 1874–1913. Since the house price index relies on data for Zurich between 1901–1929, we rely on the construction cost index for Zurich since 1914. The long-term construction cost index splices the available series as shown in Table A.26.

**Table A.26:** Switzerland: sources of construction cost index, 1874–2012.

| Period | Source | Details |
|---|---|---|
| 1874–1913 | Michel (1927) | *Geographic Coverage*: Basel; *Type(s) of Dwellings*: All types of residential dwellings; *Type of Index*: Average construction value per cubic meter. |
| 1914–2012 | Statistics Zurich (2012) | *Geographic Coverage*: Zurich ; *Type(s) of Dwellings*: Apartment houses; *Type of Index*: Output price index. |

### Land price data

Data on land prices for the period 1899–1977 comes from the Statistics Switzerland (2013b) based on data published in the annual Statistical Abstracts of the city of Zurich. The Statistics Switzerland (2013b), for each year, reports the number of transactions of undeveloped lots, the total value and total area of all transactions. This allows to calculate average prices per square meter of undeveloped lots. We compute an index (1914=100) for 1901–1975 based on the five year moving average sales price per square meter of undeveloped lots in Zurich to smooth out

[128]Michel (1927) excludes all observations based on appraisals of dwellings of particular low quality. Often, these were residential baracks built during the years of World War I. The authors also excludes all observations based on appraisals of luxury houses as these generally not only covered the size and construction value of the house but also of garden pavilions and similar adjacent buildings.

[129]Note that the index house has been re-defined several times since the index was first published in 1932.

[130]Since 1932, the index is based on bids collected from 85 to 150 building firms.

[131]Between 1914 and 1924, the construction cost index for Basel increases by a factor of 1.9. The index for Zurich increases by a factor of 1.7.

some of the fluctuation stemming from year-to-year variations in the number of transactions. Note that the sample size is substantial. On average, the Statistics Switzerland (2013b) reports data on 595 transactions per year.

To compare imputed land prices with observed land prices for Switzerland we calculate a corresponding house price index for Zurich. Specifically, we use the data reported by the Statistics Switzerland (2013b) on transaction prices of developed lots (i.e. including structures) to again calculate an index based on the five year moving average sales price per square meter. Again, the sample is substantial. On average, the Statistics Switzerland (2013b) reports data on more than 1200 transactions per year. This approach allows us to compare an imputed land price based on construction costs and house prices in Zurich with empirical land prices in Zurich in Figure 2.8.

#### Other housing related data

*Farmland prices*: 1953-2012: Swiss Farmers' Union (various years) - Average purchase price of farm real estate per hectare in canton Zurich and canton Bern.

*Value of housing stock*: Goldsmith (1985, 1981) provides estimates of the value of total housing stock, dwellings, and land for the following benchmark years: 1880, 1900, 1913, 1929, 1938, 1948, 1960, 1965, 1973, and 1978.

*CPI*: 1870–2007: Taylor (2002); 2008–2012: International Monetary Fund (2012b).

### A.2.14 United Kingdom

#### House price data

Historical data on house prices in the United Kingdom is available for 1899–2012.

The earliest available data has been collected by the U.K. Land Registry. In the years 1899–1955, price data were registered by the Land Registry at the occasion of first registrations or transfers of already registered commercial and residential estate in selected - so called compulsory - areas. The database contains information on the value and the number of buildings for both freehold and leasehold property. The value of the land and the number of buildings on it had to be reported by the respective owner. For non-compulsory areas, data are available for the years 1930–1956.[132]

Another early source for house prices covering the period 1920–1938 is provided by Braae (Holmans, 2005, 270 f.). For the years 1920–1927, Braae estimated property values from contract prices for newly constructed properties for local authorities. For the years 1928–1938, the series is based on estimated average construction costs for private dwellings as indicated on building permits issued by

[132] Data kindly provided by Peter Mayer, Land Registry. The Land Registry would take the price paid in a transfer as the market value. On transfers not for money the buying party has to provide an estimate of the market value.

local authorities.

For the years since 1930 the Department of Communities and Local Government Department for Communities and Local Government (2013) has gathered house price data from various sources.[133] The data for 1930–1938 are from Holmans (2005, 128) who produces a hypothetical average house price for this period.[134] There is no data available for the years of World War II, i.e. 1939–1945. For the period 1946–1952 DCLG draws on a house price index for modern, existing dwellings constructed by the Co-operative Building Society.[135] For 1952–1965 data for the DCLG dataset were taken from a survey by the Ministry of Housing and Local Government (MHLG) on mortgage completions for new dwellings (*BS4 survey*).[136] For 1966–2005, data on average house prices were drawn from the so-called five percent survey of building societies. For the years 1966–1992 the *Five Percent Survey* has been conducted under the *Building Societies Mortgage (BSM) Survey*. It is based on a five percent sample drawn from the pool of completed building society house purchase mortgages.[137] The index is mix-adjusted so that changes in the mix of dwellings sold do not affect the average price (Holmans, 2005, 259 ff.). Since the BSM records prices at the mortgage completion state, the index refers to existing dwellings (Holmans, 2005, 259 ff.). For the periods 1993–2002 and 2003–2005 the five percent survey refers to the Survey of Mortgage Lenders. For 2005–2010 data come from the Regulated Mortgage Survey.[138]

Another house price index that, however, only covers more recent years (i.e. since 1995) is provided by the Land Registry. The index relies on the *Price Paid Dataset*, i.e. a record of all residential property transactions conducted in England and Wales. The index thus includes more observations than the one computed by DCLG. The index is calculated using a repeat sales method[139] and is adjusted for quality changes over time. Nevertheless, since the underlying *Price Paid Dataset* only reports few dwelling characteristics, the quality adjustment is rather simplis-

[133]The DCLG index has been transferred to the Office for National Statistics (ONS) in March 2012.

[134]This hypothetical price is derived using data on the average value of new loans and Halifax Building Society's deposit percentages (Holmans, 2005, 272).

[135]The original index by the Co-operative Building Society covers 1946–1970. Holmans (2005) reasons that the price index for modern existing dwellings is likely to refer to houses that were built in the interwar period as there was only little new building for private owners during the war or in the immediate post-war years. The Co-Operative Permanent Building Society was renamed into Nationwide Building Society in 1970.

[136]The *BS4 survey*, conducted by the Ministry of Housing and Local Government (MHLG), is based upon data supplied by several building societies. The index reflects average house prices (Holmans, 2005). The index based on the BS4 survey and the one based on data from the Co-Operative Building Society essentially show the same trajectory for the years they overlap: an acceleration of house prices starting in the early 1960s (Holmans, 2005, Table I.5). This suggests that prices for new and existing dwellings did not vary at a statistically significant level during this period.

[137]Thus, the index calculated from the data (generally referred to as the Department of the Environment (DoE) mix-adjusted index) is not affected by changes in the respective market share of the building societies or changes in their mix of business.

[138]For the period 1970–2012 an index is available from the OECD using the mix-adjusted house price series from the Department for Communities and Local Government. For the period 1975–2012 the Federal Reserve Bank of Dallas also uses the mix-adjusted house price series from the Department for Communities and Local Government (Department for Communities and Local Government, 2013).

[139]The index therefore excludes new houses.

tic.[140]

Furthermore, two indices compiled by two principal mortgage banks are available: the index by the Nationwide Building Society (2013) and the index by Halifax (Lloyds Banking Group, 2013). The Nationwide Building Society (2012, 2013) based on data on its own mortgage approvals produces indices for four different categories of houses: i) all houses; ii) new houses; iii) modern houses; and iv) old houses. The index covers the years from 1952 to 2012 and is published on a quarterly basis. Nationwide has changed the methodology of computation several times: the index for 1952–1959 is based on the simple average of the purchase price. For 1960–1973, this has been changed to an average weighted by the floor area of the houses in the sample. For 1974–1982, the average is weighted by ground floor area, property type and geographical region. Since 1983, a hedonic regression is applied.[141] The index by Halifax (since 2009 a subsidiary of the Lloyds Banking Group) is calculated from the company's own database of mortgage approvals, published on a monthly basis, and reaches back to 1983. Several regional sub-indices by types of buyers (all, first-time buyers, home-movers) and by type of property (all, existing, new) are available. The index is calculated using a hedonic regression.[142] Both, the index by Nationwide and by Halifax suffer from sample selection bias as they are solely based on price information from finalized and approved mortgages.[143]

Figure A.39 compares the available nominal house price indices for the period prior to 1954. These are the indices calculated from data by the Land Registry (1899–1955) and Braae (1920–1938) and the index by DCLG (1930–2012). It shows that the DCLG and the Braae indices follow the same trend for the years they overlap but the Land Registry fluctuates comparably more. While, for example, the Land Registry index suggests an increase in nominal house prices during the first half of the 1930s, the other two series decrease. A possible explanation for this disjunct picture is that the data we use for the Land Registry index has to a very large extent been collected for property in the London area.[144] Therefore, the data may vis-à-vis to the national trend provide a blurred picture, particularly as London during the 1930s recovered much faster from the Great Depression than most

[140]Several sub-indices covering different property types (i.e. detached, semi-detached, terraced, flat) and different regions, counties, and boroughs are also available (Land Registry, 2013).

[141]The specification controls for several characteristics: location, type of neighborhood, floor size, property design (detached, semi-detached, terraced, etc.), tenure, number of bathrooms, type of garage, number of bedrooms, vintage of the property (Nationwide Building Society, 2012).

[142]The Halifax house price index controls for location, type of property (detached, semi-detached, terraced, bungalow, flat), age of the property, tenure, number of rooms, number of separate toilets, central heating, number of garages and garage spaces, land area, road charge liability, and garden.

[143]Whether any of property transaction enters into the database depends on the buyers' decision to apply for a mortgage by Halifax or Nationwide and the bankers' approval.

[144]During the 1930s, registrations outside London were concentrated on property in southeast England. A 1934 government report found that 73 percent of first registrations outside London were undertaken in the four counties bordering London (see National Archives, TNA/LAR/1/50). The Land Registry also has details of the average number of new titles being created in short periods before May 1938. New titles are not just created on first registrations, but also when part of a title is sold or leased. There is only one northern county (Yorkshire) included in this data. Apart from that, even though Yorkshire is a large county, the number of registrations was small compared to Surrey and Kent for example.

northern regions. Yet, for the years prior to the Great Depression, i.e. 1899–1929, house prices in London were comparably less elevated relative to the rest of the country (Justice, 1999).[145] Although the underlying data collected from the Registries of Deeds[146] is unfortunately not available, the graphical analysis of nominal hedonic house price indices for 15 towns in the county of Yorkshire for the years 1900–1970 in Wilkinson and Sigsworth (1977) can be used as a comparative to the index calculated from the Land Registry database.[147] Except for the 1930s, the Yorkshire indices generally follow a trend similar to the index calculated from the London centered Land Registry database. Accordingly, it seems that with the exception of the 1930s, the Land Registry data may provide a reasonable approximation of broad trends in national property markets.

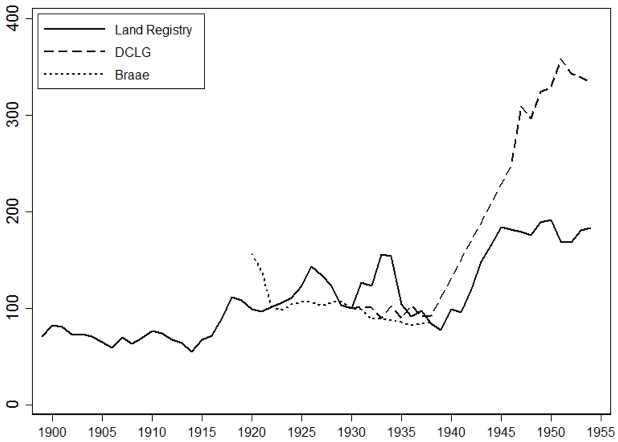
Figure A.40 depicts the nominal indices for the time of the postwar period. The Halifax (all houses), the DCLG-index, the Nationwide index (all houses) and the index computed from the data by the Land Registry (available since 1995)

[145]The trajectory of this series is confirmed by additional measures of property values prior to World War I: First, as a measure for house values in the period 1895–1913, Holmans (2005, Table I.20) calculated capital values of house prices combining data on capital values as multiples of annual rental income and data on rents. Second, Offer (1981, 259 ff.) presents data on property sales for the years 1892, 1897, 1902, 1907, 1912. Both series indicate an increase in real estate values throughout the 1890s, a peak early in the 1900s and then fall until the onset of World War I. This trend is also confirmed by contemporary accounts of the housing market (The Economist, 1912, 1914, 1918). Several developments are reported to have played a role in falling property prices: First, as discussed before, the crisis of 1907 contributed to falling property prices. After several years of *"marked depression in the property market"* (The Economist, 1914), the years from 1911 to 1913 marked a brief interlude of rising house prices, which was already reversed in 1913. The Economist (1914) provides several explanations for that: First of all, larger returns could be obtained from other forms of investment. This adversely affected prices in both the market for leasehold and for freehold properties. In all parts of the U.K., builders complained about difficulties of selling particularly middle- and working-class property. In addition, also mortgages, even though readily available, were only offered at rates of about four percent which was considered to be quite high at the time. Furthermore, building and material costs had increased at higher annual rates than rents thereby lowering the return from residential property investment. Consequently, construction activity declined at such a pace that *The Economist* thus forecasted a housing shortage in industrial centers, i.e. in agglomeration of London, the North and Midlands. House prices remained surprisingly stable during the years of World War I, despite a virtual standstill of building activity and a rise in the price of building materials (The Economist, 1918; Needleman, 1965). In response to the increasing housing shortage and the stagnation in construction activities, the government in 1915 introduced rent controls which would remain a feature of the housing market for a long time (Bowley, 1945). The housing shortage that continued to persist after the end of World War I was large – both in absolute terms as also with regard to the capacity of the building industry. A substantive increase in building activity occurred as part of a general post-war boom but already came to a halt in the summer of 1920 (Bowley, 1945). During the ensuing postwar depression, property prices due to an increase in interest rates and a scarcity of credit fell further and remained depressed until 1922. Only real estate in the London area recovered somewhat faster (The Economist, 1923, 1927). Also for the 1920s, the trajectory of the Land Registry index seems plausible: Rising real incomes, the rise of building societies and thus more favorable terms for mortgage financing, and changes in public attitudes toward homeownership as preferred housing tenure all contributed to an increase in demand for owner-occupied housing (Bowley, 1945; Pooley, 1992).

[146]At that time, only two counties had deed registries: Middlesex and Yorkshire. To the best of the authors' knowledge, the Middlesex registry, however, did not normally record the price paid.

[147]Wilkinson and Sigsworth (1977, 23) control for several characteristics such as plot size, square yardage of the land the property stands, sanitary arrangements, garage, age. The 15 towns are: Middlesborough, Redcar, Scarborough, Harrogate, Skipton, Leeds, Bradford, Halifax, Keighley, Dewbury, Barnsley, Doncaster, Hull, Bridlington, Driffield.

**Figure A.39:** United Kingdom: nominal house price indices, 1899–1954 (1930=100).




generally follow the same trend during the periods in which they overlap. For the three decades succeeding World War II, the three available indices (Halifax, Nationwide and DCLG) show a marked increase that peaks in the late 1980s. While the Halifax and the Nationwide indices report a nominal price contraction for the early 1990s the DCLG index only shows a stagnant trend. For years since 1995 all four indices report an impressive acceleration of nominal house prices that continued until the onset of the Great Recession but differ with regard to the magnitude of the trends. In comparison to the other indices, the DCLG index shows a more pronounced increase in house prices since the mid-1990s. This can be explained by the fact that DCLG in the computation of its index uses price weights while the other three indices rely on transaction weights. As a result, the DCLG-index is biased toward relatively expensive areas, such as South England (Department for Communicities and Local Government, 2012). The Land Registry index generally shows a less pronounced increase in house prices when compared to the other three indices. This may be associated with by the fact that the index is calculated using a repeat sales method and therefore does not include data on new structures (Wood, 2005).

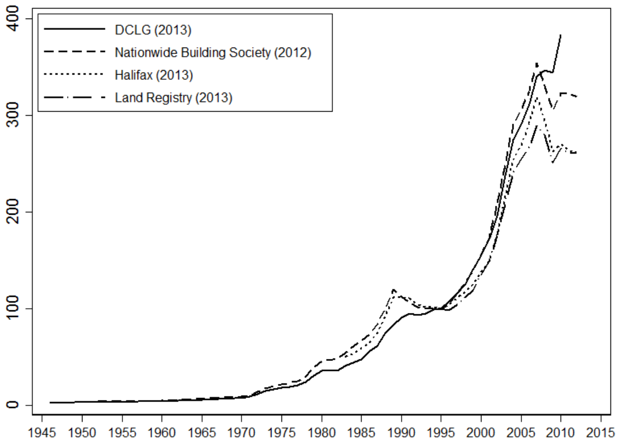
The long-run index is constructed as shown in the Table A.27. For the period after 1930, we use the DCLG-index. As discussed above, this source is in comparison to the indices by Halifax and Nationwide considered least vulnerable for possible distortions and biases. For the period after 1995, the here constructed long-run index draws on the index by the Land Registry as it relies on the largest possible data source.

The resulting index may suffer from two weaknesses: First, before 1930, the index is only based on house prices in the London area and Southeast England. Hence, the exact extent to which the index mirrors trends in other parts of the country remains difficult to determine. Second, the index does not control for quality changes prior to 1969, i.e. depreciation and improvements. To gauge the extent of the quality bias, we can rely on estimates by Feinstein and Pollard (1988) of the changing size and quality of dwellings. If we adjust the growth rates of our

**Table A.27:** United Kingdom: sources of house price index, 1899–2012.

| Period | Series ID | Source | Details |
|---|---|---|---|
| 1899–1929 | GBR1 | Land Registry | *Geographic Coverage*: Three cities; *Type(s) of Dwellings*: All kinds of existing properties (residential and commercial); *Data*: Land Registry; *Method*: Average property value. |
| 1930–1938 | GBR2 | Department for Communities and Local Government (2013) | *Geographic Coverage*: Nationwide; *Type(s) of Dwellings*: All dwellings; *Data*: Holmans (2005) using data from Halifax Building Society; *Method*: Hypothetical average house price. |
| 1946–1952 | GBR3 | Department for Communities and Local Government (2013) | *Geographic Coverage*: Nationwide; *Type(s) of Dwellings*: Modern, existing dwellings; *Data*: Co-operative Building Society. |
| 1952–1965 | GBR4 | Department for Communities and Local Government (2013) | *Geographic Coverage*: Nationwide; *Type(s) of Dwellings*: New Dwellings; *Data*: BS4 survey of mortgage completions; *Method*: Average house prices. |
| 1966–1968 | GBR5 | Department for Communities and Local Government (2013) | *Geographic Coverage*: Nationwide; *Type(s) of Dwellings*: Existing dwellings; *Data*: Building Societies Mortgage Survey (BSM); *Method*: Average house prices. |
| 1969–1992 | GBR6 | Department for Communities and Local Government (2013) | *Geographic Coverage*: Nationwide; *Type(s) of Dwellings*: Existing dwellings; *Data*: Building Societies Mortgage Survey (BSM); *Method*: Mix-adjustment. |
| 1993–1995 | GBR7 | Department for Communities and Local Government (2013) | *Geographic Coverage*: Nationwide; *Type(s) of Dwellings*: Existing dwellings; *Data*: Five Percent Survey of Mortgage Lenders; *Method*: Mix-adjustment. |
| 1995–2012 | GBR8 | Land Registry (2013) | *Geographic Coverage*: England and Wales; *Type(s) of Dwellings*: Existing dwellings; *Data*: Land Registry; *Method*: Repeat sales method. |

**Figure A.40:** United Kingdom: nominal house price indices, 1946–2012 (1995=100).




long-run index downward accordingly, the average annual real growth rate 1899–2012 of 1.02 percent becomes 0.72 percent in constant quality terms. As this is a rather crude adjustment, however, we use the unadjusted index (see Table A.27) for our analysis.

### Construction cost data

Historical data on construction costs in the United Kingdom are available for 1870–2012.

Maiwald (1954) constructs a construction cost index for all kinds of buildings for 1845–1938. The input cost index is based on hourly wage rates for adult workers in 39 large towns[148] and an unweighted average series of the price of 10 building materials.[149] The aggregate construction cost index assigns equal weights to wages and material prices.[150] The construction cost index by Maiwald (1954) is not constructed so as to only cover residential dwellings but as a more general index of building costs.

A second index covering construction costs in the London area during the late 19th century (1845–1922) is presented by Jones (1933). The series is constructed as an output price index.[151] Saville (1949) extends the index by Jones (1933) to 1933 and provides a detailed discussion of the properties of these series. Neither the series calculated by Jones (1933) nor the series by Saville (1949) exclusively refers

[148] The series covers development in wages of bricklayers, masons, carpenters, joiners, plumbers, plasterers, and painters.

[149] These include stone, bricks, tiles, cement, wood, iron joists, iron girders, lead, linseed oil (paint), and window glass.

[150] Maiwald (1954) relies on data from the *Statistical Abstracts of the United Kingdom*, Laxton's *Builders' Price Book*, the weekly review *The Builder*, *The Economist*, and a report on wholesale and retail prices published by the U.K. Board of Trade.

[151] The index uses data from Laxton's *Builders' Price Book* and is a composite measure of the price of brickwork (including excavator and concretor), carpentry and joinery, masonry, roofing, plumbing, painting and plastering (Saville, 1949).

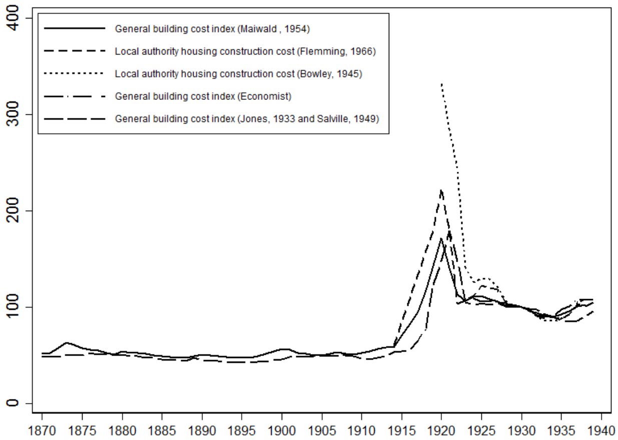



**Figure A.41:** United Kingdom: nominal construction cost indices, 1870–1939 (1930=100).

to residential building.

For 1914–1963, Fleming (1966) reports a construction cost index for residential dwelling in England and Wales for which tenders were received by local authorities based on average prices per square foot. For the pre-World War II years, the index refers to non-parlor houses, for post-World War II years, the index refers to three bedroom houses. Since 1951, the index has been adjusted to a standard house size of 900 square feet.[152] For 1955–2012, the Department for Business, Innovation and Skills (2013) publishes an output price index for private housing. For the years the two series overlap, they generally follow the same trend.[153]

A number of additional series for the interwar period are available. For 1920–1938, Bowley (1945) publishes an index for average building costs of local authority houses with three bedrooms. *The Economist* presents an input cost index for all kinds of buildings based on an unweighted average of wages and materials.[154] Figure A.41 depicts the nominal indices available for the time of the pre-World War II period, i.e. the indices by Bowley (1945), Maiwald (1954), Fleming (1966) as well as the index published by the Economist (as reported by Fleming (1966)). All series generally follow the same trend. Yet, the indices based on construction costs of local authority housing fluctuate more widely in the years following World War II compared to the series that cover building costs more generally.

To the extent possible, we use construction cost indices that are constructed so as to cover residential dwellings rather than all types of buildings. The long-run construction cost index therefore splices the available series as shown in Table A.28. In addtion, we calculate real unit labor costs in the construction sector for 1950–1970 based on national accounts data published by the Central Statistical

[152] See Table A.1 (b) in Fleming (1966) for 1914–1939 and Table A.2 (b) for 1939–1963.

[153] Correlation coefficent of 0.86 for 1955–1963.

[154] Wage rates refer to wages in the building industry covering occupations similar to Maiwald (1954) but only relying on data from London and Manchester. Materials included are the same as covered by the index from Maiwald (1954) excluding cement.

**Table A.28:** United Kingdom: sources of construction cost index, 1870–2012.

| Period | Source | Details |
|---|---|---|
| 1870–1913 | Maiwald (1954) | *Geographic Coverage*: Urban areas; *Type(s) of Dwellings*: All types of building ; *Type of Index*: Input cost index. |
| 1914–1954 | Fleming (1966) | *Geographic Coverage*: England and Wales; *Type(s) of Dwellings*: Single-family houses built by local authorities; *Type of Index*: Output price index. |
| 1955–2012 | Department for Business, Innovation and Skills (2013) | *Geographic Coverage*: Nationwide; *Type(s) of Dwellings*: All types of (private) residential dwellings; *Type of Index*: Output price index. |

Office (1970, 1965, 1957). Between 1950 and 1970, real construction costs decreased by 21 percent, real unit labor costs fell by 29 percent.

### Land price data

Data on residential land prices for the period 1983–2010 comes from Homes and Community Agency (2014) and refers to land prices per hectare in England, excluding London. The series is not based on actual land transactions but on estimates of local surveyors. These estimates refer to a 'typical' site for a certain region where planning consent for residential development exists and which is serviced to the lot boundary. Data are available by region, the series for England (excluding London) is calculated as simple average of the regional series.

### Other housing related and macroeconomic data

*Farmland prices*: 1870–1914: O'Rourke et al. (1996); 1915–1943: Ward (1960); 1944–2004: U.K. Department for Environment Food and Rural Affairs (2011) - Average price of agricultural land sales per hectare, 2005–2012: RICS[155] - RICS farmland price index.

*Value of Housing Stock*: Goldsmith (1985) provides estimates of the value of total housing stock, dwellings, and land for the following benchmark years: 1875, 1895, 1913, 1927, 1937, 1948, 1957, 1965, 1973, 1977. Data on the value of housing wealth since 1957 is drawn from the Office of National Statistics.[156] To obtain an estimate of the land share in housing value for 2010 we combine data on the total value of residential land in Scotland (Wightman, 2010), the total value of residential land in Northern Ireland (Lyons and Wightman, 2014), the value of residential land (per

[155] Series sent by email, contact person is Joshua Miller, Royal Institution of Chartered Surveyors.

[156] Series sent by email, contact person is Amanda Bell. Even though the series includes data for the whole 1957-2012 period, a number of definitional changes occurred during the transition from the European System of Accounts (ESA) ESA1979 to ESA1995 in 1998. At the time, these series were not joined together and this is likely to indicate a definitional difference.

hectare, by local authority) in England and Wales(Department for Communities and Local Government, 2015) and the amount of residential land in England and Wales (by local authority) in England and Wales (Office for National Statistics, 2010).

*CPI*: 1870–2009: Hills et al. (2010); 2010–2012: International Monetary Fund (2012b).

### A.2.15 United States

#### House price data

Historical data on house prices in the United States are available for 1890–2012.

The standard reference for U.S. house prices is Shiller (2009) and covers 1890–2012. To arrive at a long-run index, Shiller (2009) combines several indices for shorter time periods: for 1890–1934, he relies on an index constructed by Grebler et al. (1956); for 1934–1953, he calculates an average price index for 5 cities; for 1975–1987, he uses the national house price index published by the U.S. Office of Housing Enterprise Oversight (OFHEO); and for the years since 1987, he relies on the national Case-Shiller-Weiss house price index. In this section, we will discuss each of these four series separately and compare them to other available house price series.

The earliest series used by Shiller (2009) is drawn from Grebler et al. (1956) and covers the years 1890–1934. The series is based on data for new and existing owner-occupied single-family dwellings in 22 cities and calculated using an approach similar to the repeat sales method. Grebler et al. (1956) argue that due to the substantive geographical coverage the index provides a good approximation of house prices in the U.S. as a whole. In addition to the index for 22 cities, Grebler et al. (1956) also provide an index for all types of single-family dwellings for Seattle and Cleveland. Data are drawn from the *Financial Survey of Urban Housing* conducted in 1934 (Grebler et al., 1956, 344 f.) for which owners were asked to indicate the year of acquisition and the price paid as well as the estimated value of their house in 1934.[157] The index thus traces changes in the value of individual houses and circumvents the problem of unobserved heterogeneity. Yet, a major drawback of this method of data collection is that homeowners' value estimates for 1934 may be systematically biased. Notably, it may not account for quality changes of the structure. Grebler et al. (1956) argue that value losses due to depreciation – by and large – tend to outweigh value gains due to structural additions or alterations during this period. To correct for depreciation gross of improvements, the authors also present a depreciation-adjusted index.[158] Note that Shiller (2009) uses the non-adjusted index for 1890–1934 to construct his long-run index.

Besides the Grebler et al. (1956)-index used by Shiller (2009), five more in-

[157]The authors then calculate relatives for each year for each city, i.e. the ratio of the price of the house at time of acquisition and the value in 1934, determine median relatives for each year and convert the resulting index to a 1929 base.

[158]Grebler et al. (1956) assume a curvilinear rate of depreciation and apply an annual compound rate of depreciation of 1.374 percent (Grebler et al., 1956, 349 ff.).

dices exist that cover the decades prior to or the time of the Great Depression. Their geographical coverage is, however, rather limited. First, Garfield and Hoad (1937), also relying on the *Financial Survey of Urban Housing*, provide indices computed from three-year moving averages of prices for new owner-occupied six-room, single-family farm houses in Cleveland and Seattle for 1907–1930. Grebler et al. (1956) suggest that in comparison to their index, the series computed by Garfield and Hoad (1937) may be more consistent as they are based on more homogenous data, i.e. on price data for wooden dwellings of a similar size, most of which were built based on similar plans and also in similar locations. Second, an index by Wyngarden (1927) is based on the median ask or list price from three districts in Ann Arbor, MI, for the period 1913–1925.[159] Wyngarden (1927) claims that although the level of list and ask prices is generally higher than the actual transaction price, the index consistently measures changes in actual transaction prices as it can be assumed that the listing price bears a generally constant relationship to the actual transaction price. The index by Wyngarden (1927) is computed using a repeat sales method and price data for all kinds of existing properties for 1918–1947.[160] Third, Fisher (1951) provides an index for Washington, DC, based on ask price data for existing single-family houses from newspaper advertisements collected for an unpublished study by the National Housing Agency.[161]. Fourth, a real estate price index for Manhattan (residential and commercial) covering the period 1920–1930 comes from Nicholas and Scherbina (2013).[162] They use data on real estate transactions from the Real Estate Record and Builders' Guide and apply a hedonic method controlling for type of property, i.e. tenements, dwellings, lofts, and an "other" category with the latter also including commercial buildings. Fifth, Fishback and Kollmann (2015) revisit the trajectory of house prices during the years of the Great Depression. Using data from the Home Owners' Loan Corporation City Survey on housing values, they construct a new national-level house price index for 1929–1940. The resulting index improves the existing data for this period particularly in two respects: Relying on data for 106 cities, the index provides a substantially larger geographic coverage than data series reported by previous studies. In addition, the index is constructed as a hedonic price index controlling for a set of housing and neigborhood characteristics and thus provides a more reliable picture of quality-adjusted price changes.

For the period 1934–1953, the Shiller-index is calculated as an average of five individual indices; for Chicago, Los Angeles, New Orleans, and New York as well as the index for Washington, D.C by Fisher (1951). The indices for Chicago, Los Angeles, New Orleans and New York are computed from annual median ask

[159]The raw data was provided by Carr and Tremmel, a local real estate agent at that time. These districts are the University District, the Old Town District, and the Western District Wyngarden (1927, 12).

[160]However, according to Wyngarden (1927, 12) "[r]esidential properties were far in the majority, and single-family dwellings were the predominant type."

[161]According to Fisher (1951, 52), the study was undertaken in 100 metropolitan areas. However, the series gathered for Washington, DC, represents the longest series with respect to the time period covered.

[162]According to the authors, even though Manhattan is geographically a small era having 1.5 percent of the total U.S. population in 1930, it contained about 4 percent of total U.S. real estate wealth at that time (Nicholas and Scherbina, 2013, 1).

prices as advertised in local newspapers.

For the period 1953–1975, Shiller (2009) relies on the home purchase component of the U.S. Consumer Price Index. It is calculated from price data for one-family dwellings purchased with FHA-insured loans and controls for age and square footage obtained from the Federal Housing Administration (FHA) by mix-adjustment.[163] Gillingham and Lane (1982, 10), however, suggest that *"the data represents a small and specialized segment of the housing market"* and hence may not be representative of general changes in real estate prices (Greenlees, 1982).[164] Davis and Heathcote (2007) specifically conclude that the index may underestimate house price appreciation during the 1960s and 1970s.

For the period 1975–1987, Shiller (2009) uses the weighted repeat sales home price index originally published by the U.S. Office of Housing Enterprise Oversight (OFHEO).[165] The index is calculated from price data for individual single-family dwellings on which conventional conforming mortgages were originated and purchased by Freddie Mac (FHLMC) or Fannie Mae (FNMA).[166] While the index provides comprehensive geographical coverage, it however only reflects price developments of one particular housing type: single-family houses that are debt financed and comply with the requirements of the FNMA and the FHLMC.[167]

For the years since 1987, Shiller (2009), for the construction of his long-run index, draws on the Case-Shiller-Weiss index (CSWI) and its successors.[168] The CSW national index is constructed from nine regional indices (one for the each of the nine census divisions) using the repeat sales method and price data for existing single-family homes in the U.S.[169]

Figure A.42 shows the above presented nominal house price indices for various parts of the U.S. and the time prior to World War II. The indices under consideration appear to follow the same trends: It shows that the years prior to World War I were a period of relative nominal price stability. Prices began to moderately increase after World War I. The period of rising prices was accompanied by an increase in general construction activity. A veritable real estate boom is described to have occurred in Florida and Chicago (White, 2014; Galbraith, 1955). How-

[163]For further details, see Greenlees (1982).

[164]In particular, Gillingham and Lane (1982, 11) argue that the data suffers from three major drawbacks that may result in a time lag and a downward bias of the house price index: "Processing delays often mean that several months elapse between the time a house sale occurs and the time it is used in the CPI. For some geographic areas, especially those in the Northeast, the number of FHA transactions is very small. In addition, the FHA mortgage ceiling virtually eliminates higher priced homes from consideration."

[165]Now published by the Federal Housing Finance Agency (2013).

[166]The index controls for price changes due to renovation and depreciation as well as for price variance associated with infrequent transactions.

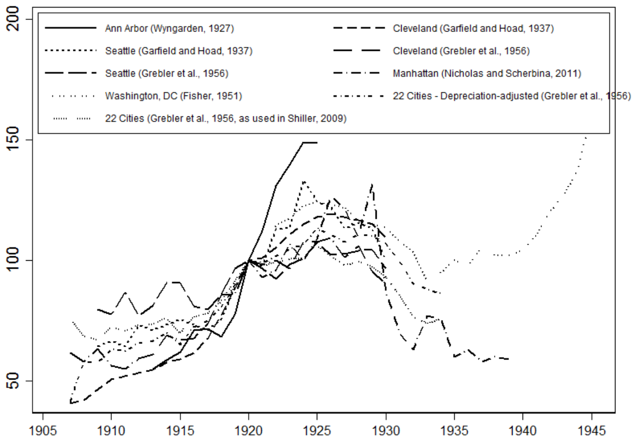
[167]For the period 1975–2012, the Federal Reserve Bank of Dallas uses the OFHEO/FHFA index (Mack and Martínez-García, 2012). For the period 1970–2012, an index is available from the OECD using the all transaction index provided by the FHFA.

[168]These are the Fiserv Case-Shiller-Weiss index and the S&P/Case-Shiller Home Price Index (S&P Dow Jones Indices, 2013).

[169]Transactions that do not reflect market values, i.e. because the property type has changed, the property has undergone substantial physical changes, or a non-arms-length transaction has taken place, were excluded from the sample.

ever, even though the upswing was felt in in other regions across the country, it is hardly detectable in the inflation-adjusted Shiller-index. White (2014) therefore argues that for the 1920s, the Shiller-index may have a substantial downward bias the size of which is difficult to assess. This notion is supported by the comparison of the various indices available for the 1920s (cf. Figure A.42). Overall, the performance of U.S. real estate prices in the 1920s and 1930s continues to be debated. While the Shiller (2009)-index suggests a recovery of real house prices during the 1930s, a series constructed by Fishback and Kollmann (2014) indicates that during the Great Depression house prices fell back to their early 1920s level.

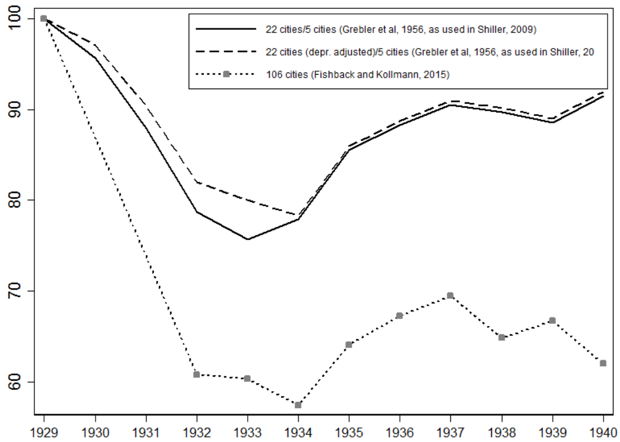
**Figure A.42:** United States: nominal house price indices, 1907–1946 (1920=100).




As indicated above, Fishback and Kollmann (2015) report new estimates of house prices for 1929, and 1932–1940. Figure A.43 depicts the three series available for this period: i) the (unadjusted) Grebler et al. (1956) index used by Shiller (2009) spliced with the index for 5 cities as constructed by Shiller (2009); ii) an index combining the adjusted Grebler et al. (1956) series with index for 5 cities as constructed by Shiller (2009); and iii) the hedonic index calculated by Fishback and Kollmann (2015). Whereas the two Grebler et al. (1956)-Shiller (2009) hybrids suggest a decrease in nominal house prices of a little more than 20 percent between 1929 and 1933, the new data by Fishback and Kollmann (2015) depict a decrease of about 40 percent. In addtion, the index by Fishback and Kollmann (2015) shows that house prices remained significantly below pre-Depression levels until 1940. By contrast, according to the two Grebler et al. (1956)-Shiller (2009) series, house prices had recovered to a little more than 90 percent of pre-Depression values by 1940.

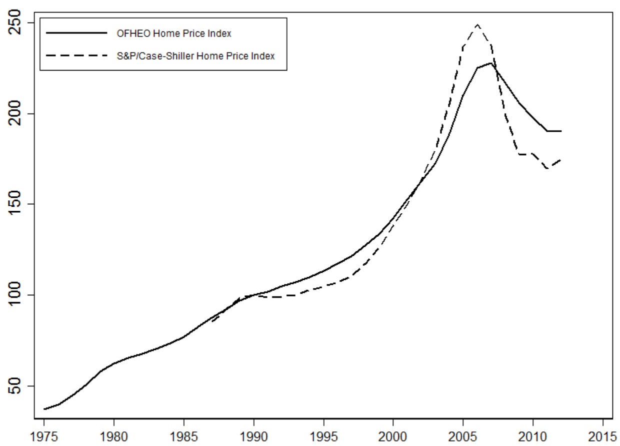
Immediately after the end of World War II, in the second half of the 1940s, the U.S. entered a brief but substantial house price boom. The index by Shiller (2009, 236 f.) clearly reflects this demand-driven price hike of the post-war years. However, for the period 1934–1953, the Shiller-index is, as discussed above, calculated from price data for only five cities and may thus not fully represent the broader national trends. This suspicion is countered by Shiller (2009) who – drawing on additional evidence collected from various sources – comes to the conclu-

**Figure A.43:** United States: nominal house price indices, 1929–1940 (1929=100).



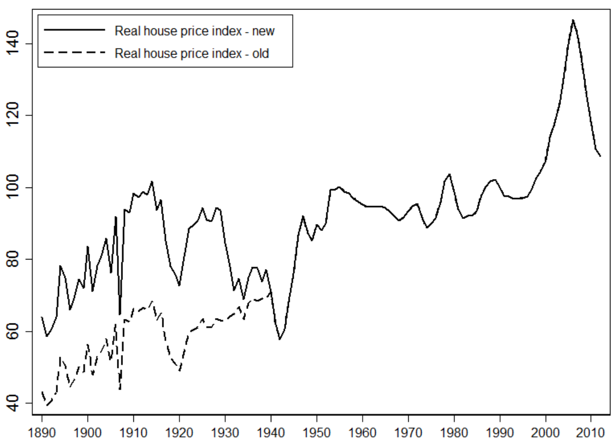

sion that the price boom in the after war years was not a geographically limited phenomenon but indeed represented a nationwide development even though the boom may have generally been weaker than the index suggests. While Glaeser (2013) confirms that the post-World War II decades were an ideal setting for a housing boom or even bubble due to changes in mortgage finance and an increase in household formation, he finds that prices did not trend upwards between the 1950s and 1970s since housing supply substantially increased. According to the index by Shiller (2009), house prices indeed remained by and large stable between the mid-1950s and the 1970s. Yet, as noted above, it has been suggested that the index may be downward biased during this period (Davis and Heathcote, 2007; Gillingham and Lane, 1982).

**Figure A.44:** United States: nominal house price indices, 1975–2012 (1990=100).




When turning to Figure A.44 that depicts the development of the nominal OFHEO and the CSW index, it shows that the two indices can due to their joint movement be considered as reasonable substitutes. However, the CSW index points toward a weaker growth of real estate prices during the first half of the 1990s but catches up until 2000. Moreover, while both indices indicate a remarkable acceleration of house prices for the years 2000-2006/7 the reported magnitudes vary: For this period the CSW index in comparison to the OFHEO index reports a more pronounced increase. The two indices also provide diverging turning point information; while the CSW index peaks in 2006 the OFHEO does so only in 2007. Shiller (2009, 235) suggests that these differences arise mainly due to the fact that the OFHEO-index is computed from data on actual sales prices as well as on refinance appraisals while the CSW-index for this period is solely based on sales data. Assuming that refinance appraisals generally are more conservative while at the same time having more inertia, it appears plausible that the OFHEO-index vis-à-vis the CSW-index may report very pronounced market movements with a minor delay. Leventis (2007) provides a different explanation and argues that the divergence between the CSW- and the OFHEO-index is caused by incongruent geographic coverage S&P Dow Jones Indices (2013, 29). In addition, Leventis (2007) points towards the differences in the weighting methods applied by CSW and OFHEO. He argues that once appraisal values are removed from the OFHEO data set and geographical coverage and weighting methods are harmonized, the two indices behave almost identical for the years after 2000. Due to the broader geographical coverage of the OFHEO index vis-à-vis the CSW index the here constructed long-run index uses the OFHEO-index for the post-1987 period.

**Figure A.45:** United States: old and revised house price index, 1890–2012 (1990=100).




Our long-run house price index for the United States 1890–2012 splices the available series as shown in Table A.29.

A drawback of the index is that it does not represent constant-quality home prices throughout the whole 1890–2012 period. This is particularly the case for 1940–1952 (see discussion above). For 1890–1929, we use the depreciation-adjusted index computed by Grebler et al. (1956) to somewhat reduce the quality bias. In a previous version of this paper, we relied on the adjusted index by Grebler et al. (1956) for 1890–1934 and combined it with the index for 5 cities reported by Shiller

**Table A.29:** United States: sources of house price index, 1890–2012.

| Period | Series ID | Source | Details |
|---|---|---|---|
| 1890–1928 | USA1 | Grebler et al. (1956) | *Geographic Coverage*: 22 cities; *Type(s) of Dwellings*: Owner-occupied existing and new single-family dwellings; *Data*: Financial Survey of Urban Housing, assessment of home owners; *Method*: Repeat sales method. |
| 1929–1940 | USA2 | Fishback and Kollmann (2015) | *Geographic Coverage*: 106 cities; *Type(s) of Dwellings*: Existing single-family dwellings; *Data*: HOLC city survey; *Method*: Hedonic index. |
| 1941–1952 | USA3 | Shiller (2009) | *Geographic Coverage*: Five cities; *Type(s) of Dwellings*: Existing single-family houses; *Data*: Newspaper advertisements and Fisher (1951); *Method*: Average of median home prices. |
| 1953–1974 | USA4 | Shiller (2009) | *Geographic Coverage*: Nationwide; *Type(s) of Dwellings*: New and existing dwellings; *Data*: Federal Housing Administration data as used in the home purchase component of the CPI; *Method*: Weighted, mix-adjusted index. |
| 1975–2012 | USA5 | Federal Housing Finance Agency (2013) (former OFHEO House Price Index) | *Geographic Coverage*: Nationwide; *Type(s) of Dwellings*: New and existing single-family houses; *Data*: FNMA and FHLMC; Method: Weighted repeat sales method. |

(2009) for 1935–1952. Recall from Section 2.2 that we choose constant quality indices wherever available. In this version, we therefore use the new estimates by Fishback and Kollmann (2015) for 1929, and 1932–1940. To construct an annual index, we interpolate between 1929 and 1932 using growth rates in nominal house prices as indicated by the adjusted Grebler et al. (1956)-index while taking the 1929 and 1932 point estimates by Fishback and Kollmann (2015) as given. Figure A.45 depicts the two resulting CPI-adjusted long-run indices side by side. Moreover, for 1940–1952, the index has a rather limited geographic coverage that may result in a bias of unknown size and direction. Finally, as suggested by Gillingham and Lane (1982) and Davis and Heathcote (2007), the index for 1953–1974 may suffer from a downward bias.

### Construction cost data

Historical data on construction costs in the United States are available for 1889–2012.

The earliest series on construction costs for residential buildings covering 1889–

1953 is constructed by Grebler et al. (1956, Table B-10). For 1910–1953, Grebler et al. (1956) rely on the Boeckh residential construction cost index. The series refers to construction costs of frame and brick one- to six-family houses in 20 cities. Grebler et al. (1956) extend the series back to 1889 using several data series on prices of building materials and on wage rates in the construction sector.[170] The resulting input cost index is calculated as weighted average of these series using analyses of construction costs of "typical houses selected in various parts of the country" Housing and Home Finance Agency (1948, 31) from the National Housing Agency to determine the respective weights.[171]

A second source for 1930–2012 is Davis and Heathcote (2007). The authors calculate a price index for residential structures based on data from the U.S. Bureau of Economic Analysis. The series reflects replacement values of residential structures.

A third source for construction costs for the period 1909–2012 are the indices for construction costs and building costs constructed by the Engineering News Record (Engineering News Record, 2013). The series are constructed as input cost indices combining data on three main building materials (steel, cement, and lumber) and wages in the construction sector in 20 cities. The two series are identically except for wage rates where the construction cost index includes skilled labor wages whereas the building cost index is based on data of common labor wage rates. Note that both series represent more general input cost indices and are not constructed so as to specifically reflect changes in construction costs of residential buildings. There are several other long-run series available reflecting construction costs more general as well as non-residential construction costs (e.g. series constructed by the Associated General Contractors, the Department of Commerce, and the American Appraisal Company (U.S. Bureau of the Census, 1975, Series N118–137)).

To the extent possible, we use i) construction cost indices that are constructed so as to cover residential dwellings rather than all types of buildings or ii) indices of replacement values of residential structures. Note also that for the years since 1975, the index for replacement costs of structures by Davis and Heathcote (2007) is constructed so as to match the house prices series published by the Federal Housing Finance Agency (2013) that we use for constructing our long-run house price index (see Table A.29). The long-term construction cost index therefore splices the available series as shown in Table A.30. In addition, we calculate real unit labor costs in the construction sector for 1950–1970 based on national accounts data published by Bureau of Economic Analysis (2016). Between 1950 and 1970, real unit labor costs increased by about 2 percent.

[170] Data are derived from the Historical Statistics of the United States (1949). The wage series refers to union wage rates in 39 cities 1907–1912, for 1889–1906 wage rates and prices of building materials are based on data from the so-called Aldrich report (Senate Committee on Finance, 1893) and the continuation of this study by the Department of Commerce and Labor (Department of Commerce and Labor, 1908). For 1889-1909, the price series is based on data from the Aldrich report and the continuation of these series by the Department of Labor. See notes to Grebler et al. (1956, Table B-10) for details.

[171] Weights: wages: 1.0; material: 1.5, see notes to Grebler et al. (1956, Table B-10).

**Table A.30:** United States: sources of construction cost index, 1889–2012.

| Period | Source | Details |
|---|---|---|
| 1889–1909 | Grebler et al. (1956) | *Geographic Coverage*: Nationwide; *Type(s) of Dwellings*: All types of dwellings; *Type of Index*: Input cost index. |
| 1910–1929 | Boeckh residential construction cost index as reported in Grebler et al. (1956) | *Geographic Coverage*: Urban areas; *Type(s) of Dwellings*: 1–6-family houses; *Type of Index*: Input cost index. |
| 1930–2012 | Davis and Heathcote (2007) | *Geographic Coverage*: Nationwide; *Type(s) of Dwellings*: All types of dwellings; *Type of Index*: Replacement values. |

### Land price data

Data on residential land prices for the 1930–2012 comes from Davis and Heathcote (2007). Their index, however, is neither based on actual transactions or appraisals but is an imputed land price. Hence, similar to our decomposition in Section 2.4, the authors infer land prices from data on house prices and the value of structures.

### Other housing related and macroeconomic data

*Farmland prices*: 1870–1985: Lindert (1988) - Farmland value per acre; 1986–2012: U.S. Department of Agriculture (2013) - Farmland value per acre.

*Value of housing stock*: Goldsmith (1962) provides estimates of the value of total housing stock, dwellings, and land for the following benchmark years: 1900, 1912, 1922, 1929, 1933, 1939, 1945, 1950, and 1958. Davis and Heathcote (2007) provide estimates for the total market value of housing stock, dwellings and land for 1930–2000. Data on the value of household wealth including the value of housing, and underyling land for 2001–2012 is drawn from Piketty and Zucman (2014).

*CPI*: 1870–2007: Taylor (2002); 2008–2012: International Monetary Fund (2012b).

### A.2.16 Summary of house price series

The sources of the respective series are listed in Tables A.3–A.29.

**Table A.31:** Frequency.

| Country | Series | Annual | Other | Adjustment |
|---|---|---|---|---|
| Australia | AUS1 | ✓ | | |
| | AUS2 | ✓ | | |
| | AUS3 | ✓ | | |
| | AUS4 | ✓ | | |
| | AUS5 | ✓ | | |
| | AUS6 | ✓ | | |
| | AUS7 | ✓ | | |
| | AUS8 | | ✓ | Average of quarterly index |
| Belgium | BEL1 | ✓ | | |
| | BEL2 | ✓ | | |
| | BEL3 | ✓ | | |
| | BEL4 | ✓ | | |
| | BEL5 | ✓ | | |
| Canada | CAN1 | ✓ | | |
| | CAN2 | ✓ | | |
| | CAN3 | | ✓ | Average of quarterly index |
| Denmark | DNK1 | ✓ | | |
| | DNK2 | ✓ | | |
| | DNK3 | | ✓ | Average of quarterly index |
| Finland | FIN1 | ✓ | | Three year moving average of annual data |
| | FIN2 | ✓ | | |
| | FIN3 | | ✓ | Average of quarterly index |
| France | FRA1 | ✓ | | |
| | FRA2 | ✓ | | |
| | FRA3 | | ✓ | Average of quarterly index |
| Germany | DEU1 | ✓ | | |
| | DEU2 | ✓ | | |
| | DEU3 | ✓ | | |
| | DEU4 | ✓ | | |
| | DEU5 | | ✓ | Average of quarterly index |
| | DEU6 | | ✓ | Average of quarterly index |
| Japan | JPN1 | ✓ | | |
| | JPN2 | ✓ | | |
| | JPN3 | | ✓ | Average of semi-annual index |
| The Netherlands | NLD1 | | ✓ | Interpolate biannual index |
| | NLD2 | | ✓ | Average of monthly index |
| | NLD3 | | ✓ | Average of monthly index |
| Norway | NOR1 | ✓ | | |
| | NOR2 | ✓ | | |
| Sweden | SWE1 | ✓ | | |
| | SWE2 | ✓ | | |
| Switzerland | CHE1 | ✓ | | Five year moving average of annual data |
| | CHE2 | ✓ | | Five year moving average of annual index |
| | CHE3 | | ✓ | Average of quarterly data |

*Table continues on the next page.*

**Table A.31, ctd.:** Frequency.

| Country | Series | Annual | Other | Adjustment |
|---|---|---|---|---|
| United Kingdom | GBR1 | ✓ | | |
| | GBR2 | ✓ | | |
| | GBR3 | ✓ | | |
| | GBR4 | ✓ | | |
| | GBR5 | ✓ | | |
| | GBR6 | ✓ | | |
| | GBR7 | ✓ | | |
| | GBR8 | | ✓ | Average of monthly index |
| United States | USA1 | ✓ | | |
| | USA2 | ✓ | | Interpolate missing values (1930,1931) |
| | USA3 | ✓ | | |
| | USA4 | ✓ | | |
| | USA5 | | ✓ | Average of quarterly index |

**Table A.32:** Covered area.

| Country | Series | Nationwide | Other | Coverage |
|---|---|---|---|---|
| Australia | AUS1 | | ✓ | Melbourne |
| | AUS2 | | ✓ | Melbourne |
| | AUS3 | | ✓ | Six capital cities |
| | AUS4 | | ✓ | Six capital cities |
| | AUS5 | | ✓ | Six capital cities |
| | AUS6 | | ✓ | Six capital cities |
| | AUS7 | | ✓ | Six capital cities |
| | AUS8 | | ✓ | Eight capital cities |
| Belgium | BEL1 | | ✓ | Brussels Area |
| | BEL2 | | ✓ | Brussels Area |
| | BEL3 | ✓ | | |
| | BEL4 | ✓ | | |
| | BEL5 | ✓ | | |
| Canada | CAN1 | ✓ | | |
| | CAN2 | ✓ | | |
| | CAN3 | | ✓ | Five cities |
| Denmark | DNK1 | ✓ | | Rural areas |
| | DNK2 | ✓ | | |
| | DNK3 | ✓ | | |
| Finland | FIN1 | | ✓ | Helsinki |
| | FIN2 | | ✓ | Helsinki |
| | FIN3 | ✓ | | |
| France | FRA1 | | ✓ | Paris |
| | FRA2 | ✓ | | |
| | FRA3 | ✓ | | |
| Germany | DEU1 | | ✓ | Berlin |
| | DEU2 | | ✓ | Hamburg |
| | DEU3 | | ✓ | Ten cities |
| | DEU4 | | ✓ | Western Germany |
| | DEU5 | | ✓ | Urban areas in Western Germany |
| | DEU6 | | ✓ | Urban areas in Western Germany |

*Table continues on the next page.*

**Table A.32, ctd.:** Covered area.

| Country | Series | Nationwide | Other | Coverage |
|---|---|---|---|---|
| Japan | JPN1 | | ✓ | Six cities |
| | JPN2 | | ✓ | All cities |
| | JPN3 | | ✓ | All cities |
| The Netherlands | NLD1 | | ✓ | Amsterdam |
| | NLD2 | ✓ | | |
| | NLD3 | ✓ | | |
| Norway | NOR1 | | ✓ | Four cities |
| | NOR2 | | ✓ | Four cities |
| Sweden | SWE1 | | ✓ | Two Cities |
| | SWE2 | | ✓ | Two Cities |
| Switzerland | CHE1 | | ✓ | Zurich |
| | CHE2 | | ✓ | Nationwide, predominantly large & medium-sized urban centers |
| | CHE3 | ✓ | | |
| United Kingdom | GBR1 | | ✓ | Three cities |
| | GBR2 | ✓ | | |
| | GBR3 | ✓ | | |
| | GBR4 | ✓ | | |
| | GBR5 | ✓ | | |
| | GBR6 | ✓ | | |
| | GBR7 | ✓ | | |
| | GBR8 | | ✓ | England & Wales |
| United States | USA1 | | ✓ | 22 cities |
| | USA2 | | ✓ | 106 cities |
| | USA3 | | ✓ | Five cities |
| | USA4 | ✓ | | |
| | USA5 | ✓ | | |

**Table A.33:** Property type.

| Country | Series | Single-Family | Multi-Family | All Kinds of Dwellings | Other | Property Type |
|---|---|---|---|---|---|---|
| Australia | AUS1 | | | ✓ | | |
| | AUS2 | | | ✓ | | |
| | AUS3 | | | ✓ | | |
| | AUS4 | | | ✓ | | |
| | AUS5 | | | ✓ | | |
| | AUS6 | | | ✓ | | |
| | AUS7 | ✓ | | | | |
| | AUS8 | ✓ | | | | |
| Belgium | BEL1 | ✓ | | | | |
| | BEL2 | ✓ | | | | |
| | BEL3 | | | | ✓ | Small & medium sized dwellings |
| | BEL4 | | | | ✓ | Small & medium sized dwellings |
| | BEL5 | ✓ | | | | |

*Table continues on the next page.*

**Table A.33, ctd.:** Property type.

| Country | Series | Single-Family | Multi-Family | All Kinds of Dwellings | Other | Property Type |
|---|---|---|---|---|---|---|
| Canada | CAN1 | | | ✓ | | |
| | CAN2 | | | | ✓ | All kinds of real estate (residential & non-residential) |
| | CAN3 | | | | ✓ | Bungalows and two story executive buildings |
| Denmark | DNK1 | | | | ✓ | Farms |
| | DNK2 | ✓ | | | | |
| | DNK3 | ✓ | | | | |
| Finland | FIN1 | | | | ✓ | Building sites for residential use |
| | FIN2 | | ✓ | | | |
| | FIN3 | | ✓ | | | |
| France | FRA1 | | ✓ | | | |
| | FRA2 | | | ✓ | | |
| | FRA3 | | | ✓ | | |
| Germany | DEU1 | | | | ✓ | All kinds of real estate (residential & non-residential) |
| | DEU2 | | | | ✓ | All kinds of real estate (residential & non-residential) |
| | DEU3 | | | | ✓ | All kinds of real estate (residential & non-residential) |
| | DEU4 | | | | ✓ | Land only |
| | DEU5 | ✓ | | | | |
| | DEU6 | ✓ | | | | |
| Japan | JPN1 | | | | ✓ | Land only |
| | JPN2 | | | | ✓ | Land only |
| | JPN3 | | | | ✓ | Land only |
| The Netherlands | NLD1 | | | | ✓ | All kinds of real estate (residential & non-residential) |
| | NLD2 | | | ✓ | | |
| | NLD3 | | | ✓ | | |
| Norway | NOR1 | | | ✓ | | |
| | NOR2 | | | ✓ | | |
| Sweden | SWE1 | | ✓ | | | |
| | SWE2 | | | | ✓ | Single- and two family houses |

*Table continues on the next page.*

**Table A.33, ctd.:** Property type.

| Country | Series | Single-Family | Multi-Family | All Kinds of Dwellings | Other | Property Type |
|---|---|---|---|---|---|---|
| Switzerland | CHE1 | | | | ✓ | All kinds of real estate (residential & non-residential) |
| | CHE2 | | ✓ | | | |
| | CHE3 | | | | ✓ | Apartments |
| United Kingdom | GBR1 | | | | ✓ | All kinds of real estate (residential & non-residential) |
| | GBR2 | | | ✓ | | |
| | GBR3 | | | ✓ | | |
| | GBR4 | | | ✓ | | |
| | GBR5 | | | ✓ | | |
| | GBR6 | | | ✓ | | |
| | GBR7 | | | ✓ | | |
| | GBR8 | | | ✓ | | |
| United States | USA1 | ✓ | | | | |
| | USA2 | ✓ | | | | |
| | USA3 | ✓ | | | | |
| | USA4 | | | ✓ | | |
| | USA5 | ✓ | | | | |

**Table A.34:** Property vintage.

| Country | Series | Existing | New | New & Existing | Other |
|---|---|---|---|---|---|
| Australia | AUS1 | ✓ | | | |
| | AUS2 | ✓ | | | |
| | AUS3 | ✓ | | | |
| | AUS4 | ✓ | | | |
| | AUS5 | ✓ | | | |
| | AUS6 | ✓ | | | |
| | AUS7 | | | ✓ | |
| | AUS8 | | | ✓ | |
| Belgium | BEL1 | ✓ | | | |
| | BEL2 | ✓ | | | |
| | BEL3 | ✓ | | | |
| | BEL4 | ✓ | | | |
| | BEL5 | ✓ | | | |
| Canada | CAN1 | ✓ | | | |
| | CAN2 | ✓ | | | |
| | CAN3 | ✓ | | | |
| Denmark | DNK1 | ✓ | | | |
| | DNK2 | ✓ | | | |
| | DNK3 | | | ✓ | |

*Table continues on the next page.*

**Table A.34, ctd.:** Property vintage.

| Country | Series | Existing | New | New & Existing | Other |
|---|---|---|---|---|---|
| Finland | FIN1 | | | ✓ | Land only |
| | FIN2 | ✓ | | | |
| | FIN3 | ✓ | | | |
| France | FRA1 | ✓ | | | |
| | FRA2 | ✓ | | | |
| | FRA3 | ✓ | | | |
| Germany | DEU1 | ✓ | | | |
| | DEU2 | ✓ | | | |
| | DEU3 | ✓ | | | |
| | DEU4 | | | ✓ | Land only |
| | DEU5 | | | ✓ | |
| | DEU6 | | | ✓ | |
| Japan | JPN1 | | | ✓ | Land only |
| | JPN2 | | | ✓ | Land only |
| | JPN3 | | | ✓ | Land only |
| The Netherlands | NLD1 | ✓ | | | |
| | NLD2 | ✓ | | | |
| | NLD3 | ✓ | | | |
| Norway | NOR1 | ✓ | | | |
| | NOR2 | ✓ | | | |
| Sweden | SWE1 | | | ✓ | |
| | SWE2 | | | ✓ | |
| Switzerland | CHE1 | ✓ | | | |
| | CHE2 | ✓ | | | |
| | CHE3 | ✓ | | | |
| United Kingdom | GBR1 | ✓ | | | |
| | GBR2 | ✓ | | | |
| | GBR3 | ✓ | | | |
| | GBR4 | | ✓ | | |
| | GBR5 | ✓ | | | |
| | GBR6 | ✓ | | | |
| | GBR7 | ✓ | | | |
| | GBR8 | ✓ | | | |
| United States | USA1 | | ✓ | | |
| | USA2 | ✓ | | | |
| | USA3 | ✓ | | | |
| | USA4 | | | ✓ | |
| | USA5 | | | ✓ | |

**Table A.35:** Priced unit.

| Country | Series | Per Dwelling | Per Square Meter | Other | Unit |
|---|---|---|---|---|---|
| Australia | AUS1 | | | ✓ | Per Room |
| | AUS2 | | | | |
| | AUS3 | | | | |
| | AUS4 | | | | |
| | AUS5 | | | | |
| | AUS6 | | | | |
| | AUS7 | | | | |
| | AUS8 | | | | |
| Belgium | BEL1 | | ✓ | | |
| | BEL2 | | ✓ | | |
| | BEL3 | ✓ | | | |
| | BEL4 | ✓ | | | |
| | BEL5 | ✓ | | | |
| Canada | CAN1 | ✓ | | | |
| | CAN2 | ✓ | | | |
| | CAN3 | ✓ | | | |
| Denmark | DNK1 | ✓ | | | |
| | DNK2 | ✓ | | | |
| | DNK3 | ✓ | | | |
| Finland | FIN1 | | ✓ | | |
| | FIN2 | | ✓ | | |
| | FIN3 | | ✓ | | |
| France | FRA1 | ✓ | | | |
| | FRA2 | ✓ | | | |
| | FRA3 | ✓ | | | |
| Germany | DEU1 | ✓ | | | |
| | DEU2 | | ✓ | | |
| | DEU3 | | ✓ | | |
| | DEU4 | | ✓ | | |
| | DEU5 | ✓ | | | |
| | DEU6 | ✓ | | | |
| Japan | JPN1 | | | ✓ | Cannot be determined from the source |
| | JPN2 | | | ✓ | Cannot be determined from the source |
| | JPN3 | | ✓ | | |
| The Netherlands | NLD1 | ✓ | | | |
| | NLD2 | ✓ | | | |
| | NLD3 | ✓ | | | |
| Norway | NOR1 | ✓ | | | |
| | NOR2 | | | ✓ | Cannot be determined from the source |
| Sweden | SWE1 | ✓ | | | |
| | SWE2 | ✓ | | | |
| Switzerland | CHE1 | | ✓ | | |
| | CHE2 | ✓ | | | |
| | CHE3 | ✓ | | | |

*Table continues on the next page.*

**Table A.35, ctd.:** Priced unit.

| Country | Series | Per Dwelling | Per Square Meter | Other | Unit |
|---|---|---|---|---|---|
| United Kingdom | GBR1 | ✓ | | | |
| | GBR2 | ✓ | | | |
| | GBR3 | ✓ | | | |
| | GBR4 | ✓ | | | |
| | GBR5 | ✓ | | | |
| | GBR6 | ✓ | | | |
| | GBR7 | ✓ | | | |
| | GBR8 | ✓ | | | |
| United States | USA1 | ✓ | | | |
| | USA2 | ✓ | | | |
| | USA3 | ✓ | | | |
| | USA4 | ✓ | | | |
| | USA5 | ✓ | | | |

**Table A.36:** Method.

| Country | Series | Repeat Sales | Mix-Adj. | Hedonic | SPAR | Mean/ Med. | Other | Method |
|---|---|---|---|---|---|---|---|---|
| Australia | AUS1 | | | | | ✓ | | |
| | AUS2 | | | | | ✓ | | |
| | AUS3 | | | | | ✓ | | |
| | AUS4 | | | | | | ✓ | Estimate of Fixed Price |
| | AUS5 | | | | | ✓ | | |
| | AUS6 | | | | | ✓ | | |
| | AUS7 | | ✓ | | | | | |
| | AUS8 | | ✓ | | | | | |
| Belgium | BEL1 | | | | | ✓ | | |
| | BEL2 | | | | | ✓ | | |
| | BEL3 | | | | | ✓ | | |
| | BEL4 | | | | | ✓ | | |
| | BEL5 | | ✓ | | | | | |
| Canada | CAN1 | | | | | | ✓ | Estimated replacement value |
| | CAN2 | | | | | ✓ | | |
| | CAN3 | | | | | ✓ | | Based on price information of standardized dwellings |

*Table continues on the next page.*

**Table A.36, ctd.:** Method.

| Country | Series | Repeat Sales | Mix-Adj. | Hedonic | SPAR | Mean/ Med. | Other | Method |
|---|---|---|---|---|---|---|---|---|
| Denmark | DNK1 | | | | | ✓ | | Adjusted for size of property |
| | DNK2 | | | | | ✓ | | |
| | DNK3 | | | | ✓ | | | |
| Finland | FIN1 | | | | | ✓ | | |
| | FIN2 | | | | | ✓ | | |
| | FIN3 | | ✓ | ✓ | | | | |
| France | FRA1 | ✓ | | | | | | |
| | FRA2 | ✓ | | | | | | |
| | FRA3 | | ✓ | ✓ | | | | |
| Germany | DEU1 | | | | | ✓ | | |
| | DEU2 | | | | | ✓ | | |
| | DEU3 | | | | | ✓ | | |
| | DEU4 | | | | | ✓ | | |
| | DEU5 | | ✓ | | | | | |
| | DEU6 | | ✓ | | | | | |
| Japan | JPN1 | | | | | ✓ | | |
| | JPN2 | | | | | ✓ | | |
| | JPN3 | | | | | ✓ | | |
| The Netherlands | NLD1 | ✓ | | | | | | |
| | NLD2 | ✓ | | | | ✓ | | |
| | NLD3 | | | | ✓ | | | |
| Norway | NOR1 | ✓ | | ✓ | | | | |
| | NOR2 | | | ✓ | | | | |
| Sweden | SWE1 | | | | ✓ | | | |
| | SWE2 | | ✓ | | ✓ | | | |
| Switzerland | CHE1 | | | | | ✓ | | |
| | CHE2 | | | ✓ | | | | |
| | CHE3 | | ✓ | | | | | |
| United Kingdom | GBR1 | | | | | ✓ | | |
| | GBR2 | | | | | | ✓ | Hypothetical average price |
| | GBR3 | | | | | ✓ | | |
| | GBR4 | | | | | ✓ | | |
| | GBR5 | | | | | ✓ | | |
| | GBR6 | | ✓ | | | | | |
| | GBR7 | | ✓ | | | | | |
| | GBR8 | ✓ | | | | | | |
| United States | USA1 | ✓ | | | | | | |
| | USA2 | | | ✓ | | | | |
| | USA3 | | | | | ✓ | | |
| | USA4 | | ✓ | | | | | |
| | USA5 | ✓ | | | | | | |

Appendix B

# Appendix to Chapter 3

# As Volatile as Houses: Return Predictability in International Housing Markets, 1870–2015

## B.1 Supplementary material

**Table B.1:** Rents and house prices: annual summary statistics by country and by period.

| | Δ log Nominal Rent Index | | | Δ log Nominal House Price Index | | | Δ log CPI | | |
|---|---|---|---|---|---|---|---|---|---|
| | N | mean | s.d. | N | mean | s.d. | N | mean | s.d. |
| *Australia* | | | | | | | | | |
| Full sample | 99 | 0.047 | 0.060 | 130 | 0.048 | 0.105 | 130 | 0.027 | 0.046 |
| Pre-World War II | 31 | 0.030 | 0.037 | 62 | 0.009 | 0.083 | 62 | 0.000 | 0.037 |
| Post-World War II | 70 | 0.054 | 0.066 | 70 | 0.081 | 0.111 | 70 | 0.051 | 0.040 |
| *Belgium* | | | | | | | | | |
| Full Sample | 110 | 0.049 | 0.067 | 122 | 0.043 | 0.093 | 130 | 0.022 | 0.055 |
| Pre-World War II | 42 | 0.048 | 0.090 | 54 | 0.029 | 0.126 | 62 | 0.011 | 0.072 |
| Post-World War II | 70 | 0.051 | 0.047 | 70 | 0.054 | 0.056 | 70 | 0.030 | 0.036 |
| *Denmark* | | | | | | | | | |
| Full Sample | 130 | 0.029 | 0.033 | 125 | 0.031 | 0.074 | 130 | 0.021 | 0.052 |
| Pre-World War II | 62 | 0.014 | 0.029 | 57 | -0.002 | 0.060 | 62 | -0.004 | 0.058 |
| Post-World War II | 70 | 0.042 | 0.031 | 70 | 0.062 | 0.073 | 70 | 0.043 | 0.033 |
| *Finland* | | | | | | | | | |
| Full Sample | 86 | 0.087 | 0.106 | 95 | 0.085 | 0.156 | 130 | 0.030 | 0.058 |
| Pre-World War II | 18 | 0.080 | 0.148 | 27 | 0.094 | 0.244 | 62 | 0.006 | 0.055 |
| Post-World War II | 70 | 0.090 | 0.091 | 70 | 0.082 | 0.104 | 70 | 0.061 | 0.076 |
| *France* | | | | | | | | | |
| Full Sample | 130 | 0.055 | 0.081 | 130 | 0.060 | 0.075 | 130 | 0.036 | 0.071 |
| Pre-World War II | 62 | 0.020 | 0.045 | 62 | 0.023 | 0.055 | 62 | 0.017 | 0.073 |
| Post-World War II | 70 | 0.092 | 0.095 | 70 | 0.097 | 0.076 | 70 | 0.063 | 0.087 |
| *Germany* | | | | | | | | | |
| Full Sample | 125 | 0.026 | 0.048 | 113 | 0.041 | 0.106 | 130 | 0.220 | 1.840 |
| Pre-World War II | 57 | 0.017 | 0.066 | 60 | 0.043 | 0.140 | 62 | 0.431 | 2.660 |
| Post-World War II | 70 | 0.033 | 0.025 | 53 | 0.038 | 0.045 | 70 | 0.028 | 0.027 |
| *Italy* | | | | | | | | | |
| Full Sample | 79 | 0.083 | 0.103 | 79 | 0.051 | 0.108 | 130 | 0.033 | 0.060 |
| Pre-World War II | 11 | 0.007 | 0.046 | 11 | -0.035 | 0.053 | 62 | 0.011 | 0.062 |
| Post-World War II | 69 | 0.097 | 0.105 | 70 | 0.075 | 0.124 | 70 | 0.061 | 0.072 |
| *Japan* | | | | | | | | | |
| Full Sample | 62 | 0.033 | 0.038 | 87 | 0.076 | 0.153 | 130 | 0.027 | 0.088 |
| Pre-World War II | 7 | -0.002 | 0.014 | 19 | -0.006 | 0.093 | 62 | 0.010 | 0.092 |
| Post-World War II | 55 | 0.038 | 0.037 | 70 | 0.123 | 0.210 | 70 | 0.062 | 0.142 |
| *Netherlands* | | | | | | | | | |
| Full Sample | 130 | 0.031 | 0.036 | 130 | 0.025 | 0.091 | 130 | 0.015 | 0.044 |
| Pre-World War II | 62 | 0.010 | 0.031 | 62 | -0.009 | 0.086 | 62 | -0.007 | 0.049 |
| Post-World War II | 70 | 0.049 | 0.031 | 70 | 0.055 | 0.084 | 70 | 0.036 | 0.027 |
| *Norway* | | | | | | | | | |
| Full Sample | 129 | 0.035 | 0.057 | 130 | 0.041 | 0.086 | 130 | 0.021 | 0.050 |
| Pre-World War II | 61 | 0.015 | 0.072 | 62 | 0.013 | 0.085 | 62 | -0.003 | 0.053 |
| Post-World War II | 70 | 0.052 | 0.031 | 70 | 0.065 | 0.079 | 70 | 0.043 | 0.033 |
| *Portugal* | | | | | | | | | |
| Full Sample | 67 | 0.071 | 0.070 | 75 | 0.076 | 0.147 | 129 | 0.051 | 0.109 |
| Pre-World War II | 0 | | | 7 | 0.113 | 0.179 | 62 | 0.034 | 0.129 |
| Post-World War II | 67 | 0.071 | 0.070 | 70 | 0.080 | 0.152 | 69 | 0.068 | 0.084 |
| *Spain* | | | | | | | | | |
| Full Sample | 128 | 0.049 | 0.072 | 100 | 0.061 | 0.122 | 130 | 0.035 | 0.060 |
| Pre-World War II | 60 | 0.013 | 0.050 | 32 | 0.018 | 0.149 | 62 | 0.003 | 0.054 |
| Post-World War II | 70 | 0.078 | 0.074 | 70 | 0.080 | 0.102 | 70 | 0.067 | 0.052 |

*Note:* World Wars (1914–1919 and 1939–1947) omitted.

**Table B.1, ctd.:** Rents and house prices: annual summary statistics by country and by period

| | Δ log Nominal Rent Index | | | Δ log Nominal House Price Index | | | Δ log CPI | | |
|---|---|---|---|---|---|---|---|---|---|
| | N | mean | s.d. | N | mean | s.d. | N | mean | s.d. |
| *Sweden* | | | | | | | | | |
| Full Sample | 117 | 0.036 | 0.048 | 125 | 0.037 | 0.077 | 130 | 0.021 | 0.048 |
| Pre-World War II | 49 | 0.020 | 0.050 | 57 | 0.010 | 0.052 | 62 | -0.004 | 0.047 |
| Post-World War II | 70 | 0.047 | 0.043 | 70 | 0.060 | 0.086 | 70 | 0.043 | 0.036 |
| *Switzerland* | | | | | | | | | |
| Full sample | 110 | 0.028 | 0.032 | 99 | 0.030 | 0.050 | 130 | 0.008 | 0.047 |
| Pre-World War II | 42 | 0.018 | 0.037 | 31 | 0.019 | 0.062 | 62 | -0.008 | 0.061 |
| Post-World War II | 70 | 0.034 | 0.027 | 70 | 0.036 | 0.043 | 70 | 0.023 | 0.023 |
| *United Kingdom* | | | | | | | | | |
| Full Sample | 117 | 0.037 | 0.051 | 101 | 0.045 | 0.088 | 130 | 0.024 | 0.046 |
| Pre-World War II | 58 | 0.009 | 0.027 | 33 | -0.008 | 0.085 | 62 | -0.004 | 0.035 |
| Post-World War II | 60 | 0.063 | 0.054 | 69 | 0.072 | 0.080 | 70 | 0.048 | 0.040 |
| *United States* | | | | | | | | | |
| Full Sample | 110 | 0.029 | 0.041 | 110 | 0.027 | 0.078 | 130 | 0.015 | 0.040 |
| Pre-World War II | 42 | 0.006 | 0.052 | 42 | 0.007 | 0.115 | 62 | -0.007 | 0.040 |
| Post-World War II | 70 | 0.044 | 0.025 | 70 | 0.044 | 0.047 | 70 | 0.037 | 0.030 |
| *All Countries* | | | | | | | | | |
| Full Sample | 1729 | 0.043 | 0.063 | 1751 | 0.047 | 0.102 | 2079 | 0.038 | 0.465 |
| Pre-World War II | 664 | 0.019 | 0.057 | 678 | 0.016 | 0.107 | 992 | 0.030 | 0.671 |
| Post-World War II | 1091 | 0.059 | 0.062 | 1102 | 0.070 | 0.103 | 1119 | 0.048 | 0.062 |

*Note:* World Wars (1914–1919 and 1939–1947) omitted.

**Figure B.1:** Population and GDP weighted mean real rent and house price indices, 16 countries.

**Table B.2:** Returns on housing: annual summary statistics by country and by period.

| | Real total return | | | Real rental yield | | | Real capital gain | | |
|---|---|---|---|---|---|---|---|---|---|
| | N | mean | s.d. | N | mean | s.d. | N | mean | s.d. |
| *Australia* | | | | | | | | | |
| Full sample | 99 | 0.075 | 0.062 | 99 | 0.055 | 0.014 | 99 | 0.020 | 0.061 |
| Pre-World War II | 32 | 0.060 | 0.057 | 32 | 0.048 | 0.007 | 32 | 0.012 | 0.057 |
| Post-World War II | 69 | 0.080 | 0.065 | 69 | 0.059 | 0.015 | 69 | 0.022 | 0.064 |
| *Belgium* | | | | | | | | | |
| Full Sample | 111 | 0.112 | 0.104 | 111 | 0.087 | 0.022 | 111 | 0.026 | 0.101 |
| Pre-World War II | 43 | 0.123 | 0.149 | 43 | 0.092 | 0.022 | 43 | 0.031 | 0.147 |
| Post-World War II | 70 | 0.108 | 0.070 | 70 | 0.082 | 0.021 | 70 | 0.026 | 0.066 |
| *Denmark* | | | | | | | | | |
| Full Sample | 125 | 0.086 | 0.074 | 125 | 0.074 | 0.030 | 125 | 0.012 | 0.067 |
| Pre-World War II | 57 | 0.095 | 0.060 | 57 | 0.090 | 0.015 | 57 | 0.005 | 0.057 |
| Post-World War II | 70 | 0.085 | 0.090 | 70 | 0.063 | 0.035 | 70 | 0.022 | 0.077 |
| *Finland* | | | | | | | | | |
| Full Sample | 86 | 0.120 | 0.152 | 86 | 0.077 | 0.030 | 86 | 0.043 | 0.139 |
| Pre-World War II | 18 | 0.150 | 0.251 | 18 | 0.073 | 0.050 | 18 | 0.077 | 0.220 |
| Post-World War II | 70 | 0.104 | 0.126 | 70 | 0.077 | 0.024 | 70 | 0.028 | 0.118 |
| *France* | | | | | | | | | |
| Full Sample | 130 | 0.077 | 0.086 | 130 | 0.049 | 0.011 | 130 | 0.028 | 0.080 |
| Pre-World War II | 62 | 0.060 | 0.081 | 62 | 0.050 | 0.008 | 62 | 0.009 | 0.077 |
| Post-World War II | 70 | 0.087 | 0.096 | 70 | 0.048 | 0.013 | 70 | 0.039 | 0.088 |
| *Germany* | | | | | | | | | |
| Full Sample | 110 | 0.082 | 0.097 | 110 | 0.060 | 0.027 | 110 | 0.022 | 0.087 |
| Pre-World War II | 57 | 0.108 | 0.124 | 57 | 0.078 | 0.027 | 57 | 0.030 | 0.114 |
| Post-World War II | 53 | 0.053 | 0.043 | 53 | 0.041 | 0.007 | 53 | 0.012 | 0.042 |
| *Italy* | | | | | | | | | |
| Full Sample | 79 | 0.037 | 0.092 | 79 | 0.028 | 0.012 | 79 | 0.009 | 0.089 |
| Pre-World War II | 11 | -0.021 | 0.039 | 11 | 0.006 | 0.001 | 11 | -0.026 | 0.039 |
| Post-World War II | 70 | 0.049 | 0.102 | 70 | 0.030 | 0.010 | 70 | 0.018 | 0.102 |
| *Japan* | | | | | | | | | |
| Full Sample | 64 | 0.082 | 0.092 | 64 | 0.059 | 0.038 | 64 | 0.023 | 0.075 |
| Pre-World War II | 8 | 0.150 | 0.055 | 8 | 0.145 | 0.018 | 8 | 0.006 | 0.041 |
| Post-World War II | 56 | 0.073 | 0.093 | 56 | 0.047 | 0.020 | 56 | 0.025 | 0.078 |
| *Netherlands* | | | | | | | | | |
| Full Sample | 130 | 0.072 | 0.087 | 130 | 0.058 | 0.018 | 130 | 0.013 | 0.083 |
| Pre-World War II | 62 | 0.058 | 0.078 | 62 | 0.057 | 0.019 | 62 | 0.001 | 0.077 |
| Post-World War II | 70 | 0.083 | 0.093 | 70 | 0.060 | 0.017 | 70 | 0.023 | 0.088 |
| *Norway* | | | | | | | | | |
| Full Sample | 130 | 0.120 | 0.096 | 130 | 0.096 | 0.024 | 130 | 0.024 | 0.088 |
| Pre-World War II | 62 | 0.125 | 0.107 | 62 | 0.104 | 0.017 | 62 | 0.021 | 0.094 |
| Post-World War II | 70 | 0.114 | 0.084 | 70 | 0.089 | 0.027 | 70 | 0.025 | 0.081 |
| *Portugal* | | | | | | | | | |
| Full sample | 67 | 0.041 | 0.113 | 67 | 0.027 | 0.012 | 67 | 0.014 | 0.112 |
| Post-World War II | 67 | 0.041 | 0.113 | 67 | 0.027 | 0.012 | 67 | 0.014 | 0.112 |
| *Spain* | | | | | | | | | |
| Full Sample | 98 | 0.060 | 0.115 | 98 | 0.040 | 0.017 | 98 | 0.020 | 0.111 |
| Pre-World War II | 30 | 0.069 | 0.133 | 30 | 0.056 | 0.015 | 30 | 0.013 | 0.128 |
| Post-World War II | 70 | 0.051 | 0.110 | 70 | 0.032 | 0.012 | 70 | 0.018 | 0.107 |
| *Sweden* | | | | | | | | | |
| Full Sample | 118 | 0.090 | 0.083 | 118 | 0.069 | 0.017 | 118 | 0.021 | 0.079 |
| Pre-World War II | 50 | 0.090 | 0.071 | 50 | 0.069 | 0.015 | 50 | 0.021 | 0.064 |
| Post-World War II | 70 | 0.091 | 0.091 | 70 | 0.069 | 0.018 | 70 | 0.022 | 0.089 |

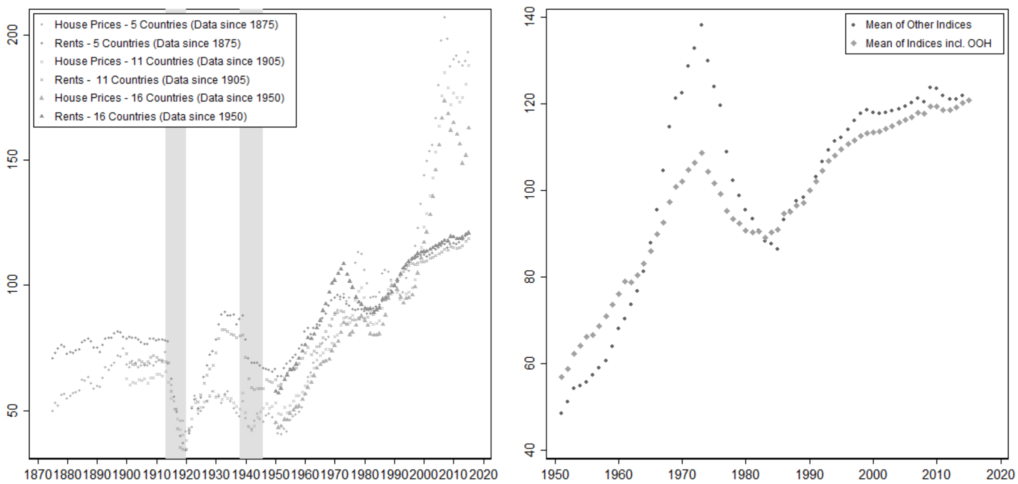
*Table continues on the next page.*

**Table B.2, ctd.:** Returns on housing: Annual summary statistics by country and by period.

| | Real return | | | Real rental yield | | | Real capital gain | | |
|---|---|---|---|---|---|---|---|---|---|
| | N | mean | s.d. | N | mean | s.d. | N | mean | s.d. |
| *Switzerland* | | | | | | | | | |
| Full Sample | 99 | 0.064 | 0.057 | 99 | 0.046 | 0.008 | 99 | 0.019 | 0.055 |
| Pre-World War II | 31 | 0.080 | 0.073 | 31 | 0.050 | 0.009 | 31 | 0.030 | 0.071 |
| Post-World War II | 70 | 0.059 | 0.047 | 70 | 0.044 | 0.007 | 70 | 0.015 | 0.046 |
| *United Kingdom* | | | | | | | | | |
| Full Sample | 93 | 0.060 | 0.093 | 93 | 0.038 | 0.009 | 93 | 0.022 | 0.090 |
| Pre-World War II | 33 | 0.039 | 0.101 | 33 | 0.037 | 0.006 | 33 | 0.001 | 0.099 |
| Post-World War II | 60 | 0.072 | 0.086 | 60 | 0.039 | 0.010 | 60 | 0.034 | 0.084 |
| *United States* | | | | | | | | | |
| Full Sample | 110 | 0.108 | 0.083 | 110 | 0.099 | 0.014 | 110 | 0.009 | 0.077 |
| Pre-World War II | 42 | 0.123 | 0.125 | 42 | 0.107 | 0.017 | 42 | 0.016 | 0.117 |
| Post-World War II | 70 | 0.101 | 0.041 | 70 | 0.093 | 0.009 | 70 | 0.008 | 0.039 |
| *All Countries* | | | | | | | | | |
| Full Sample | 1673 | 0.082 | 0.096 | 1673 | 0.062 | 0.029 | 1673 | 0.020 | 0.088 |
| Pre-World War II | 598 | 0.089 | 0.110 | 598 | 0.072 | 0.031 | 598 | 0.017 | 0.099 |
| Post-World War II | 1075 | 0.079 | 0.090 | 1075 | 0.057 | 0.027 | 1075 | 0.022 | 0.084 |

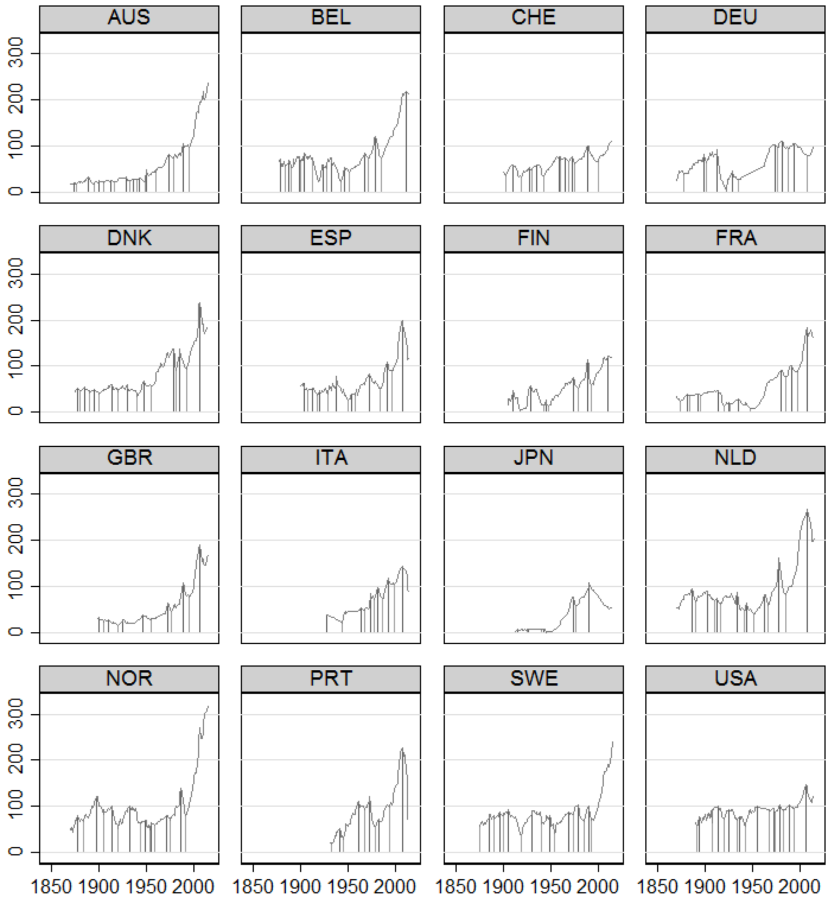
*Note:* World Wars (1914–1919 and 1939–1947) omitted.

**Figure B.2:** Fixed samples and implicit rents of owner-occupiers, 16 countries.




*Notes:* Index, 1990=100. *Left panel:* The years of the two world wars are shown with shading. 5-, 11-, and 16-country indices include only continuous series. The 5-country sample includes Denmark, France, Germany, the Netherlands and Norway. The 11-country sample includes Australia, Belgium Denmark, France, Germany, the Netherlands, Norway, Switzerland, Sweden, the U.K. and the U.S. *Right panel:* The mean of the rent indices covering tenants' rents only includes the following countries: Belgium, France, Italy, Portugal, Spain and Switzerland. The mean of the rent indices covering tenants' rents and implicit rents of owner-occupiers includes all remaining countries.

**Figure B.3:** Peaks and troughs in real house prices, 16 countries.




Note: Indices 1990=100. Dark grey spikes denote a peak, ligth grey spikes denote a trough.

**Figure B.4:** Duration and amplitude of expansions and contractions, 16 countries.

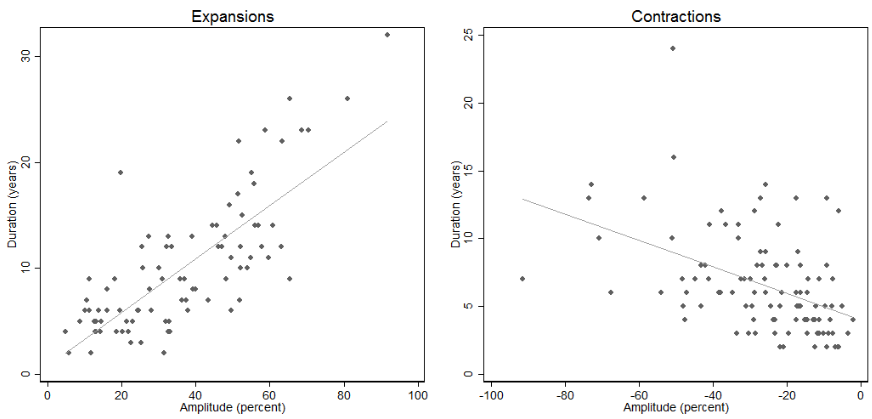


**Table B.3:** Vector autoregression estimates: forecasting returns and rent growth with the rent-price ratio.

| | | (A) Excluding war years | | | (B) Excess returns | | |
|---|---|---|---|---|---|---|---|
| Country | Years | Returns $h_{t+1}$ | Rent Growth $\Delta r_{t+1}$ | N | Returns $e_{t+1}$ | Rent Growth $\Delta r_{t+1}$ | N |
| | | (1) | (2) | (3) | (4) | (5) | (6) |
| All Countries | | 0.070*** | -0.016*** | 1600 | 0.076*** | -0.024*** | 1774 |
| | | (0.007) | (0.004) | | (0.007) | (0.005) | |
| Australia | 1901–2015 | 0.137*** | 0.044* | 96 | 0.089*** | 0.017 | 113 |
| | | (0.021) | (0.024) | | (0.025) | (0.026) | |
| Belgium | 1890–2015 | 0.057*** | -0.055** | 107 | 0.042** | -0.101*** | 116 |
| | | (0.019) | (0.020) | | (0.020) | (0.025) | |
| Denmark | 1875–2015 | 0.045*** | -0.008 | 122 | 0.046*** | 0.002 | 139 |
| | | (0.013) | (0.006) | | (0.011) | (0.003) | |
| Finland | 1920–2015 | 0.125*** | -0.033 | 84 | 0.132*** | -0.038 | 84 |
| | | (0.035) | (0.023) | | (0.034) | (0.024) | |
| France | 1870–2015 | 0.051*** | -0.006 | 127 | 0.073*** | -0.029* | 144 |
| | | (0.015) | (0.015) | | (0.018) | (0.018) | |
| Germany | 1924–2015 | 0.074*** | -0.024*** | 107 | 0.068*** | -0.016*** | 108 |
| | | (0.022) | (0.004) | | (0.028) | (0.005) | |
| Italy | 1927–2015 | 0.055*** | -0.014 | 77 | 0.046*** | -0.040*** | 78 |
| | | (0.018) | (0.009) | | (0.017) | (0.012) | |
| Japan | 1931–2015 | 0.041** | -0.000 | 60 | 0.051*** | 0.001 | 66 |
| | | (0.017) | (0.004) | | (0.014) | (0.004) | |
| Netherlands | 1870–2015 | 0.087*** | 0.002 | 127 | 0.076*** | 0.003 | 144 |
| | | (0.020) | (0.007) | | (0.015) | (0.005) | |
| Norway | 1871–2015 | 0.077*** | -0.019* | 126 | 0.062*** | -0.026* | 143 |
| | | (0.019) | (0.012) | | (0.019) | (0.013) | |
| Portugal | 1948–2015 | 0.113*** | 0.005 | 66 | 0.163*** | 0.027** | 66 |
| | | (0.040) | (0.013) | | (0.036) | (0.013) | |
| Spain | 1900–2015 | 0.048** | -0.012 | 95 | 0.051* | -0.011 | 110 |
| | | (0.024) | (0.011) | | (0.028) | (0.010) | |
| Sweden | 1883–2015 | 0.080*** | -0.014 | 114 | 0.091*** | -0.019 | 131 |
| | | (0.022) | (0.013) | | (0.025) | (0.013) | |
| Switzerland | 1901–2015 | 0.029 | -0.026*** | 96 | 0.036* | -0.027*** | 113 |
| | | (0.023) | (0.010) | | (0.023) | (0.009) | |
| United Kingdom | 1899–2015 | 0.092*** | -0.024 | 89 | 0.115*** | -0.021 | 96 |
| | | (0.028) | (0.017) | | (0.031) | (0.017) | |
| United States | 1890–2015 | 0.245*** | -0.032*** | 107 | 0.170*** | -0.052*** | 123 |
| | | (0.053) | (0.012) | | (0.049) | (0.016) | |

*Note:* This table reports VAR estimates of returns and rent growth rates and decomposition results based on the VAR estimates. The data is annual. The model is estimated by two-step generalized method of moments subject to the present value model constraints. Heteroskedasticity and autocorrelation corrected standard errors based on Bartlett kernel are reported in parentheses below the estimated parameters. The Newey and West method is used for the selection of the optimal bandwidth. *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$. Panel (A) excludes years of World War 1 (1914–1919) and World War 2 (1939–1947).

**Table B.4:** Homeownership rates, 16 countries.

| | Australia | Belgium | Denmark | Finland | France | Germany | Italy | Japan |
|---|---|---|---|---|---|---|---|---|
| 1910 | 45.02 | | | | | | | |
| 1920 | 47.93 | | | | | | | |
| 1930 | 40.04 | | | 21.90 | | | | |
| 1940 | | | 21.70 | | | | | |
| 1950 | 48.05 | 55.00 | 23.00 | | 38.00 | 39.10 | 40.00 | |
| 1960 | 59.24 | 50.00 | 45.60 | 60.80 | 41.40 | 33.80 | 45.80 | 63.40 |
| 1970 | 68.66 | | 48.50 | 58.50 | 44.80 | 35.80 | 50.80 | 60.30 |
| 1980 | 68.09 | | 54.50 | 62.87 | 46.60 | 39.30 | 58.90 | 59.77 |
| 1990 | 68.77 | 65.00 | 54.10 | 71.33 | 54.90 | 38.80 | 68.00 | 61.19 |
| 2000 | 66.20 | 73.00 | 53.30 | 65.48 | 55.60 | 43.30 | 80.00 | 60.30. |
| 2010 | 68.10 | 71.60 | 50.60 | 74.30 | 62.00 | 47.50 | 72.60 | 61.10 |

| | Netherlands | Norway | Portugal | Spain | Sweden | Switzerland | U.K. | U.S. |
|---|---|---|---|---|---|---|---|---|
| 1890 | | | | | | | | 47.80 |
| 1900 | | | | | | | | 46.50 |
| 1910 | | | | | | | | 45.90 |
| 1920 | | | | | | | 23.00 | 45.60 |
| 1930 | | | | | | | | 47.80 |
| 1940 | | | | | | | 32.00 | 43.60 |
| 1950 | 28.00 | | 50.50 | 45.90 | | 37.00 | 32.00 | 55.00 |
| 1960 | 29.00 | 52.90 | 44.50 | 50.50 | 47.00 | 33.70 | 42.00 | 61.90 |
| 1970 | 35.00 | 53.00 | | 63.40 | 49.00 | 28.50 | 50.00 | 64.20 |
| 1980 | 42.00 | 67.00 | 52 | 73.10 | 55.00 | 30.10 | 58.00 | 65.60 |
| 1990 | 44.10 | 78.17 | 60.30 | 77.50 | 58.00 | 31.30 | 68.00 | 64.00 |
| 2000 | 52.00 | 77.60 | 65.20 | 85.40 | 60.00 | 34.60 | 69.00 | 67.40 |
| 2010 | 67.20 | 82.90 | 74.90 | 79.80 | 70.80 | 44.40 | 70.00 | 66.90 |

*Notes:* Dates are approximate. Sources: Australian Bureau of Statistics (various years); Van den Eeckhout (1992); Miron and Clayton (1987); Statistics Canada (various years,a, 2011); Statistics Denmark (2013b); Statistics Finland (2013a); Friggit (2010); Statistics Germany (2011); United Nations (various years); Padovani (1996); Statistics Japan (2012a); Statistics Netherlands (2001); Kullberg and Iedema (2010); Vandevyvere and Zenthöfer (2012); Doling and Elsinga (2013); Eurostat (2016); Alberdi and Levenfeld (1996); Werczberger (1997); Bundesamt für Wohnungswesen (2013); Office for National Statistics (2013b); Mazur and Wilson (2010)

**Table B.5:** Structural break tests by country.

| Country | k=1 | k=2 | k=3 |
|---|---|---|---|
| Australia | 2002 | 1930, 2002 | 1930, 1961, 2002 |
| Belgium | 2002 | 1910, 2002 | 1919, 1930, 2002 |
| Denmark | 1964 | 1964 | 1932, 1962, 1999 |
| Finland | 1954 | 1955, 1983 | 1955, 1983 |
| France | 2000 | 2000 | 2000 |
| Germany | 1962 | 1928, 1962 | 1887, 1928, 1962 |
| Italy | 1958 | 1946, 1958 | 1946, 1958, 1974 |
| Japan | 1967 | 1961, 1970 | 1961, 1971, 2003 |
| Netherlands | 1999 | 1999 | 1999 |
| Norway | 1999 | 1999 | 1999 |
| Portugal | 1983 | 1969, 1982 | 1971, 1981, 1999 |
| Spain | 1970 | 1963, 1980 | 1921, 1940, 1977 |
| Sweden | 2002 | 1908, 2002 | 1908, 2002 |
| Switzerland | 1949 | 1949, 1967 | 1926, 1949, 1968 |
| United Kingdom | 2003 | 2003 | 2003 |
| U.S. | 1908 | 1908 | 1908 |

Note: $k$ is the maximum number of structural breaks in the log-level of the rent-price ratio determined using the Bai and Perron (2003) methodology with a trimming parameter of 10% and a significance level of 0.05, using White heteroskedasticity-consistent standard errors and heterogeneous error distributions across breaks. Break dates shown correspond to first date of new regime. Sample 1870–2013.

**Table B.6:** Persistence properties of adjusted rent-price ratio.

| Country | No. of Breaks | ADF Test | $p$ val | s.d | Country | No. of Breaks | ADF Test | $p$ val | s.d. |
|---|---|---|---|---|---|---|---|---|---|
| Australia | 0 | -1.13 | 0.70 | 0.26 | Japan | 0* | -3.27 | 0.02 | 0.53 |
| | 1* | -2.85 | 0.05 | 0.19 | | 1 | -2.22 | 0.20 | 0.26 |
| | 2 | -4.58 | 0.00 | 0.12 | | 2 | -1.61 | 0.48 | 0.20 |
| | 3 | -2.22 | 0.20 | 0.22 | | 3 | -3.09 | 0.03 | 0.18 |
| Belgium | 0 | -1.80 | 0.38 | 0.29 | Netherlands | 0 | -1.75 | 0.41 | 0.32 |
| | 1 | -1.88 | 0.34 | 0.32 | | 1* | -2.58 | 0.10 | 0.28 |
| | 2* | -2.84 | 0.05 | 0.23 | | 0 | -0.04 | 0.96 | 0.28 |
| | 3 | -3.43 | 0.01 | 0.20 | Norway | 1* | -3.72 | 0.00 | 0.16 |
| Denmark | 0 | -0.31 | 0.92 | 0.46 | Portugal | 0 | -1.42 | 0.57 | 0.44 |
| | 1 | -2.14 | 0.23 | 0.24 | | 1 | -1.35 | 0.61 | 0.57 |
| | 3* | -3.80 | 0.00 | 0.17 | | 2 | -2.43 | 0.13 | 0.28 |
| Finland | 0 | -2.19 | 0.21 | 0.39 | | 3* | -2.36 | 0.10 | 0.25 |
| | 1 | -2.47 | 0.12 | 0.36 | Spain | 0 | -1.03 | 0.74 | 0.40 |
| | 2* | -2.91 | 0.04 | 0.32 | | 1 | -2.04 | 0.27 | 0.35 |
| France | 0 | -1.25 | 0.65 | 0.22 | | 2 | -2.51 | 0.11 | 0.31 |
| | 1* | -2.90 | 0.05 | 0.16 | | 3* | -2.95 | 0.04 | 0.25 |
| Germany | 0 | -2.11 | 0.24 | 0.41 | Sweden | 0 | -0.45 | 0.90 | 0.23 |
| | 1* | -2.88 | 0.05 | 0.28 | | 1 | -2.57 | 0.11 | 0.18 |
| | 2 | -4.13 | 0.00 | 0.24 | | 2* | -3.78 | 0.00 | 0.14 |
| | 3 | -4.64 | 0.00 | 0.17 | Switzerland | 0 | -1.50 | 0.54 | 0.19 |
| Italy | 0* | -2.66 | 0.08 | 0.70 | | 1 | -1.58 | 0.50 | 0.18 |
| | 1 | -2.43 | 0.13 | 0.43 | | 2 | -2.20 | 0.22 | 0.15 |
| | 2 | -3.08 | 0.02 | 0.33 | | 3* | -3.60 | 0.01 | 0.11 |
| | 3 | -3.57 | 0.01 | 0.29 | United | 0 | -1.92 | 0.32 | 0.24 |
| | | | | | Kingdom | 1* | -2.90 | 0.05 | 0.20 |
| | | | | | United | 0* | -3.48 | 0.01 | 0.15 |
| | | | | | States | 1 | -3.57 | 0.01 | 0.12 |

Note: The table reports, for each country in the sample, an Augmented Dickey-Fuller test (testing the null hypothesis of a unit root and the associated $p$-value) and the time-series standard deviation for the unadjusted log rent-price ratio and the log rent-price ratio adjusted for a change in its mean. * denotes the adjusted rent-price ratio used in Table 3.6.

## B.2 Data appendix

### B.2.1 Rent indices: methodology

Rent indices measure the change in 'pure' rents for primary residences, i.e. net of house furnishings, maintenance costs, and utilities. For modern rent indices included in CPIs, data are usually collected by statistical offices through surveys of housing authorities, landlords, households, or real estate agents (International Labour Organization et al., 2004).

Rental units are heterogeneous goods.[1] Consequently, there are several main challenges involved when constructing consistent long-run rent indices. First, rent indices may be national or cover several cities or regions. Second, rent indices may cover different housing types ranging from high to low value housing, from new to existing dwellings. Third, rental leases are normally agreed to over longer periods of time. Hence, current rental payments may not reflect the current *market rent* but the *contract rent*, i.e. the rent paid by the renter in the first period after the rental contract has been negotiated.[2] Fourth, if the quality of rental units improve over time, a simple mean or median of observed rents can be upwardly biased. These issues are similar to those when constructing house price indices and the same standard approaches can be applied to adjust for quality and composition changes. For a survey of the different approaches, the reader is referred Knoll et al. (2017). Yet, as can be seen from the data description that follows, these index construction methods commonly used for house price indices have less often been applied to rents.

Another important question when it comes to rent indices is the treatment of subsidized and controlled rents. Rental units may be private or government owned and hence be subject to different levels of rent controls or subsidies. Since these regulations may apply to a substantial share of the rental market, rent indices typically cover also subsidized and controlled rents (International Labour Organization et al., 2004).[3] It is worth noting that not properly controlling for substantial changes in rent regulation may result in a mis-measurement of rent growth rates. More specifically, if the share of the rental market subject to these regulations suddenly increases – e.g. during wars and in the immediate post-war years – the rent index can be downwardly biased.[4]

An additional challenge when constructing rent indices is the treatment of

[1] Compared to owner-occupied houses, Gordon and van Goethem (2007) argue that rental units are, however, less heterogeneous in size at any given time and more homogenous over time. The authors provide also scattered evidence for the U.S. that rental units experience quality change along fewer dimensions than owner-occupied units.

[2] Typically, in times of low or moderate general inflation, the market rent will be higher than the contract rent. Yet, the introduction of rent controls or a temporary strong increase in the supply of rental units may result in the market rent being lower than the contract rent (Shimizu et al., 2015).

[3] Exceptions include, for example, the Canadian rent index where subsidized dwellings are excluded (Statistics Canada, 2015).

[4] For example, this has been the case for the Australia CPI rent index after World War 2 (see Section B.2.5).

owner-occupied housing. Since a significant share of households in advanced economies are owner-occupants, rent indices typically cover changes in the cost of shelter for both renters and owner-occupiers.[5] The cost for owner-occupied shelter is an estimate of the implicit rent owner occupants would have to pay if they were renting their dwellings. Different approaches to estimate the change in implicit rents exist, each with advantages and disadvantages. Most statistical offices rely on the *rental equivalent approach*.[6] The resulting rent index is based on an estimate of how much owner-occupiers would have to pay to rent their dwellings or would earn from renting their home in a competitive market. Data either come from surveys asking owner-occupiers to estimate the units' potential rent or are based on matching owner-occupied units with rented units with similar characteristics.[7] The *user cost approach* assumes that a landlord would charge a rent that at least covers repairs and maintenance, taxes, insurance, and the cost of ownership (i.e. depreciation, mortgage interest, opportunity costs of owning a house). The resulting rent index is a weighted average of the change in the price of these components.[8] The user cost approach is important in its own right (i.e. when the size of the rental market is relatively small, it is not possible to value the services of owner-occupied housing using the *rental equivalence approach*). Nevertheless, the user-cost and rental equivalence approach should, in principle, yield similar results given that capital market theory implies that the price of an asset should equal the discounted value of the flow of income or services (e.g., rents) that it provides over the lifetime of the asset. The *net acquisitions approach* measures the costs associated with the purchase and ongoing ownership of dwellings for own use. Hence it covers the costs of repair and maintenance, taxes, insurances and the change in the cost of the net acquisition of the dwelling, i.e. the change in the total market value (Diewert, 2009; International Labour Organization et al., 2004; OECD, 2002).[9] If rents of owner-occupants are included in rent indices, the combined rent index is a weighted average of rents for rented and owner-occupied dwellings. Weights are based on the share of owner-occupants and tenants in the respective housing market.

[5]Imputed rents of owner-occupied housing are excluded in Belgium and France. In some countries, two rent indices are reported, one for renter-occupied and one for owner-occupied dwellings (International Labour Organization et al., 2004; OECD, 2002).

[6]The *rental equivalent approach* is currently used in the U.S., Japan, Denmark, Germany, the Netherlands, Norway, and Switzerland (OECD, 2002).

[7]This approach may result in a bias of unknown size and direction if i) owners' assessment of the rental value of their dwelling is unreliable, ii) if the rental market is small and the rental housing stock is not comparable to the owner-occupied housing stock, and ii) if rents set in rental markets are significantly affected by government regulation since subsidized and controlled rents should not be used in calculating an owners' equivalent rent index (Diewert, 2009; International Labour Organization et al., 2004; OECD, 2002).

[8]A (partial) *user cost approach* is currently used in Canada, Finland, Sweden, and the United Kingdom (OECD, 2002).

[9]Hence, a basic requirement of this method is the existence of a constant- quality house price index. The *net acquisitions approach* is currently used in Australia (OECD, 2002).

### B.2.2 Rent regulation

Rental markets in all advanced economies have historically been strongly regulated. On the broadest level, one can distinguish between first, second, and third generation rent controls. First generation rent controls were typically introduced during the years of the two world wars and entailed rent freezes with intermittent upward adjustment of rents. Since the second half of the 20th century, second and third generation rent controls have been more common. Second generation rent controls limit rent increases between tenancies and the extent to which rents can be increased for sitting tenants. Third generation rent controls, limit rent increases within a tenancy but increases are unrestricted between tenancies. Second and third generation rent controls differ widely across jurisdictions. They may, for example, focus on certain types of rental housing – e.g. exempt high-rent housing or new construction – but also deal with conversion, maintenance and different aspects of landlord-tenant relations (Turner and Malpezzi, 2003; Arnott, 2003). While rent controls in most countries were lifted fairly early after the end of World War 1, they emerged as a persistent feature of housing markets after the end of World War 2. Table B.7 provides a summary of the most important national rent controls.[10]

**Table B.7:** Rent regulation by country and period.

| Period | Rent regulations |
|---|---|
| | *Australia* |
| 1916–1928 | The *Fair Rent Act* introduced a limited form of rent control in 1916. During the 1920s, the act was amended several times. Rent control was abolished in 1928 (Schneller, 2013). |
| 1939–1949 | In 1939, the *National Security Act* introduced price controls. Rent controls were enforced by state governments until 1941 when the various state regulations were replaced by national regulations (*National Security (Landlord and Tenant) Regulations*). Wartime price controls were gradually lifted from 1949 onwards but affected rent levels well into the 1960s (Stapledon, 2007). |
| | *Belgium* |
| 1919–1926 | Rent controls were introduced in 1919 limiting rents to 30 percent above the prewar level of 1914. Gradually, the maximum increase relative to prewar levels was adjusted upwards. In 1926, rents were liberalized but the exact timing of liberalization varied with dwelling type. As a result, controls affected rent levels until 1930. A small share of low-rent dwellings continued to be regulated throughout the 1930s, i.e. rents for these dwellings were limited to 6 times the prewar level until 1934 and to 7 times the prewar level thereafter (Buyst, 1992; Van den Eeckhout, 1992). |
| 1945–1952 | In 1945, rents were limited to 40 percent above the prewar level of 1939. In 1947, high rent dwellings were liberalized, all other dwellings' rents were limited to 70 percent above prewar levels. Three years later, medium-sized dwellings were liberalized, all other dwellings' rents were limited to 100 percent above prewar levels. Rent controls were lifted in 1952 (Buyst, 1992). |
| 1975– | During the 1970s, several temporary rent acts aimed at limiting rent increases. Subsequent legislation in 1983, 1991 and 1997 provided for free negotiation of contracts but limited rent increases in line with a retail price or a health index (De Decker, 2001). |

*Table continues on the next page.*

[10] Many rent control programs have been introduced and administered by local rather than national governments which makes it difficult to document their history comprehensively and accurately.

**Table B.7, ctd.:** Rent regulation by country and period.

| Period | Rent regulations |
|---|---|
| | *Denmark* |
| 1916–1931 | Rent controls were enacted in 1916. After 1918, rent controls were gradually lifted and finally abolished in 1931 (Whitehead, 2012; Willis, 1950). |
| 1939–1975 | The 1939 *Rent Act (Lejeloven)* reintroduced rent controls. Several amendments throughout the 1950s and 1960s relaxed but did not remove rent controls (Whitehead, 2012). |
| 1975– | The 1975 Housing Regulation Act *(Boligreguleringsloven)* introduced a system of cost-based rents and replaced or supplemented some of the provisions of the *Lejeloven*. In 1991, rents for newly built dwellings were liberalized. Today, the largest share of private rental dwellings are still subject to some form of regulation (Whitehead, 2012). |
| | *Finland* |
| WW1–1925 | Rent controls were introduced during the years of World War 1. All restrictions were ended in 1924 (Willis, 1950). |
| WW2–1961 | Rent controls were reintroduced during World War 2. The 1961 *Tenancy Act* abolished all wartime rent restrictions (Whitehead, 2012). |
| 1968–1974 | In 1968, rents on existing dwellings were frozen (Lyytikäinen, 2006). |
| 1974–1992 | In 1974, a rent control system was introduced that regulated maximum rent levels and rent increases depending on type, age, and location of the dwelling. The system was slightly modified in 1987 so as to ensure a reasonable profit to landlords (Lyytikäinen, 2006). |
| 1992–1995 | New tenancies were deregulated in 1992. In 1995, all rent controls were abolished (Whitehead, 2012; Lyytikäinen, 2006). |
| | *France* |
| 1914–1930s | A rent moratorium was enacted in 1914 and subsequently extended through 1918. Landlords were partially compensated for foregone rent payments after the end of World War 1. Rents of existing dwellings were kept at prewar levels until 1920 and allowed to slowly increase during the 1920s. Newly constructed dwellings were exempt from regulations. Due to the consequences of the Great Depression, a 1929 plan to liberalize rents of existing dwellings was never implemented (Führer, 1999; Friggit, 2002; Whitehead, 2012). |
| WW2–1948 | Strict rent controls were reintroduced. Rent controls were gradually lifted from 1945 onwards and abolished in 1948. (Friggit, 2002). |
| 1982–1989 | The 1982 *Quilliot Law* strengthened tenants' rights and re-introduced rent controls for all dwellings. Rent controls were relaxed for new and vacated units according to the 1986 *Mehaignerie Law* (Whitehead, 2012). |
| 1989– | Since 1989, the *Mermaz-Malandain Law* restricts rent increases during the period of the lease but provides for free negotiation of new leases (Whitehead, 2012). |
| | *Germany* |
| 1917–1923 | Rent controls and tenant protection were introduced in 1917 (*Erste Mieterschutzverordnung*). After 1923, subsequent legislation relaxed and partially dismantled rent controls (Kholodilin, 2015; Führer, 1999; Hubert, 1998; Willis, 1950). |
| 1936–1945 | A rent freeze was introduced in 1936 and remained in place throughout the years of World War 2. Wartime rent controls were gradually lifted in the 1950 Housing Act (*Wohnungsbaugesetz*) and the 1951 Rent Regulation Act (*Mietpreisverordnung*) but affected rent levels well into the 1960s (Kholodilin, 2015; Hubert, 1998). |
| 1971– | The Comparable Rent System (*Vergleichsmietenregelung*) introduced in 1971 regulates size and frequency of rent increases for sitting tenants. Subsequent legislation adjusted the size of maximum rent increases. Special allowances apply to newly constructed dwellings. The 2015 Rental Price Brake (*Mietpreisbremse*) limited rents on new tenancies in certain property market hotspots. Exceptions apply to initial lettings of newly constructed dwellings (Kholodilin, 2015; Whitehead, 2012). |

*Table continues on the next page.*

**Table B.7, ctd.:** Rent regulation by country and period.

| Period | Rent regulations |
|---|---|
| | *Italy* |
| 1915–1923 | Rent controls were introduced in 1915 – initially for the duration of World War 1. But only in 1920, new legislation provided for the gradual removal of all rent controls until mid-1923 (Memo, 1976; Bortolotti, 1978). |
| 1934–1963 | Rent regulation was introduced as part of an effort to stabilize consumer prices in 1934. The regulations remained in effect until 1947 and subsequent postwar legislation gradually liberalized the rental market. In 1962, only about a quarter of the rental housing stock was still affected by rent regulation (Bortolotti, 1978). |
| 1978–1998 | The 1978 Fair Rent Act (*Equo Canone*) regulated rent increases between tenancies depending on dwelling characteristics such as location, year of construction etc. In 1992, regulation became more relaxed. The Fair Rent Act was abolished in 1998. |
| | *Netherlands* |
| 1917–1927 | The 1917 Rent Commission Law (*Huurcommissiwet*) froze rents of lower and middle class dwellings at the level of 1916. Subsequent legislation provided for rent increases in line with general inflation. After 1923, controls were gradually relaxed. Rent controls were abolished in 1927 (Willis, 1950; Ambrose et al., 2013). |
| 1940–1967 | The rent freeze introduced in 1940 was abolished in 1951 and replaced by system of differentiated rent increases. Rent controls were gradually relaxed after 1967 (Whitehead, 2012; Priemus, 2010). |
| 1971– | In 1971, maximum allowable rent levels were introduced based on a national points index of housing quality. Since 1976, rent increases are limited. The more expensive segment of the housing market is exempt from rent regulations since 1994 (Whitehead, 2012). |
| | *Norway* |
| 1916–1920s | The 1916 Rent Restriction Law introduced rent controls for certain types of apartments. Controls were gradually relaxed during the 1920s. Yet, in Oslo, rents remained regulated throughout the 1930s (Eitrheim and Erlandsen, 2004; Willis, 1950). |
| 1940–2010 | In 1940, rent controls were re-introduced for existing dwellings in urban areas. Rent controls were gradually relaxed after the end of World War 2. As part of a more flexible system of rent controls, local housing rent committees kept rent increases roughly in line with the consumer price index. After 1985, rents were only controlled in Oslo and Trondheim. The 1999 Rent Act abolished rent controls for new and existing dwellings built after World War 2. In 2010, rent controls for dwellings built before World War 2 were removed (Whitehead, 2012; Eitrheim and Erlandsen, 2004). |
| | *Portugal* |
| 1910–1930s | Rent controls were introduced in 1910 and gradually relaxed after 1926. Controls were abolished in the 1930s (Azevedo, 2016). |
| 1974–1980s | After the 1974 revolution, rent controls were reintroduced. Starting in the mid-1980s, controls were gradually relaxed. As of today, only a very small fraction of the housing market remains affected by the 1974 regulations (Azevedo, 2016). |
| | *Spain* |
| 1920 | According to the 1920 *Decreto Bugallal*, rents in urban areas (cities with more than 20,000 inhabitants) had to return to their 1914 levels. Landlords could however negotiate rent increases up to 20% relative to the 1914 level (Blanco, 2012; Torrejon, 1996). |
| 1931–1945 | All rents were frozen. The rent freeze remained effective until the end of World War 2 (Blanco, 2012; Torrejon, 1996). |
| 1946–1964 | New legislation limited rent increases within tenancies for all contracts signed after 1942 (Blanco, 2012; Torrejon, 1996). |
| 1964–1985 | Rent increases within tenancies were limited for contracts signed before 1964. Contracts signed after 1964 could be freely negotiated. In 1985, the *Decreto Bover* abolished all existing rent regulation (Torrejon, 1996). |

*Table continues on the next page.*

**Table B.7, ctd.:** Rent regulation by country and period.

| Period | Rent regulations |
|---|---|
| | *Sweden* |
| 1916–1923 | Rent controls were enacted in 1916 and abolished in 1923 (Willis, 1950). |
| 1942–1969 | Rent controls were introduced in 1942. Rent increases were only permitted in case of rising capital or maintenance expenditures. Subsequent postwar regulation relaxed rent controls. Wartime rent controls were abolished in 1969 (Whitehead, 2012). |
| 1969– | The 1969 Tenancy Act and its 1978 supplement provided for a new system of "fair rents," i.e. an acceptable rent level defined by municipal housing companies, and limited rent increases (Whitehead, 2012; Turner, 1988). |
| | *Switzerland* |
| 1916–1924 | Rent controls were introduced in 1916. All controls were abolished in 1924 (Werczberger, 1997; Willis, 1950). |
| 1936–1950s | Rent controls were re-introduced during the Great Depression. After the end of World War 2, controls were gradually relaxed and completely removed in 1970 (Whitehead, 2012; Werczberger, 1997). |
| 1972– | The 1972 Rental Act (*Obligationenrecht*) provided for free negotiation of new leases within limits and allowed rent increases for sitting tenants in line with increases in costs (maintenance costs, property taxes etc.) and general inflation (Werczberger, 1997). |
| | *United Kingdom* |
| 1915–1923 | The 1915 *Rent Restriction Act* introduced rent controls and strengthened tenants' rights. Rent controls were gradually relaxed after 1923. By 1933, the private rental market was, by and large, uncontrolled (Heath, 2013; Führer, 1999; Willis, 1950). |
| 1939–1957 | The *Rent Act* of 1939 re-introduced full rent control. In 1954, the *House Repairs and Rent Act* permitted limited increases in rents for dwellings let before September 1939 and lifted rent controls from new and converted dwellings. The Rent Act of 1957 dismantled wartime rent control for all dwellings above a certain rateable value, decontrolled all new tenancies, decontrolled vacant possessions, and allowed for a general rise of controlled rents (Heath, 2013; Whitehead, 2012). |
| 1965–1988 | The 1965 *Rent Act* introduced "regulated tenancies," i.e. provided for long-term security of tenure, and established a system of "fair rents" assessed by independent rent officers. In the 1980s, the Thatcher government deregulated the rented sector. Most importantly, the 1988 *Housing Act* completely abolished rent regulation for new leases (Heath, 2013; Whitehead, 2012). |
| | *United States* |
| 1918–1924 | Rent controls were introduced in 1918 but with some exceptions – mainly large cities and the District of Columbia – only imposed voluntarily (Willis, 1950). |
| 1942–1953 | During World War 2, rent controls existed under the *Federal Emergency Price Control Act* which expired in 1953. New York City and some neighboring counties maintained the rent control system which was adjusted in 1969 as part of the *Rent Stabilization Program* (U.S. Department of Housing and Urban Development, 1991). |
| 1971–1973 | Rent controls were re-introduced under Nixon's *Economic Stabilization Program*. Since 1973, there are no nation- or statewide rent controls. Rent controls, however, still exist in some localities in CA, CT, MD, MA, NJ, and NY. The vast majority of controlled units are found in New York, Los Angeles, San Francisco, and Washington, DC (U.S. Department of Housing and Urban Development, 1991). |

### B.2.3 Long-run rent-price ratios and housing returns

To construct long-run rent-price ratios and compute time-series of housing returns for each country, I follow the *rent-price approach*. I therefore start with the rent-price ratio $\frac{RI_1}{HPI_0}$ estimated in a baseline year $t = 0$, net of maintenance costs and depreciation, and compute a time series of the rent-price ratio for a representative portfolio of houses by combining a price index ($HPI$) and a rent index ($RI$) as follows

$$\frac{RI_{t+1}}{HPI_t} = \frac{HPI_{t-1}}{HPI_t}\frac{RI_{t+1}}{RI_t}\frac{RI_t}{HPI_{t-1}} \tag{B.1}$$

In a second step, total returns on housing $H_t$ can be calculated as

$$H_t = \frac{RI_{t+1}}{HPI_t} + \frac{HPI_{t+1} - HPI_t}{HPI_t} \tag{B.2}$$

As discussed in Section 3.4.1, corroborating the plausibility of the level of historical returns on housing is an important robustness check when applying this approach. In addition, to historical estimates of rent-price ratios collected from a variety of sources, I construct rent-price ratios for benchmark years following a procedure related to the *balance-sheet approach* to constructing returns on housing. The *balance-sheet approach* combines information from national accounts on the value of the stock of residential estate and total rental income – or household expenditure on housing – controlling for changes in the housing stock. Let $HW$ denote total housing wealth, $RIC$ total rental income, and $S$ be a measure of the housing stock. The one-period gross return on housing $H$ is then given by

$$H_{t+1} = \frac{HW_{t+1} + RIC_t}{HW_t}\frac{S_t}{S_{t+1}} \tag{B.3}$$

Comparing the results from applying the *rent-price approach* and the *balance-sheet approach* using data for the U.S. and the U.K. since the 1980s, Giglio et al. (2016) and Favilukis et al. (2017) report only minor discrepancies.

Yet, it is important to note that the independent estimates, i.e. the data collected from historical material as well as the estimates derived using the *balance-sheet approach*, are unlikely to be identical to the long-run rent-price ratios constructed by applying the *rent-price approach* in any given year. Discrepancies may stem from differences in geographical coverage and in the types of dwellings covered. For example, according to data reported by *Numbeo.com*, the difference between price-rent ratios in city centers and out of city centers for the countries in the sample in 2013 amounts to a little less than 3 times the annual rent. Moreover, if the independent estimates do not account for maintenance and depreciation but reflect gross rent-price ratios, they may be somewhat higher compared to the long-run rent-price ratio. The estimates therefore serve to confirm the general level and trajectory of the long-run rent-price ratios rather than their exact value.

### B.2.4 Data sources

To construct rent indices reaching back to the late 19th century, I rely on two main sources. First, I use the rent components of the cost of living or consumer price indices published by regional or national statistical offices such as Statistics Sweden (1961) and Statistics Norway (2015). The cost of shelter is a major component of household expenditure. Cost of living (COLIs) or consumer price indices (CPIs) therefore typically include a component for housing. In many advanced economies, the construction of COLIs/CPIs was initiated by governments during World War 1 to calculate necessary wage adjustments in times of strongly rising price levels. Hence, most countries' statistical offices started to collect data on rents and calculate rent indices in the early 20th century.[11] The Yearbook of Labor Statistics (International Labour Organization, various years) serves as main repository for these data from national statistical offices. Second, to extend these indices back to the late 19th century, I draw on previous work of economic historians, such as Rees (1961) for the U.S., Lewis and Weber (1965) for the U.K., or Curti (1981) for Switzerland.

### B.2.5 Australia

**Rent data** Historical data on rents in Australia are available for 1901–2015.

For Australia, there are two principal sources for historical rent data. First, the CPI rent component constructed by the Australian Bureau of Statistics covers the period 1901–2015. This rent index is based on data for urban areas and has historically been published in two versions, the *A* and the *C series*.[12]. For the years the two series overlap, the difference appears negligible (Stapledon, 2012a). Since 1961, the CPI rent index is based on rent data for 8 capital cities. The sample of dwellings included is stratified according to location, dwelling type and dwelling size based on data from the most recent *Census of Population and Housing* (Australian Bureau of Statistics, 2011). Rent data are collected from real estate agents and state and territory housing authorities (Australian Bureau of Statistics, 2011).

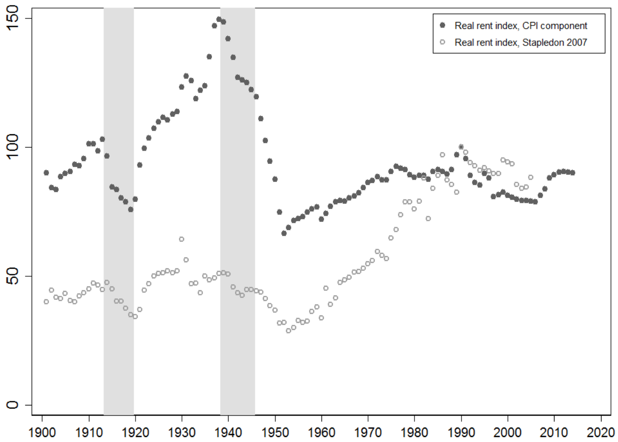
The second source is Stapledon (2007) who presents an index of average rents per dwelling based on census estimates for 1901–2005. The author observes substantial differences between his series and the CPI rent index described above. While for the years prior to World War 2, the rent index based on census data and the CPI rent index are highly correlated,[13] the CPI rent index increases much less than the index based on census data during the immediate post-World War 2 decades (see Figure B.5). Stapledon (2007) hypothesizes that this may reflect difficulties of the Australian statistical office to construct a rent index after the

[11] One exception is Belgium where house rents were only added to the CPI basket in 1989.

[12] The *A series* starts in 1901 and refers to average rents of all kinds of dwellings in the 6 capital cities. The series was discontinued in 1938. The *C series* starts in 1920, covers 30 towns (including the 6 capital cities) and is based on rent data for 4- and 5-room houses (Australian Bureau of Statistics, 2011).

[13] Correlation coefficient of 0.75.

**Figure B.5:** Australia: comparison of real rent indices.




*Note:* Index, 1990=100

introduction of wartime rent controls.[14]

Given this potential bias in the CPI rent index in the post-World War 2 period, I rely on the series constructed by Stapledon (2007) for the years 1940–1989 and the CPI rent component before and after.[15]. For the pre-World War 2 period, I rely on the *C series* whenever possible as it is based on a more homogeneous dwelling sample and may thus be less affected by shifts in the composition of the sample. The available series are spliced as shown in Table B.8.

The most important limitation of the long-run rent series is the lack of correction for quality changes and sample composition shifts before 1990. As noted above, the latter aspect may be less of a problem for the years 1921–1939 since the index is confined to a specific market segment, i.e. 4- and 5-room dwellings. Note that matching the Australian house price and rent series in terms of geographical coverage has been – by and large – possible. Both series are based on data for capital cities since 1901. Yet, no information exists on the quality differences that may exist between the dwellings included in the house price and the dwellings included in the rent series. The matching of the series with respect to the exact type of dwelling covered may hence be imperfect and I need to assume that changes in rents of different types of houses are strongly correlated.

**Long-run rent price ratio & housing returns** To construct a long-run rent-price ratio and compute a time-series of housing returns, I follow the rent-price approach (see Section 3.4.1) using a benchmark rent-price ratio for 2013, the house price index presented by Knoll et al. (2017) and the rent index introduced in the previous subsection. For 2013, the MSCI (2016) reports a rent-price ratio for Australian residential real estate of 0.032. Figure B.6 displays the resulting long-run

[14]See also Appendix Section B.2.2

[15]Rent controls were introduced in 1939 and gradually lifted after 1949. According to Stapledon (2007), rent controls affected rent levels well into the 1960s.

**Table B.8:** Australia: sources of rent index, 1901–2015.

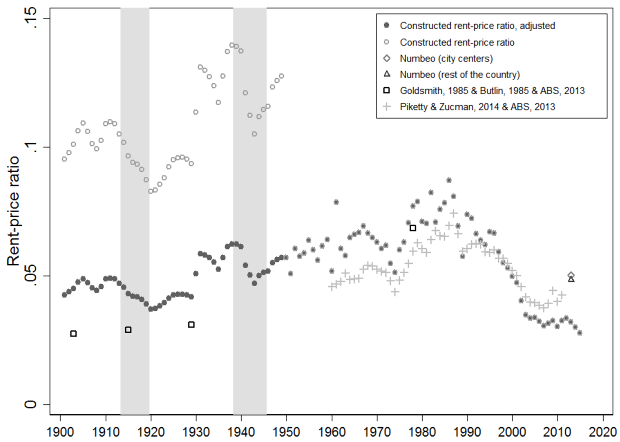
| Period | Source | Details |
|---|---|---|
| 1901–1920 | Australian Bureau of Statistics, CPI A series as published in Stapledon (2012a) | *Geographic Coverage*: Urban areas; *Type(s) of Dwellings*: All kinds of dwellings; *Method*: Average rents. |
| 1921–1939 | Australian Bureau of Statistics, CPI C series as published in Stapledon (2012a) | *Geographic Coverage*: Urban areas; *Type(s) of Dwellings*: Houses with 4-5 rooms; *Method*: Average rents. |
| 1940–1989 | Stapledon (2007) | *Geographic Coverage*: Urban areas; *Type(s) of Dwellings*: All kinds of dwellings; *Method*: Average rents. *Note:* Growth rate 1949/1950 adjusted (see below). |
| 1990–2015 | Australian Bureau of Statistics, CPI series | *Geographic Coverage*: Urban areas; *Type(s) of Dwellings*: All kinds of dwellings; *Method*: Stratification. |

rent-price ratio along with independent estimates as detailed below.

I obtain several scattered independent estimates of rent-price ratios in Australia. First, estimates of gross rent-price ratios (i.e. not accounting for maintenance and depreciation) since 2009 are also available from *Numbeo.com* for one- and three-bedroom apartments i) within city-centers and ii) in the rest of the country. For 2013, these estimates are comparable to the data reported by MSCI (2016) (see Figure B.6). Second, I construct rent-price ratios for benchmark years (1903, 1915, 1929, 1978) combining data on total housing value presented by Goldsmith (1985) and total expenditure on rents (Butlin, 1985; Australian Bureau of Statistics, 2014) as well as for 1959–2011 based on housing wealth data from Piketty and Zucman (2014) and total expenditure on rents (Australian Bureau of Statistics, 2014). For the post-World War 2 period, these scattered estimates are consistent with the long-run rent-price ratio (see Figure B.6). Yet, for the pre-World War 2 period, they are significantly lower. Note that the long-run rent-price ratio shows a structural break in 1949/1950 stemming from a surge in house prices after the lifting of wartime price controls in 1949.[16] While the abandonment of price controls undoubtedly had an effect on house prices, it appears unlikely that it also resulted in single sudden shift in the relationship between house prices and rents. The structural break in the long-run rent-price ratio may thus be interpreted as an artifact of the historical data. I therefore adjust the growth rate in rents between 1949 and 1950 to mirror the growth rate in the house price index. Figure B.6 shows that the adjusted long-run rent price ratio generally concords with the independent estimates of rent-price ratios for the pre-World War 2 period. Average annual real gross returns, rental yields, and capital yields for Australia are summarized in Table B.2.

[16] Price controls for houses and land were introduced in 1942.

**Figure B.6:** Australia: plausibility of rent-price ratio.




### B.2.6 Belgium

**Rent data** Historical data on rents in Belgium are available for 1890–2015.

The long-run rent index relies on five different sources. First, for the years since 1984, I rely on the CPI rent index constructed by Statistics Belgium.[17] The index covers tenants' rents only, i.e. imputed rents of owner-occupiers are excluded. Second, for 1977–1983, I use the rent index published by the International Labour Organization (2014) which, in turn, is based on data provided by Statistics Belgium. The main characteristics of these two series are summarized in Table B.9.

For earlier periods, data has been drawn from two major historical studies (Segers, 1999; Buyst, 1994) and an unpublished database by Anne Henau.[18] The rent index for seven cities[19] constructed by Segers (1999) for 1890–1920 is based on data from two public institutions for social welfare, the *Burelen van Weldadigheid* and the *Burgerlijke Godshuizen*. The individual city series are constructed as chain indices so as to at least partially account for changes in the underlying sample. The combined index is an unweighted average of the seven city indices. The rent index reported in Buyst (1994) for 1921–1938 is an unweighted average of five city indices[20] combining data drawn from studies by Leeman (1955) and Henau (1991) (see below). The unpublished index constructed by Henau for 1939–1961 covers four cities[21] using records of local Public Welfare Committees (OCMWs).

Three alternative series for the pre-World War 2 period are available. Van den Eeckhout and Scholliers (1979) present a rent index for dwellings let by the OCMW in Brussels for 1800–1940. Henau (1991), also using records of local OCMWs, constructs rent indices for Leuven, Luik, Ghent, and Antwerp for 1910–1940. Leeman

[17] Only in 1989, house rents were added to the CPI basket. Series sent by email, contact person is Erik Vloeberghs, Statistics Belgium.

[18] Series sent by email, contact person is Erik Buyst, KU Leuven.

[19] These are Antwerp, Brugge, Brussels, Gent, Kortrijk, Leuven, Luik.

[20] These are Brussels, Antwerp, Ghent, Leuven, and Luik.

[21] These are Leuven, Luik, Ghent, and Antwerp.

**Table B.9:** Belgium: sources of rent index, 1870–2015.

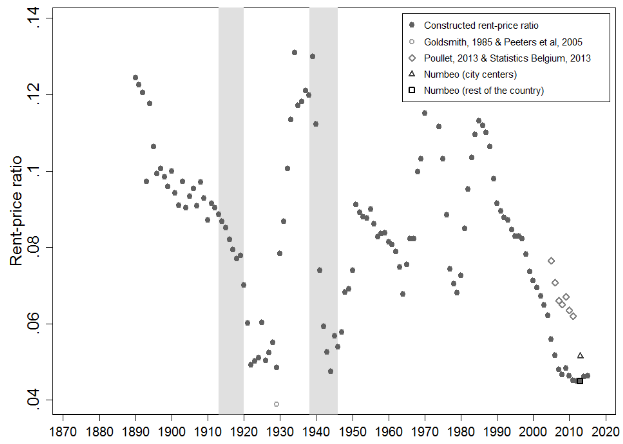
| Period | Source | Details |
|---|---|---|
| 1870–1920 | Segers (1999) | *Geographic Coverage*: 7 cities ; *Type(s) of Dwellings*: All kinds of dwellings; *Method*: Average rents. |
| 1921–1938 | Buyst (1994) | *Geographic Coverage*: 5 cities; *Type(s) of Dwellings*: All kinds of dwellings; *Method*: Average rents. |
| 1939–1961 | Unpublished database by Anne Henau. | *Geographic Coverage*: 4 cities; *Type(s) of Dwellings*: All kinds of dwellings let by Public Welfare Committees; *Method*: Average rents. |
| 1977–1983 | International Labour Organization (2014) | *Geographic Coverage*: Nationwide; *Type(s) of Dwellings*: Non-public housing; representative sample of 1,521 apartments and houses of various sizes; *Method*: Average rents. |
| 1984–2013 | Statistics Belgium | *Geographic Coverage*: Nationwide; *Type(s) of Dwellings*: Non-public housing; representative sample of 1,521 apartments and houses of various sizes; *Method*: Average rents. |

(1955) calculates city indices for a small sample of houses for Brussels, Gent, and Hoei for 1914–1939. As these series, however, are less comprehensive in terms of geographic coverage, I rely on the indices by Segers (1999) and Buyst (1994). The rent indices constructed by Van den Eeckhout and Scholliers (1979), Leeman (1955), Buyst (1994), and Segers (1999) follow a joint, almost identical path for the years they overlap.

The available series are spliced as shown in Table B.9. Since no time series of rents is available for 1961–1977, the two sub-indices (1870–1961 and 1977–2013) are linked using scattered data on rent increases between 1963 and 1982 reported by Van Fulpen (1984).

The resulting index suffers from two weaknesses. The first relates to the lack of correction for quality changes and sample composition shifts. Second, for 1939–161, the series relies on dwellings let by Public Welfare Committees only. It is of course possible that this particular market segment does not perfectly mirror fluctuations in prices of other residential property types. Note further that the matching of the Belgian house price and rent series is imperfect for two reasons. First, the house price index is based on data for the Brussels area prior to 1950. Since the available rent data for the pre-1950 period relies on a rather mall sample, I opted for the indices with broader geographic coverage. Second, no information exists on the quality differences that may exist between the dwellings included in the house price and the dwellings included in the rent series. The matching of the series with respect to the exact type of dwelling covered may hence be imperfect and I need to assume that changes in rents of different types of houses are strongly correlated.

**Figure B.7:** Belgium: plausibility of rent-price ratio.




**Long-run rent price ratio & housing returns** To construct a long-run rent-price ratio and compute a time-series of housing returns, I follow the rent-price approach (see Section 3.4.1) using a benchmark rent-price ratio for 2013, the house price index presented by Knoll et al. (2017) and the rent index introduced in the previous subsection. For 2013, the MSCI (2016) reports a rent-price ratio for Belgian residential real estate of 0.045. Figure B.7 displays the resulting long-run rent-price ratio along with independent estimates as detailed below.

I obtain three independent estimates of rent-price ratios. First, for 1929, I calculate a rent-price ratio of 0.025 based on data on total housing value (Goldsmith, 1985) and total expenditure on rents (Peeters et al., 2005). Second, for 2005–2011, I calculate a rent-price ratio based on data on total housing value (Poullet, 2013) and total expenditure on rents (Statistics Belgium, 2013b). Finally, estimates of gross rent-price ratios (i.e. not accounting for maintenance and depreciation) since 2009 are also available from *Numbeo.com* for one- and three-bedroom apartments i) within city-centers and ii) in the rest of the country. Reassuringly, all estimates appear – by and large – consistent with the long-run rent-price ratio (see Figure B.7). Average annual real returns, rental yields, and capital yields for Belgium are summarized in Table B.2.

### B.2.7 Denmark

**Rent data** Historical data on rents in Denmark are available for 1870–2015.

For 1870–1926, no rent series for Denmark as a whole exists. I therefore combine three series on rents in Copenhagen to proxy for development of rents in Denmark as a whole. First, for 1870–1911, I rely on an index of average rents for 3 room apartments – which can generally be considered working class or lower middle class dwellings – in Copenhagen (Pedersen, 1930). Second, for 1914–1917, the long-rent index is based on the increase in average rents of 1–8 room houses in Copenhagen as reported in Statistics Copenhagen (1906–1966). Third, for 1918–

**Table B.10:** Denmark: sources of rent index, 1870–2015.

| Period | Source | Details |
|---|---|---|
| 1870–1913 | Pedersen (1930) | *Geographic Coverage*: Copenhagen; *Type(s) of Dwellings*: 3 room apartments; *Method*: Average rents. |
| 1914–1917 | Statistics Copenhagen (1906–1966) | *Geographic Coverage*: Copenhagen; *Type(s) of Dwellings*: 1-8 room houses; *Method*: Average rents. |
| 1918–1926 | Statistics Copenhagen (1906–1966); Statistics Denmark (1925) | *Geographic Coverage*: Copenhagen; *Type(s) of Dwellings*: 1-5 room houses; *Method*: Average rents. |
| 1927–1954 | International Labour Organization (various years) | *Geographic Coverage*: Danish towns; *Type(s) of Dwellings*: New and existing dwellings; *Method*: Average rents. |
| 1955–1964 | Statistics Copenhagen (1906–1966) | *Geographic Coverage*: Copenhagen; *Type(s) of Dwellings*: 1-5 room houses; *Method*: Average rents. |
| 1965–2015 | Statistics Denmark (2003, 2015a); International Labour Organization (various years) | *Geographic Coverage*: Nationwide; *Type(s) of Dwellings*: New and existing dwellings; *Method*: Average rents. |

1926, I rely on the rent component of the cost of living index reported in Statistics Denmark (1925) and Statistics Copenhagen (1906–1966) referring to average rents of 1-5 room houses in Copenhagen.

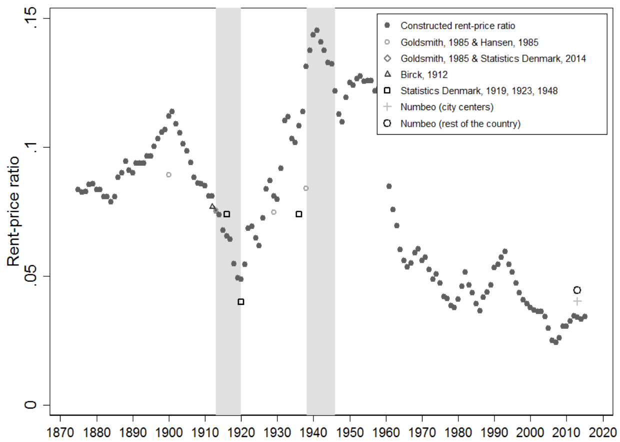
For 1927–1955, I use the CPI rent index as reported in the Yearbook of Labor Statistics (International Labour Organization, various years) which for the years prior to 1947 is based on average rents in 100 towns and in 200 towns for the years thereafter.

For 1955–1964, to the best of my knowledge, no data on rents for Denmark as a whole are available. I therefore use the increase in average rents of 1–5 room houses in Copenhagen as reported in Statistics Copenhagen (1906–1966) as a proxy for rent increases in Denmark.

For 1965–2015, I rely on the CPI rent index as reported in Statistics Denmark (2003), Statistics Denmark (2015a), and the yearbooks of the International Labour Organization (various years). The available series are spliced as shown in Table B.10.

The most important limitation of the long-run rent series is the lack of correction for quality changes and sample composition shifts. To some extent, the latter aspect may be less problematic for 1870–1913 since the index for these years is confined to a specific market segment, i.e. 3-room apartments. It is important to note that the matching of the Danish house price and rent series is imperfect. While the house price index relies on daa for dwellings in rural areas prior to 1938, the rent index mostly covers urban areas. Moreover, no information exists on the quality differences that may exist between the dwellings included in the house price and the dwellings included in the rent series. The matching of the series

**Figure B.8:** Denmark: plausibility of rent-price ratio.




with respect to the exact type of dwelling covered may hence be inaccurate and I need to assume that changes in rents of different types of houses are strongly correlated.

**Long-run rent price ratio & housing returns** To construct a long-run rent-price ratio and compute a time-series of housing returns, I follow the rent-price approach (see Section 3.4.1) using a benchmark rent-price ratio for 2013, the house price index presented by Knoll et al. (2017) and the rent index introduced in the previous subsection. For 2013, the MSCI (2016) reports the rent-price ratio for Danish residential real estate of 0.034. Figure B.8 displays the resulting long-run rent-price ratio along with independent estimates as detailed below.

I obtain several additional estimates of rent-price ratios in Denmark throughout the past century and a half. Overall, the long-run rent-price ratio in line with these scattered data from various accounts. First, according to Birck (1912), at the time of his writing, housing values in Copenhagen typically amounted to 13 times the annual rental income. Second, in line with this estimate, Statistics Denmark (1919) reports that housing values in urban areas in 1916 were about 13.5 times the annual rental income.[22] These data imply a rent-price ratio of about 0.06–0.07. For 1920, Statistics Denmark (1923) states that housing values in urban areas were about 25 times the annual rental income implying a rent-price ratio of roughly 0.04. In 1936, rent-price ratios in urban areas had returned to pre-World War 1 levels (Statistics Denmark, 1948). Third, I calculate a rent-price ratio for benchmark years (1900, 1913, 1929, 1938) using data on total housing value (Goldsmith, 1985) and total expenditure on rents (Statistics Denmark, 2014). Reassuringly, all of these estimates appear consistent with the long-run rent-price ratio (see Figure B.8). Finally, estimates of gross rent-price ratios (i.e. not accounting for maintenance and depreciation) since 2009 are also available from *Numbeo.com* for one- and three-bedroom apartments i) within city-centers and ii) in the rest of the coun-

[22] Note that housing values reported in Statistics Denmark (1954, 1948, 1923, 1919) relate to valuation for tax purposes.

try. For 2013, these estimates are comparable to the data reported by MSCI (2016) (see Figure B.8). Average annual real returns, rental yields, and capital yields for Denmark are summarized in Table B.2.

### B.2.8 Finland

**Rent data** Historical data on rents in Finland are available for 1920–2015.

The long-run rent index relies on the rent component of the consumer price index as published by the Ministry for Social Affairs (1920–1929), the International Labour Organization (various years), and Statistics Finland (2009). The main characteristics of the rent series are summarized in Table B.11.

The main weakness of the long-run rent series relates to the lack of correction for quality changes and sample composition shifts. These aspects may be somewhat less problematic for the post-1964 period since the index is adjusted for the size of the dwelling. Unfortunately, due to data limitations, the matching of the Finnish house price and rent series is imperfect. While the house price index relies on data for Helskinki prior to 1969, the rent index also covers more urban areas but is based on a larger city sample. In addition, no information exists on the quality differences that may exist between the dwellings included in the house price and the dwellings included in the rent series. The matching of the series with respect to the exact type of dwelling covered may hence be inaccurate and I need to assume that changes in rents of different types of houses are strongly correlated.

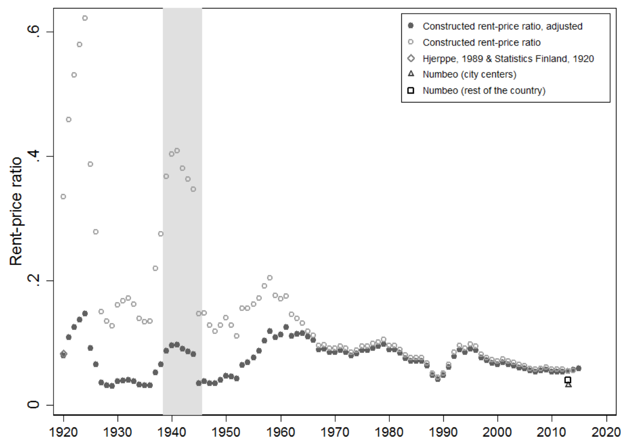
**Table B.11:** Finland: sources of rent index, 1920–2015.

| Period | Source | Details |
|---|---|---|
| 1920–1926 | Ministry for Social Affairs (1920–1929) | *Geographic Coverage*: 21 towns; *Type(s) of Dwellings*: All kinds of dwellings; *Method*: Average rents. |
| 1927–1965 | International Labour Organization (various years) | *Geographic Coverage*: 21 towns (1927–1936), 36 towns (1937–1965); *Type(s) of Dwellings*: All kinds of dwellings; *Method*: Average rents. |
| 1964–2015 | Statistics Finland (2009) | *Geographic Coverage*: Nationwide; *Type(s) of Dwellings*: All kinds of dwellings; *Method*: Average rents per sqm. |

**Long-run rent price ratio & housing returns** To construct a long-run rent-price ratio and compute a time-series of housing returns, I follow the rent-price approach (see Section 3.4.1) using a benchmark rent-price ratio for 2013, the house price index presented by Knoll et al. (2017) and the rent index introduced in the previous subsection. For 2013, the MSCI (2016) reports the rent-price ratio for Finnish residential real estate of 0.054. Figure B.8 displays the resulting long-run rent-price ratio along with independent estimates as detailed below.

I obtain two independent estimates of rent-price ratios in Finland since 1920.

**Figure B.9:** Finland: plausibility of rent-price ratio.




First, estimates of gross rent-price ratios (i.e. not accounting for maintenance and depreciation) since 2009 are also available from *Numbeo.com* for one- and three-bedroom apartments i) within city-centers and ii) in the rest of the country. For 2013, these estimates are similar to the data reported by MSCI (2016) (see Figure B.9). Second, I calculate a rent-price ratio for 1920 based on data on total housing value (Statistics Finland, 1920) and total expenditure on rents (Hjerppe, 1989). Figure B.9 shows that this estimate is significantly below the long-run rent price ratio in 1920. Yet it also suggests that rent-price ratios were generally higher before 1960, decreased during the first half of the 1960s and remain within a relatively tight range thereafter. Similar to the case of Australia (see Appendix section B.2.5), this trajectory may reflect difficulties of the Finnish statistical office to construct a rent index after the introduction of wartime rent controls. Rent controls were introduced during World War 2 and were only abolished under the *Tenancy Act* of 1961 (Whitehead, 2012). While this period of deregulation was rather short-lived,[23] the downward trend of the long-run rent-price ratio appears particularly remarkable. In other words, the data suggests that rents during the period of deregulation increased significantly less than house prices. To the best of my knowledge, no quantitative or qualitative evidence exists supporting such a pronounced fall in the rent-price ratio during the first half of the 1960s. I therefore conjecture that the rent index suffers from a downward bias during the period of wartime rent regulation and immediately thereafter. To mitigate this bias, I adjust the growth rate in rents between World War 2 and 1961 by a constant factor calibrated so the adjusted long-run rent-price ratio concords with the independent estimate in 1920.[24] Figure B.9 displays the resulting adjusted long-run rent-price ratio. Average annual real returns, rental yields, and capital yields for Finland are summarized in Table B.2.

[23]Rent regulation was re-introduced in 1968 and parts of the private rental market were subject to rent regulation until the mid-1990s.

[24]Factor of 1.07.

### B.2.9 France

**Rent data** Historical data on rents in France are available for 1870–2015.

The long-run rent index relies on two main sources. For 1870–1948, I use an average rent index for Paris constructed by Marnata (1961). The index is based on a sample of more than 10,000 dwellings. Data come from lease management books from residential neighbourhoods in Paris and mostly refer to dwellings of relatively high quality. After 1949, I rely on national estimates, measured by the rent component of the CPI from the Statistics France (2015a). The index covers tenants' rents only, i.e. imputed rents of owner-occupiers are excluded.

For the years prior to 1949, data on rents are also available for Paris (1914–1962) from the yearbooks of the International Labour Organization (various years). Reassuringly, the series by Marnata (1961) and the series published by the International Labour Organization (various years) are highly correlated for the years the overlap.[25] In addition, the International Labour Organization (various years) also presents a series for 45 departments for 1930–1937. For the years the series for Paris and the series for 45 departments overlap, they show similar rent increases. Note, however, that the house price index also relies on data for Paris only prior to 1936. For this reason, I use the Paris series throughout for the years prior to 1949 Marnata (1961). The available series are spliced as shown in Table B.12.

**Table B.12:** France: sources of rent index, 1870–2015.

| Period | Source | Details |
|---|---|---|
| 1870–1948 | Marnata (1961) | *Geographic Coverage*: Paris; *Type(s) of Dwellings*: High-quality existing dwellings; *Method*: Average rents. |
| 1949–2015 | Statistics France (2015a) as published in Conseil General de l'Environnement et du Developpement Durable (2013a) | *Geographic Coverage*: Nationwide; *Type(s) of Dwellings*: All kinds of dwellings; *Method*: Average rents. |

The most important drawback of the long-run rent series is again the lack of correction for quality changes and sample composition shifts. Both aspects may be less problematic for the pre-World War 2 years since the rent index is confined to a specific market segment, i.e. high-quality existing dwellings in Paris. Note further that the matching of the French house price and rent series in terms of geographical coverage has been generally possible. Both series are based on data for Paris prior to World War 2 and on data for France as a whole for the second half of the 20th century. Yet, no additional information exists on the quality differences that may exist between the dwellings included in the house price and the dwellings included in the rent series. The matching of the series with respect to the exact type of dwelling covered may hence be imperfect and I need to assume

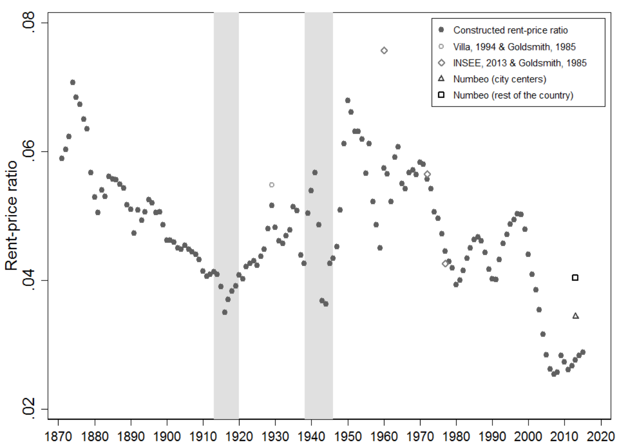
[25]Correlation coefficient of 0.98.

that changes in rents of different types of houses are strongly correlated.

**Long-run rent price ratio & housing returns** To construct a long-run rent-price ratio and compute a time-series of housing returns, I follow the rent-price approach (see Section 3.4.1) using a benchmark rent-price ratio for 2013, the house price index presented by Knoll et al. (2017) and the rent index introduced in the previous subsection. For 2013, the MSCI (2016) reports the rent-price ratio for French residential real estate of 0.028. Figure B.10 displays the resulting long-run rent-price ratio along with independent estimates as detailed below.

I obtain several scattered independent estimates of rent-price ratios in France since 1870. First, I calculate rent-price ratios for benchmark years (1929, 1960, 1972, 1977) based on data on total housing value (Goldsmith, 1985) and total expenditure on rents (Villa, 1994; Statistics France, 2013). Second, estimates of gross rent-price ratios (i.e. not accounting for maintenance and depreciation) since 2009 are also available from *Numbeo.com* for one- and three-bedroom apartments i) within city-centers and ii) in the rest of the country. All of these estimates are – by and large – consistent with the long-run rent-price ratio (see Figure B.10).

**Figure B.10:** France: plausibility of rent-price ratio.




A few additional scattered estimates on housing returns for the pre-World War 2 period are available. For 1903, Haynie (1903) reports an average gross rental yield for Paris of about 4 percent. For 1906, Leroy-Beaulieu (1906) estimates a gross rental yield for Paris of 6.36 percent – ranging from 5.13 percent in the 16th arrondissement to 7.76 percent in the 20th arrondissement. Friggit (2002) states that the gross rent of residential properties purchased by the real estate agency *La Fourmi Immobiliere* amounted to about 6 to 7 percent of the properties' value between 1899 and 1913. These estimates are generally comparable with an average annual real rental yield of about 5 percent for 1914–1938 calculated by merging the indices of house prices and rents and relying on the benchmark rent-price ratio in 2013. Average annual real returns, rental yields, and capital yields for France are summarized in Table B.2.

### B.2.10 Germany

**Rent data** Historical data on rents in Germany are available for 1870–2015.

The earliest data on rents in Germany comes from Hoffmann (1965). Hoffmann (1965) presents a rent index for 1850–1959. For 1850–1913, Hoffmann (1965) calculates a rent index using data on long-term interest rates and the replacement value of residential buildings, hence assuming that rents only depend on replacement costs and interest rates.

There are two additional sources on rents prior to World War 1, both providing data on average rents in (parts of) Berlin. **?** presents data on average rents for 1- and 2-room apartments between 1890 and 1910, and for 1-6 room apartments (separately for each size) in Berlin-Wilmersdorf between 1906–1913. Kuczynski (1947) provides an average rent based on scattered data for a number of larger German cities[26] for 1820–1913. Both sources, however, only report data for some years, not for the full period. For the 1895–1913 period, Kuczynski (1947) suggests a substantially stronger rise in nominal rents (42 percent) when compared to the index constructed by Hoffmann (1965) (22 percent). According to Hoffmann (1965), this can be explained by the fact that the index by Kuczynski (1947) does not account for quality improvements and may hence be upwardly biased. To be precise, the same bias should be present in Bernhardt (1997) as the data also refers to average rents. Yet, during the period they overlap (1890–1910), the series by Hoffmann (1965) and Bernhardt (1997) show about the same increase in rents while Kuczynski (1947) again suggests a significantly steeper rise.

For the years after 1913, Hoffmann (1965) relies on the rent component of the consumer price index as published by the Statistics Germany (1924–1935) (for 1913–1934) and Statistics Germany (various years) (for 1934–1959). The CPI rent index is a weighted average of rents in 72 municipalities (with population used as weights) including small, medium, and large cities. It is based on data for working class family dwellings, typically 2 rooms with a kitchen. The index refers to existing dwellings, i.e. built prior to World War 1, throughout. This, however, should not underestimate increases in rents given that dwellings built after World War 1 only accounted for about 15 percent of all rental dwellings in 1934 (Statistics Germany, 1934, 1925).

Statistics Germany (various years) reports the CPI rent index for the years since 1948. The index relies on a survey of households and landlords and covers 3-4 room apartments in more than 100 German municipalities. Subsidized apartments are included. The index is calculated as a matched-models index and adjusts for major renovations (Kurz and Hofmann, 2004; Angermann, 1985).[27]

The long-run index is constructed as shown in the Table B.13. For 1870–1912, I use the rent index constructed by Hoffmann (1965). For the years since 1913, I

[26]These include Berlin, Halle, Hamburg, Leipzig, Breslau, Dresden, Magdeburg, Barmen, Chemnitz, Jena, Lübeck, Magdeburg, Strassburg, and Stuttgart.

[27]The matched models method aims to control for quality changes by matching rents collected for a sample of models (or varieties of selected apartments) in a baseline period with rents of these same matched models in subsequent periods (Kurz and Hofmann, 2004).

**Table B.13:** Germany: sources of rent index, 1870–2015.

| Period | Source | Details |
|---|---|---|
| 1870–1912 | Hoffmann (1965) | *Geographic Coverage*: Nationwide; *Type(s) of Dwellings*: All kinds of dwellings; *Method*: Imputed rent based on long-term rates and replacement values of residential buildings. |
| 1913–1947 | Statistics Germany (1924–1935, various years) | *Geographic Coverage*: 72 municipalities; *Type(s) of Dwellings*: Working class dwellings; *Method*: Weighted average rents. |
| 1948–2015 | Statistics Germany (various years) | *Geographic Coverage*: Nationwide; *Type(s) of Dwellings*: 3-4 room apartments; *Method*: Matched models index. |

rely on the rent component of the consumer price index as published in Statistics Germany (1924–1935) and Statistics Germany (various years).

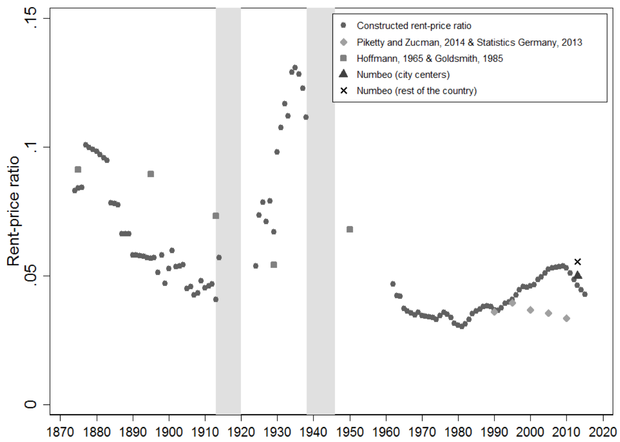
The long-run rent index has two main weaknesses. First, for the years prior to World War 2, the index neither controls for quality changes nor for sample composition shifts. The latter aspect may be less of a problem for the interwar period ince the index is confined to a specific and presumably relatively homogeneous market segment, i.e. working class dwellings. Second, data prior to World War 1 are not based on actual observed rents but have been estimated using data in replacement values and long-term interest rates.

Matching the German house price and rent series in terms of geographical coverage has been largely possible for the post-World War 2 period. In both cases, data refers to Germany as a whole or at least covers a substantial share of the German housing market. This is unfortunately not the case for the pre-World War 2 period. House price data for the pre-World War 1 years only reflects trends in Berlin and Hamburg but the rent index covers all of Germany. For the interwar period, the house price index refers to urban real estate while the rent index provides a somewhat broader coverage. Moreover, no information on differences between the characteristics of the dwellings in the house price and the dwellings included in the rent index exist. The matching of the series with respect to the exact type of dwelling covered may hence be imperfect and I need to assume that changes in rents of different types of houses are strongly correlated.

**Long-run rent price ratio & housing returns** To construct a long-run rent-price ratio and compute a time-series of housing returns, I follow the rent-price approach (see Section 3.4.1) using a benchmark rent-price ratio for 2013, the house price index presented by Knoll et al. (2017) and the rent index introduced in the previous subsection. For 2013, the MSCI (2016) reports a rent-price ratio for German residential real estate of 0.047. Figure B.11 displays the resulting long-run rent-price ratio along with independent estimates as detailed below.

To corroborate the plausibility of the long-run rent-price ratio, I obtain four

**Figure B.11:** Germany: plausibility of rent-price ratio.




independent estimates. First, I calculate rent-price ratios for benchmark years based on data on total housing value (Goldsmith, 1985) and total expenditure on rents (Hoffmann, 1965). Figure B.11 shows that the resulting estimates confirm a downward trend of the rent-price ratio prior to World War 2. Yet, they tend to be somewhat higher compared to the long-run rent-price ratio. Second, one additional series on housing returns is available for the pre-World War 2 period. For 1870–1913, Tilly (1986) reports housing returns for Germany and Berlin. Average annual real net returns according to Tilly (1986) amount to about 8 percent. This estimate is about 1 percentage point lower compared to average annual real returns of a little less than 9 percent calculated by merging the house price and rent indices. As third plausibility check, for 1992–2011, I calculate rent price ratios for benchmark years combining data on total housing value (Piketty and Zucman, 2014) and total expenditure on rents (Statistics Germany, 2013). Again, the resulting estimates appear to be broadly consistent with the long-run rent-price ratio (Figure B.11). Finally, estimates of gross rent-price ratios (i.e. not accounting for maintenance and depreciation) since 2009 are also available from *Numbeo.com* for one- and three-bedroom apartments i) within city-centers and ii) in the rest of the country. For 2013, these estimates are similar to the data reported by MSCI (2016) (Figure B.11). Average annual real returns, rental yields, and capital yields for Germany are summarized in Table B.2.

### B.2.11 Italy

**House price data** Historical data on house prices in Italy are available for 1927–2015.

I rely on the long-run house price index constructed by Cannari and D'Alessio (2016) throughout. For 1927–1941, Cannari and D'Alessio (2016) rely on a series published in Statistics Italy's statistical yearbooks which, in turn, are based on house price indices constructed by the *Federazione Nazionale Fascista di Proprietari di Fabbricati*. The series is based on data for existing dwellings and reflects average transaction prices per room. For the years since 1966, the index relies on average transaction prices per square meter of new and existing dwellings in provincial capitals before 1997 and average transaction prices per square meter of new and existing dwellings in municipal districts after 1998. Data are drawn from publications of the *Consulente Immobiliare*.

Unfortunately, no price data are available for the period 1941–1961. To obtain a long-run index, Cannari and D'Alessio (2016) link average prices per room in eight cities (Turin, Genoa, Milan, Trieste, Bologna, Rome, Naples and Palermo) in 1941 with average transaction prices per room in these cities in 1966 assuming an average room size of 18 square meters. To obtain an annual house price series for 1941–1966, Cannari and D'Alessio (2016) interpolate using data on year-to-year increases in construction costs.

**Rent data** Historical data on rents in Italy are available for 1927–2015. The long-run index relies on the CPI rent component throughout and spliced as shown in Table B.14. Data are drawn from International Labour Organization (various years) and reflect average rents. The index covers tenants' rents only, i.e. imputed rents of owner-occupiers are excluded. Due to data availability, geographic coverage varies over time. The series reflects average rents in Milan (pre-1938), in 62 cities (1938–1955), and 92 cities (post-1955). The series has a gap between 1939 and 1945. Since, to the best of the author's knowledge, no data on rents are available for this period, I link the pre-1939 and post-1945 series assuming that rents increased in lockstep with house prices, i.e. by a factor of about 1.6 adjusted for inflation.

The single most important drawback of the long-run rent series is again the lack of correction for quality changes and sample composition shifts. Moreover, the matching of the Italian house price and rent series is unfortunately imperfect. While the rent index is only based on data for Milan before 1937 and for urban areas more generally thereafter, the house price index offers a more comprehensive geographic coverage. Second, no additional information exists on the quality differences that may exist between the dwellings included in the house price and the dwellings included in the rent series. The matching of the series with respect to the exact type of dwelling covered may hence be inaccurate and I need to assume that changes in rents of different types of houses are strongly correlated.

| Period | Source | Details |
|---|---|---|
| 1927–1937 | International Labour Organization (various years) | *Geographic Coverage*: Milan; *Type(s) of Dwellings*: All kinds of dwellings; *Method*: Average rents. |
| 1938–1955 | International Labour Organization (various years) | *Geographic Coverage*: 62 cities; *Type(s) of Dwellings*: All kinds of dwellings; *Method*: Average rents. |
| 1956–2015 | International Labour Organization (various years) | *Geographic Coverage*: 92 cities; *Type(s) of Dwellings*: All kinds of dwellings; *Method*: Average rents. |

**Table B.14:** Italy: sources of rent index, 1927–2015.

**Long-run rent price ratio & housing returns** To construct a long-run rent-price ratio and compute a time-series of housing returns, I follow the rent-price approach (see Section 3.4.1) using a benchmark rent-price ratio for 2013, the house price index presented by Knoll et al. (2017) and the rent index introduced in the previous subsection. For 2013, the MSCI (2016) reports a rent-price ratio for Italian residential real estate of 0.038.

Estimates of gross rent-price ratios (i.e. not accounting for maintenance and depreciation) since 2009 are also available from Numbeo.com for one- and three-bedroom apartments within city-centers and in the rest of the country. For 2013, these estimates range between 0.03 (within city centers) and 0.038 (rest of the country) and are thus consistent with the data reported by MSCI (2016). Unfortunately, to the best of the author's knowledge, no additional independent estimates of rent-price ratios in Italy are available. Average annual real returns, rental yields, and capital yields for Italy are summarized in Table B.2.

### B.2.12 Japan

**Rent data** Historical data on rents in Japan are available for 1931–2015.

The long-run rent index relies on the rent component of the consumer price index throughout. For 1931–1946, the CPI rent index is reported in the yearbooks of the International Labour Organization (various years). The index covers 13 cities through 1936 and 24 cities thereafter and refers to average rents of wooden houses.

For the years since 1947, the rent component of the CPI is published by Statistics Japan (2012a). Data are collected as part of the *Retail Price Survey* in more than 1200 districts. The rent index covers small and medium-sized wooden houses as well as non-wooden houses and refers to the average rent per sqm. Subsidized dwellings are included. Imputed rents for owner-occupiers are included since 1970 (International Labour Organization, 2013; Shiratsuka, 1999). The available series are spliced as shown in Table B.15.

The most important limitation of the long-run rent index is the lack of correction for quality improvements and sample composition shifts. Particularly the latter aspect may be somewhat less problematic for the post-World War 2 years since the series controls for the size of the dwelling. Matching the Japanese house price and rent series in terms of geographical coverage has been partly possible. For the pre-World War 2 years both series are based on data for urban dwellings only. Yet for the second half of the 20th century, the rent index offers a somewhat broader coverage. In addition, the house price index reflects residential land prices inly whereas the rent index naturally is based on rents for dwellings.

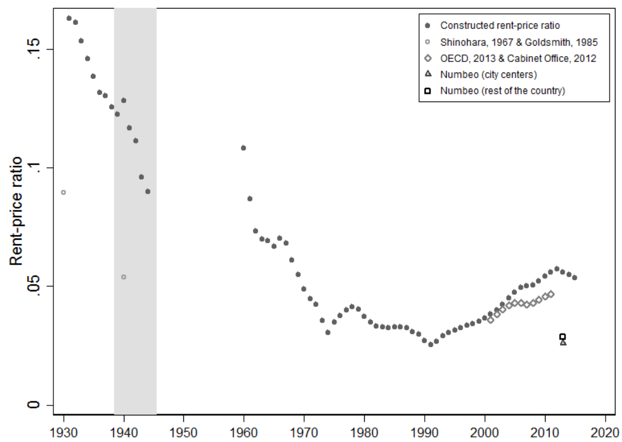
**Table B.15:** Japan: sources of rent index, 1914–2015.

| Period | Source | Details |
|---|---|---|
| 1931–1946 | International Labour Organization (various years) | *Geographic Coverage*: Urban areas; *Type(s) of Dwellings*: Wooden houses; *Method*: Average rents. |
| 1947–2015 | Statistics Japan (2012a) | *Geographic Coverage*: Nationwide; *Type(s) of Dwellings*: Small and medium-sized wooden houses, non-wooden houses; *Method*: Average rents per sqm. |

**Long-run rent price ratio & housing returns** To construct a long-run rent-price ratio and compute a time-series of housing returns, I follow the rent-price approach (see Section 3.4.1) using a benchmark rent-price ratio for 2013, the house price index presented by Knoll et al. (2017) and the rent index introduced in the previous subsection. For 2013, the MSCI (2016) reports a rent-price ratio for Japanese residential real estate of 0.056.

I obtain two independent estimates for rent-price ratios in Japan. First, I calculate rent-price ratios for benchmark years (1930, 1940, 2000–2011) based on data on total housing value (Goldsmith, 1985; OECD, 2013) and total expenditure on rents (Shinohara, 1967; Cabinet Office. Government of Japan, 2012). Reassuringly, the resulting estimates appear consistent with the long-run rent-price ratio for 2000–2011 (Figure B.12). Yet, for 1930 and 1940 the estimates are somewhat lower compared to the long-run rent price ratios suggesting that the rent index may underestimate rent growth between 1945 and 1960 which would mechanically result in overestimating the level of the rent-price ratio before 1945. To the best of the authors' knowledge, no rent data are available for 1945–1960 limiting my ability to corroborate the plausibility of the long-run rent-price index for the pre-World War 2 period. Second, estimates of gross rent-price ratios (i.e. not accounting for maintenance and depreciation) since 2009 are also available from *Numbeo.com* for one- and three-bedroom apartments i) within city-centers and ii) in the rest of the country. For 2013, these estimates are somewhat lower compared to the data reported by MSCI (2016) but are within a reasonable range of the long-run rent-price ratio. Average annual real returns, rental yields, and capital yields for Japan are summarized in Table B.2.

**Figure B.12:** Japan: plausibility of rent-price ratio.




### B.2.13 Netherlands

**Rent data** Historical data on rents in the Netherlands are available for 1870–2015.

I rely on the long-run rent index constructed by Ambrose et al. (2013) throughout. The series is based on two main sources. For 1870–1913, it uses the rent component of the cost of living index calculated by Van Riel (2006). This pre-World War 1 series refers to imputed rents of owner-occupied houses. Data comes from tax authorities and are estimated relying on average rents of comparable renter-occupied dwellings in the vicinity. For the post-World War 1 period, Ambrose et al. (2013) draw data from various publications of Statistics Netherlands. Statistics Netherlands collects data through annual rent surveys and covers more than two thirds of Dutch municipalities. The nationwide index is a weighted average of rent changes by region. It is adjusted for the effect of major renovations (Statistics Netherlands, 2014, 2010). The main characteristics of the series are summarized in B.16.

One alternative series for the pre-World War 2 period is available which can be used as comparative to the index presented by Ambrose et al. (2013). For 1909–1944, Statistics Amsterdam (1916–1944) reports average rents of working class in Amsterdam that have not undergone significant alteration or renovation.[28] Both series, i.e. the index constructed by Ambrose et al. (2013) and the series published in the Statistics Amsterdam (1916–1944) are strongly correlated for the years they overlap.[29] This is reassuring since the long-run house price index only relies on data for Amsterdam prior to 1970 (Knoll et al., 2017).

[28]For 1909 to 1928, Statistics Amsterdam (1916–1944) provides only scattered evidence, i.e. data on 1909, 1912, 1918. The series are continuous after 1928. Statistics Amsterdam (1916–1944) also presents data on average rents of middle class dwellings. Yet, this series is based on a significantly smaller sample compared to the one for working class dwellings. According to the 1936–37 yearbook, for example, the data covers 1719 working class dwellings but only 110 middle class dwellings.

[29]Correlation coefficient of 0.92 for 1909–1940.

**Table B.16:** Netherlands: sources of rent index, 1870–2015.

| Period | Source | Details |
|---|---|---|
| 1870–1913 | Van Riel (2006) as published in Ambrose et al. (2013) | *Geographic Coverage*: Nationwide; *Type(s) of Dwellings*: All kinds of dwellings; *Method*: Average rents. |
| 1914–2015 | Statistics Netherlands as published in Ambrose et al. (2013) | *Geographic Coverage*: Nationwide ; *Type(s) of Dwellings*: All kinds of dwellings; *Method*: Weighted average rents. |

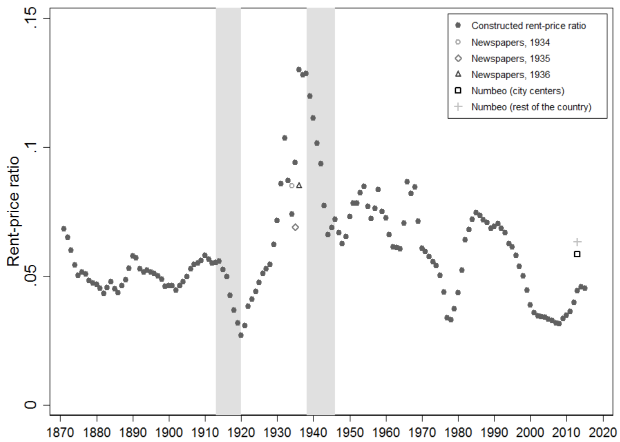
The main weakness of the long-run rent series is again the lack of correction for quality changes and sample composition shifts. Moreover, it is important to note that the matching of the Dutch rent and house price series is unfortunately imperfect. This is mainly for two reasons. First, while the house price index relies on data for Amsterdam only prior to 1970, the rent index offers a broader geographical coverage. Yet, the evidence suggests that at least during the first half of the 20th century, rents in Amsterdam and the rest of the country moved closely together. Second, no information exists on the extent to which characteristics of the dwellings included in the house price index differ from those included in the rent index. The matching of the series with respect to the exact type of dwelling covered may hence be inaccurate and I need to assume that changes in rents of different types of houses are strongly correlated.

**Long-run rent price ratio & housing returns** To construct a long-run rent-price ratio and compute a time-series of housing returns, I follow the rent-price approach (see Section 3.4.1) using a benchmark rent-price ratio for 2013, the house price index presented by Knoll et al. (2017) and the rent index introduced in the previous subsection. For 2013, the MSCI (2016) reports a rent-price ratio for Dutch residential real estate of 0.044.

The resulting long-run rent-price ratio appears to be – by and large – in line with rent-price ratios reported in several newspaper advertisements and articles. According to these sources, rent-price ratios were in the range of 0.07-0.09 in the first half of the 1930s (Nieuwe Tilburgsche Courant, 1936; Limburgsch Dagblaad, 1935; Nieuwe Tilburgsche Courant, 1934) and residential real estate was perceived as highly profitable investment throughout the decade (De Telegraaf, 1939). By comparison, the rent-price ratio constructed by merging the indices of house prices and rents was on average about 0.011 during the first half of the 1930s (Figure B.13).

Finally, estimates of gross rent-price ratios (i.e. not accounting for maintenance and depreciation) since 2009 are also available from *Numbeo.com* for one- and three-bedroom apartments i) within city-centers and ii) in the rest of the country. For 2013, these estimates are consistent with the data reported by MSCI (2016) (Figure B.13). Average annual real returns, rental yields, and capital yields for the Netherlands are summarized in Table B.2.

**Figure B.13:** Netherlands: plausibility of rent-price ratio.




### B.2.14 Norway

**Rent data** Historical data on rents in Norway are available for 1871–2015.

For the period 1871–1978, the long-run index relies on a rent index presented by Jurgilas and Lansing (2012).[30] The series uses the rent component of the consumer price index since 1914[31] which for the years since 1920 is based on data for 26 towns and 5 industrial centers across Norway and on data for Oslo only for 1914–1919. For the pre-World War 1 period, the index is constructed as a weighted average of average rents in 32 cities and towns.[32] Data comes from consumption surveys conducted by Statistics Norway.

For the years prior to World War 1, an additional series is available in Statistics Oslo (1915) covering average expenditures for rents of a family of four in Oslo for 1901–1914. Both series, i.e. the rent index by Jurgilas and Lansing (2012) and the data published in Statistics Oslo (1915), depict a similar trend for the years they overlap.

For 1979–2015, the long-run rent index relies on the rent component of the consumer price index as published by Statistics Norway (2015). The series is based on a sample of about 2000 rented dwellings that are classified according to their age. The aggregate index is calculated as a weighted average rent index (Statistics Norway, 1991). The available series are spliced as shown in Table B.17.

The main weakness of the long-run rent series is the lack of adjustment for quality changes and sample composition shifts. On the upside, the matching of the Norwegian house price and rent series in terms of geographic coverage has been generally possible. Both series rely on data for urban areas. Yet the coverage

[30] The series was constructed by Ola Grytten, Norwegian School of Economics, and sent by email. Contact person is Marius Jurgilas, Norges Bank.

[31] See for example the rent index for 1914–1948 as reported in Statistics Norway (1949, Table 185) and for 1924–1959 as reported in Statistics Norway (1978, Table 287) for comparison.

[32] Population is used as weights.

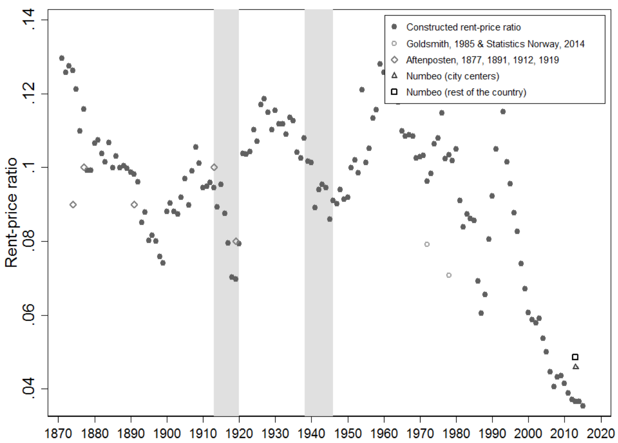
of the rent series is relatively more comprehensive. Unfortunately, no information exists on the quality differences that may exist between the dwellings included in the house price and the dwellings included in the rent series. The matching of the series with respect to the exact type of dwelling covered may hence be imperfect and I need to assume that changes in rents of different types of houses are strongly correlated.

**Table B.17:** Norway: sources of rent index, 1871–2015.

| Period | Source | Details |
|---|---|---|
| 1871–1978 | Rent index underlying by the price to rent ratio reported in Jurgilas and Lansing (2012) | *Geographic Coverage*: Urban areas; *Type(s) of Dwellings*: All kinds of dwellings; *Method*: Weighted average rents. |
| 1979–2013 | Statistics Norway (2015) | *Geographic Coverage*: Urban areas; *Type(s) of Dwellings*: All kinds of dwellings; *Method*: Weighted average rents. |

**Long-run rent price ratio & housing returns** To construct a long-run rent-price ratio and compute a time-series of housing returns, I follow the rent-price approach (see Section 3.4.1) using a benchmark rent-price ratio for 2013, the house price index presented by Knoll et al. (2017) and the rent index introduced in the previous subsection. For 2013, the MSCI (2016) reports the rent-price ratio for Norwegian residential real estate of 0.037. Figure B.14 displays the resulting long-run rent-price ratio along with independent estimates as detailed below.

**Figure B.14:** Norway: plausibility of rent-price ratio.




I obtain several scattered independent estimates of rent-price ratios in Norway since 1871. First, I calculate rent-price ratios for benchmark years (1972, 1978) based on data on total housing value (Goldsmith, 1985) and total expenditure on rents (Statistics Norway, 2014, 1954). Second, estimates of gross rent-price ratios (i.e. not accounting for maintenance and depreciation) since 2009 are also available from *Numbeo.com* for one- and three-bedroom apartments i) within city-centers and ii) in the rest of the country. For 2013, these estimates are comparable to the data reported by MSCI (2016) (see Figure B.14). Third, I collected scattered data from advertisements for Oslo residential real estate in *Aftenposten*, one of Norway's largest newspapers. According to these advertisements, rent-price ratios for apartment houses in different parts of Oslo ranged between 0.08 and 0.10 prior to World War 1 and reached similar levels in the interwar period (Aftenposten, 1919, 1912, 1891, 1877, 1874). All estimates are – by and large – consistent with the long-run rent-price ratio (see Figure B.14). Average annual real returns, rental yields, and capital yields for Norway are summarized in Table B.2.

### B.2.15 Portugal

**House price data** Historical data on house prices in Portugal are available for 1931–2015.

I rely on the long-run house price index constructed by Azevedo (2016). The author relies on the total number and value of transactions of new and existing real estate as reported to the land registry and collected by the Ministry of Justice to construct a weighted average house price index.[33] The number of transactions is used as weights. The data cover Portugal as a whole and are published in yearbooks and monthly bulletins by Statistics Portugal.[34]

**Rent data** Historical data on rents in Portugal are available for 1948–2015.

The long-run rent index is based on the rent component of the consumer price index as published in International Labour Organization (various years). Data are collected by personal or phone interviews. The index covers tenants' rents only, i.e. imputed rents of owner-occupiers are excluded. The main characteristics of the series are summarized in Table B.18.

The main weakness of the long-run rent series is again the lack of correction for quality changes and sample composition shifts. Moreover, the matching of the Portuguese house price and rent series is unfortunately imperfect. While the rent index is only based on data for urban areas throughout, the house price index consistently offers a more comprehensive geographic coverage. Second, no additional information exists on the quality differences that may exist between the dwellings included in the house price and the dwellings included in the rent series. The matching of the series with respect to the exact type of dwelling covered may hence be inaccurate and I need to assume that changes in rents of different types of houses are strongly correlated.

[33] While the data also includes commercial real estate, Azevedo (2016) argues based on evidence presented by Evangelista and Teixeira (2014) that commercial property transactions only account for a small share of all transactions recorded.

[34] Sources are the various issues of the *Annuário estatístico de Portugal*, the *Estatísticas Monetárias e Financeiras*, and the *Boletins Mensais de Estística*.

**Table B.18:** Portugal: sources of rent index, 1948–2015.

| Period | Source | Details |
|---|---|---|
| 1948–2015 | International Labour Organization (various years) | *Geographic Coverage*: 1948–1950: Lisbon, 1951–1953: Lisbon and Porto, 1954–1961: 5 cities, 1962–1976: 6 cities, 1976–2015: 41 cities; *Type(s) of Dwellings*: All kinds of dwellings; *Method*: Average rents. |

**Long-run rent price ratio & housing returns** To construct a long-run rent-price ratio and compute a time-series of housing returns, I follow the rent-price approach (see Section 3.4.1) using a benchmark rent-price ratio for 2013, the house price index presented by Knoll et al. (2017) and the rent index introduced in the previous subsection. For 2013, the MSCI (2016) reports a rent-price ratio for Portuguese residential real estate of 0.037.

Estimates of gross rent-price ratios (i.e. not accounting for maintenance and depreciation) since 2009 are also available from Numbeo.com for one- and three-bedroom apartments within city-centers and in the rest of the country. For 2013, these estimates are consistent with the data reported by MSCI (2016). Unfortunately, to the best of the author's knowledge, no additional independent estimates of rent-price ratios in Portugal are available. Yet, the trajectory of the long-run rent-price ratio is broadly in line with narrative evidence on house price and rent developments.[35]

### B.2.16 Spain

**House price data** Historical data on house prices in Spain are available for 1900–2015.

I rely on the long-run house price index constructed by Amaral (2016) throughout. The author combines data from various sources to arrive at a long-run index. For 1900–1904, the series is based on average transaction prices of new and existing dwellings in Madrid and Barcelona. Data are collected from newspaper advertisements.[36] For 1905–1933, Amaral (2016) uses an average transaction price index constructed by Carmona et al. (forthcoming) based on data for all kinds of

[35]Real house prices in Portugal rose after the end of World War 2 until the Carnation Revolution in 1974. After a brief but substantial house price recession after the revolution, real house prices embarked on a steep incline Azevedo (2016). By contrast, real rents remained broadly stable between 1948 and the mid-1960s as well as after 1990 but exhibit a pronounced boom and bust pattern between the mid-1960s and the mid-1980s. According to Cardoso (1983), the rapid growth of inflation-adjusted rents between the mid-1960s and the mid-1970s was the result of both rising construction costs and high inflation expectations. In 1974, new rent legislation provided for a rent freeze on existing contracts. Rent increases were also regulated between tenancies but unregulated for new construction. These regulations resulted in lower rent growth rates and rents considerably lagging behind inflation (Cardoso, 1983). Average annual real returns, rental yields, and capital yields for Portugal are summarized in Table B.2.

[36]On average, more than 120 observations per year were collected.

**Table B.19:** Spain: sources of rent index, 1870–2015.

| Period | Source | Details |
|---|---|---|
| 1870–1936 | Maluquer de Motes (2013) | *Geographic Coverage*: Catalunya; *Type(s) of Dwellings*: All kinds of dwellings; *Method*: Average rents. |
| 1937–1976 | International Labour Organization (various years) | *Geographic Coverage*: 1937–1956: 50 cities; 1957–1976: Nationwide; *Type(s) of Dwellings*: All kinds of dwellings; *Method*: Weighted average rents. |
| 1977–2015 | Statistics Spain (2016) | *Geographic Coverage*: Nationwide; *Type(s) of Dwellings*: All kinds of dwellings; *Method*: Weighted average rents. |

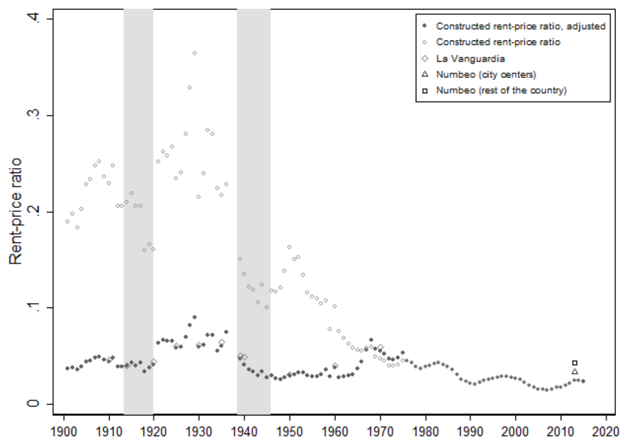
existing dwellings drawn from the *Registrars' Yearbooks*. For 1934–1975, Amaral (2016) uses transaction price data for new and existing dwellings collected from the *Registrars' Yearbooks* to construct a weighted average house price index covering Spain as a whole. For 1976–1986, the authors relies on a series of average transaction prices per square meter of new dwellings in Madrid constructed by the real estate agency *Tecnigrama*. For 1987–1994, the series is based on weighted average transaction prices per square meter of new and existing dwellings collected by the Spanish Ministry of Housing covering Spain as a whole. For the years after 1995, he relies on a nationwide index published by the Spanish Ministry of Public Works and Transports which reflects average transaction prices per square meter for new and existing dwellings.

**Rent data** Historical data on rents in Spain are available for 1870–2015.

The earliest source for data on rents in Spain is Maluquer de Motes (2013) covering average rents of all kinds of dwellings in Catalunya between 1870 and 1933. Data are drawn from archival records and from the *Registrars' Yearbooks*. For the years since 1935, the long-run rent index is based on the CPI rent index as published in the yearbooks of the International Labour Organization (various years) and Statistics Spain (2016). The index covers tenants' rents only, i.e. imputed rents of owner-occupiers are excluded. The available series are spliced as shown in Table B.19.

The single most important drawback of the long-run rent series is again the lack of correction for quality changes and sample composition shifts. Moreover, the matching of the Spanish house price and rent series is unfortunately imperfect. While the rent index is only based on data for urban areas before 1976, the house price data covers the whole of Spain. The opposite is true for the years between 1987 and 1994. After 1994, both series provide nationwide coverage. Second, no additional information exists on the quality differences that may exist between the dwellings included in the house price and the dwellings included in the rent series. The matching of the series with respect to the exact type of dwelling covered may hence be inaccurate and I need to assume that changes in rents of different types of houses are strongly correlated.

**Figure B.15:** Spain: plausibility of rent-price ratio.




**Long-run rent price ratio & housing returns** To construct a long-run rent-price ratio and compute a time-series of housing returns, I follow the rent-price approach (see Section 3.4.1) using a benchmark rent-price ratio for 2013, the house price index presented by Knoll et al. (2017) and the rent index introduced in the previous subsection. For 2013, the MSCI (2016) reports the rent-price ratio for Spanish residential real estate of 0.025. Figure B.15 displays the resulting long-run rent-price ratio along with independent estimates as detailed below.

I obtain several scattered independent estimates of rent-price ratios in Spain. First, estimates of gross rent-price ratios (i.e. not accounting for maintenance and depreciation) since 2009 are also available from Numbeo.com for one- and three-bedroom apartments within city-centers and in the rest of the country. For 2013, these estimates are comparable to the data reported by MSCI (2016) (see Figure B.15). Second, I collected scattered data on rent-price ratios from advertisements for Barcelona residential real estate in *La Vanguardia* for benchmark years (1910, 1914, 1920, 1925, 1930, 1935, 1940, 1950, 1960, 1970). For each of the benchmark years, I construct an average rent-price ratio based on between 25 and 46 advertisements. Figure B.15 shows that these estimate are significantly below the rent-price ratio for the benchmark years between 1910 and 1960. Yet it also suggests that rent-price ratios were generally higher before the mid-1950s. Similar to Australia (see Appendix section B.2.5), this trajectory may reflect difficulties of the Spanish statistical office to construct a rent index after the introduction of rent freezes in the 1930s and during the years of strong rent regulation after World War 2. While the rent freeze was lifted in 1945, these regulations remained effective until the mid-1960s (see Table B.7). Specifically, the data suggests that rents between the end of World War 2 and the mid-1960s increased substantially less than house prices. To the best of my knowledge, no quantitative or qualitative evidence exists supporting such a pronounced fall in the rent-price ratio in the immediate post-World War 2 years or a generally higher level of rental yields prior to the 1960s. To mitigate this bias, I adjust the growth rate in rents between 1910 and 1960 so the adjusted long-run rent-price ratio concords with the independent estimates obtained from *La Vanguardia*. Figure B.15 displays the resulting adjusted long-run rent-price ratio. Average annual real returns, rental yields, and capital yields for Spain are summarized in Table B.2.

### B.2.17 Sweden

**Rent data** Historical data on rents in Sweden are available for 1883–2015.

The earliest source for data on rents in Sweden is Myrdal (1933). For 1883–1913, Myrdal (1933) reports an index of average rents per room in Stockholm based on data published in the *Stockholm list of houses to let (Stockholms hyreslista)*, a publication advertising dwellings to let edited by the *Stockholms Intecknings Garanti Aktiebolag*. For 1913/14–1931, Myrdal (1933) reports the rent component of the cost of living index of the Social Board based on housing surveys and covering working or lower middle class dwellings in more than 40, predominantly urban, municipalities (Statistics Sweden, 1933).

For the years since 1932, the long-run rent index is based on the rent component of the consumer price index as published in International Labour Organization (various years); Statistics Sweden (1961) and Statistics Sweden (1933). The main characteristics of this series are summarized in Table B.20. The available series are spliced as shown in Table B.20.

The most important drawback of the long-run rent series is again the imperfect of correction for quality changes and sample composition shifts. Both aspects may be less problematic for years prior to 1931 since the rent index reflects average rents per room. Note further that the matching of the Swedish house price and rent series in terms of geographical coverage has been largely possible. For the years prior to 1960, both series are based on for urban areas. For the years after 1960, however, the rent index provides a more comprehensive geographical coverage compared to the house price series. Moreover, no additional information exists on the quality differences that may exist between the dwellings included in the house price and the dwellings included in the rent series. The matching of the series with respect to the exact type of dwelling covered may hence be imperfect and I need to assume that changes in rents of different types of houses are strongly correlated.

**Long-run rent price ratio & housing returns** To construct a long-run rent-price ratio and compute a time-series of housing returns, I follow the rent-price approach (see Section 3.4.1) using a benchmark rent-price ratio for 2013, the house price index presented by Knoll et al. (2017) and the rent index introduced in the previous subsection. For 2013, the MSCI (2016) reports the rent-price ratio for Swedish residential real estate of 0.036. Figure B.16 displays the resulting long-run rent-price ratio along with independent estimates as detailed below.

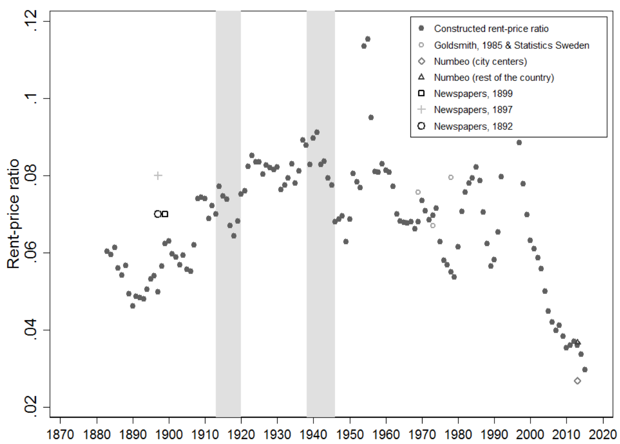
I obtain three independent estimates of rent-price ratios. First, the resulting long-run rent-price ratio appears to be – in line with rent-price ratios reported in several newspaper advertisements and articles. According to these sources, rent-price ratios were in the range of 0.07 to 0.08 in the late 19th century (Dagens

**Table B.20:** Sweden: sources of rent index, 1883–2015.

| Period | Source | Details |
|---|---|---|
| 1882–1913 | Myrdal (1933) | *Geographic Coverage*: Stockholm; *Type(s) of Dwellings*: All kinds of dwellings; *Method*: Average rents per room. |
| 1914–1931 | Myrdal (1933) | *Geographic Coverage*: Urban areas; *Type(s) of Dwellings*: All kinds of dwellings; *Method*: Average rents per room. |
| 1932–1959 | Statistics Sweden (1961, 1933) | *Geographic Coverage*: Urban areas; *Type(s) of Dwellings*: All kinds of dwellings; *Method*: Average rents. |
| 1960–2015 | International Labour Organization (various years) | *Geographic Coverage*: Nationwide; *Type(s) of Dwellings*: All kinds of dwellings; *Method*: Average rents. |

Nyheter, 1899, 1897, 1892) and residential real estate was perceived as highly profitable investment at the time. By comparison, the rent-price ratio constructed by merging the indices of house prices and rents was on average about 0.053 during the last years of the 19th century (see Figure B.16). Second, I calculate a rent-price ratio for benchmark years (1969, 1973, 1979) using data on total housing value (Goldsmith, 1985) and total expenditure on rents (data drawn from Statistics Sweden[37]). Reassuringly, the resulting estimates appear consistent with the long-run rent-price ratio (see Figure B.16). Finally, estimates of gross rent-price ratios (i.e. not accounting for maintenance and depreciation) since 2009 are also available from Numbeo.com for one- and three-bedroom apartments within city-centers and in the rest of the country. For 2013, these estimates are comparable to the data reported by MSCI (2016) (see Figure B.16). Average annual real returns, rental yields, and capital yields for Sweden are summarized in Table B.2.

**Figure B.16:** Sweden: plausibility of rent-price ratio.




[37]Series sent by email, contact person is Birgitta Magnusson Wärmark, Statistics Sweden.

### B.2.18 Switzerland

**Rent data** Historical data on rents in Switzerland are available for 1890–2015.

The earliest source for rent data in Switzerland is Curti (1981). Curti (1981) separately calculates indices of rents for 3-room apartments for five cities (Zurich, Winterthur, Bern, Biel, and Basel) and the Zurich highlands for 1890–1910. Data are collected from newspaper advertisements.[38] For 1908–1920, Curti (1981) relies on data from the city of Zurich housing authority (as collected by Statistics Zurich). Curti (1981) adjusts the 3-year moving average of the spliced series so as to conform with the average rents of 3 room apartments according to the housing censuses of 1896, 1910 and 1920. Since for the years prior to 1930 the house price index for Switzerland is based on data for Zurich only (Knoll et al., 2017), I use the city index for Zurich for 1890–1910 to construct a long-run rent index.

For 1920–1939, I rely on the index of average rents for 3 room apartments in six working class neighborhoods as published by Statistics Zurich (1946–1962).[39]

For 1940–2015, the long-run index is based on the rent component of the consumer price index as published by Statistics Switzerland (2015). The series refers to new and existing 1-5 room apartments in 89 municipalities. Data are collected through surveys of households and the index is calculated as a weighted average.[40] The index is adjusted for major quality changes. The index covers tenants' rents only, i.e. imputed rents of owner-occupiers are excluded. The available series are spliced as shown in Table B.21.

**Table B.21:** Switzerland: sources of rent index, 1890–2015.

| Period | Source | Details |
|---|---|---|
| 1890–1919 | Curti (1981) | *Geographic Coverage*: Zurich; *Type(s) of Dwellings*: 3 room apartment; *Method*: Average rent. |
| 1920–1939 | Statistics Zurich (1946–1962) | *Geographic Coverage*: Zurich; *Type(s) of Dwellings*: 3 room apartment; *Method*: Average rent. |
| 1940–2015 | Statistics Switzerland (2015) | *Geographic Coverage*: Nationwide; *Type(s) of Dwellings*: New and existing 1-5 room apartments; *Method*: Weighted average rent, adjusted for quality changes. |

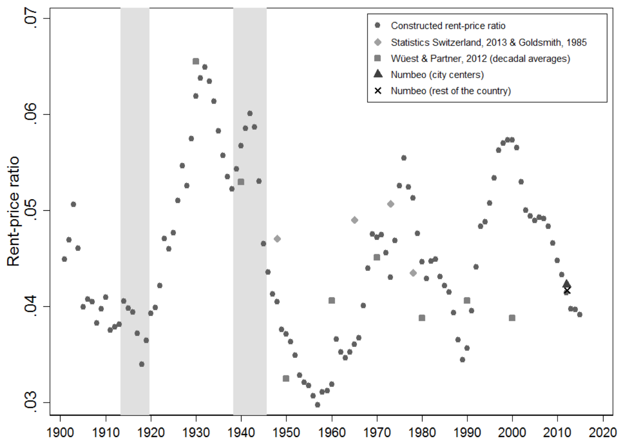
The main weakness of the long-run rent series is the lack of adjustment for quality changes for the pre-World War 2 period. Sample composition shifts are unlikely to affect the index since data reflects the rent of 3-room apartments only. Note further, that matching the rent and the house price series with respect to geographic coverage has been largely possible. Both series before the 1930s are based on data for Zurich and for the whole of Switzerland after 1940. Yet, no

[38]The author collects about 30 advertisements per year from *Tagblatt der Stadt Zürich*.

[39]These are Aussersihl, Industriequartier, Wiedikon, Wipkingen, and Unter- and Oberstrass.

[40]The number of the different kinds of apartments (new and existing) is used as weights.

**Figure B.17:** Switzerland: plausibility of rent-price ratio.




additional information exists on the quality differences that may exist between the dwellings included in the house price and the dwellings included in the rent series. The matching of the series with respect to the exact type of dwelling covered may hence be imperfect and I need to assume that changes in rents of different types of houses are strongly correlated.

**Long-run rent price ratio & housing returns** To construct a long-run rent-price ratio and compute a time-series of housing returns, I follow the rent-price approach (see Section 3.4.1) using a benchmark rent-price ratio for 2013, the house price index presented by Knoll et al. (2017) and the rent index introduced in the previous subsection. For 2013, the MSCI (2016) reports the rent-price ratio for Swiss residential real estate of 0.040. Figure B.17 displays the resulting long-run rent-price ratio along with independent estimates as detailed below.

To corroborate the plausibility of the long-run rent-price ratio, I obtain four independent estimates. First, Real (1950) reports real returns on residential real estate in Zurich of 6 percent in 1927 and 7.3 percent in 1933. These data are – by and large – in line with the estimates of housing returns constructed by merging the indices of house prices and rents.[41] Second, Wüest and Partner (2012) estimate 10-year averages of real rental yields in Switzerland for 1920–2000. Again, the resulting estimates appear to be broadly consistent with the long-run rent-price ratio (Figure B.17). For the post-World War 2 period, I calculate rent-price ratios for benchmark years (1948, 1965, 1973, 1978) using the data drawn from Goldsmith (1985) and Statistics Switzerland (2014). Reassuringly, the resulting estimates appear consistent with the long-run rent-price ratio (Figure B.17). It is important to note, however, that the long-run rent-price ratio accounts for maintenance and depreciation while combining data from (Goldsmith, 1985) and (Hoffmann, 1965) results in an estimate of gross rent-price ratios. In fact, in most cases, the benchmark rent-price estimates are somewhat higher compared to the long-run rent-price ratio. Finally, estimates of gross rent-price ratios (i.e. not accounting

[41] Average annual real gross returns of 8 percent for 1920–1929 and 7 percent for 1930–1939.

for maintenance and depreciation) since 2009 are also available from *Numbeo.com* for one- and three-bedroom apartments i) within city-centers and ii) in the rest of the country.[42] For 2013, these estimates are comparable to the data reported by MSCI (2016) (Figure B.17). Average annual real returns, rental yields, and capital gains for Switzerland are summarized in Table B.2.

### B.2.19 United Kingdom

**Rent data** Historical data on rents in the United Kingdom are available for 1874–2015.

For 1874–1914, I rely on an index of average rents by Lewis and Weber (1965). The series is based on property valuations for the *Inhabited House Duty*, a tax applied to residential houses with an annual rental value of 20 GBP or more.[43]

For 1914–1938, the long-run rent index is based on the rent component of the official cost of living index compiled by the Ministry of Labor (as reported by Holmans (2005) and International Labour Organization (various years)). The series refers to average rents of working class dwellings in more than 500 towns. It is worth noting that the index reflects not only increases in rent proper but also in domestic rates.[44]

For the post-World War 2 period, I use the rent component of the consumer price index as published in the yearbooks of the International Labour Organization (various years). Data are collected through surveys and cover also subsidized dwellings. For the years since 1956, the series includes expenditures on maintenance and repair. To the best of my knowledge, no data on rents exists between 1946 and 1954. To link the pre- and post-World War 2 series, I use scattered data on average rents of houses and flats let by local authorities 1936–1957 presented by Holmans (2005). The available series are spliced as shown in Table B.22.

The most important limitation of the long-run rent series is the lack of correction for quality changes and sample composition shifts. As noted above, the latter aspect may be less of a problem for the years 1914–1946 since the index is confined to a specific and presumably relatively homogeneous market segment, i.e. working class dwellings. The matching of the U.K. house price and rent series in terms of geographical coverage has been largely possible. Both series are based on data for the whole of the U.K. after World War 2. The house price series reflects urban developments prior to 1930 as does the rent index during the interwar period. Yet, the rent series provides a more comprehensive coverage prior to World War

[42] Numbeo.com is a large database on world living conditions.

[43] The index may hence include an element of quality increase as well as a true increase in rents. Holmans (2005), for the period the index covers, estimates a quality increase of about 0.3 percent a year. Yet, while accounting for quality changes would thus result in a downward correction of the rent index, there is little doubts that rents significantly increased over the period 1874–1914.

[44] According to Holmans (2005), in the housing market for working class families, dwellings were generally let at a rent that included domestic rates. Landlords recouped the rates they paid to local authorities through the rents they charged. While the dwellings may have thus been subject to rent controls according to the Rent Restriction Acts (see Table B.7), increases in total rents to recoup increases in domestic rates were not limited according to these acts.

**Table B.22:** United Kingdom: sources of rent index, 1874–2015.

| Period | Source | Details |
|---|---|---|
| 1874–1913 | Lewis and Weber (1965) | *Geographic Coverage*: Nationwide; *Type(s) of Dwellings*: All kinds of dwellings; *Method*: Average rents. |
| 1914–1946 | Rent component of official consumer price index as published in Holmans (2005) and International Labour Organization (various years) | *Geographic Coverage*: Urban areas; *Type(s) of Dwellings*: Working class dwellings; *Method*: Average rents. |
| 1954–2013 | Rent component of official consumer price index as published in International Labour Organization (various years) | *Geographic Coverage*: Nationwide; *Type(s) of Dwellings*: All kinds of dwellings; *Method*: |

1 compared to the house price series. Moreover, to the best of my knowledge, no information exists on the quality differences that may exist between the dwellings included in the house price and the dwellings included in the rent series. The matching of the series with respect to the exact type of dwelling covered may hence be imperfect and I need to assume that changes in rents of different types of houses are strongly correlated.

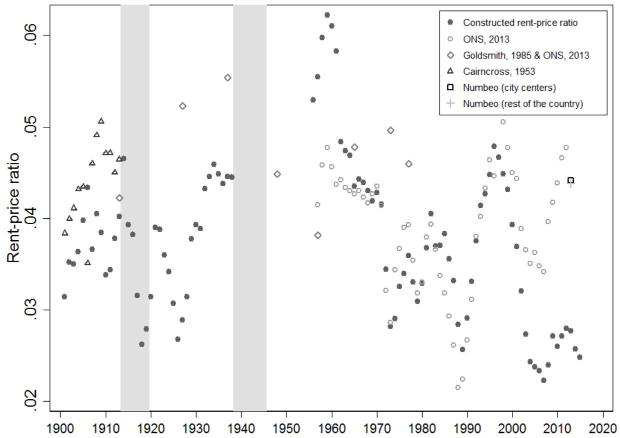
**Long-run rent price ratio & housing returns** To construct a long-run rent-price ratio and compute a time-series of housing returns, I follow the rent-price approach (see Section 3.4.1) using a benchmark rent-price ratio for 2013, the house price index presented by Knoll et al. (2017) and the rent index introduced in the previous subsection. For 2013, the MSCI (2016) reports the rent-price ratio for U.K. residential real estate of 0.032. Figure B.18 displays the resulting long-run rent-price ratio along with independent estimates as detailed below.

Some scattered data on rent-price ratios are available for the pre-World War 2 period. For England, Cairncross (1975) reports an average rent-price ratio of 0.043 between 1895 and 1913. Offer (1981) estimates a little higher rent-price ratios for selected years between 1892 and 1913 for occupied leasehold dwellings in London. As Figure B.18 shows, these data are broadly consistent with the long-run rent-price ratios.[45] Tarbuck (1938) states that high quality freehold houses were valued at 25 to 16 years purchase and lower quality freehold houses at 14 to 11 years purchase in the 1930s. Again, these estimates are consistent with the long-run rent-price ratio.

I also calculate rent-price ratios for benchmark years (1913, 1927, 1937, 1948, 1957, 1965, 1973, 1977) based on data on total housing value (Goldsmith, 1985) and total expenditure on rents (Mitchell, 1988). Reassuringly, the resulting estimates appear consistent with the long-run rent-price ratio (Figure B.18).

[45] Average rent-price ratio of 0.037 percent for 1900–1913.

**Figure B.18:** United Kingdom: plausibility of rent-price ratio.




As additional plausibility check for the post-World War 2 period, I calculate a rent-price ratio combining data on total housing value from the Office of National Statistics[46] and total expenditure on rents (Office for National Statistics, 2013a). Again, the resulting estimates of average annual real gross housing returns of 9 percent are consistent with the series summarized in Table B.2.[47]

Finally, estimates of gross rent-price ratios (i.e. not accounting for maintenance and depreciation) since 2009 are also available from *Numbeo.com* for one- and three-bedroom apartments i) within city-centers and ii) in the rest of the country. For 2013, these estimates are comparable to the data reported by MSCI (2016) (Figure B.18). Average annual real returns, rental yields, and capital yields for the U.K. are summarized in Table B.2.

### B.2.20 United States

**Rent data** Historical data on rents in the United States are available for 1890–2015.

For the 1890–1914, the long-run rent index relies on the rent component of the NBER cost of living index for manufacturing wage earners constructed by Rees (1961). The index is based on newspaper advertisements in six cities[48] and is confined to working class dwellings. The aggregate series is a simple average of the city indices. The index controls for differences in size but not for other potential sources of quality differences.

Data for 1915–1940 is available from U.S. Bureau of Labor Statistics (2015)

[46]Series sent by email, contact person is Amanda Bell. Even though the series includes data for the whole 1957-2012 period, a number of definitional changes occurred during the transition from the European System of Accounts (ESA) ESA1979 to ESA1995 in 1998. At the time, these series were not joined together and this is likely to indicate a definitional difference.

[47]Average annual real gross housing returns of 10 percent on average for 1970–2012.

[48]These are New York, Chicago, Philadelphia, Boston, Cincinnati, St. Louis.

which, in turn, are based on the Bureau of Labor Statistics' rental survey of landlords. The index is based on data on average rents for working class dwellings in 32 shipbuilding and other industrial centers for 1915–1935 and 42 cities with population over 50,000 thereafter. The series is based on comparisons of average rents for identical housing units (Bureau of Labor Statistics, 1966). Yet, several authors made the case for a downward bias of the historical U.S. Bureau of Labor Statistics (2015) rent series (Crone et al., 2010; Gordon and van Goethem, 2007), e.g. due to aging bias or omission of new units. To adjust for the downward bias for 1915–1940, I use estimates by Gordon and van Goethem (2007).[49]

For 1941–1995, the long-run index relies on the revised CPI for tenant rents constructed by Crone et al. (2010). Crone et al. (2010) argue that for the post-1995 period, tenant rents should be correctly calculated in the original U.S. Bureau of Labor Statistics (2015) series. For the post-1995 years, I therefore use the CPI rent index as published by U.S. Bureau of Labor Statistics (2015). The available series are spliced as shown in Table B.23.

Compared to data for other countries, the U.S. rent series is relatively well adjusted for quality changes and sample composition shifts. Also, matching the house price and rent series with respect to geographical coverage has been largely possible. Both series rely on data for urban areas prior to World War 2. Yet, while this is still true for the post-World War 2 rent series, the house price index provides a more comprehensive coverage during that period. Apart from that, to the best of my knowledge, no information exists on the quality differences that may exist between the dwellings included in the house price and the dwellings included in the rent series. The matching of the series with respect to the exact type of dwelling covered may hence be imperfect and I need to assume that changes in rents of different types of houses are strongly correlated.

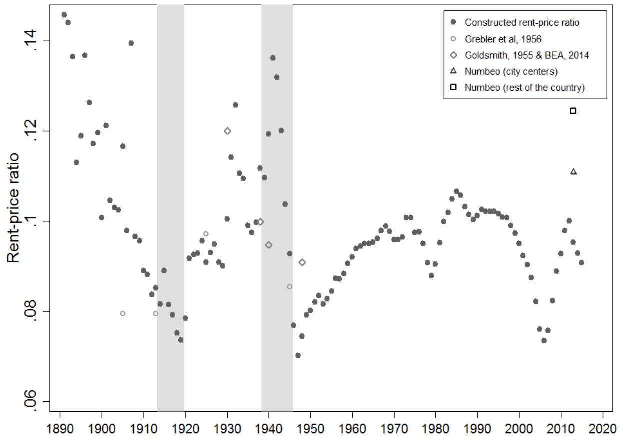
**Table B.23:** United States: sources of rent index, 1890–2015.

| **Period** | **Source** | **Details** |
|---|---|---|
| 1890–1914 | Rees (1961) | *Geographic Coverage*: Urban areas; *Type(s) of Dwellings*: All kinds of working class dwellings; *Method*: Stratification. |
| 1915–1940 | U.S. Bureau of Labor Statistics (2015), adjusted using estimates by Gordon and van Goethem (2007) | *Geographic Coverage*: Urban areas; *Type(s) of Dwellings*: Working class dwellings; *Method*: Average rents. |
| 1941–1995 | Crone et al. (2010) | *Geographic Coverage*: Urban areas; *Type(s) of Dwellings*: All kinds of dwellings; *Method*: Stratification. |
| 1996–2015 | U.S. Bureau of Labor Statistics (2015) | *Geographic Coverage*: Urban areas; *Type(s) of Dwellings*: All kinds of dwellings; *Method*: Stratification. |

[49] Gordon and van Goethem (2007) estimate a CPI bias of -0.86 percent per year for 1914–1935 and of -1.04 percent for 1935–1960.

**Long-run rent price ratio & housing returns** To construct a long-run rent-price ratio and compute a time-series of housing returns, I follow the rent-price approach (see Section 3.4.1) using a benchmark rent-price ratio, the house price index presented by Knoll et al. (2017) and the rent index introduced in the previous subsection. I rely on a rent-price ratio of 0.1 from the real estate portal Trulia for 2012 as suggested by Giglio et al. (2016) as benchmark. Figure B.19 displays the resulting long-run rent-price ratio along with independent estimates as detailed below.

**Figure B.19:** United States: plausibility of rent-price ratio.




I obtain independent estimates of U.S. rent-price ratios from three additional sources. First, decadal averages of price-rent ratios are available for 1899–1938 from Grebler et al. (1956) ranging between 10.4 and 12.6. Overall, these data are very similar to the price-rent ratios resulting from merging the indices of house prices and rents (see Figure B.19). As additional plausibility check, I calculate a rent-price ratio for benchmark years (1930, 1938, 1940, 1948) using the data drawn Goldsmith (1955) and Bureau of Economic Analysis (2014). Reassuringly, the resulting estimates are comparable to the long-run rent-price ratio. Finally, estimates of gross rent-price ratios (i.e. not accounting for maintenance and depreciation) since 2009 are also available from *Numbeo.com* for one- and three-bedroom apartments i) within city-centers and ii) in the rest of the country. Given that the data from *Numbeo.com* is not adjusted for maintenance and depreciation, it is unsurprising that these estimates are somewhat higher compared to the long-run rent-price ratio (see Figure B.19). Average annual real returns, rental yields, and capital yields for the U.S. are summarized in Table B.2.

Appendix C

# Appendix to Chapter 4

# Household Debt and Economic Recovery: Evidence from the U.S. Great Depression

## C.1 Supplementary material

**Table C.1:** Explanatory factor analysis.

| | Eigenvalue | Difference | Proportion | Cumulative |
|---|---|---|---|---|
| Factor 1 | 3.616 | 3.397 | 0.904 | 0.90 |
| Factor 2 | 0.219 | 0.111 | 0.055 | 0.96 |
| Factor 3 | 0.108 | 0.053 | 0.027 | 0.99 |
| N | | | | 192 |

**Table C.2:** Scoring coefficients.

| | Factor1 |
|---|---|
| *INC* | 0.267 |
| *WAGE* | 0.252 |
| *EMP* | 0.268 |
| *SALES* | 0.264 |

**Table C.3:** Loading patterns.

| | Factor1 | Uniqueness |
|---|---|---|
| *INC* | 0.967 | 0.065 |
| *WAGE* | 0.912 | 0.168 |
| *EMP* | 0.954 | 0.060 |
| *SALES* | 0.969 | 0.091 |

**Table C.4:** Summary statistics.

| | Mean | Min | Max | Std. Dev. | N |
|---|---|---|---|---|---|
| $Factorscore_{1929}$ | 187.20 | 96.01 | 286.37 | 52.30 | 48 |
| $Factorscore_{1933}$ | 124.51 | 56.96 | 223.12 | 39.21 | 48 |
| $Factorscore_{1939}$ | 190.88 | 96.44 | 315.82 | 59.48 | 48 |

**Table C.5:** Regression results recovery, 1933–1937 and 1933–1939 (including data on mortgage loans outstanding made by savings & loan associations).

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|---|---|---|---|---|---|---|---|
| | $\Delta\ INC_{s,1933-39}$ | $\Delta\ WAGE_{s,1933-39}$ | $\Delta\ EMP_{s,1933-39}$ | $\Delta\ SALES_{s,1933-39}$ | $\Delta\ INC_{s,1933-37}$ | $\Delta\ WAGE_{s,1933-37}$ | $\Delta\ EMP_{s,1933-37}$ |
| $DEBT2_{s,1929}$ | -0.316*** | -0.264*** | -0.375** | -0.376** | -0.286** | -0.236*** | -0.275* |
| | (0.082) | (0.268) | (0.150) | (0.160) | (0.120) | (0.061) | (0.141) |
| $INC_{s,1933}$ | -0.041 | -0.064** | -0.017 | 0.078 | 0.000 | 0.016 | -0.047 |
| | (0.038) | (0.026) | (0.057) | (0.068) | (0.046) | (0.024) | (0.051) |
| $BOUNCEBACK_s$ | -0.303** | -0.146 | -1.542*** | -0.137 | -0.540*** | -0.336*** | -1.709*** |
| | (0.153) | (0.140) | (0.392) | (0.187) | (0.146) | (0.123) | (0.297) |
| $AGRIC_{s,1929}$ | 2.172*** | 0.003 | -0.703 | -0.282 | 1.555*** | 0.317 | -0.399 |
| | (0.255) | (0.218) | (0.572) | (0.607) | (0.455) | (0.407) | (0.462) |
| $MAN_{s,1929}$ | 0.282* | 0.312** | -0.310 | -0.050 | 0.185 | 0.096 | -0.056 |
| | (0.157) | (0.157) | (0.251) | (0.233) | (0.162) | (0.139) | (0.224) |
| $NEWDEAL_s$ | -0.001 | 0.001 | 0.001 | 0.001 | -0.001 | 0.000 | 0.001 |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| $MONPOL_s$ | -0.035** | -0.033* | -0.049* | -0.019 | -0.018 | -0.018 | -0.035* |
| | (0.017) | (0.013) | (0.025) | (0.025) | (0.019) | (0.013) | (0.020) |
| Constant | 0.224** | 0.050*** | 0.079** | 0.352*** | 0.164** | 0.227*** | 0.182*** |
| N | 45 | 46 | 45 | 45 | 45 | 45 | 43 |
| $R^2$ | 0.716 | 0.521 | 0.504 | 0.248 | 0.688 | 0.531 | 0.527 |

*Notes:* Standard errors in parentheses; *** p<0.01, ** p>0.05, * p<0.1. Standard errors are heteroskedasticity-robust.

**Table C.6:** Regression results recovery, 1933–1937 and 1933–1939 (weighted by state size).

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|---|---|---|---|---|---|---|---|
| | $\Delta\ INC_{s,1933-39}$ | $\Delta\ WAGE_{s,1933-39}$ | $\Delta\ EMP_{s,1933-39}$ | $\Delta\ SALES_{s,1933-39}$ | $\Delta\ INC_{s,1933-37}$ | $\Delta\ WAGE_{s,1933-37}$ | $\Delta\ EMP_{s,1933-37}$ |
| $DEBT_{s,1929}$ | -0.317*** | -0.304*** | -0.370** | -0.561** | -0.229** | -0.340*** | -0.211 |
| | (0.093) | (0.098) | (0.168) | (0.222) | (0.113) | (0.103) | (0.196) |
| $INC_{s,1933}$ | -0.050 | -0.019 | -0.001 | 0.090 | -0.051 | 0.051 | 0.002 |
| | (0.040) | (0.023) | (0.061) | (0.064) | (0.045) | (0.034) | (0.061) |
| $BOUNCEBACK_s$ | -0.372** | -0.527*** | -1.577*** | 0.016 | -0.640*** | -0.595*** | -2.051*** |
| | (0.202) | (0.121) | (0.399) | (0.244) | (0.180) | (0.108) | (0.331) |
| $AGRIC_{s,1929}$ | 2.660*** | 0.449* | -0.573 | 0.628 | 1.645*** | 1.005 | -0.317 |
| | (0.351) | (0.252) | (0.499) | (0.742) | (0.275) | (0.460) | (0.457) |
| $MAN_{s,1929}$ | 0.208* | 0.084 | -0.457*** | -0.036 | 0.209 | -0.062 | -0.377** |
| | (0.117) | (0.093) | (0.156) | (0.189) | (0.113) | (0.092) | (0.157) |
| $NEWDEAL_s$ | -0.002 | 0.001 | 0.001 | -0.001 | -0.002 | -0.0001 | 0.001 |
| | (0.001) | (0.001) | (0.001) | (0.002) | (0.001) | (0.001) | (0.001) |
| $MONPOL_s$ | -0.027 | -0.017 | -0.015 | -0.016 | -0.016 | -0.011 | -0.005 |
| | (0.021) | (0.014) | (0.032) | (0.038) | (0.020) | (0.015) | (0.028) |
| Constant | 0.237*** | 0.221*** | 0.222*** | 0.421*** | 0.171** | 0.161*** | 0.187*** |
| N | 48 | 49 | 48 | 48 | 48 | 48 | 47 |
| $R^2$ | 0.781 | 0.655 | 0.557 | 0.310 | 0.767 | 0.701 | 0.648 |

*Notes:* Standard errors in parentheses; *** p<0.01, ** p>0.05, * p<0.1. Standard errors are heteroskedasticity-robust.

**Table C.7:** Regression results recovery, 1933–1937 and 1933–1939 - Deleveraging.

| | (1) $\Delta\ INC_{s,1933-39}$ | (2) $\Delta\ WAGE_{s,1933-39}$ | (3) $\Delta\ EMP_{s,1933-39}$ | (4) $\Delta\ SALES_{s,1933-39}$ | (5) $\Delta\ INC_{s,1933-37}$ | (6) $\Delta\ WAGE_{s,1933-37}$ | (7) $\Delta\ EMP_{s,1933-3}$ |
|---|---|---|---|---|---|---|---|
| $DELEV_s$ | 0.084*** | 0.056*** | 0.055* | 0.082** | 0.087* | 0.070* | 0.028 |
| | (0.025) | (0.019) | (0.033) | (0.038) | (0.051) | (0.041) | (0.043) |
| $INC_{s,1933}$ | -0.054 | -0.075 | -0.063 | 0.057 | -0.002 | -0.007 | -0.072* |
| | (0.037) | (0.027) | (0.042) | (0.053) | (0.045) | (0.029) | (0.043) |
| $BOUNCEBACK_s$ | -0.401*** | -0.138 | -0.408 | -0.255 | -0.657*** | -0.248** | -1.687*** |
| | (0.146) | (0.103) | (0.328) | (0.159) | (0.161) | (0.120) | (0.314) |
| $AGRIC_{s,1929}$ | 2.182*** | -0.129 | -0.614* | -0.212 | 1.636*** | 0.110 | -0.361 |
| | (0.245) | (0.256) | (0.306) | (0.644) | (0.393) | (0.402) | (0.502) |
| $MAN_{s,1929}$ | 0.185 | 0.189 | -0.114 | -0.148 | 0.043 | 0.133 | -0.195 |
| | (0.122) | (0.092) | (0.174) | (0.162) | (0.145) | (0.111) | (0.206) |
| $NEWDEAL_s$ | -0.001 | 0.001 | 0.002** | 0.001 | -0.001 | 0.000 | 0.000 |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| $MONPOL_s$ | -0.038** | -0.039*** | -0.026 | -0.022 | -0.017 | -0.0260* | -0.032 |
| | (0.016) | (0.014) | (0.018) | (0.024) | (0.016) | (0.016) | (0.020) |
| Constant | 0.164** | 0.310*** | 0.237** | 0.278*** | 0.118* | 0.208*** | 0.292*** |
| N | 48 | 48 | 48 | 48 | 49 | 48 | 47 |
| $R^2$ | 0.725 | 0.386 | 0.316 | 0.221 | 0.681 | 0.277 | 0.470 |

*Notes:* Standard errors in parentheses; *** p<0.01, ** p>0.05, * p<0.1. Standard errors are heteroskedasticity-robust.

## C.2 Data appendix

Data on credit is drawn from the All Bank Statistics (ABS) (Board of Governors of the Federal Reserve System, 1959). The ABS include data on bank balance sheets by bank class and by state for the period 1896–1955, with total loan amounts being recorded on June 30 for each year. Real estate loans include loans on farm land, loans on residential properties, loans on other properties, bonds and mortgages, mortgages purchased, and mortgages owned. When using the mortgage debt-to-income ratio, controlling for agricultural states is particularly important because a considerable share of real estate loans might be loans on farm land. Overall, the share of farm mortgages was between 20 and 30 percent of total mortgages during the period in which real estate loans were reported in the ABS (1925–1937). Nevertheless, the real estate loans reported in the ABS are a good proxy for total residential mortgage lending (as discussed in Section 4.3.1 of Chapter C). The source also contains data on loans on collateral and other loans. Before 1928, loans on collateral include: loans on demand or time secured by stocks and bonds, loans on demand or time secured by other personal securities including merchandise, warehouse receipts, etc., loans on securities, loans on demand or time secured by collateral, and loans secured by collateral other than real estate. For the period 1929–1938, however, loans on collateral only include loans with securities as collateral. All other loans include: loans on personal security; loans on depositors' books; acceptances or bills of exchange purchased or discounted; syndicate participations; customers' liability on account or drafts paid under letters of credit; advances to trust estates; personal loans; commercial paper bought in open market; overdrafts; notes and bills rediscounted loans to banks and trust companies not secured by collateral; loans and discounts not classified. With such a variety of loans, it is difficult to explain why loans in this category might have decreased or increased over time.

The federal government did not initiate a monthly survey of the labor force as defined today until 1940 (Margo, 1993). Hence, unemployment statistics for the 1930s are not entirely reliable. The employment index as calculated by Wallis (1989) is based on establishment surveys of employment conducted by the Bureau of Labor Statistics (BLS). The BLS, in turn, reports changes in employment over two month periods for firms that reported for both months. This means that the data is biased: it does not include reports of new firms and firms that stopped operations. To construct a yearly index, Wallis (1989) benchmarked the estimated employment changes to known employment totals such as the *Census of Manufactures*. The author provides three employment indices: total employment, manufacturing employment, and nonmanufacturing employment. According to the author, the nonmanufacturing index is less reliable than the manufacturing index, as nonmanufacturing indices had to be approximated while manufacturing employment was collected by the BLS.

Income data is drawn from the series "Personal Income by States, 1929–1954" reported in the *Survey of Current Business* (Schwartz and Graham, 1955). It includes five different flows of income: i) wage and salary disbursements, ii) other labor income, iii) proprietor's income, iv) property income, and v) transfer payments.

Wages and salary disbursements consist of wages and salaries including compensations of executives, commissions, tips, and bonuses. It covers all payments received in the current period, including retroactive wages. Contributions made by employees for social insurance are deducted from the income flows. Other labor income covers the following: contributions made by employers to health and welfare funds and private pensions; pay of military reservists; compensation for injuries; and director's fees. Proprietor's income includes the net business earnings from owners of noncorporate business both for the farm and nonfarm sector. Property income refers to rental income, cash dividend disbursements by corporations, and personal interest income. As defined here, rental income measures income received from the rental of property, royalties on patents, copyrights and rights to natural resources, and net rental returns to owner-occupants of nonfarm dwellings. Schwartz and Graham (1955) provide additional data disaggregating personal income into its components and wages and salaries by industrial sources. Wages and salaries are subdivided into disbursements received from i) farms, ii) mining, iii) contract construction, iv) manufacturing, v) contract construction, vi) manufacturing, vii) wholesale and retail trade, viii) finance, insurance, and real estate, ix) transportation, x) communication and public utilities, xi) services, xii) government, and xiii) other industries.

Measures of the importance of the manufacturing, agricultural, and construction sector are calculated as the average annual percentage of personal income received from the respective sector in salary and wage disbursements in 1929. The data are drawn from Schwartz and Graham (1956).

The degree of bank distress in a state is measured by the annual average rate of bank suspensions in the period 1929–1933. Data on the number of bank suspensions are drawn from Board of Governors of the Federal Reserve System (1943); data on the number of total banks from the Board of Governors of the Federal Reserve System (1959). The term "bank suspension" refers to banks closed to the public both temporarily or permanently on account of financial difficulties. Suspended banks are closed either by supervisory authorities or by the banks boards of directors. Banks closed during the bank holiday in 1933 have not been counted as suspensions. Banks that merged with other banks without closing are also not counted as suspensions. The same holds for banks that agreed with depositors to defer the withdrawal of a part of their deposits. Banks that closed and reopened later or were taken over by other institutions after having closed are counted as suspensions.

Data on lending and spending of the federal government as part of New Deal programs 1933–1939 are drawn from Fishback et al. (2003). The measure used includes New Deal grants and loans. Grants include Federal Emergency Relief Administration grants, Civil Work Administration grants, Works Progress Administration grants, Public Assistance grants provided under the Social Security Act, Public Work Administration federal grants, Public Works Administration nonfederal grants, Public Roads Administration grants, Public Buildings Administration grants, Agricultural Adjustment Act grants, Farm Security Administration grants, and U.S. Housing Administration grants. Loans include Public Works Administration nonfederal loans, Farm Credit Administration loans, Rural Electrification

Administration loans, Reconstruction Finance Corporation loans, Home Owners Loan Corporation loans, and U.S. Housing Administration loan contracts. For the conversion into per capita grants and loan dollars, population data for 1930 was used. County-level data on retail sales were drawn from Fishback et al. (2005) and converted into state-level data. For retail sales data for 1933, the authors used the *Consumer Market Data Handbook* as published by the U.S. Department of Commerce in 1936. For retail sales data for 1939, the authors relied on "Historical, Demographic, Economic, and Social Data: The United States, 1790–1970, ICPSR study number 0003," as corrected by Michael Haines. As there are no data on retail sales in 1937, the period of recovery cannot be analyzed for consumption as has been done for per capita, salaries and wages per capita, and employment.

Federal Reserve Districts cut across state lines. If a state has two different regional Federal Reserve Banks, the state is assigned to the District that includes the larger share of its population (Board of Governors of the Federal Reserve System, 1933). Accordingly, CT is assigned to the 1st District; NJ to the 2nd; PA to the 3rd; WV to the 5th; LA and TN to the 6th; IL, IN, MI and WI to the 7th; MS, MO, and KY to the 8th; NM and OK to the 10th; AZ to the 12th. Discount rates set by the regional Federal Reserve Banks are drawn from Board of Governors of the Federal Reserve System (1943).

For calculating per capita values on debt and income, annual estimates for population by state were constructed using data drawn from Haines (2006) and U.S. Bureau of the Census (various years). Haines (2006) provides state-level data on population for the census years 1920, 1930, and 1940. U.S. Bureau of the Census (various years) reports annual national population for the whole period. Combining these two series, the average annual percentage change in the national data was used for the interpolation of the state-level decadal census data. Even though this data might not cover short-term fluctuations, it provides reliable estimates on general trends of growth or decline in population on a state level.

To adjust for inflation, I relied on the *Consumer Price Index for All Urban Consumers (All Items)* as reported by U.S. Bureau of Labor Statistics (2012).

Appendix D

# Translation of Names of Statistical Offices

For convenience, names of regional or national statistical offices have been translated into English. Except for Statistics Canada, the Office for National Statistics (United Kingdom) and the U.S. statistical agencies, statistical offices are referred to as *Statistics [Name of Country or City]*, both in the text and in the bibliography.

Full original names of statistical offices are listed below.

| | |
|---|---|
| Statistics Amsterdam | Bureau van Statistiek der Gemeente Amsterdam |
| Statistics Belgium | Algemene Directie Statistiek, Direction Générale Statistique |
| Statistics Berlin | Statistisches Amt der Stadt Berlin |
| Statistics Copenhagen | Københavns Statistiske Kontor |
| Statistics Denmark | Danmarks Statistik |
| Statistics France | Institut National de la Statistique et des Études Économiques |
| Statistics Germany | Statistisches Bundesamt (since 1950), Statistisches Reichsamt (1918–1948) |
| Statistics Helsinki | Helsingin Kaupungin Tilastokonttori |
| Statistics Japan | Statistics Bureau – Ministry of Internal Affairs and Communications |
| Statistics Netherlands | Centraal Bureau voor de Statistiek |
| Statistics Norway | Statistisk Sentralbyrå |
| Statistics Oslo | Oslo Statistiske Kontor (since 1924), Kristiania Statistiske Kontor (before 1924) |
| Statistics Spain | Instituto Nacional de Estadística |
| Statistics Sweden | Statistiska Centralbyrån |
| Statistics Switzerland | Bundesamt für Statistik |
| Statistics Zurich | Statistik Stadt Zürich |

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Wiesbaden, 21. Februar 2017

# Erklärung

Hiermit versichere ich, Katharina Knoll, dass ich diese Arbeit selbstständig verfasst und alle Quellen ordnungsgemäß gekennzeichnet habe.

Ich versichere, dass die Dissertation nicht bereits in einem früheren Promotionsverfahren angenommen oder als ungenügend beurteilt worden ist.

Katharina Knoll

# Zusammenfassung

Die vorliegende kumulative Dissertationsschrift setzt sich aus drei wissenschaftlichen Einzelbeiträgen zusammen. Der gemeinsame Forschungsschwerpunkt ist die empirische Analyse von Immobilienmärkten westlicher Industrienationen aus wirtschaftshistorischer Perspektive.

Der erste Beitrag (Kapitel 2), *No Price Like Home: Global House Prices, 1870–2012*, analysiert die langfristige Preisentwicklung von Wohnimmobilien. Auf Grundlage umfassender historischer Quellenarbeit werden in diesem Kapitel lange Zeitreihen für Wohnimmobilienpreise in 14 westlichen Industrieländern konstruiert. Die Analyse der aufbereiteten Daten zeigt, dass sich die Preise für Wohneigentum seit dem Ende des 19. Jahrhunderts im Durchschnitt etwa verdreifacht haben. Jedoch war dieser Anstieg im Zeitverlauf nicht kontinuierlich. In den meisten untersuchten Ländern blieben die inflationsbereinigten Häuserpreise zwischen dem späten 19. Jahrhundert und der Mitte des 20. Jahrhunderts nahezu konstant. Seit dem Ende des zweiten Weltkriegs ist hingegen ein erheblicher Preisanstieg zu beobachten. Eine Zerlegung der Wohnimmobilienpreise in Landpreise und Wiederherstellungswerte für Wohngebäude ermittelt den Landpreis als die vorrangige Triebkraft dieser spezifischen Entwicklung. Die Ergebnisse zeigen, dass die Verteuerung von Bauland ca. 80 Prozent des globalen Immobilienpreisbooms seit den 1950er Jahren erklärt. Diese Erkenntnis hat eine Reihe von bedeutenden Implikationen. Zum Einen legt sie nahe, dass steigende Landpreise eine vorrangige Rolle für die Zunahme der Immobilienvermögen während der vergangenen 60 Jahre spielten und somit auch für die Zunahme des Verhältnisses von Privatvermögen zu Nationaleinkommen (wealth-to-income ratio). Zum Anderen kann eine Verteuerung der Landpreise Wirtschaftswachstum durch Agglomerationseffekte direkt beeinflussen. Weiterhin widerspricht die Erkenntnis steigender Landpreise der weitverbreiteten Auffassung einer hohen langfristigen Preiselastizität des Wohnungsangebotes, da diese auf der Annahme von Verfügbarkeit zusätzlichen Landes für Wohnungsbau zu gleichbleibenden Preisen basiert.

Der zweite Beitrag (Kapitel 3), *As Volatile As Houses: Return Predictability in International Housing Markets, 1870–2015*, untersucht die Volatilität der Wohnimmobilienpreise in 16 Industrienationen während der vergangenen 140 Jahre. Im Zentrum steht dabei die Frage, ob die historisch zu beobachtenden Preisdynamiken durch Schwankungen im Fundamentalwert begründbar sind oder ob die Preise relativ zu diesen Fundamentalwertschwankungen eine zu hohe Volatilität aufweisen. In den meisten makrökonomischen Studien werden für die Bestimmung des Fundamentalwertes hauptsächlich angebots- und nachfrageseitige Variablen herangezogen. Das vorliegende Kapitel bedient sich dagegen eines Ansatzes aus der Finanzwissenschaft, demzufolge der fundamentale Wert eines Hauses der Summe der zukünftig erwarteten, diskontierten Mieteinnahmen entspricht. Im Verhältnis von Miete und Hauspreis, der rent-price ratio, spiegeln sich demnach die Markterwartungen künftiger Renditen und künftiger Mietveränderungen. Die Frage nach exzessiver Volatilität wird in diesem Kontext zur Frage nach der Prognostizierbarkeit von Renditen oder/und von Mietveränderungen durch die rent-price ratio. Bisher existierende Studien untersuchten diese Frage in der Regel lediglich auf Basis von Daten für den U.S. amerikanischen Markt bzw. für die Jahre nach 1970. Um eine umfassendere empirische Untersuchung durchzuführen, wird daher in diesem Beitrag der Datensatz aus dem vorangegangen Kapitel um lange Zeitreihen für Mieten erweitert. Eine umfassende Charakterisierung von Immobilienpreiszyklen auf Basis dieser Daten zeigt, dass es historisch wiederholt zu ausgeprägten Preisdynamiken kam, wobei die Preise über längere Zeiträume von Mieten abwichen. Vor allem in der zweiten Hälfte des 20. Jahrhunderts überstieg die Verteuerung von Wohnimmobilien systematisch den Anstieg der Mieten. Die nachfolgende Analyse unter Verwendung eines restriktierten vektor-autoregressiven Modells legt nahe, dass die Prognostizierbarkeit von Renditen ein wesentliches Merkmal von Immobilienmärkten ist.

Der dritte Beitrag (Kapitel 4) *Household Debt and Recovery: Evidence from the U.S. Great Depression* untersucht am Beispiel der Großen Depression in den USA den Zusammenhang zwischen Hypothekarverschuldung und der Dauer und Schwere von Rezessionen. Die goldenen zwanziger Jahre waren in den Vereinigten Staaten nicht nur durch wirtschaftliche Prosperität, sondern auch maßgeblich durch eine fortschreitende Verschuldung der privaten Haushalte geprägt. Die Ergebnisse einer Analyse von Querschnittsdaten für 49 US-Bundesstaaten weisen darauf hin, dass der daraus resultierende Verschuldungsgrad das Ausmaß der Großen Depression nachhaltig beeinflusste. Dabei bedingte dieser nicht die Intensität des Abschwungs, sondern vorrangig die Dynamik der wirtschaftlichen Erholung. In US-Bundesstaaten, in denen die privaten Haushalte eine vergleichbar höhere Relation von Hypothekarverschuldung zu Einkommen (mortgage debt-to-income ratio) aufwiesen, war die Wirtschaftsentwicklung zwischen 1933 und 1939 signifikant schwächer als in US-Bundestaaten mit niedrigerem Verschuldungsniveau. Auch andere historische Episoden privater Schuldenüberhänge zeigen, dass die Anpassungsprozesse bei deren Rückführung grundsätzlich mit einer gedämpften Wirtschaftsdynamik verbunden sind. Die Ähnlichkeit der in diesem Kapitel vorgestellten Ergebnisse zu Studien anderer Krisenepisoden legt nahe, dass es einen engen Zusammenhang zwischen dem Verlauf wirtschaftlicher Erholung und dem Grad der vorangegangen Schuldenakkumulation gibt.

# Abstract


This dissertation consists of three essays that empirically analyze different aspects of housing markets in historical perspective. The first two essays seek to broaden our understanding about long-run trends and fluctuations in housing markets of advanced economies. The third focuses on the interplay of mortgage debt and macroeconomic fluctuations.

Chapter 2; *No Price Like Home: House Prices in Advanced Economies, 1870–2012*, studies how house prices have evolved over the long run. Based on extensive historical research, the essay presents annual house price series for 14 advanced economies since 1870. The historical journey into long-run house price trends yields two important new insights. First, it shows that real house prices stayed constant from the 19th to the mid-20th century, but rose strongly in the second half of the 20th century. Second, a decomposition of house prices into the replacement cost of the structure and land prices reveals that rising land prices have been the driving force behind this hockey-stick pattern of real house prices. They explain about 80 percent of the global house price boom that has taken place after World War 2. These findings have a number of important implications. They suggest that higher land prices likely played a critical role in the recent increase of housing wealth and hence in the rise of wealth-to-income ratios in Western economies. In addition to these distributional consequences, land prices may also impact economic growth directly through agglomeration effects. Finally, the findings contradict the popular notion that the long-run price elasticity of housing supply is high, because new land for additional construction is still in ample supply and available at constant prices.

Chapter 3, *As Volatile As Houses: Return Predictability in International Housing Markets, 1870–2015*, examines house price fluctuations and their sources over the past 140 years to answer the following question: Are house prices excessively volatile relative to fundamentals? To capture changes in fundamentals, macroeconomists typically focus on variables that might shift supply and demand. In this essay, I borrow from the finance literature to take a different approach. Assuming that any asset's fundamental value equals the present value of its future cash flows, rents are one of the most important fundamental determinant of housing value and the rent-price ratio summarizes market expectations of future housing returns and/or rent growth. In this setting, the question about excess volatility translates into asking whether the rent-price ratio predicts returns or rent growth. Most studies examining the rent-price ratio's predictive power for housing returns and rents have focused on relatively recent U.S. data and produced mixed evidence. To conduct a comprehensive study of return predictability in international housing markets, I combine the long-run house price data from Chapter 2 with a novel dataset covering data on housing rents since the late 19th century. I start by providing a comprehensive characterization of house price cycles and show that house prices have deviated from rents for extended periods of time. House price growth in advanced economies particularly outpaced rent growth in the second

half of the 20th century resulting in strongly decreasing rent-price ratios. Based on the dynamic Gordon growth model and using a restricted vector-autoregressive framework, I find that return predictability and thus the excess volatility puzzle have been a pervasive feature of modern housing markets. In this way, housing markets appear to be remarkably similar to stock and bond markets.

The last essay in Chapter 4, *Household Debt and Economic Recovery: Evidence from the U.S. Great Depression*, investigates the link between the accumulation of debt and the severity and duration of recessions. In the wake of the Great Recession, household debt overhang and the ensuing process of deleveraging have often been cited as factors holding back economic recovery. In this chapter, I zoom in on the years of the Great Depression and use cross-sectional data for U.S. states to examine the connection between state-level variation in household indebtedness and the strength of recovery. The years preceding the Great Depression were a time of great economic prosperity and credit expansion that fostered a significant increase in household debt in general, and mortgage debt in particular. The level of mortgage debt varied substantially across states at the onset of the Depression. I present evidence that the level of indebtedness is an important aspect in explaining the severity and duration of the Great Depression. This relationship is mostly driven by a slower pace of economic recovery, rather than a more severe recession. U.S. states with higher initial debt-to-income ratios recovered considerably slower between 1933 and 1939. The similarity of the results for very different historical episodes suggests a close link between the accumulation of household indebtedness and recovery paths.