Essays on Reasons and Consequences of the Great Recession

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Fabian Lindner
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Erstgutachter: Univ.-Prof. Dr. Irwin Collier

Zweitgutachter: Prof. Dr. Sven Schreiber

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Für Yuko und Jonah

Eigenanteil der Leistung

Diese Dissertation besteht aus drei Artikeln, von denen einer in Zusammenarbeit mit zwei Koautoren entstanden ist.

- **Lindner, Fabian** (2014) "The Housing Wealth Effect on Consumption Reconsidered", veröffentlicht als *Economics Discussion Paper Nr. 2014-15, Kiel Institute for the World Economy*.
- **Lindner, Fabian** (2014) "The Interaction of Mortgage Credit and Housing Prices in the US", veröffentlicht als *IMK Working Paper Nr. 133*.
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Allgemeine Einleitung und Ergebnisse

Die vorliegende Dissertation besteht aus drei Kapiteln, die einige der Bestimmungsgründe und Konsequenzen der Großen Rezession näher beleuchten, die zwischen 2008 und 2009 die Weltwirtschaft erschütterte. Die Große Rezession enstand in den Vereinigten Staaten, ergriff dann aber die gesamte Weltwirtschaft (Baldwin, ed, 2009; Bagliano and Morana, 2011). Deswegen betrachtet die Arbeit sowohl die Dynamiken innerhalb der USA und die Effekte der US-Rezession auf Teile des Rests der Welt.

Die beiden ersten Kapitel beleuchten die Interaktion zwischen Kredit, Häuserpreisen und dem Konjunkturzyklus in den USA und das dritte Kapitel die Effekte des "Großen Handelszusammenbruchs" (Baldwin, ed, 2009) für die deutsche Wirtschaft und vor allem für den deutschen Arbeitsmarkt. Das erste Kapitel analysiert den Effekt von Häuserpreisen auf den Konsum. Das zweite Kapitel untersucht die Interaktion von Hyothekenkrediten und Häuerpreisen und fragt, wie die beiden Variablen interagieren: Hat der Hypothekenkredit die Häuserpreise getrieben oder umgekehrt? Das dritte Kapitel betrachtet den Effekt der Grpßen Rezession für die stark exportorientierte deutsche Wirtschaft, besonders auf den Arbeitsmarkt. Die deutsche Arbeitsmarktentwicklung wurde als "Arbeitsmarktwunder" bezeichnet, da die Beschäftigung in der Krise stieg, obwohl Deutschland die tiefste Rezession seit Ende des Zweiten Weltkrieg verzeichnete.

Die Ergebnisse der einzelnen Kapitel werden im Folgenden zusammengefasst:

Kapitel 1: Eine neue Betrachtung des Hausvermögenseffekts für den Konsum

Das Gros der Literatur bettet den Effekt von Veränderungen des Immobilienvermögens auf den Konsum in einen einfachen Lebenszkylusmodell ein, in dem Veränderungen der Häuserpreise einen "Vermögenseffekt" ausüben. In solchen Modellen führen Wertänderungen von Häusern immer zu gleichgerichteten Veränderungen des Konsums. Diese Schlussfolgerung könnte allerdings einem Trugschluss der Verallgemeinerung unterliegen. Die Modelle ignorieren, dass Veränderungen von Häuerpreisen Verteilungseffekte haben zwischen denjenigen, die einen Häuserkauf und denjenigen, die einen Häuserverkauf planen. Da darüber hinaus die meisten Häuser nicht aus Barreserven finanziert werden, sondern über die Aufnahme einer Hypothek, müssen auch die Institutionen des Hypothekenmarktes in die Betrachtung des Häuserpreiseffektes mit einbezogen werden.

Um diese Probleme zu analysieren, wird im Kapitel ein Modell überlappender Generationen entwickelt, aus dem die klassische Ando-Modigliani-Konsumfunktion abgeleitet werden kann, allerdings erweitert um Immobilienvermögen. Es wird gezeigt, dass das tiefere strukturelle Modell, aus dem diese Funktion abgeleitet ist, impliziert, dass Veränderungen der Häuserpeise nicht notwendig positiv mit dem Konsum korreliert sind. Wie Häuserpreise und Konsum zusammenhängen, wird wesentlich durch die Demographie (die Zusammensetzung der Altersgruppen in der Bevölkerung) und die Institutionen des Hypothekenmarktes bestimmt. Es wird die These aufgestellt, dass Veränderungen in diesen beiden Größen zu einem strukturellen Bruch des Immobilienvermögenseffektes Mitte der 1980er Jahre geführt haben.

Zur Überprüfung dieser These werden im empirischen Teil des Kapitels zwei VAR-Modelle geschätzt und Impuls-Respons-Funktionen berechnet. Diese zeigen, dass Häuserpreise den Konsum tatsächlich unterschiedlich vor und nach der Mitte der 1980er Jahre beeinflusst haben. Während Häuserpreisänderungen den Konsum in beiden Modellen positiv ab Mitte der 1980er Jahre beeinflusst haben, gab es keinen oder sogar einen negativen Effekt davor. Das heißt, der Häuserpreiseffekt hängt stark vom Kontext ab. Nur unter der Bedingung deregulierter Hypothekenmärkte und einer relativ alten Bevölkerung mit vielen Immobilieneigentümern beeinflussen Häuserpreise den Konsum stark positiv und damit auch den Konjunkturzyklus. Unter diesen spezifischen Bedingungen konnte der Boom und Bust der Häuserpreise zu einem Boom und Bust des US-Konjunkturzyklus in der Großen Rezession werden.

Kapitel 2: Die Interaktion von Hypothekenkrediten und Häuserpreisen

Während im ersten Kapitel die Effekte von Häuserpreisänderungen auf die Realökonomie untersucht wurden, untersucht das zweite Kapitel, wie Häuserpreise bestimmt werden und welche Rolle Hypothekenkredite dabei spielen. Allerdings ist ex ante nicht klar, wie Häuserpreise und Hypothekenmärkte interagieren: Häuserpreise können den Hypothekenkredit beeinflussen oder umgkehrt.

Um das Verhältnis zwischen den beiden Variablen besser zu verstehen, wird das Johansenverfahren zur Schätzung langfristiger Beziehungen zwischen Variablen verwendet und Ko-Integrationsbeziehungen für Hypohtkenkredite und Häuserpreise zwischen 1984 und 2012 geschätzt. Dabei werden zwei Modelle mit zwei unterschiedlichen Häuserpreismaßen geschätzt. Es stellt sich heraus, dass der Kredit schwach exogen ist und damit die langfristige Beziehung treibt. Impuls-Respons-Funktionen, Varianzdekompositionen und Prognosen zeigen, dass Kredite Häuserpreise getrieben haben und nicht umgekehrt.

Das Kapitel betrachtet auch die Rolle von kurzfristigen und langfristigen Zinsen. Zu geringe geldpolitische Zinsen werden oft als einer der Hauptgründe für die Entstehung der Häuserpreisblase gesehen. Allerdings wird in diesem Kapitel keine wichtige Rolle für die Zinsen gefunden, weder für Häuserpreise noch für Häuserkredite. Die Geldpolitik scheint damit vernachlässigbar für die Häuserpreisinflation zu sein.

Die Bestimmungsgründe für Häuserpreise aus Kapitel 2 sind allerdings nicht kompatibel mit der Modellierung der Häuerpreise im ersten Kapitel. Im Modell aus Kapitel 1 wird angenommen, dass die Häuerpreise durch den klassischen "user cost"-Ansatz erklärt werden können. Dieser Ansatz wird im zweiten Kapitel allerdings explizit kritisiert, weil Probleme asymmetrischer Information darin ausgelassen werden, die allerdings zentral für das Verständnis des Zusammenhangs zwischen Kreditvergabe und Vermögenspreisen ist. Auch das Ergebnis, das die Realzinsen - die wichtigsten Bestimmungsgrößen der "user costs" - kaum einen effekt auf die Häuserpreise haben, steht im Kontrast zu den Annahmen des ersten Kapitels. Weitere Forschung sollte Wege finden, diese beiden Ansätzen stärker miteinander zu kombinieren.

Kapitel 3: Eine Dekomposition des deutschen Beschäftigungswunders in der Großen Rezession

Das dritte Kapitel betrachtet den Effekt des "Großen Handelseinbruchs" für die stark vom Export abhängige deutsche Wirtschaft. Deutschlands Banken gehörten zu den größten Gläubigern der USA und mussten wegen der US-Krise gerettet werden (Acharya and Schnabl, 2010; Shin, 2012; Borio and Disyatat, 2011; Lindner, 2012). Der Haupttransmissionsmechanismus zwischen den USA und Deutschland (und dem Rest der Welt) waren allerdings Export-Import-Verflechtungen (Baldwin, ed, 2009; Bagliano and Morana, 2011). Tatsächlich hat der starke Fall des deutschen Exports zur schwersten Rezession nach dem Zweiten Weltkrieg geführt. Die Beschäftigung hat aber in der Rezession sogar leicht zugelegt. Die Bestimmungsgründe für dieses "Arbeitsmarktwunder" werden in Kapitel 3 näher betrachtet.

Dazu werden zyklische (trendbereinigte) Veränderungen der durchschnittlichen Arbeitszeit und der Arbeitsproduktivität pro Stunde für das Verarbeitende Gewerbe und den Rest der Wirtschaft analysiert. Veränderungen beider Größen bilden einen Puffer zwischen Veränderungen des BIP und der Beschäftigung. Zur Analyse werden historische Vergleiche und kontrafaktische Szenarien verwendet. Dabei stellt sich heraus, dass Reduzierungen der Arbeitszeit der Hauptgrund für das "Arbeitsmarktwunder" waren. Die Arbeitszeit sank sehr viel stärker in der Großen Rezession als man auf Grundlage der historischen Erfahrung hätte erwarten können. Der unerwartete Rückgang der Arbeitszeit scheint vor allem aus dem Rest der Wirtschaft zu kommen, nicht vom Verarbeitenden Gewerbe, in dem die Arbeitzeitentwicklung kaum von der Norm - gegeben den starken Fall des BIP - abwich.

Die meisten der Instrumente zur Arbeitszeitverkürzung wurden im Rahmen des deutschen Korporatismus verhandelt und waren nicht das Result von Regierungshandeln. Damit scheinen gute Tarifverhandlungsinstitutionen eine Voraussetzung für den Gebrauch der Arbeitszeitverkürzung als Mittel zur Stützung der Beschäftigung zu sein.

Alles in allem wird in der Dissertation der Versuch unternommen, zu einem besseren Verständnis der Bestimmungsgründe der Großen Rezession beizutragen, um zukünftige Krisen zu vermeiden. Darüber hinaus soll zu einem einem besseren Verständnis von Instrumenten beigetragen werden, die die Effekte einer Krise abfedern könnten.

General Introduction and Results

The present dissertation comprises three chapters on some of the causes and consequences of the Great Recession that took place in 2008 and 2009. The Great Recession emanated in the United States but almost the whole world was hit by it (Baldwin, ed, 2009; Bagliano and Morana, 2011). This is why the dissertation looks both at the dynamics within the United States and the effects of the US recession on parts of the rest of the world.

More specifically, the first two chapters look at the interaction of credit, housing prices and the business cycle in the US and the third chapter at the effects of the "Great Trade Collapse" (Baldwin, ed, 2009) for the German labor market. The first chapter looks at the "housing wealth effect", i.e. the effect of housing price changes on consumption. The second chapter analyzes the interaction of mortgage credit and housing prices and asks how those two variables interacted: did mortgage credit drive housing prices or vice versa? The third chapter looks at the effects of the crisis on the strongly export oriented German economy, specifically at the German labor market development. The German development was termed a "labor market miracle" because employment even increased in the crisis although Germany experienced the deepest economic downturn since the Second World War. The chapter looks at the reasons for this surpising development.

The main contributions and results of the chapters can be summarized thus:

Chapter 1: The Housing Wealth Effect on Consumption Reconsidered

Most of the literature on the effect of housing wealth on consumption has been embedded in a simple life-cycle model in which housing price changes work as a "wealth effect". In such models, windfall gains in housing always lead to positive changes in consumption. But this might constitute a fallacy of composition. Such models ignore that changes in housing prices have distributional consequences between those planning to sell their house and those planning to buy a house. Further, since most housing is not simply financed out of current cash holdings but by mortgages, the institutions on mortgage markets have to be considered when looking at the "wealth effect" of housing.

To analyze this problem, an overlapping generations model is presented from which the classic Ando-Modigliani consumption function augmented by housing wealth can be deduced. It is shown that the deeper structural model from which this equation is deduced implies that changes in housing prices are not necessarily positively correlated with consumption. It will be argued that changes both in demographics (the composition of the age groups in the population) as well as in mortgage markets have led to a structural break in the effect of housing wealth on consumption in the mid-1980s in the US.

To test this hypothesis, two Vector Autoregressive (VAR) models are estimated and impulse-response functions are computed. The results show that housing price changes affected consumption differently before the mid-1980s and afterward. While both models show that consumption was positively related to housing wealth shocks after the mid-1980s, there was no or even a negative relation before. This means that the housing wealth effect depends on the economic context. Only under the conditions of deregulated mortgage markets and a relatively old population could housing prices positively and markedly affect consumption and thereby the US business cycle. It is under those specific conditions that the boom and bust pattern of housing prices could become a boom and bust pattern for the US business cycle.

Chapter 2: The interaction between mortgage credit and housing prices

While the first chapter analyzed the effects of housing price changes on the real economy, the second chapter further analyzes how housing prices are determined and more specifically what role mortgage credit plays in the determination of housing prices. However, it is not clear ex ante how housing prices and mortgage markets interact: housing prices could drive mortgage credit or mortgage credit housing prices.

In order to better understand the interaction between these two variables, the Johansen procedure is used to estimate a long run co-integration relationship between mortgage credit and housing prices between 1984 and 2012. To this effect, two models with two different housing price variables are estimated. It is found that mortgage credit is weakly exogenous. Impulse-response functions, variance decompositions and out of sample forecasts show that mortgage credit drives housing prices and not vice versa.

The chapter also looks at the role of short-term and long-term interest rates. Too low monetary policy rates were often seen as one of the key reasons behind the built up of the housing price bubble. However, the models do not find important influences of both interest rates on housing prices or mortgage credit. Thus, the role of monetary policy is not likely to have been very important in the built-up of the housing bubble.

The finding of chapter 2 is not compatible with the housing model of chapter 1. Housing prices in chapter 1's model are determined by the traditional user cost approach. This approach is explicitly criticized in the second chapter because it leaves out problems of asymmetrical information which might be important in the relation between credit-financed asset purchases and the evolution of credit. Further research might find ways to combine those two approaches in a more coherent way.

Chapter 3: Decomposing the German Employment Miracle in the Great Recession

The third chapter looks at the effects of the "Great Trade Collapse" on the highly export-dependent German economy. While German banks were among the largest lenders to the US and many of its banks were threatened by insolvency when US default rates increased (Acharya and Schnabl, 2010; Shin, 2012; Borio and Disyatat, 2011; Lindner, 2012), the main transmission mechanism to the German economy (and more generally to the rest of the world) seems to have been via exports and imports (Baldwin, ed, 2009; Bagliano and Morana, 2011). Indeed, the strong decrease in German exports led to the deepest recession in Germany after the Second World War. However, employment even slightly increased in the recession. The reasons for this "labor market miracle" are looked at more closely.

In order to do that, de-trended, i.e. cyclical, changes in average working time and hourly labor productivity are analyzed both for the manufacturing and for the non-manufacturing sector. Decreases in both variables can buffer the effect of changes in GDP on employment. By using historical comparisons and a forecast exercise, it is found that reductions in working time indeed seem to have caused the "miracle" because they declined more than anticipated based on past experience. This unanticipated decrease mainly seems to have come from the non-manufacturing sector while working time developments were hardly surprising in the manufacturing sector, given the steep decline in GDP.

Most of the instruments allowing for a reduction in average working time were negotiated in collective bargaining and were not the results of government action. It thus seems that good collective bargaining institutions are a pre-requisite for the use of work sharing as a labor-saving instrument.

Overall, the dissertation tries to contribute to a better understanding of the causes that drive economic crises and to a better understanding of the instruments and means to buffer crises once they occur.

1 The Housing Wealth Effect on Consumption Reconsidered

The study of the influence of housing wealth on consumption has gained much interest since the steady rise in housing prices since the mid-1990s - and even more so since the fall in housing prices that led to the global financial crisis (Duca et al., 2011). Especially the paper by Case et al. (2005) gained much prominence and did start a new interest in the housing wealth effect on consumption. The authors find significant positive effects of housing wealth on consumption. Many other authors have reached similar results (Benjamin et al., 2004; Carroll et al., 2006; Kundan, 2007).

Most of the research on the effect of housing wealth on consumption is conducted in the framework of the theory of the “wealth effect”, going back to the classic life cycle hypothesis (LCH) formulated by Ando and Modigliani (1963). The LCH states that wealth is accumulated by households to maintain a relatively constant level of consumption in the face of varying income over the life cycle. The “wealth effect” is one corollary of that hypothesis, namely that households consume out of wealth and that changes in the prices of their accumulated assets may influence consumption.

However, it is not clear that a change in asset prices always has beneficial effects on consumption. Asset price changes do not necessarily make all consumers better off since they have distributional consequences. Economic agents that own the asset gain by an increase in asset prices while those planning to purchase the asset are worse off (Attanasio et al., 2011; Attanasio and Weber, 1995; Li and Yao, 2007). Those distributional effects are likely to be larger for housing than for financial assets since the demand for housing is less elastic. Owner-occupied housing is not only an asset but also a durable consumption good that provides essential housing services (Fernández-Villaverde and Krueger, 2011). Financial assets do not provide consumption services so that the price elasticity of demand of financial assets is likely to be higher.

Also, since one can buy small units of financial assets, no credit financing is necessary for acquiring those assets. On the other hand, most housing is financed by a mortgage loan, especially by first-time buyers. While house price increases benefit home owners who plan to sell their house, they might lead first-time buyers to save more for their down payment, thus possibly depressing their consumption. The net effect of housing price changes is thus not clear ex ante (Bajari et al., 2005; Muellbauer and Lattimore, 1995).

The theoretical literature on the distributional consequences on housing price changes is still rather small. Li and Yao (2007) have developed and simulated a life-cycle model with distributional consequences of housing price changes and their consequences for household welfare. They found large welfare losses due to housing price increases in the USA for renters and young owners who plan to upgrade their housing stock over the life cycle. Old homeowners with high housing equity gain and middle aged owners are hardly affected since they neither plan to upgrade nor to downgrade their housing stock.

Kiyotaki et al. (2011) develop and simulate a general equilibrium model and estimate welfare changes between net sellers and net buyers of housing wealth for Japan. They find that net buyers have large welfare costs if housing prices increase.

Both papers focus on welfare costs, i.e. changes in utility due to housing price changes and less on the classic macroeconomic question of the effect of housing value changes on consumption. However, this is what Attanasio et al. (2011) do. They calibrate aggregate and age-specific consumption of households with different housing equity and simultate income and housing price shocks for the UK. They are mostly interested in the effect of housing prices on homeowners and less on the effects on households that plan to increase their housing stock. The authors consider the endogenous effect of housing price changes on homeowner rates with a given credit constraint so that some households planning to buy housing cannot afford it and thus abstain from buying.

However, Attanasio et al. do not consider the effect of “target-saving” of household, i.e. targeted saving for the downpayment and a potential inelasticity of housing demand by such savers. This motive can be very important for US household saving (Browning and Lusardi, 1996).

For instance, Sheiner (1995) finds that US potential first time buyers are more likely to increase their saving with higher housing prices and do not abstain from buying. She estimates that downpayment saving accounts for a quarter of household saving. Engelhardt (1996) also finds such saving to be very important. This is in contrast to other countries. For Japan, Yoshikawa and Ohtake (1989) find that households tend to abstain from buying their house when housing prices increase. It might be the case that the behavior of potential first-time buyers also depends on cultural influences.

The present chapter focuses on down payment saving and develops a simple, partial-equilibrium overlapping generations model. In the model, young households save for their down payment based on the expected value of a house they plan to buy. When they are in their middle age, they buy their house from the current old generation and use their accumulated down payment saving. When they are old, they sell their house to the current middle aged.

A positive housing price shock has distributional consequences between the current members of the different generations. Old homeowners who trade down their housing unambiguously gain from higher housing prices. However, since housing price increases change the actual down payment relative to the expected down payment for the middle aged, this generation is forced to save more and consume less if their demand for housing is not elastic.

The sign of the effect of housing price changes on consumption is not clear ex ante. In the model, the overall effect depends on demographics and financial market institutions. More liberalized financial markets will lead to lower down payments for first-time buyers (Ortalo-Magné and Rady, 1999). The lower the required minimum down payment is, the lower additional saving will have to be with a given unexpected housing price shock. This mitigates the negative effect of higher housing prices on consumption.

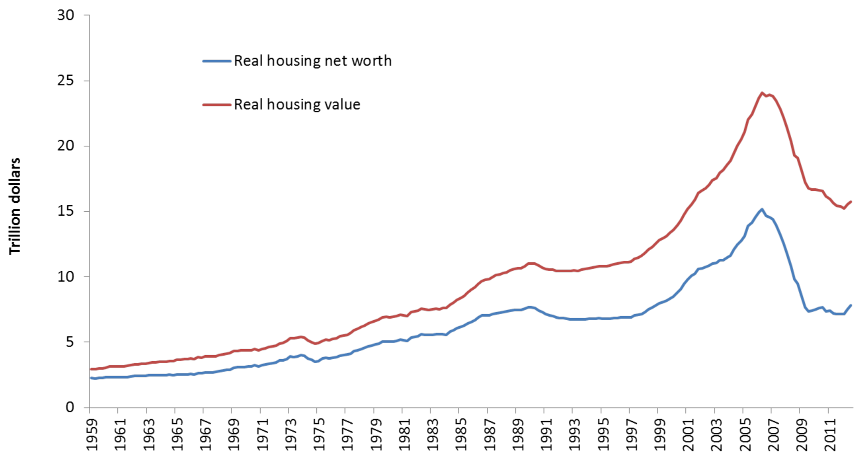
On the other hand, demographics change the ratio of middle-aged to old households. With a given housing stock, the existence of more old households relative to young households in the economy will lead to a more positive relation between housing and consumption. Then, more households profit from the realization of capital gains than lose.

While the model uses a borrowing constraint for housing, it does not allow households to use their house as a collateral for non-housing borrowing, an aspect of housing that has been widely discussed in the literature (Aoki et al., 2004; Iacoviello, 2004). The decision to leave that aspect out of the model has a theoretical and an empirical reason.

The theoretical reason is that collateralized borrowing for consumption does not constitute a wealth effect. The wealth effect measures changes in housing net worth, i.e. housing assets minus mortgage debt. If households increased their mortgage debt in line with the increased value of the housing asset, housing net worth would not increase. Then, one would observe varying housing values, mortgages and consumption but not varying housing equity. However, this is not what can be observed in the US. Figure 1.1 shows that housing equity changes and that most of the change is caused by changes in housing values which are not counteracted by mortgage credit.

Also, empirical studies have shown that mortgage equity extraction does not seem to finance higher paths of aggregate consumption. Studies found that mortgage equity extraction might finance consumption in the case of an adverse income shock, e.g. due to an unemployment shock, but not an increase of overall consumption (Cooper, 2009; Hurst and Stafford, 2004; Klyuev and Mills, 2007). Thus, equity extraction works as an insur-

Figure 1.1: Housing value and housing net worth



Source: Federal Reserve Flow of Funds, own calculations

ance against income shocks (Lustig and Van Nieuwerburgh, 2005). Also, taking out a mortgage secured by a house might not only be used to finance consumption, but also in order to improve the housing asset. This use of mortgages has been extensive (Canner et al., 2002; Greenspan and Kennedy, 2008).

The implications of the model for aggregate US consumption will be tested using a structural vector autoregressive model and by computing impulse-response functions. This is done to show how shocks of housing value, labor income and financial wealth influence consumption. In line with Galí (1990) and Banjamin and Chinloy (2004) but in contrast to Kundan (2007) and Lettau and Ludvigson (2004), no co-integration relationship is found between the variables.

The lack of a co-integration relationship between the variables is likely to reflect the changes in demography and financial market institutions that are argued to influence the relation between housing and consumption. Two models are estimated. In the first, the influence of net housing wealth (gross housing value minus mortgage debt) on consumption is looked at; in the second model housing prices and the housing stock are seperated in order to determine whether it was housing prices as such that drove consumption.

The estimation shows that there was a *negative* influence of net housing wealth shocks on consumption before the mid-1980s and a positive influence only after the mid-1980s. If one looks at the separate influence of prices and quantities, shocks to housing prices did not affect consumption before the mid-1980s and positively afterwards. Thus, the effect of housing wealth and housing prices on consumption is highly context specific.

The chapter is structured as follows. In the next part, the overlapping generation model with three generations will be presented. From this model an aggregate consumption function augmented by net housing wealth will be deduced. It will be shown that its deeper structure implies that unanticipated housing wealth changes are not unambiguously positively correlated with consumption. In the second part, vector autoregressive models will be estimated and impulse-response functions will be computed. A final part will conclude.

1.1 An overlapping generations model of the housing market

Here, an overlapping generation model with three generations is developed with housing and a composite consumption good. In the model, young households rent and save for their house, middle aged households buy their house and pay off their mortgage, and old households sell their house and realize possible capital gains. Households maximize both non-housing and housing consumption over the life-cycle. The middle aged households buy the complete housing stock from the old and rent out housing to both the young and the old households. Changes in housing prices affect both middle aged households who buy their house and old households who realize capital gains.

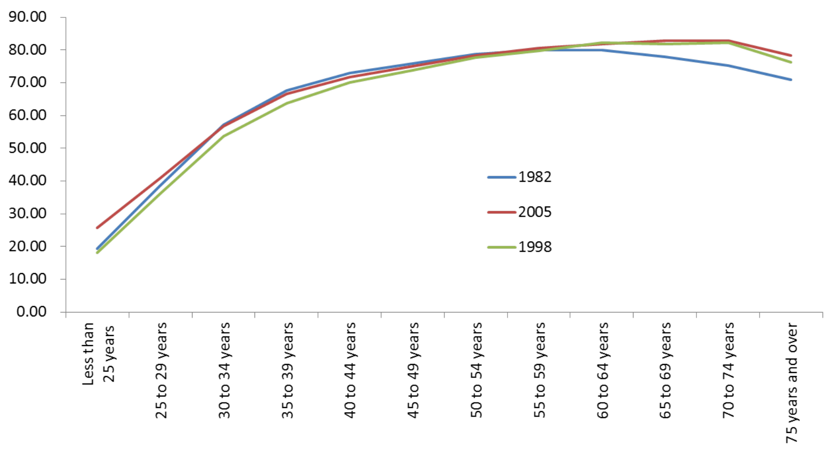
The interesting dynamic of the model comes from young households' saving decision. They form expectations about the housing price that will be realized once they enter their middle-age and save accordingly. However, if housing prices increase once households want to buy their house, they are worse off and have to reduce their consumption in order to pay the higher down payment.

The strength of the effect depends on the down payment ratio, i.e. the own funds relative to the housing value they have to come up with. The lower the down payment ratio, the less they will have to save additionally in the period and the less will housing price increases affect their consumption. On the other hand, housing price increases will always have a positive effect on consumption for the old who realize their capital gains.

Another factor that influences the aggregate effect is the demographic situation. A higher proportion of old homeowners to middle aged first-time buyers will increase the positive correlation between housing wealth and consumption; a lower proportion will tend to decrease it.

The basic set-up is similar to the models developed by Brueckner and Pereira (1994; 1997). However, those authors neither derive an aggregate consumption function nor

Figure 1.2: Home ownership rates in percent of households by household age



Source: US Census, own calculations

look at the distributional consequences of housing price changes between generations; they only look at two generations and do not model the mortgage market and especially liquidity constraints explicitly.

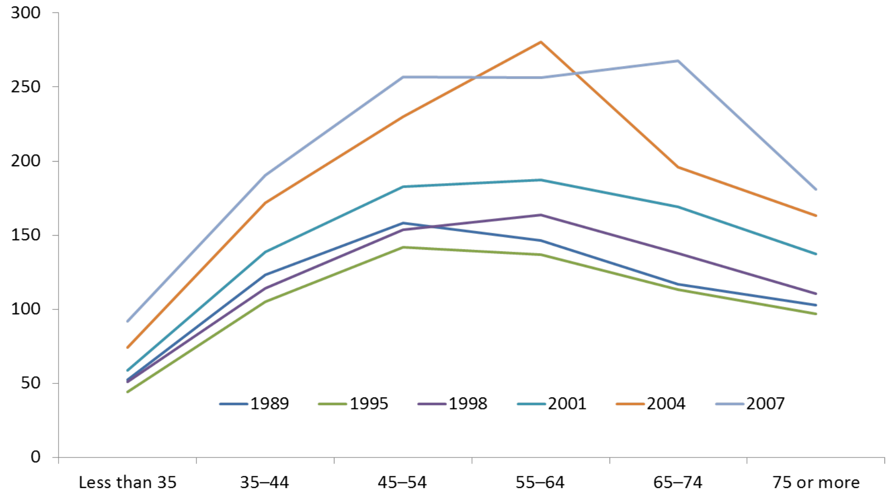
The structure of the model is exogenously imposed and not endogenously derived. Other models explicitly model the housing choice of different households given their income, preference of housing relative to consumption and borrowing constraints (Attanasio et al., 2009, 2011; Li and Yao, 2007). This is not done here in order to focus on the effect of a non-elastic housing demand given saving for down payments.

This somewhat inflexible approach is justified on empirical grounds. First-time buyers in the US do not buy smaller houses or abstain from buying but save more and consume less when housing prices have increased (Engelhardt, 1996; Sheiner, 1995). For the middle-aged US consumers, housing does not seem to play an important role for their consumption because they are less likely to sell their house (Skinner, 1989).

As far as the old generation is concerned, Lehnert (2004) finds that the housing wealth effect for households shortly before retirement (52 to 62 years) was highest among different age groups he looked at, confirming that those who plan to trade down their stock of housing benefit most from a housing price increase. The model uses the insights of those micro-econometric studies and draws the implications for aggregate consumption.

Empirically, there is a clear life-cycle pattern present for owning homes in the US. Figure 1.2 shows the rate of ownership by age of the households' heads in 1982, 1998 and 2005. Data before 1982 is not available. One can see that the basic age pattern of housing ownership has hardly changed since the early 1980s. The biggest difference is

Figure 1.3: Mean value of primary residence (thousands of 2007 dollars), weighted by percentage of families owning their residence



Source: Survey of Consumer Finance (2007), own calculations

that in 2005 a higher proportion of older households did own their housing. On first sight, the model's assumption that older households sell their house is not documented by the data.

However, the data only shows whether households own or not, not the value, i.e. either the size or price of their house. Figure 1.3 shows the mean value of primary residences weighted by the percentage of families who own their house from 1989 - the earliest available data - until 2007. The data is taken from the Federal Reserve's Survey of Consumer Finance. The data captures the total housing value, not just the homeowner rate, for each age group in the economy. A clear hump shaped life-cycle pattern is evident: older households reduce their housing so that they own houses with lower values. The different levels of value of houses in different years reflect the increase in housing prices, especially from 1995 until 2007. According to this data, the assumption of a hump shaped life-cycle behavior in the model makes sense.

An additional bequest motive in the model could be used to model the high ownership of old households (Attanasio et al., 2011). However, such a motive would not mitigate the distributional consequences between credit constrained first-time buyers and old sellers. It would mitigate the strength of the effect: Old households would not gain since they would not sell their house and heirs would not have to save for their housing. Since according to the data presented in figure 1.3, downsizing takes place to a significant degree and somebody has to buy the houses that are sold, I stick with the assumption that households sell their house when they are old and leave no bequests.

The model

The three generations have a simple logarithmic, time-separable additive utility function. The utility function of the young is written:

$$
\begin{aligned}
U_t^y &= ln(c_t^y) + \beta ln(h_t^y) \\
&+ (1+\rho)^{-1} E_t[ln(c_{t+1}^m) + \beta ln(h_{t+1}^m)] \\
&+ (1+\rho)^{-2} E_t[ln(c_{t+2}^o) + \beta ln(h_{t+2}^o)]
\end{aligned} \tag{1.1}
$$

Where the indices y, m, and o denote households' consumption when young, when in the generation of the middle aged and when old, respectively. The subjective discount factor is ρ and the term β is a parameter for consumers' tastes for housing relative to non-housing consumption. It is assumed that both parameters are the same irrespective of age. Consumers maximize both non-housing consumption c and housing services h throughout their lives.

Middle aged consumers maximize the same kind of utility function at time t:

$$
U_t^m = ln(c_t^m) + \beta ln(h_t^m) + (1+\rho)^{-1} E_t[ln(c_{t+1}^o) + \beta ln(h_{t+1}^o)] \tag{1.2}
$$

The old maximize:

$$
U_t^o = ln(c_t^o) + \beta ln(h_t^o) \tag{1.3}
$$

There is a fixed housing stock which has to be shared by the young, the middle-aged and the old and which is normalized to 1 in order to ease the exposition:

$$
H = h_t^y + h_t^m + h_t^o = 1 \tag{1.4}
$$

For each episode in their life, households face a period budget constraint. Young households receive labor income, y_t^y, they rent housing, h_t^y at a rental rate R, save in the form of financial assets, s_t^{fa}, and they save for the discounted expected down payment for their house, $H\frac{\phi E_t(p_{t+1})}{1+r}$. Here, ϕ is the percentage of the house value households have to put up in order to buy the house in period $t+1$, the so called down payment ratio. Thus, the young's period budget constraint reads:

$$
y_t^y - \frac{\phi E_t(p_{t+1})}{1+r} - s_t^{fa} - c_t^y - R_t h_t^y = 0 \tag{1.5}
$$

Note that the term H has been skipped in the budget constraint because it is normalized to one. Total saving of young households, s_t, is equal to their financial saving and saving for the downpayment, so that:

$$s_t = \frac{\phi E_t(p_{t+1})}{1+r} + s_t^{fa} = y_t^y - c_t^y - R_t h_t^y \tag{1.6}$$

At the beginning of their middle age, households buy a house. It is assumed that they buy the entire housing stock from the old even if prices change. That means that the change in the housing price is assumed never to be as high as to lead households to buy a smaller house or to abstain from buying.

Households in their middle age have to meet their mortgage payments with a mortgage rate, r_m, so that their mortgage payment is equal to the amount they pay for their house net of the down payment, i.e $r_m(1-\phi)p_t$. Since the middle aged rent out part of their housing to the old and the young, they have both a rental income, R_t, and opportunity costs for living themselves in the house, $-R_t h_t^m$. Since, by (1.4) the housing used by the young, the middle aged and the old sum to one, one can write $R(1-h_t^m) = R_t(h_t^y + h_t^o)$. Then, the period budget constraint of the middle aged reads:

$$y_t^m + R_t(1-h_t^m) + (1+r)s_{t-1} - s_t - c_t^m - r_m(1-\phi)p_t - \phi p_t = 0 \tag{1.7}$$

To pay the down payment, ϕp_t, middle aged households draw on their savings from the previous period, given by (1.6). Combining (1.6) and (1.7) and rearranging yields the period budget constraint of the middle-aged generation at time t:

$$y_t^m + R_t(1-h_t^m) + (1+r)s_{t-1}^{fa} - s_t - c_t^m - r_m(1-\phi)p_t + \phi(E_{t-1}(p_t) - p_t) = 0 \tag{1.8}$$

One can see that, if the young's expectations from the previous period about housing prices differ from the actual price they have to pay - once they are in the middle age - the term $\phi(E_{t-1}(p_t) - p_t)$ is different from zero. If actual prices were higher, households will have to pay more for their house than expected; if it is lower, they will have to pay less than expected.

Finally, when households are old, they sell their house and pay off their mortgage. It is assumed that they live off their financial savings and do not receive other income:

$$p_t - (1-\phi)p_{t-1} + (1+r)s_{t-1}^{fa} - c_t^o - R_t h_t^o = 0 \tag{1.9}$$

$(1-\phi)p_{t-1}$ is the amount of outstanding mortgage debt.

From the different period constraints, the life-cycle budget constraint for the young and the middle-aged can be computed. For the old, the life-cycle budget constraint is equal to their period budget constraint since they die at the end of the period and consume all their wealth.

For the young, the life-cycle budget constraint is derived by combining the different period budget constraints (1.5), (1.8) and (1.9):

$$
\begin{aligned}
&c_t^y + R_t h_t^y + \frac{c_{t+1}^m + R_{t+1} h_{t+1}^m}{(1+r)} + \frac{c_{t+2}^o + R_{t+2} h_{t+2}^o}{(1+r)^2} = \\
&y_t^y + \frac{y_{t+1}^m + R_{t+1}}{(1+r)} - \frac{E_t(p_{t+1})(1-\phi)(r_m + (1+r)^{-1})}{(1+r)} + \frac{E_t(p_{t+2})}{(1+r)^2}
\end{aligned}
\tag{1.10}
$$

The term $E_t(p_{t+1})(1-\phi)(r_m+(1+r)^{-1})$ is the expected total debt service that households will have to pay over their life-cycle and $E_t(p_{t+2})$ is the price of their house that they expect to get when they sell their house at the beginning of their old age.

Equivalently, the life-cycle budget constraint of the middle-aged is a substitution of (1.9) into (1.8):

$$
\begin{aligned}
&c_t^m + R_t h_t^m + \frac{c_{t+1}^o + R_{t+1} h_{t+1}^o}{(1+r)} = y_t^m + R_t + (1+r) s_{t-1}^{fa} + \\
&\phi(E_{t-1}(p_t) - p_t) - p_t(1-\phi)(r_m + (1+r)^{-1}) + \frac{E_t(p_{t+2})}{(1+r)}
\end{aligned}
\tag{1.11}
$$

After having bought their house, middle aged households have locked in an actual mortgage service and expect the selling value of their houses.

In order to derive the aggregate consumption function, the utility functions (1.1), (1.2) and (1.3) have to be maximized under the constraints (1.9), (1.10) and (1.11) (see the appendix for the derivation). Further, overall consumption depends on the share of each generation G in the whole population, pop:

$$
1 = \frac{G^y + G^m + G^o}{pop} = g^y + g^m + g^o \tag{1.12}
$$

Total per capita consumption at time t, $C_t/pop = c_t$, is the sum of consumption of all three generations at time t, weighted by their share in the population:

$$
\begin{aligned}
& c_t = g^y c_t^y + g^m c_t^m + g^o c_t^o = \\
& g^y mpc^y \left(y_t^y + \frac{y_{t+1}^m + R_{t+1}}{(1+r)} - \frac{E_t(p_{t+1})d}{(1+r)} + \frac{E_t(p_{t+2})}{(1+r)^2} \right) + \\
& g^m mpc^m \left(y_t^m + R_t + (1+r)s_{t-1}^{fa} + \phi(E_{t-1}(p_t) - p_t) - p_t d + \frac{E_t(p_{t+1})}{(1+r)} \right) + \\
& g^o mpc^o \left(p_t - (1-\phi)p_{t-1} + (1+r)s_{t-1}^{fa} \right)
\end{aligned}
\tag{1.13}
$$

The term d stands for debt service:

$$d \equiv (1-\phi)(r_m + (1+r)^{-1}) \tag{1.14}$$

The term mpc stands for the marginal propensities to consume for the old, the middle generation and the young. They have been derived from the first order conditions (see appendix):

$$mpc^o = (1+\beta)^{-1} \tag{1.15}$$

$$mpc^m = \left((1+\beta)(1+(1+\rho)^{-1})\right)^{-1} \tag{1.16}$$

$$mpc^y = \left((1+\beta)(1+(1+\rho)^{-1}+(1+\rho)^{-2})\right)^{-1} \tag{1.17}$$

Since the generations are assumed to be homogenous so that both β and ρ are equal for all generations, it is clear that $mpc^o > mpc^m > mpc^y$. The old will spend all of their income before they die while the young and the middle generation discount their future income at their subjective discount rate. The marginal propensity changes with the subjective discount rate ρ. An increase in ρ will lead to a higher mpc because households will discount their life-time income at a higher rate, i.e. they are less patient.

To close the model, a no-arbitrage condition has to be introduced that determines the price of housing. Under perfect competition, arbitrage should lead to the state in which costs (the debt service) and revenues (rent and the sale price) from the housing asset are the same so that, for the determination of p_t:

$$p_t = \left(R_t + (1+r)^{-1}E_t(p_{t+1})\right)d^{-1} \tag{1.18}$$

Assuming equilibrium ($p_t = E_{t-1}(p_t)$) and substituting the no-arbitrage condition (1.18) into (1.13) yields:

$$
\begin{aligned}
&c_t = g^y c_t^y + g^m c_t^m + g^o c_t^o = \\
&g^y mpc^y \left(y_t^y + \frac{y_{t+1}^m}{(1+r)} \right) + \\
&g^m mpc^m \left(y_t^m + R_t + (1+r) s_{t-1}^{fa}) \right) + \\
&g^o mpc^o \left(p_t - (1-\phi) p_{t-1} + (1+r) s_{t-1}^{fa} \right)
\end{aligned}
\tag{1.19}
$$

In equation (1.19), the no-arbitrage condition leads to an elimination of the housing market terms for the young and the middle generation. The term $\phi(E_{t-1}(p_t) - p_t)$ does not appear in (1.19) because in equilibrium, expectations are fulfilled so that there is no difference between the actual price p_t and its expected value one period before, $E_{t-1}(p_t)$. Housing prices are determined under the no arbitrage conditions (1.18) so that a change in housing prices could only come about by changes in one of the variables of this condition.

Thus, if one assumes equilibrium in the system, housing prices would only play a role for the old. Note also that it is housing *net* wealth which matters, i.e. $p_t - (1-\phi)p_{t-1}$. The term p_t is the housing asset that old households hold and $(1-\phi)p_{t-1}$ is the mortgage stock they have to pay back.

Now, it is straightforward to deduce the classic Ando-Modigliani life-cycle consumption function from equation (1.19). For simplicity, assume y_t^y, y_t^m and y_t^o to be the same and equal to Y (they could also be expressed as multiples of each other, see Ando and Modigliani (1963)), then the classical life-cycle function can be written, augmented by housing net worth:

$$
C_t = \alpha_1 Y_t + \alpha_2 A_t + \alpha_3 (p_t - m_t) \tag{1.20}
$$

Where:

$$
\begin{aligned}
\alpha_1 &= g^y \left(mpc^y + \frac{mpc^y}{(1+r)} \right) + g^m mpc^m \\
\alpha_2 &= (g^m mpc^m + g^o mpc^o)(1+r) \\
\alpha_3 &= g^o mpc^o \\
A_t &= s_{t-1}^{fa} \\
m_t &= (1-\phi) p_{t-1}
\end{aligned}
$$

A_t is the stock of financial wealth at the beginning of the period that households have saved in the previous period.[1] The term m_t captures the outstanding mortgage debt so that the third term in 20) is the housing net wealth of the household sector out of which they can consume.

On first inspection of the equation it seems that a change in housing prices at time t would only have an effect on the consumption of the old. But this is not the case because a surprise change in housing prices also affects the middle generation through the term $\phi(E_{t-1}(p_t) - p_t)$ in equation (1.13). Higher or lower prices would lead to changes of what they have to pay for their house relative to what they have saved when they were young.

Where could an unexpected exogenous change in prices come from? Attanasio et al. (2011) and Li and Yao (2007) simply assume exogenous shocks but do not motivate them. In the model presented here, a housing price shock could be caused by any of the variables in the no-arbitrage condition, i.e. current rent, expected future house prices or the debt service. Since current rents are determined in the model, they are not exogenous. Only changes in future expected house prices or the debt service could thus be used as an exogenous shock.

To see how such a shock influences non-housing consumption, substitute the no-arbitrage condition into 13) but now without setting $E_t(p_t)$ equal to current actual housing prices:

$$\begin{aligned} C_t = {} & g^y mpc^y \left(y_t^y + \frac{y_{t+1}^m}{(1+r)} \right) + \\ & g^m mpc^m \left(y_t^m + (1+r)s_{t-1}^{fa} + \phi \left(E_{t-1}(p_t) - (R_t + (1+r)^{-1} E_t(p_{t+1}))d^{-1} \right) \right) + \\ & g^o mpc^o \left((R_t + (1+r)^{-1} E_t(p_{t+1}))d^{-1} - (1-\phi)p_{t-1} + (1+r)s_{t-1}^{fa} \right) \end{aligned} \tag{1.21}$$

Differentiating aggregate consumption with respect to expected prices yields:

$$\frac{\partial C_t}{\partial E_t(p_{t+1})} = \left(-g^m mpc^m \phi + g^o mpc^o\right) \left((1+r)d\right)^{-1} \tag{1.22}$$

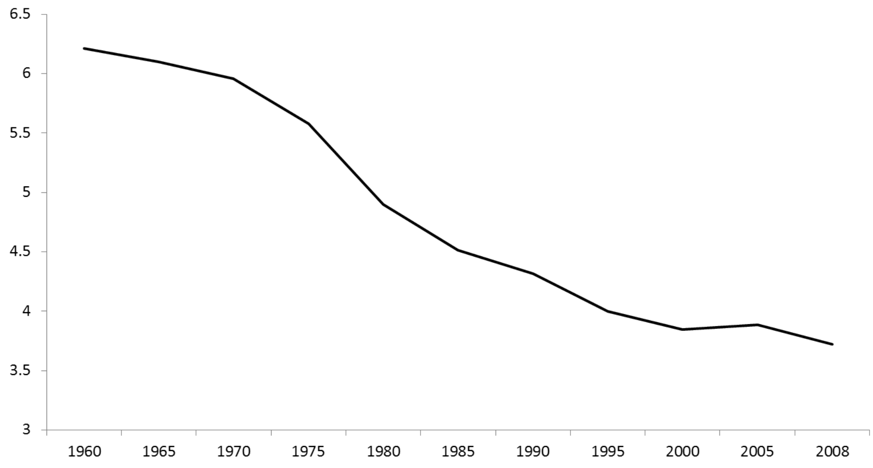
Differentiating aggregate consumption with respect to the debt service yields:

$$\frac{\partial C_t}{\partial d} = -\left(-g^m mpc^m \phi + g^o mpc^o\right) \left(R_t + (1+r)^{-1} E_t(p_{t+1}) \right) d^{-2} \tag{1.23}$$

In both cases, the sign of the effect depends on the term $-g^m mpc^m \phi + g^o mpc^o$ and thus on demographics, g^m and g^o, and the down payment ratio, ϕ.

[1]Note that s_{t-1}^{fa} is the sum of both the financial savings of the middle aged and the old.

Figure 1.4: Ratio of households younger than 35 to households older than 65



Source: US Census, own calculations

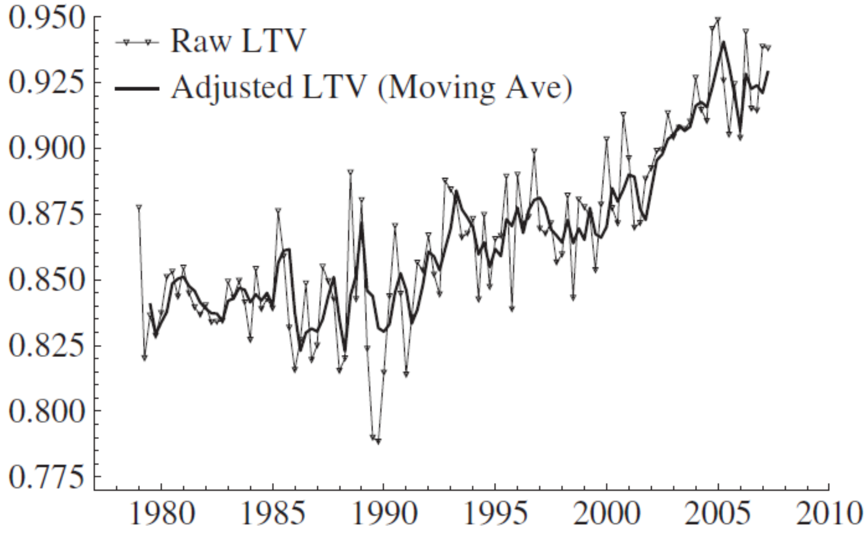
Given the marginal propensity to consume, the higher the proportion of young households to old households and the higher the down payment ratio, ϕ, the more will the positive influence of housing price changes on consumption be mitigated. With a high down payment ratio and a young population (i.e. many potential first-time buyers) the effect of housing price changes on consumption are likely to be negative.

The evidence on US demographics and down payment ratios is shown in figures 1.4 and 1.5. Looking at the demographic situation (figure 1.4) one can observe an ever decreasing share of young potential first-time buyers (households younger than 35 years old) to older households (older than 65). In 1960, there were 6 times as much young households than older households while in 2008, there were only 3.7 times more younger households than older households. In terms of the model, this would mean that the aggregate negative effect of a house price change on first-time buyers should have decreased over time.

Figure 1.5 shows the loan-to-value ratio for first-time buyers which is the inverted down-payment ratio. Data has been computed by Duca et al. (2011). Unfortunately, this data is only available since 1979. However, one can see a clear upward pattern and thus ever decreasing down payments for young first time buyers, from roughly 15 % in 1990 to 5 % in 2005. That means that credit market liberalization did have an influence on credit restrictions thus making it easier for first-time buyers to buy a house and be less affected in their saving behaviour by increases in housing prices.

From the evidence on demographics and the development of the down-payment ratio, one can deduce the following hypothesis: Since there were less potential first-time buyers and lower down-payment ratios over time, it is likely that the housing wealth effect was

Figure 1.5: Loan-to-value ratios for first-time buyers



Source: Duca et al. (2011)

higher over time. In the past, the housing wealth effect is likely to have been smaller or even negative since there were more potential first-time buyers and higher down-payment requirements. This hypothesis will be tested by estimating a wealth effect for aggregate time series data.

1.2 Estimation of the housing wealth effect

The implications of the model will be tested by using four VAR models, with two different data sets and two sample periods. In the first data set, the effect of net housing wealth on non-housing consumption will be evaluated, using financial wealth and labor income as control-variables; in the second set, the net housing wealth variable will be split into a housing price and a housing stock variable in order to specifically test for the effect of housing *price* changes on non-housing consumption.

Both variants will be estimated for two time periods, in order to test whether housing wealth and housing price effects differed in time. The models will be estimated using a sample period before the mid-1980s and afterward. Before estimating the models, the data will be presented in detail.

1.2.1 Data

The consumption data used measures consumption expenditure less the services from housing and durable consumption goods. It has become standard to exclude durable consumption in studies of the wealth effect and of the life-cycle model. In their classic study of the life-cycle hypothesis, Ando and Modigliani (1963) consider current outlays for non-durable goods and services plus the rental value of the stock of service-yielding consumer durable goods. Hall (1978), on the other hand, excludes the services from durables and only examines non-durables and services.

This has become the standard procedure in the literature on consumption. Hall's argument is mainly practical: he does not want to discuss the sensitivity of his findings to the method of imputation of services from durables which are not part of the official National Income and Product Accounts (NIPA) statistics.

A further problem with using durables in estimations of consumption models is that their introduction in the consumption measure is likely to lead to some form of serial correlation in the estimation of a consumption function (Mankiw, 1982).

In the estimation a measure of consumption will be used that only includes non-durables and services minus housing services. Housing prices are likely to be correlated with housing services, since a rise in rents would ceteris paribus also lead to a rise in housing prices. If housing services were included in the consumption function, there would be both a problem of endogeneity (if changes in housing services caused changes in housing wealth) and a problem of testing whether housing wealth changes have an effect on consumption since housing wealth increases would automatically lead to higher consumption if housing services and housing wealth were correlated. This problem might lead to serious problems in the estimates by Lettau and Ludvigson (2001; 2004) since they do not control for this correlation in their estimates of the wealth effect.

The next variable to consider is labor income. Disposable personal income cannot be used as labor income in a wealth effect model because it also contains property and capital income. Both the effect of property and capital income should be gauged by the wealth measures which are theoretically present values of future expected property and capital income. This is why one has to isolate disposable labor income from disposable personal income. Blinder and Deaton (1985) have proposed a measure that is now standard

(Palumbo et al., 2006; Campbell and Mankiw, 1990). They use the disaggregated income data by the Bureau of Economic Analysis (BEA) and compute labor income thus:

$$\begin{aligned} &\textit{Labor income} = \\ &\textit{wages and salaries} + \textit{transfer payments} - \\ &\textit{social security contributions} - \textit{labor taxes} \end{aligned} \tag{1.24}$$

The problem with labor taxes is that the NIPA only registers overall income taxes and not whether those income taxes are applicable to labour or capital income. The part of taxes paid by labour is then computed as the part of wages and salaries as a share of all labor and capital income:

$$\textit{Labor taxes} = \textit{taxes}\frac{\textit{wages and salaries}}{\textit{wages and salaries, interest, dividend and rental income}} \tag{1.25}$$

Next, wealth data is discussed. As Rudd and Whelan (2006) argue, wealth data and consumption data have to be consistent. If only a consumption measure without durable goods is used, the stock of durables also has to be excluded from aggregate wealth since consumption would then measure additions to the stock of wealth. Thus, although the Federal Reserve Flow of Funds also contains data on the stock of durables as part of overall wealth, these items are excluded here.

The wealth data used for the estimation consist of financial wealth and net housing wealth. Net housing wealth is the value of the stock of residential housing minus mortgage debt. While consumer debt could also be deducted from wealth, this is not done here. Since most of consumer debt is used to finance durable consumption and durable consumption is excluded from the model, consumer debt is also excluded.

In a second model, net housing wealth will be split into housing prices and quantities in order to evaluate whether it was housing prices and/or quantities that drove the housing wealth effect. However, mortgages will be ignored since an additional variable - the housing stock - in the VAR already reduces the degrees of freedom significantly.

The housing price index that will be used has been published by Shiller (2005).[2] It is compiled using different data sources. From 1959 to 1974, the housing price index is the PHCPI, from 1975 to 1986 the FHFA housing price index and from 1987 to 2012 the Case-Shiller index.

[2]The data is available online: http://www.econ.yale.edu/ shiller/data/Fig2-1.xls

The housing stock variable is constructed by taking the sum of the stock of owner-occupied and vacant housing published by the U.S. census bureau and also used by the Federal Reserve to construct the housing wealth variable. Unfortunately, the variable is only available since the first quarter of 1965. This is why the model in which the separated values for housing prices and the housing stock are used will only be estimated starting at this quarter and not in the first quarter of 1959 like the first model.

Palumbo et al. (2006) stress that the deflator has also to be consistent with the data used. The deflator has to take into account which data is used and which is excluded. They show that this is very important for statistical tests since some tests show co-integration between variables only because different deflators are used. This might be the case because the price level for different items changes and the composition of overall consumption changes. If one uses the deflator of all personal consumption expenditures one would also have included the prices of items that were explicitly excluded beforehand, thereby possibly biasing one's results. This is why a special deflator has been constructed here, which is computed in the following way:

$$p^c = \frac{(c^{pce} - c^d - c^{hs})}{\left(\frac{c^{pce}}{p^{pce}} - \frac{c^d}{p^d} - \frac{c^{hs}}{p^{hs}}\right)} \tag{1.26}$$

All p's are price indices and c's are nominal expenditures. Then, pce stands for total personal consumption expenditure, d for durables and hs for housing services. That the use of different deflators can be crucial is shown in figure 1.6. The figure shows the ratio of the chosen consumption measure deflated by two different deflators, the deflator for personal consumption expenditure from the NIPA and the consumption deflator as it has been computed here:

$$\frac{\frac{c^{pce}-c^d-c^{hs}}{p^d}}{\frac{c^{pce}-c^d-c^{hs}}{p^{pce}}} = p^{pce}/p^c \tag{1.27}$$

This ratio has a clear upward trend so that the deflation by the NIPA deflator for personal consumption expenditure would possibly bias results downward.

Logarithms are taken of all variables in order to estimate their elasticities. The data on consumption, income, financial wealth and net housing wealth are shown in figure 1.7.

Figure 1.8 shows the real housing net wealth and real housing price index (the housing price index has been deflated by the deflator that excludes housing service prices and durables). The steeper trend in housing net worth than in prices is due to the increase in the housing stock.

Figure 1.6: Ratio of pce deflator and computed consumption deflator

Source: Bureau of Economic Analysis, own calculations

1.2.2 Estimation

In the following two VAR models will be estimated and the wealth effect which has been deduced in the theoretical model will be tested using impulse-response functions. The first model will look at the effect of *net* housing wealth on consumption, net housing wealth being the product of the housing stock and housing prices minus mortgage debt; the second model will separate the housing stock and housing prices and look in more detail at the effect of housing *price* changes and their effect on consumption.

Impulse-response functions are used because they capture the effect of a shock of one variable on another. Since theoretically, a wealth effect can only occur through a shock, this is the best method available to test for a shock of housing wealth on consumption.

Similar methods, but only for overall wealth, have been used by Lettau et al. (2001; 2004). Kundan did also look at housing wealth (2007). However, these authors estimated co-integrated VAR models. On the other hand, Galí (1990), Palumbo et al. (2006), Rudd et al. (2006) do not find any co-integration. But those authors did not distinguish between housing and financial wealth. Benjamin et al. (2004) do just that and also do not find a co-integration relationship between the variables.

Before turning to a test for co-integration, the first step is to test whether the time series under consideration have a unit root. I test for the presence of a unit root using the ADF test. With the exception of the housing price series, all other series in levels have a clear upward trend so that a deterministic trend is included in the test equation. The unit root

Figure 1.7: Data used in the estimation

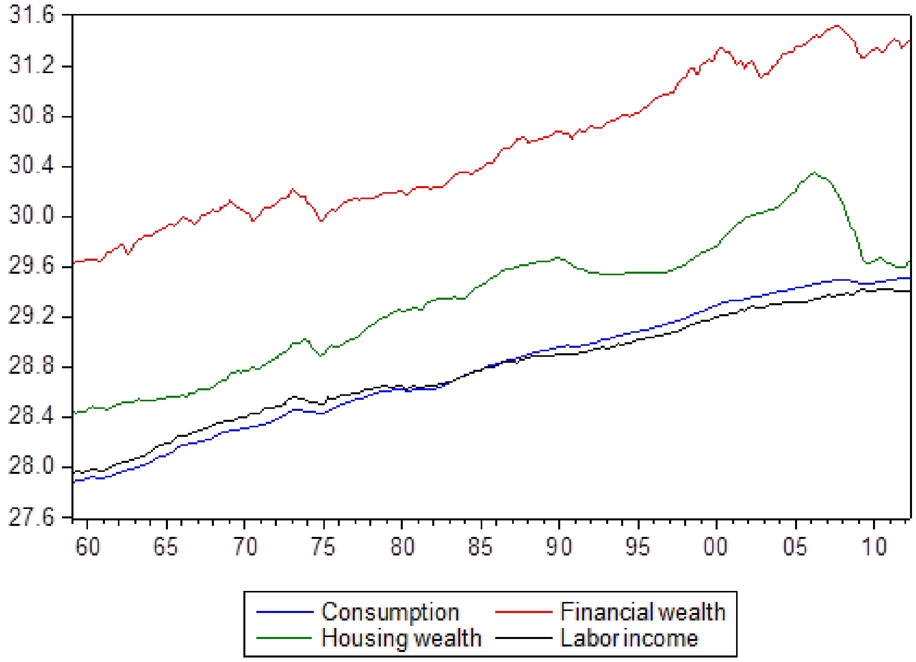


Table 1.1: Unit Root Tests

Sample	Series	Trend	Lag Length	t-statistics	95 % Critical values
1959q1-2012q2	C	Yes	2	-1.19	-3.43
	Y	Yes	0	-1.78	-3.43
	FW	Yes	1	-2.22	-3.43
	NHW	Yes	2	-2.16	-3.43
	HP	No	3	-2.41	-2.88
	HS	Yes	1	0.93	-3.43

test for the housing price series is conducted without such a trend. The length of the lags is determined by the Hannan-Quinn criterion.

The test results are reported in table 1.1. They show that the hypothesis of the presence of a unit root cannot be rejected. On the other hand, tests with first differences reject the unit root hypothesis so that it cannot be rejected that the variables are integrated of order one. If the variables were co-integrated, a VECM should be estimated. In order to test for co-integration, I perform the Johansen procedure. The Johansen (1991) procedure tests for different co-integration vectors between the variables in a multiple-equation system. In order to use the Johansen procedure, one has to choose a lag length for the whole system that is tested. The information criteria show a lag length of 3 for the whole sample for both models.

Further, critical values are affected if a constant and a trend are taken into the relationship. A deterministic trend is assumed since one can clearly discern from the data that

Figure 1.8: Housing price index and housing net worth

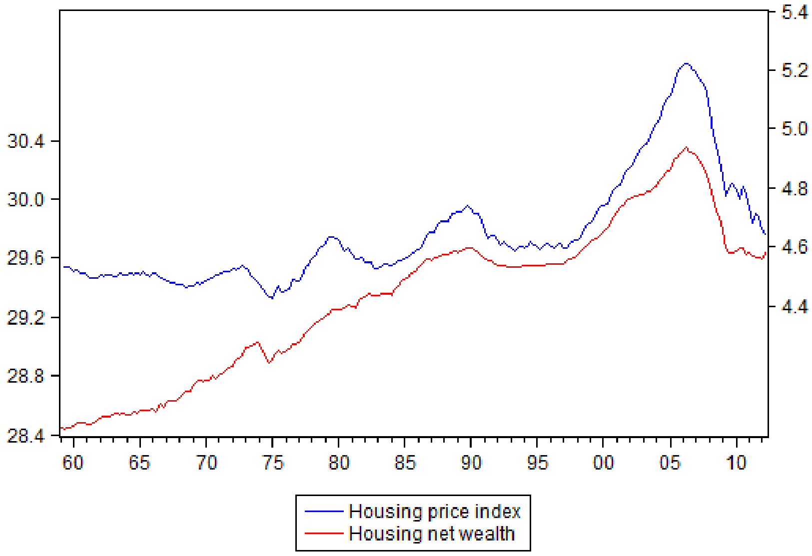


Table 1.2: Johansen test procedure, with linear deterministic trend

Sample	Rank	Eigenvalue	Trace test	p-value	Lmax-Test	p-value
With net housing wealth						
1959q4-2012q2	0	0.09	40.37	0.21	20.69	0.30
	1	0.05	19.68	0.44	10.04	0.74
	2	0.04	9.64	0.31	8.41	0.34
	3	0.01	1.23	0.27	1.23	0.27
With housing prices and housing stock						
1965q4-2012q2	0	0.14	74.97	0.02	28.54	0.19
	1	0.11	46.43	0.07	22.84	0.18
	2	0.06	23.60	0.22	11.97	0.55
	3	0.04	11.63	0.18	8.10	0.37
	4	0.02	3.54	0.06	3.54	0.06

they are trended. For the test, a constant in the short-term relation will be used but no deterministic trend in the co-integration relation.[3] In the Johansen procedure, two tests can be conducted. The first test, the trace test, tests the null hypothesis that there are no co-integration relationships between the variables higher than the rank. For each rank - that means for each possible co-integration relationship - the null hypothesis is that there is no co-integration of the order of the rank or higher. With the second test, the Lmax test, the exact order of co-integration can be tested. The null is that there are no co-integration relationships equal to the rank.

As can be seen in table 1.2, for the model with the net housing value in which there is no separation between housing prices and the stock of housing, the null of no co-

[3] Test results also reject co-integration when a deterministic trend is used in the co-integration relationship.

integration relationship cannot be rejected for all combinations of possible co-integration relationships. This means that the whole system cannot be estimated using an error-correction model as many authors have done (Case et al., 2005; Davis and Palumbo, 2001; Klyuev and Mills, 2007).

The result is less clear for the model in which housing prices and the housing stock have been separated. The trace test rejects no co-integration up to the first rank but accepts no co-integration at higher ranks so that two co-integrating relationships are found. On the other hand, the Lmax test rejects no co-integration at the fourth rank so that four co-integrating relationships are assumed. The model has been estimated with different co-integration ranks. However, no sensible result could be obtained. Often, the signs of the variables switched when the number of lags was changed so that, for instance, income had negative effects on consumption and vice versa etc. This is why no co-integrating relationship will be estimated with these variables.

The hypothesis brought forward in the theoretical part states that housing prices are likely to have different effects given different demographic as well as financial market regimes. This is why it is likely that the relationship between housing and non-housing consumption is not stable throughout time.

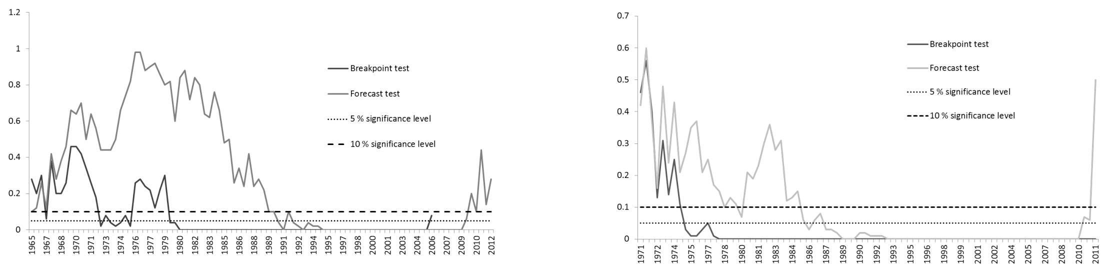
The stability of the relationship will be tested using a Chow-test applied by Candelon et al. (2001) to VAR models. Because in VAR models all variables are endogenous, the number of coefficients to be estimated is the square of a simple multivariate regression with only one variable exogenous and the rest endogenous. This is why the degrees of freedom in a VAR are much smaller than in a simple multivariate regression. The authors circumvent this problem by using bootstrap methods to estimate the standard errors and to derive the test statistics. Not using bootstrapping methods would bias the tests towards accepting structural breaks too easily. Two tests have been conducted: First, a simple Chow breakpoint test and second, a Chow forecasting test.

With the Chow test, the sample is cut into two sub-samples. The breakpoint test compares the sum of squared residuals that are obtained by fitting a single equation to the entire sample with the sum of squared residuals obtained when separate equations are fit to each subsample of the data. The tested hypothesis is whether the sub-samples are the same. A rejection of the null means that there is likely to be a breakpoint. With a Chow forecast test on the other hand, two equations are estimated, one using the full sample and the other only one sub-sample. The degrees of freedom are higher for the forecast test than for the breakpoint test.

Both tests are conducted in the dataset for each data point. In the model with net housing wealth, the tests are conducted for each data point between the first quarter of

Figure 1.9: Chow breakpoint and forecast test

(a) Housing net wealth **(b)** Housing price and housing stock



1963 and the second quarter of 2012 (figure 1.10a). For the model in which housing prices and the housing stock have been separated, the tests are conducted between the first quarter of 1971 and the second quarter of 2012 (figure 1.10b).[4]

As far as the model with net housing wealth is concerned, the breakpoint and forecast tests lead to similar results until 1980 but diverge afterwards. The breakpoint test would establish the breakpoint early in the 1980s while the forecast test would establish it late in the 1980s or early in the 1990s. I decided to use the fourth quarter of 1984 as a breakpoint. This has the advantage that the data is almost exactly cut in half, thereby having the same degrees of freedom for both sub-samples. Further, different estimations (not reported) have shown that the results are hardly different when choosing other cutoff points, either in the early or in the late 1980s.

A similar result is obtained for the model with separate prices and housing stock although the breakpoint test indicates a break already beginning in the mid-1970s. To compare the results between both approaches, the same cut-off point will be chosen as in the model in which the housing wealth has not been separated into its components.

Since I want to estimate the models in two sub-samples, one before and one after 1984, I test for separate co-integration relationships in the two sub-samples, again with a constant in the short-term relation and a constant but no deterministic trend in the co-integration relationship.[5] In table 1.3, the tests for co-integration in both periods are shown. No co-integration relationship can be detected in either of the two periods.

There is some co-integration present in the model with the separated housing stock and housing prices. However, the same problems apply as in the full sample, i.e. changing signs etc. So, the model with the separated housing wealth is estimated in the same way the first model is.

[4]Tests have been conducted with JMulTi 4.24.

[5]Again, the result that co-integration is rejected not affected by the introduction of a deterministic trend,

Table 1.3: Johansen test procedure, with linear deterministic trend, net housing wealth model only

Time	Rank	Eigenvalue	Trace-test	p-value	Lmax-Test	p-value
1959q4-1984q4	0	0.14	34.92	0.45	14.61	0.78
	1	0.11	20.31	0.40	11.48	0.60
	2	0.08	8.84	0.38	7.88	0.39
	3	0.01	0.95	0.33	0.95	0.33

Time	Rank	Eigenvalue	Trace-test	p-value	Lmax-Test	p-value
1985q1-2012q2	0	0.17	43.2	0.13	20.13	0.33
	1	0.12	23.07	0.24	14.41	0.33
	2	0.05	8.66	0.40	5.96	0.62
	3	0.02	2.7	0.10	2.7	0.10

Table 1.4: System tests for housing net worth model, p-values in brackets

Time	Autocorrelation (1-5) LM test	Normality Jarque Bera statistics	Heteroskedasticity Chi-square
1959q1-1984q4	14.90 (0.53)	12.9 (0.11)	236.29 (0.99)
1985q1-2012q2	13.63 (0.62)	4.0 (0.86)	344.68 (0.00)

Net housing wealth model

Here, the model with net housing wealth will be estimated. I will estimate a VAR model in levels and then compute impulse-response functions. For both periods, three lags are used and a deterministic trend. Lags have been chosen to minimise problems with non-normality, autocorrelation and heteroskedasticity of the residuals. Lag exclusion tests show that all lags have significant explanatory power.

Table 1.4 presents tests for autocorrelation, normality and heteroskedasticity in both periods for which the VAR has been estimated. In both periods, no autocorrelation is present and the residuals are normal. The normality test has been conducted using the identification given in equation (1.28) (see below). However, while residuals are heteroskedastic in the first period, they are not in the second.

In order to grasp the effects of housing wealth and housing price shocks on consumption, impulse-response functions are computed. In order to compute such functions, the system has to be identified. A structural VAR is estimated that is identified in the following way, where the ϵs are the structural error terms and the es the empirical residuals; the bs are the coefficients:

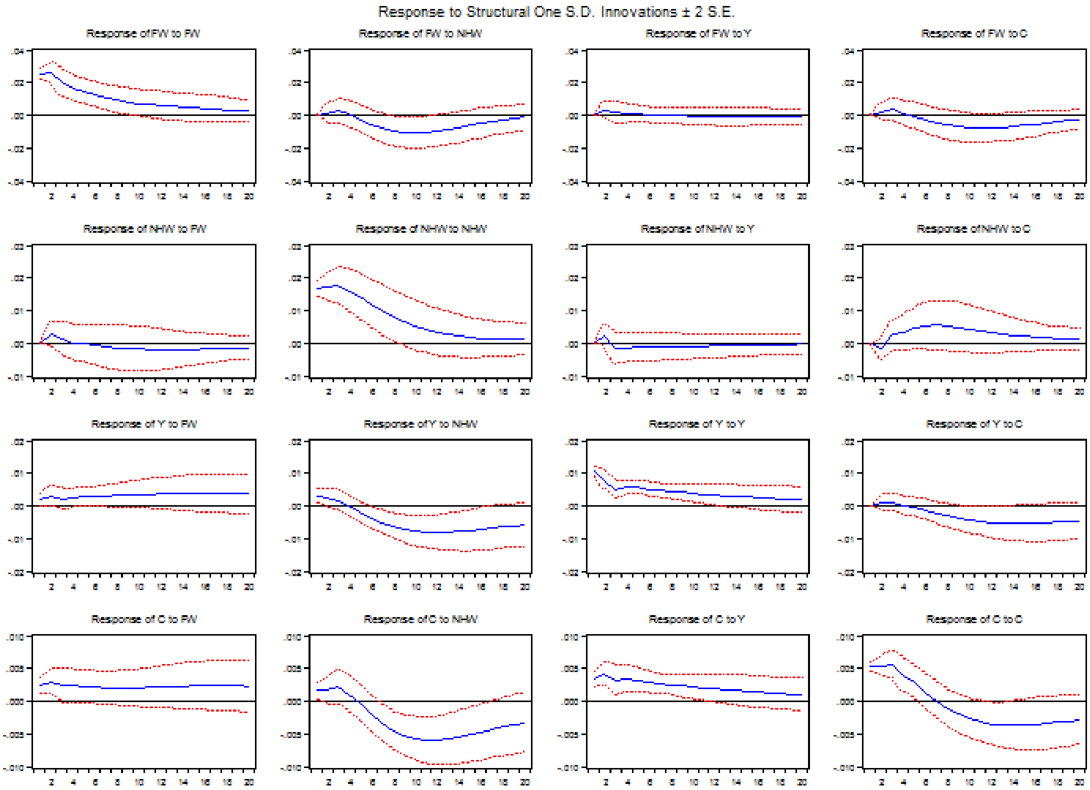
$$\begin{pmatrix} \epsilon_{fw,t} \\ \epsilon_{nhw,t} \\ \epsilon_{y,t} \\ \epsilon_{c,t} \end{pmatrix} = \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ b_{fw,y} & b_{nhw,y} & 1 & 0 \\ b_{fw,c} & b_{nhw,c} & b_{y,c} & 1 \end{pmatrix} \begin{pmatrix} e_{fw,t} \\ e_{nhw,t} \\ e_{y,t} \\ e_{c,t} \end{pmatrix} \tag{1.28}$$

The identification is chosen so that the wealth variables contemporaneously influence income and consumption but not each other. Both variables are pre-determined values at the beginning of the period so that they cannot influence each other contemporaneously. However, both can influence income and consumption contemporaneously.

The effect of all variables on consumption is theoretically established by the model presented previously. The effects of the two wealth variables on labor income are likely to be indirect, for instance via the influence of wealth on overall economic activity and thus wages and employment.

Figure 1.10: Impulse-Response functions

(a) 1959q1-1984q4



(b) 1985q1-2012q4

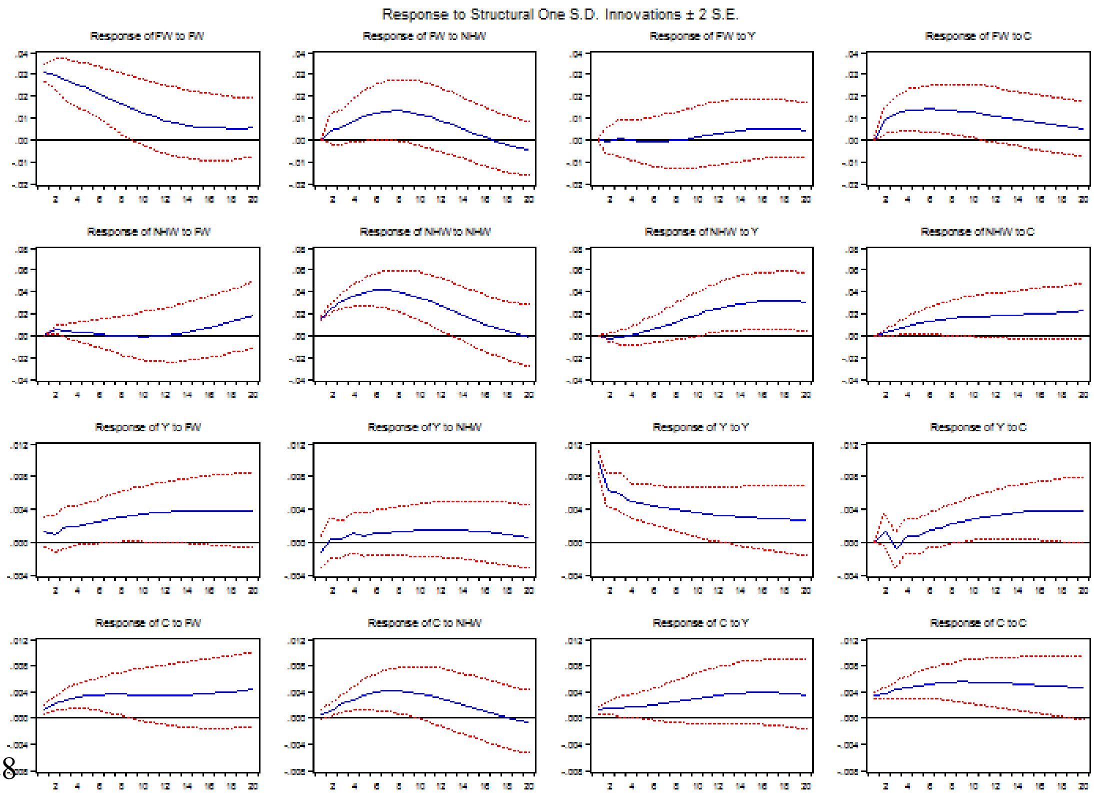
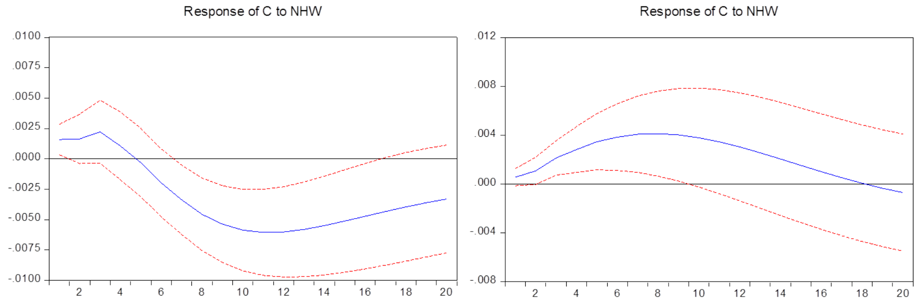


Figure 1.11: Impulse-response functions for consumption on housing wealth, left: 1959q1-1984q4; right: 1985q1-2012q4



Figures 1.11a and 1.11b show the impulse-response functions for the two sample periods; figure 1.11 shows the effect of a housing wealth shock on consumption in more detail. If one compares the two periods, one can see that there is a significant difference between shocks to consumption by changes in housing values: In the first period, housing wealth does not significantly affect consumption until the 7th quarter and than has a significantly negative effect on consumption; in the second period, it has a significantly positive effect on consumption until the 9th quarter after the shock. Thus, the theoretical model's implications for aggregate housing wealth on consumption seem not to be rejected.

The impulse-response functions for the other variables seem sensible. Financial wealth affects consumption positively in both periods and with comparable intensity. Labor income affects consumption more strongly in the first than in the second period. This is consistent with the implications of the theoretical model: In an economy with many young households which hold less wealth, labor income is a more important source of income so that changes in labor income have a more important role for the economy in the first period.

While the model has shown that there indeed is a difference between the two time periods consistent with the previous theoretical discussion, it has not shown that this difference is due to differences in the reaction of consumption to housing *prices*. In the next section, the role of prices will be looked at more closely.

Model with separated housing prices and housing stock

In the next step, the housing wealth variable is separated into housing prices, hp, and the housing stock, hs. The identification scheme chosen is the following:

$$\begin{pmatrix} \epsilon_{fw,t} \\ \epsilon_{hp,t} \\ \epsilon_{hs,t} \\ \epsilon_{y,t} \\ \epsilon_{c,t} \end{pmatrix} = \begin{pmatrix} 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ b_{fw,y} & b_{hp,y} & b_{hs,y} & 1 & 0 \\ b_{fw,c} & b_{hp,c} & b_{hs,c} & b_{y,c} & 1 \end{pmatrix} \begin{pmatrix} e_{fw,t} \\ e_{hp,t} \\ e_{hs,t} \\ e_{y,t} \\ e_{c,t} \end{pmatrix} \tag{1.29}$$

Again, all wealth variables do not influence each other because they are given at the beginning of the period but influence income and consumption. For the estimation, only two lags will be used in the first sample period and three lags in the second period. In the first period, this leads to normality of the residuals (lag lenghts criteria also indicate two lags). Also, in the first period, the residuals are not auto-correlated and homoskedastic (table 1.5).

However, in the second period, residuals are not normal (table 1.5). The non-normality of residuals is due to the non-normality of the housing stock variable. Since the impulse-response functions give almost exactly the same results as the model with net housing wealth only, I assume that non-normality in the residuals is not a significant problem.

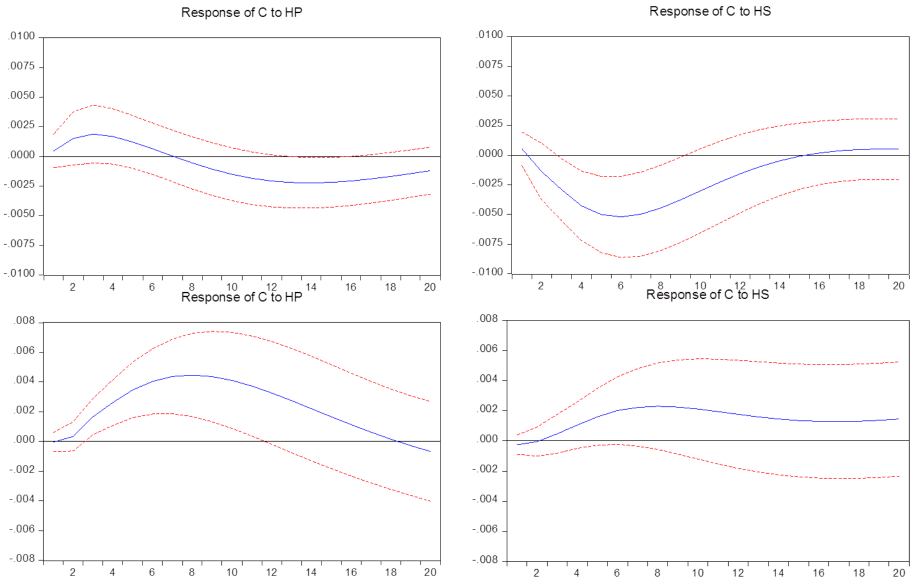
Table 1.5: System test for model with housing price and housing stock, p-values in brackets

	Autocorrelation (1-5) LM test	Normality Jarque Bera Statistics	Heteroskedasticity Chi-Square
1965q3-1984q4	21.76 (0.65)	15.43 (0.12)	332.27 (0.45)
1985q1-2012q2	22.06 (0.63)	110.99 (0.00)	508.30 (0.18)

Figure 1.12 shows the impulse-response functions of consumption to shocks in housing prices and the housing stock. It is ex ante difficult to interpret the effect of a housing stock shock. But since the shock of net housing wealth is a mixture of a price shock and a "stock shock", both variables are shown. As can be seen in the figure, in the first period, housing prices do not have a significant effect on consumption but a positive effect in the second. Thus, the model's hypothesis that housing *price* shocks differ when looking at different demographic and financial market regimes, is not rejected by the data.

One ad hoc interpretation of a "housing stock shock" consistent with the model could be that it constitutes a taste shock so that households suddenly decide to buy a higher housing stock. When they do, they have to abstain from consumption in the first period due to credit constraints but not in the second period in which credit constraints are lower.

Figure 1.12: Impulse-response functions for consumption on housing prices (left) and housing stock (right), up: 1965q1-1984q4; down: 1985q1-2012q4



That the housing wealth effect turns negative in the first period when only *net* housing wealth is considered seems to be due to the negative effect of a housing stock shock on consumption. However, in the second period, the stock does not have any significant impact on consumption.

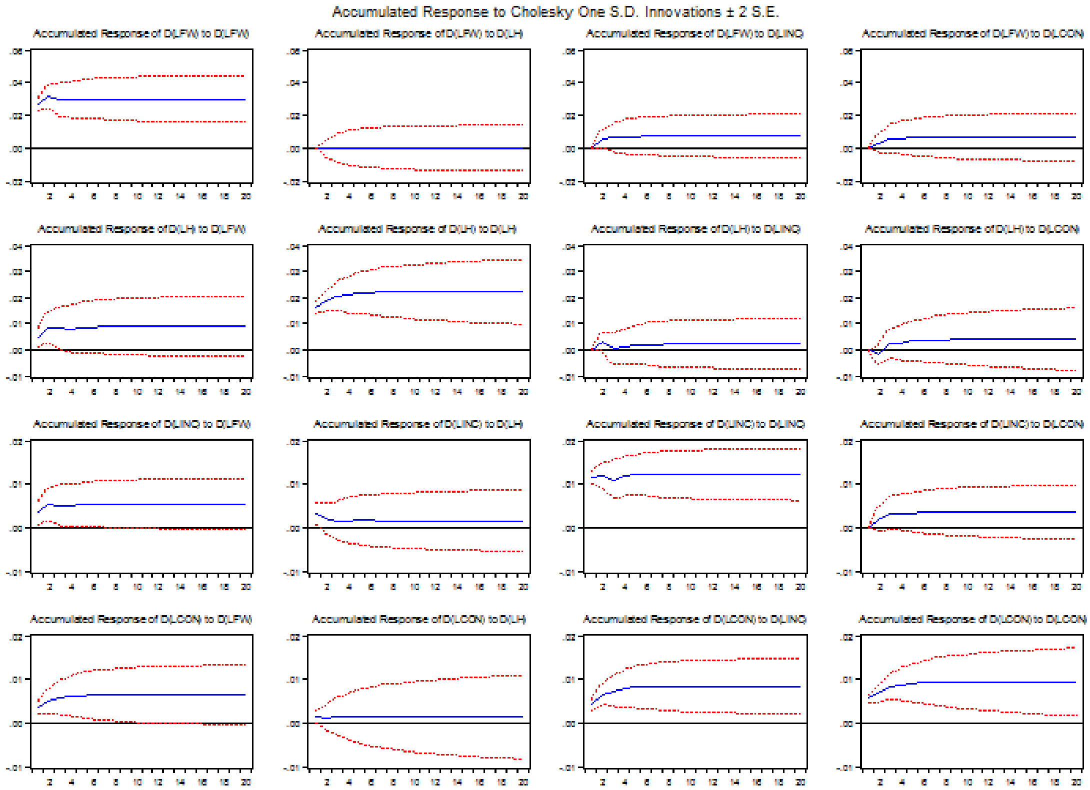
Thus, independent of the effect of housing stock shocks, the overall econometric results are consistent with the theoretical predictions of the model that housing *price* shocks differ between the two time periods.

1.2.3 Robustness test

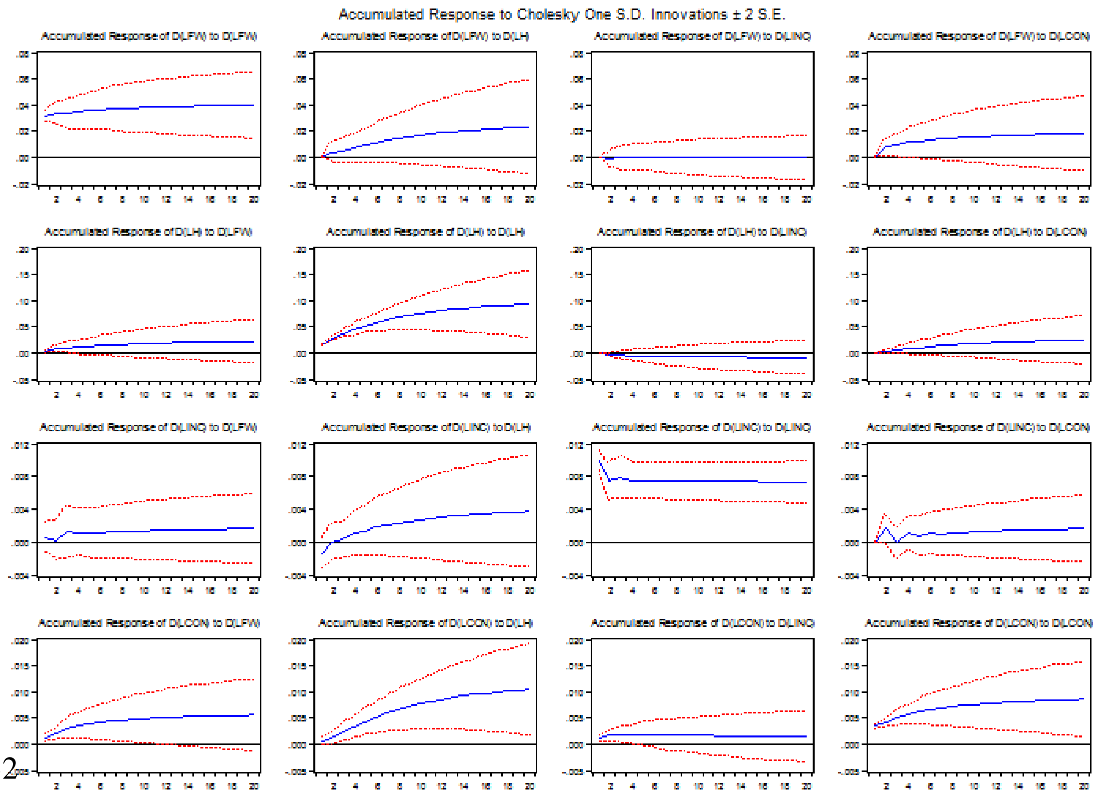
In this section, a robustness test will be conducted. The net housing wealth model will also be estimated in first differences since Phillips (1998) found that impulse response functions are inconsistent in unrestricted VARs with unit roots. Since first differences are used, the model will be estimated with one lag less than the original model, i.e. with two and not three lags. In order to compare results to the level impulse-response functions, the impulse-response functions have been accumulated (figures 1.14a and 1.14b).

Figure 1.13: Impulse-Response functions for consumption on housing wealth, first differences

(a) 1959q1-1984q4



(b) 1985q1-2012q4



In the second half of the sample - after the mid-1980s - there is no qualitative difference between the estimations. In both levels and first differences, a shock in net housing wealth leads to a significant increase in consumption. However, in the first sample period, there is no significant effect of housing prices on consumption when variables are differenced; in levels, there is a negative response of consumption to housing wealth shocks.

In terms of the argument presented above, this is not problematic. The argument is that given demographics and mortgage institutions, the housing wealth effect might be lower - or non-existent - in the first sample period than in the second.

However, there are problems with the residuals of the estimation. While residuals are well-behaved in the levels estimation, they are not in the estimation in first differences. This is likely due to outliers that show up more strongly in first differences than in levels. In the first sample period, the residuals are autocorrelated, heteroskedastic and non-normal; in the second sub-sample, they are heteroskedastic and non-normal. Variations of the lag-length have been tried, but while they mitigate some problems, the residuals are never as well behaved as in the estimation in levels. The results of the level estimation are thus more credible than the results in first differences. But the latter do not contradict the results of the former.

1.3 Conclusion

In much of the literature on the US, the wealth effect of housing has been analyzed as if it was identical to financial wealth. However, there are important differences. On the one hand, housing is a necessary good. Everybody has to live somewhere. This is why housing price changes are likely to have stronger distributional consequences than changes in prices of financial assets. Further, housing is mostly financed via mortgages and not bought out of current savings as is the case for financial assets. This has an influence on the distributional consequences of housing price changes. This is why most empirical time series studies on the US have not looked at the possible instability of the relationship between housing and consumption in time and are thus likely to be misspecified.

On the other hand, this study has developed an explicit model of the housing market in which demographics and the features of the mortgage market determine the aggregate effect of housing wealth changes on non-housing consumption. The model's analytical result is that the higher the proportion of young first-time buyers is with respect to old sellers, the higher are the negative distributional consequences of surprise housing price changes on aggregate consumption. This is modified by the financial market regime.

The higher the required down payment, the higher is the negative effect of housing price changes on aggregate consumption.

Analysis of demographic and mortgage market data has shown that due to a higher proportion of young households in the population and higher down payment requirements, housing price shocks are likely to have no or even a negative effect on consumption until the mid-1980s. Since then however, demographics changed as did the financial market regime so that there are more houseowners and less credit constraints for first-time buyers. Both factors are likely to lead to a more positive wealth effect of housing on consumption since the mid-1980s.

The VAR models which have been estimated do not refute this theory. They find that housing price shocks before the mid-1980s led to negative or no significant effects of housing wealth (and housing price) changes on consumption. Only after the 1980s did a housing wealth shock lead to a significantly positive influence on consumption.

Further research would be needed to understand the effect of housing price changes more fully. First, general equilibrium models should be developed in order to understand how housing wealth changes affect other economic variables like aggregate income and production because those channels are exluded in the present partial equilibrium model. For instance, higher housing prices could lead to higher construction, thus higher aggregate income and thus also higher consumption. This effect would be independent from a direct wealth effect but could show up in the data.

Second, the empirical strategy here was to use time series econometrics. This method has the advantage that aggregate predictions can be tested. However, since the model has stated specific microeconomic predictions, a microeconometric approach could be used to better understand the mechanisms behind the aggregate effect.

1.4 Appendix

The first order conditions for the maximization of the young, the middle aged and the old are given. The old maximize

$$U_t^o = ln(c_t^o) + \beta ln(h_t^o)$$
$$\text{s.t.} \tag{1.30}$$
$$c_t^o + R_t h_t^o - p_t + (1-\phi)p_{t-1} - (1+r)s_{t-1}^{fa} = 0$$

The first order conditions for non-housing consumption and housing consumption are (λ being the Lagrange multiplier):

(1.31a) $$\frac{1}{c_t^o} - \lambda = 0$$

(1.31b) $$\frac{\beta}{h_t^o} - \lambda R_t = 0$$

(1.31c) $$c_t^o + R_t h_t^o - p_t + (1 - \phi) p_{t-1} - (1 + r) s_{t-1}^{fa} = 0$$

Then, equations (1.31a) and (1.31b) are combined, so that:

(1.32) $$h_t^o = \frac{\beta c_t^o}{R_t}$$

This is plugged into (1.31c) and solved for consumption c_t^o. This yields the olds' consumption function:

(1.33) $$c_t^o = (1 + \beta)^{-1} (p_t - (1 - \phi) p_{t-1} + (1 + r) s_{t-1}^{fa})$$

The olds' marginal propensity to consume out of their life-cycle income is:

$$mpc^o = (1 + \beta)^{-1}$$

The middle aged maximize:

$$U_t^m = ln(c_t^m) + \beta ln(h_t^m) + (1 + \rho)^{-1} E_t[ln(c_{t+1}^o) + \beta ln(h_{t+1}^o)]$$

s.t.

(1.34) $$c_t^m + R_t h_t^m + \frac{c_{t+1}^o + R_{t+1} h_{t+1}^o}{(1 + r)} - y_t^m - R_t - (1 + r) s_{t-1}^{fa} -$$
$$\phi(E_{t-1}(p_t) - p_t) + p_t (1 - \phi)(r_m + (1 + r)^{-1}) - \frac{E_t(p_{t+2})}{(1 + r)} = 0$$

The first order conditions for the middle aged are:

(1.35a) $$\frac{1}{c_t^m} - \lambda = 0$$

(1.35b) $$\frac{\beta}{h_t^m} - \lambda R_t = 0$$

(1.35c) $$\frac{1}{c_{t+1}^m(1+\rho)} - \frac{\lambda}{(1+r)} = 0$$

(1.35d) $$\frac{\beta}{h_{t+1}^m(1+\rho)} - \frac{\lambda R_{t+1}}{(1+r)} = 0$$

(1.35e) $$c_t^m + R_t h_t^m + \frac{c_{t+1}^o + R_{t+1}h_{t+1}^o}{(1+r)} - y_t^m - R_t - (1+r)s_{t-1}^{fa} - \\ \phi(E_{t-1}(p_t) - p_t) + p_t(1-\phi)(r_m + (1+r)^{-1}) - \frac{E_t(p_{t+2})}{(1+r)} = 0$$

Combining (1.35a) with (1.35b), (1.35c), and (1.35d) yields:

(1.36a) $$h_t^m = \frac{\beta c_t^m}{R_t}$$

(1.36b) $$c_{c+1}^o = \frac{c_t^m(1+r)}{(1+\rho)}$$

(1.36c) $$h_{t+1}^o = \frac{\beta c_t(1+r)}{R_{t+1}(1-\rho)}$$

Substituting (1.36a)-(1.36c) into (1.35e) and solving for c_t^m yields the consumption function of the middle aged:

(1.37) $$c_t^m = (1+\beta(1+(1+\rho)^{-1}))^{-1}\Big(y_t^m + R_t + (1+r)s_{t-1}^{fa} + \\ \phi(E_{t-1}(p_t) - p_t) - p_t(1-\phi)(r_m + (1+r)^{-1}) + \frac{E_t(p_{t+2})}{(1+r)}\Big)$$

The marginal propensity to consume of the middle aged is thus

$$mpc^m = (1+\beta(1+(1+\rho)^{-1}))^{-1}$$

Finally, the young maximize:

$$U_t^y = ln(c_t^y) + \beta ln(h_t^y) + (1+\rho)^{-1} E_t[ln(c_{t+1}^m) + \beta ln(h_{t+1}^m)] + (1+\rho)^{-2} E_t[ln(c_{t+2}^o) + \beta ln(h_{t+2}^o)]$$

s.t.

$$c_t^y + R_t h_t^y + \frac{c_{t+1}^m + R_{t+1} h_{t+1}^m}{(1+r)} + \frac{c_{t+2}^o + R_{t+2} h_{t+2}^o}{(1+r)^2} - y_t^y - \frac{y_{t+1}^m + R_{t+1}}{(1+r)} + \frac{E_t(p_{t+1})(1-\phi)(r_m + (1+r)^{-1})}{(1+r)} - \frac{E_t(p_{t+2})}{(1+r)^2} = 0 \tag{1.38}$$

The youngs' first order conditions are:

$$\frac{1}{c_t^y} - \lambda = 0 \tag{1.39a}$$

$$\frac{\beta}{h_t^y} - \lambda R_t = 0 \tag{1.39b}$$

$$\frac{1}{c_{t+1}^y (1+\rho)} - \frac{\lambda}{(1+r)} = 0 \tag{1.39c}$$

$$\frac{\beta}{h_{t+1}^y (1+\rho)} - \frac{\lambda R_{t+1}}{(1+r)} = 0 \tag{1.39d}$$

$$\frac{1}{c_{t+2}(1+\rho)^2} - \frac{\lambda}{(1+r)^2} = 0 \tag{1.39e}$$

$$\frac{\beta}{h_{t+1}(1+\rho)^2} - \frac{\lambda R_{t+2}}{(1+r)^2} = 0 \tag{1.39f}$$

$$c_t^y + R_t h_t^y + \frac{c_{t+1}^m + R_{t+1} h_{t+1}^m}{(1+r)} + \frac{c_{t+2}^o + R_{t+1} h_{t+2}^o}{(1+r)^2} - y_t^y - \frac{y_{t+1}^m + R_{t+1}}{(1+r)} + \frac{E_t(p_{t+1})(1-\phi)(r_m + (1+r)^{-1})}{(1+r)} - \frac{E_t(p_{t+2})}{(1+r)^2} = 0 \tag{1.39g}$$

Substituting (1.39a)-(1.39f) into (1.39g) and solving for c_t^y yields the youngs' consumption function:

$$c_t^y = ((1+\beta)(1+(1+\rho)^{-1} + (1+\rho)^{-2}))^{-1} \left(y_t^y + \frac{y_{t+1}^m - R_{t+1}}{(1+r)} - \frac{E_t(p_{t+1})(1-\phi)(r_m + (1+r)^{-1})}{(1+r)} + \frac{E_t(p_{t+2})}{(1+r)^2} \right) \tag{1.40}$$

The youngs' marginal propensity to consume is

$$mpc^y = ((1+\beta)(1+(1+\rho)^{-1}+(1+\rho)^{-2}))^{-1}$$

2 Mortgage Credit and Housing Prices

Although housing price bubbles have regularly been at the root of financial and economic crises, there is surprisingly little research on the relation between real estate markets and economic crises (Gaffney, 2009). The lack of literature is astounding given the numerous real estate crises in the past. Real estate crises were at the root of the Japanese and Scandinavian financial crises in the late 1980s and early 1990s (Allen and Gale, 2000) as well as in the crises in south east Asia in the late 1990s (Collyns and Senhadji, 2002). The lack of analysis is likely due to the fact that credit - which links housing prices to financial stability and the real economy - is not sufficiently at the center of economic analysis. However, financial crises are almost always crises that both emanate from too much credit having been created before a crisis and not enough credit coming forward after a crisis (Kindleberger and Aliber, 2005; Schularick and Taylor, 2012).

The role of credit has been mainly overlooked in the traditional approach on asset and housing prices which focuses on user costs (Jorgenson, 1963; Poterba, 1984). In the user cost approach, housing prices are determined by real after tax interest rates and housing price expectations. This is why most of the literature on housing prices has looked at real interest rates (Poterba, 1984; Van Order and Dougherty, 1991) and housing price expectations (Case and Shiller, 1988; Poterba, 1991; Capozza and Seguin, 1996; Shiller, 2007) to explain actual housing price developments.

The user cost approach is also the framework within which the relation between monetary policy interest rates and housing prices is analyzed (Mishkin, 2007). Many economists (for instance Leamer (2007) and Taylor (2007; 2009)) have argued that too loose monetary policy was responsible for the built up of the US housing bubble. However, the effect of monetary policy - especially short term interest rates - on housing prices has not been found to be strong (Del Negro and Otrok, 2007; Boivin et al., 2010; Dokko et al., 2011).

The problem with the traditional user cost approach is that credit and debt and associated problems of asymmetric information and credit constraints are not considered (Bernanke and Gertler, 1995). However, those aspects might play an important role for housing prices, especially since houses are almost always financed by credit and not out of pocket. The more issues of asymmetrical information are important, the lower might be the role of interest rates alone (Stiglitz and Weiss, 1981).

But even when the relation between mortgage credit and housing prices is looked at, it is not clear ex ante how they interact: on the one hand, asset price changes could lead to changes in forthcoming credit when asset prices change economic units' equity and thus default risk (Bernanke and Gertler, 1989; Kiyotaki and Moore, 1997); on the other hand, changes in credit availability could lead to changes in asset demand and thus also changes in asset prices (Allen and Gale, 1999, 2000).

In this chapter, the relation between credit and asset prices will be looked at in more detail and it will be asked how they interact. Specifically, a co-integration relationship between mortgage credit and housing prices will be estimated and tests for weak exogeneity and Granger causality will be conducted. Similar approaches have already been applied to the real estate market in Hong Kong (Gerlach and Peng, 2005), Spain (Gimeno and Martínez-Carrascal, 2010), Ireland (Fitzpatrick and McQuinn, 2007), Finland (Oikarinen, 2009) and Greece (Brissimis and Vlassopoulos, 2008).

However, such a study has not yet been conducted for the US housing market. Using two different housing price measures, two co-integration models will be estimated. In both models, mortgage credit is weakly exogenous and housing prices adjust to the long run equilibrium. Impulse-response functions, variance decompositions and a forecast exercise also hint into the direction that mortgage credit was driving housing prices and not vice versa.

The role of interest rates for credit and housing prices is less clear cut. Both long term mortgage rates and short term monetary policy rates have been added to the basic models. While they have the right sign in all models, their influence on housing prices is very low and sometimes not significant. It is thus likely that monetary policy did not play a significant role in the built up of the US housing price bubble, but deregulated financial markets and associated moral hazard problems did.

Related work has focused on credit standards as an explanatory factor for US housing prices. Duca et al. (2011) augment the standard user cost approach by a credit availability index composed of loan-to-value ratios by first-time buyers. They find that this index has high explanatory power for housing prices. From that they deduce that the lowering of credit standards might have had an important impact on housing prices.

This approach has two drawbacks however. First, the realized loan-to-value ratio captures in the first instance the *effect* of relaxed credit standards and not the relaxation itself. Second, and more importantly, the loan-to-value ratio can also be endogenous to actual housing price developments and expectations. If lenders anticipate rising housing prices, they are ready to provide more credit today in anticipation of borrowers' higher equity and lower default risk in the future. The loan-to-value ratio then is an effect of higher housing prices, not a cause. More generally, Duca et al. (2011) do not test for causality or exogeneity of the loan-to-value ratio but state from the beginning that it is exogenous. Using actual mortgage credit - as is done in the present chapter - of course also uses the realized values. But here, it will be carefully looked at the possible endogeneity of this variable.

The remainder of the chapter is structured as follows. In the first part, economic theories of the relation between housing prices and credit will be presented after which an overview over the empirical literature will be given. After that, a detailed analysis of the development of US mortgage markets will be given in which it will be shown that deregulation is likely to have amplified problems of moral hazard in mortgage markets which in turn might have led to higher credit growth. In the third part, the co-integration relationship between housing prices and mortgage credit will be established and estimated. Different causality and exogeneity tests will be conducted. A last part concludes.

2.1 The interaction between mortgage credit and house prices

Theoretical perspective on mortgage lending and housing prices

The relation between asset prices and credit is likely to be two-fold. On the one hand, only the availability of credit makes it possible for asset prices to increase, since without credit, asset purchases could not be financed and thus not be realized; on the other hand, higher asset prices are likely to lead to higher credit since asset prices act as a collateral for banks and/or increases the borrower's net wealth which makes borrowers more willing to take out credit. In the first view, credit drives asset prices; in the second view it is the other way around.

The view that conditions of credit supply drive asset prices has been stressed by Allen and Gale (1999; 2000) (in the following, this will be called the AG model). They analyse the problem of risk-shifting that arises from asymmetric information and the principle of limited liability. In their model, asset prices depend on the riskiness of an asset and the amount of credit provided to acquire the asset. The model's main assumption is that assets like real estate are not fully financed out of an investor's net wealth but by credit.

Under the condition of limited liability an incentive asymmetry results: borrowers are more likely to invest their borrowed money in the risky asset since its average yield is higher than that of a safe asset; on the other hand, the likelihood of losses are also higher. If the higher return is realized, the investor will have a net gain after paying back his loans. If the asset will yield a lower return so that he cannot pay back the credit, he will default and the bank will realize the losses. This risk-shifting problem will lead to a market price of risky assets that is higher than the fundamental value, i.e. the value that would prevail if investors would not take out credits but only invest their own money and bear all the risk.

Financial liberalization will make the risk-shifting problem more severe. It will lead to an expansion of credit supply and thus more credit to investors who are able to purchase more of the risky asset. Furthermore, financial liberalization is a regime-shift that produces uncertainty. With new financial instruments and relaxed regulation, it is not clear ex ante to what level debt can be extended. If an expansion of credit due to new institutions is anticipated by investors, today's asset prices will increase. If, however, actual credit growth is not sufficient to validate expectations, prices will fall, leading to defaults and banking crashes. In Gale's and Allen's setting, an asset's price expectations can become self-validating if sufficient credit is forthcoming.

Note that the model can be applied both to physical and financial assets. This means the process can work when households take out mortgages to buy houses; and it can work when financial intermediaries take on debt to make loans or to purchase securities. There can be a multiple-stage process in which households and other investors lend money to banks which invest in loans or bonds that finance houses. This would drive up both the bond prices - thereby lowering interest rates - and housing prices.

However, there is also another view that links asset prices and credit to each other, but exactly in the opposite way the AG model does. Bernanke and Gertler (1989) and Kiyotaki and Moore (1997) developed models in which changes in asset prices lead to changes in credit and not vice versa (in the following those are termed the BG / KM models).

Bernanke and Gertler argue that due to asymmetric information - lenders know less about borrowers' investments than borrowers themselves - lenders monitor the borrowers' equity position. The higher the borrowers' equity, the lower will be interest rates charged - the so called external finance premium - so that borrowers with more equity, i.e. with higher asset prices relative to their liabilities, will increase their borrowing capacity and thus credit. Thus, higher asset prices lead to higher net wealth and more credit.

Kyotaki and Moore (1997) have a similar approach but do not look at the *price* of credit (the interest rate), but at the *volume* of credit. Higher collateral by a borrower will not necessarily lead to lower interest rates but could also lower the credit constraints that borrowers face, again increasing their borrowing capacity.

The main difference between the AG model on the one hand and the BG model on the other hand is that AG look specifically at the financing by credit of a particular asset. BG look at any asset that can influence borrower's net wealth and thus the general provision of credit. The BG model does not make explicit that the credit has to be used to buy the asset whose price changes were responsible for changes in its equity position. A household whose house's price increases can take out a credit to finance consumption or the purchase of other securities or to pay back older debts. But he does not have to buy a house with it.

If one focuses on the relation between overall credit (consumer credit, corporate credit and mortgage credit), changes in property prices are likely to drive those credits, i.e. the BG models hold; if one only looks at the relation of mortgage credit that is explicitly taken out to finance housing, AG's model in which credit (mortgage credit) drives assets prices (house prices) seems a priori more appropriate.

Empirical Studies

Most of the empirical literature on the relation between credit and housing prices has found that housing prices drive credit and not vice versa, vindicating the BG view of lending. However, those studies mostly did not look at mortgage credit but at overall credit. None of the studies has looked explicitly at the US case so far.

A first group of studies looked at the interaction of housing prices and *overall* bank lending (Hofmann, 2004; Goodhart and Hoffmann, 2003; Davis and Zhu, 2004; Gerlach and Peng, 2005), a second group more explicitly at the role of housing prices and *mortgage* lending (Fitzpatrick and McQuinn, 2007; Brissimis and Vlassopoulos, 2008; Gimeno and Martínez-Carrascal, 2010; Oikarinen, 2009). First, the studies using overall bank lending will be summarized:

Hofmann (2004) tries to explain bank lending for 16 OECD-countries. He estimates a VAR model with the traditional variables GDP and interest rates to explain bank lending. However, both variables - GDP as a variable catching demand for credit and interest rates as a cost of credit variable - were not able to significantly explain bank lending. The two variables only become significant when property prices are added.

Hofmann argues that property prices are likely to have influenced the ups and downs in bank lending. However, he does not test whether lending itself is an explanatory variable for the other variables, i.e. whether bank credit might influence property prices or GDP. He only looks at bank lending and not specifically at mortgage lending. By looking at the broad measure lending, he is more likely to find results explainable by the BG model.

Goodhart and Hoffmann (2003) analyze 12 countries and find that property prices drive bank credit but not the other way around. Interest rate innovations have an effect on asset prices in some countries while credit is rather unresponsive to interest rate innovations.

Davis and Zhu (2004) also use a sample of countries - 17 developed economies - but study the relation between bank lending and commercial property prices. They find that property prices influence bank credit but not vice versa while they find GDP to influence both.

Gerlach and Peng (2005) study the relation between bank credit and property prices in Hong Kong using a co-integration approach. They find that income, property prices and bank credit are co-integrated. But only property prices adjust to deviations from the long-run trend. Bank credit and income are weakly exogenous. They interpret this as indications that property prices drive bank credit. Their credit measure is total bank credit of which mortgage credit is only a part. From this result one cannot deduce what the relation between mortgage credit and housing prices is. They also find that bank credit is mostly unaffected by interest rates. Thus, they question that interest rate policy is useful as an instrument to smooth boom-bust cycles in asset and credit markets.

All the studies on overall bank lending and housing prices find results consistent with the BG model according to which the increase in collateral values increases bank lending. Studies that look more specifically at the relation between mortgage credit and housing prices find results at least partly consistent with the AG model.

Fitzpatrick and McQuinn (2007) explicitly study the relation between mortgage credit and housing prices in Ireland for the period 1996 to 2002. They estimate three single-equation error correction models with mortgage credit, residential investment and housing prices as the dependent variable, respectively. They find that there is a long run mutually re-enforcing relationship between mortgage credit and housing prices and not a one-way relation.

Gimeno and Martinez-Carrascal (2010) study the case of Spain and find that both housing prices and mortgage credit adjust to deviations in the long-run relation so that there is no uni-directional influence. Oikarinen (2009) also finds a two-sided relation between mortgage credit and housing prices for Finland.

Brissimis and Vlassopoulos (2008) look at the long-run relation between mortgage lending and property prices in Greece. They find mortgage lending to be adjusting to deviations in the long-run relationship so that property prices influence mortgage lending and not vice versa in Greece.

To conclude, studies that look at the relation between property prices and overall credit find that property prices are driving credit but not vice versa which supports the BG view. On the other hand, studies that analyze the relation between housing prices and mortgage credit find two-way interactions.

2.2 Deregulation and moral hazard in US mortgage markets

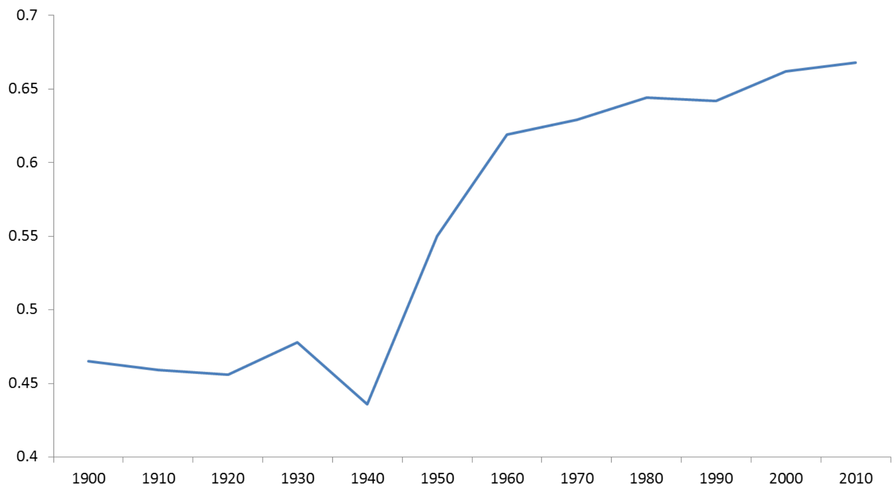
In this section, the development of the US mortgage market will be examined in order to find whether the pre-requisites for a credit-funded bubble postulated in the AG model can be seen in the US mortgage market, namely financial deregulation and moral hazard.

The development of the US mortgage system can be divided into three phases. The first phase can be called the "originate-to-hold" phase in which banks provided mortgages that they held until maturity. The second phase can be called "emergence of the originate-to-distribute model" in which private banks lent out mortgages that they increasingly sold to the Government sponsored enterprises (GSEs) Fannie Mae and Freddie Mac. The third phase can be called the "originate-to-distribute by investment banks"-phase in which mortgages were not only sold to the GSEs but also to investment banks. As will be argued, this development was driven by financial innovation and deregulation and has increased problems of moral hazard and limited liability.

The first phase ranged from the 1930s to the late 1960s. In that phase, especially saving and loan banks originated a standardized mortgage (with a maturity of 30 years, fixed interest rates, self-amortizing and insured) and held this mortgage until maturity (for more detail on that phase, see Green and Wachter (2005)). This kind of mortgage was called a "conventional" mortgage and still is the most common mortgage in the US. The loans banks were allowed to make were strictly limited by regulation; interest rates at which they could refinance were capped (by the so called Regulation Q) and their deposits were insured (Gilbert, 1986; Sellon and Van Nahmen, 1988).

The problem of moral hazard stemming from deposit insurance was counter weighted by the strict regulation of the types of assets that savings and loans were allowed to hold (White, 1993). Further, banks had to hold the mortgages they made and were thus respon-

Figure 2.1: Homeownership rate (as share of population)



Source: U.S. Census

sible if their mortgage portfolio led to losses. Within this phase falls the rapid expansion of home ownership in the United States, starting from a homeownership rate of 44 % in 1940 to 62 % in 1960 (figure 2.1). Since then, homeownership has increased, but at a much lower pace.

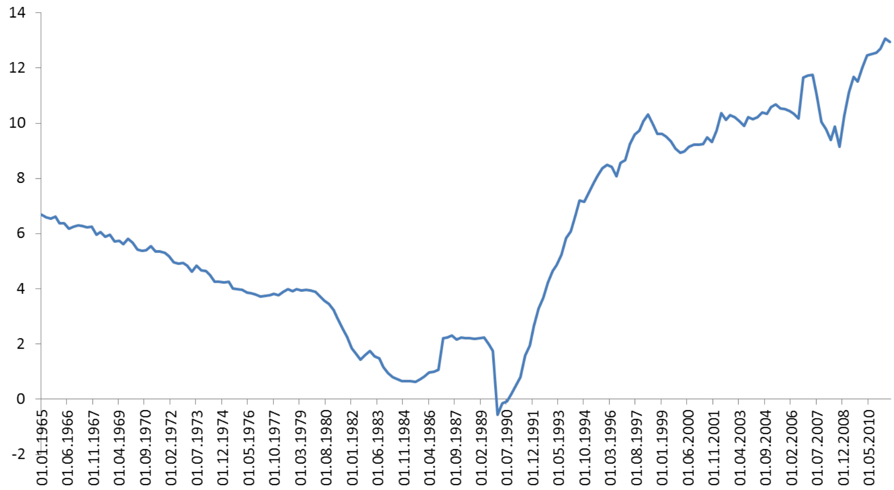
The second phase can be called the originate-to-distribute model, beginning in the 1970s. Increasingly, banks originated mortgages and sold those mortgages to the GSEs. The GSEs financed the purchases of mortgages by mortgage backed securities (Sellon and Van Nahmen, 1988). Those are securities whose yields are the interest payments of the underlying mortgages. With the ability to sell loans, banks could choose to receive liquidity now instead of receiving the income from interest payments. Further, since savings and loans were only allowed to take deposits and make loans in the states they were located, the sale of mortgages allowed them to tap the wider national financial market and thus make more loans. This was the upside.

On the downside, being able to sell the mortgages and living off the fees for their origination meant that banks were likely to be less vigilant about new borrowers than they were when they had to hold the mortgages until maturity themselves. Securitization increases the risks of moral hazard (Sellon and Van Nahmen, 1988). This problem was however initially mitigated by the GSE's regulations. GSEs could only buy "conforming" mortgages, i.e. mortgages that fulfill certain quality criteria like maximum loan-to-value, loan-to-income, debt-service-to-income ratios and an absolute size of the mortgage (McDonald and Thornton, 2008). Banks could only sell mortgages to the GSEs with these quality requirements.

While mortgage credits provide a stable income to banks from the interest payments, the originate-to-distribute model became more important due to both inflation and the savings and loans crisis of the mid-1980s. Inflation in an environment with fixed interest payments for long-term mortgages and fixed interest rates for demand deposits meant that banks' real earnings declined while depositors were less willing to provide liquidity to refinance banks' positions.

The cap of deposit interest rates by regulation Q meant that banks were cut off from deposits in times when short term interest rates rose. With the emergence of money market mutual funds that were not subject to Regulation Q, investors could get higher returns or they could invest in government securities whose yields were also not capped. The cut off from refinancing led to a cut of lending by the saving and loan industry and thus a cut of mortgage financing for households.

Figure 2.2: Savings institutions equity ratio (equity as share of total liabilities)



Source: Federal Reserve Flow of Funds, own calculations.

Further, the 1970s inflation became a problem for the banks. With fixed nominal interest rates from mortgages made before the inflation, inflation led to decreases in profitability of savings and loans and increased their liquidity problems. This mixture made many savings and loans insolvent when inflation increased and when monetary policy interest rates rose to fight inflation in the late 1970s.

However, insolvency was first not acknowledged by the Federal Savings and Loan Insurance Corporation that regulated the saving and loans industry and insured its deposits. This was also due to the fact that assets were not marked to market so that historical values were used for the accounting (White, 1993). This blinded regulators to the real problems of the banks.

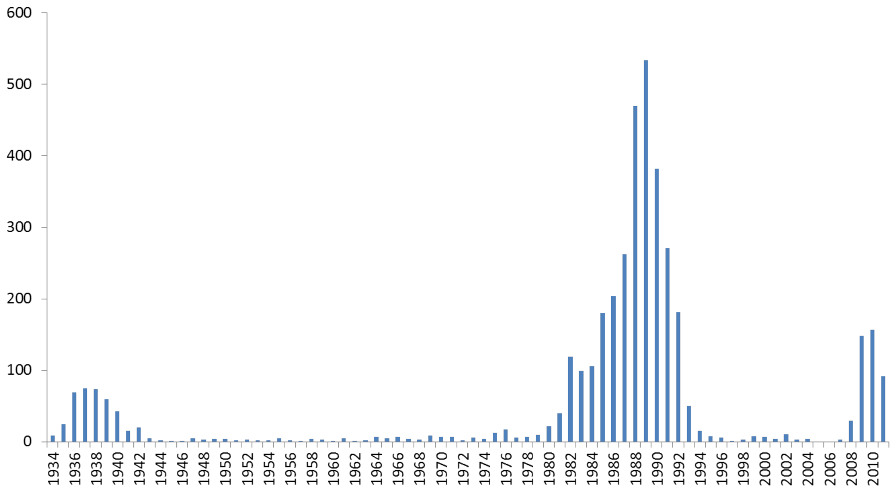
Furthermore, Congress deregulated the saving and loan industry by both abolishing Regulation Q and allowing savings and loans to invest in other assets than home mortgages, like consumer loans, unsecured commercial lending and the emerging market of junk bonds. Minimum necessary equity ratios were lowered so that banks were allowed to have higher leverage (figure 2.2) (White, 1993). Maximum loan-to-value ratios were eliminated for non-residential lending (Cole et al., 1992). Both increased moral hazard problems since regulators' forbearance combined with financial deregulation is likely to have led to a "gamble for resurrection" (Admati et al., 2012), i.e. a situation in which banks increase their risk in order to avoid default. This is likely to have led both to the housing boom in the mid-1980s and then to a bust which led to the savings and loans crisis which led to more closures of banks than was the case in the Great Depression (figure 2.3) and a decline in the provision of mortgages by savings and loans altogether (figure 2.4).

While the banking crisis led to the closure of many small regional savings and loans, in 1984 a big bank - the Continental Illinois bank - was saved by the Federal Deposit Insurance Corporation (FDIC) because it was deemed "too big to fail" (TBTF). It was argued that its failure would have threatened overall financial stability. It was at this point that the "TBTF doctrine" became official policy. Combined with a strong consolidation of the banking market due to the crisis, the TBTF doctrine was an incentive to become too big to fail, thus increasing concentration in the banking market (Boyd and Graham, 1991; Jones and Critchfield, 2005). Problems of moral hazard are likely to increase by the TBTF doctrine because the incentive asymmetry increases, with profits being privatized and possible losses being shouldered by the government.

Mortgage companies stepped in the place of savings and loans. Mortgage companies do not hold mortgages but sell them and live from the fee income generated by the services associated with the provision of mortgages. According to McCarthy and Peach (2002), savings and loans originated 50 to 60 % of all mortgages between 1970 and the mid-1980s. Then, after the saving and loans crisis, mortgage companies overtook, now originating up to 60 % of all mortgages.

If a bank mainly earns money by fee income and not by income from interest, the bank has an incentive to increase the volume of mortgages since every transaction earns fess. This may lead to a potential moral hazard problem that is aggravated since they can sell off the mortgages and are not responsible for the losses in case of default. Until the 1990s, this problem was somewhat mitigated since the GSEs still were only allowed to buy conventional mortgages that were subject to strict regulation.

Figure 2.3: Number of bankrupcies of saving and commercial banks



Source: FDIC, own calculations.

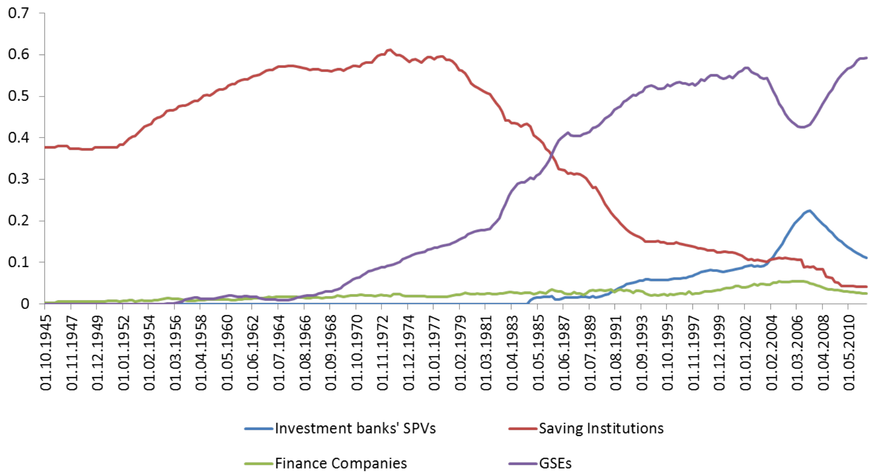
The problem intensified however when private investment banks began to buy mortgages and issue mortgage backed securities (figure 2.4). This is the third phase of the US mortgage market. In this phase, all mortgage market regulations that were designed to prevent problems of moral hazard were loosened. While the GSEs still only bought conforming loans, other loans - notably sub-prime, i.e. non-conforming loans - were bought by investment banks and financed by private mortgage backed securities (MBS). Those private MBS (in contrast to the agency MBS, i.e. MBS issued by the GSEs) were then again packed and sold and refinanced by other liabilities like short term commercial paper.

Like mortgage banks which became the primary originators of mortgages in this phase, an important part of investment banks' earnings are fees they earn by organizing the issuance and transaction of financial instruments. With every issuance of a mortgage backed security or papers that repackaged those MBS, investment banks earn money.

This gave them an incentive to repackage as much loans as possible and to issue more and more securities with ever lower quality - i.e. sub-prime mortgages (Chomsisengphet and Pennington-Cross, 2006). Since conforming loans were still securitized and insured by the GSEs, investment banks were the main players in the sub-prime market. Further, the fall of the separation between commercial and investment banking in 1999 meant that commercial banks could engage in the same business which increased the incentive to buy increasingly more high-risk assets.

The development of the mortgage system is illustrated in figure 2.4 which shows the share of mortgages held by different financial institutions. In the late 1970s, one can see

Figure 2.4: Type of mortgage holders as share of all outstanding mortgages



Source: Federal Reserve Flow of Funds, own calculations.

that savings and loans' share in mortgage holdings (savings institutions) declined while the share of mortgages held by the GSEs increased strongly beginning in the late 1960s and accelerated in the 1980s. The share of mortgage holdings by investment banks (held off-balance in so-called special purpose vehicles (SPVs)) began to increase in the mid-1980s and strongly accelerated in 2003.

The securitization of non-conforming mortgages without much regulation and their holdings in off-balance SPVs led to widespread moral hazard problems (Hellwig, 2009). Berndt and Gupta (2009) show that the originate-to-distribute model via securitization leads to moral hazard. They find that for securitized loans (not only mortgage loans), borrowers significantly underperform their peers in terms of the risk/return measures before the securitization and are more likely to suffer valuation losses after the securitization.

Ben-David (2010) shows that with mortgage brokers involved, there often was outright fraud in the mortgage process. In accordance with home buyers, sellers sold houses at inflated prices in order to allow home buyers to get higher mortgages. This inflation of home prices was more likely when the loan was sold by the mortgage broker. This practice was especially intensive in the sub-prime mortgage market.

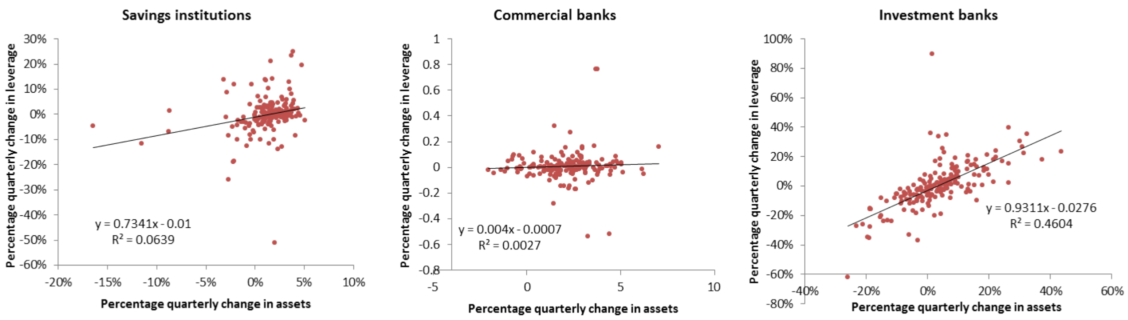
Demyanyk and Van Hemert (2009) also find that the quality of privately securitized loans to sub-prime borrowers declined monotonically since 2002 and that even the risk spread declined although borrowers became ever more riskier. The authors argue that the decline in risk spreads in the face of obviously higher risk meant that lenders that sold the mortgages were practicing moral hazard.

To sum up, there were problems of moral hazard both under the savings and loans system and the system dominated by investment banks. However, this problem is likely to have been higher in the early 2000s compared to the early 1980s. This is due to the different business models of savings and loans and investment banks.

Adrian and Shin (2009) find that investment banks increase their leverage when their assets increase, i.e. they follow a pro-cyclical business model in which rising asset prices lead to more debts and falling asset prices to less debt. This is neither the case with savings and loans nor with commercial banks. With their pro-cyclical business model, investment banks exacerbate the boom in lending and the subsequent bust. Figure 2.5 shows that pattern. In the figure, the percentage quarterly increase in assets and leverage is plotted for investment banks, savings institutions (mainly savings and loans) and commercial banks. Leverage is defined as assets divided by equity.

Investment banks do not originate mortgages themselves but buy mortgages in the market in order to repackage them into mortgage pools. By this they provide liquidity for the mortgage originators. By the pro-cyclical business model, they provide ample liquidity in the upturn when asset prices increase and cut liquidity when prices and thus their assets' worth decline.

Figure 2.5: Change in assets and leverage, 1965q02 - 2011q1



Source: Federal Reserve Flow of Funds, own calculations.

To sum up, the development of mortgage markets is likely to have led to ever higher levels of moral hazard over time. The main question is not which financial intermediary holds assets but what kind of asset any financial intermediary is allowed to hold. Securitization as such does not necessarily lead to moral hazard since regulation can make sure that only assets of good quality can be sold by financial institutions. This was mainly the case with the securitization via the GSEs.

Moral hazard only became a problem when lenders had an incentive to invest in high-risk/high yield markets and were also allowed to do so. This was the case of the deregulation of the savings and loans banks in the early 1980s and the securitization of non-conforming, i.e. subprime loans, by investment banks in the 2000s.

As far as the historical development of the US mortgage market is concerned, the ingredients of the AG model seem to be there: there exists limited liability both for households who can step away from their houses when they cannot pay their interest payments; but it even more so exists for banks that are either insured or are deemed “too big to fail”. This makes them more likely to invest in high yield / high risk assets and engage in moral hazard.

Due to moral hazard in an environment of deregulation, too much credit might have been extended so that housing prices were pushed away from their fundamental value. While it will not be explicitly tested to what extent there was a bubble in the housing market (its subsequent bursting being a sign that there actually was a bubble) it will be analyzed whether credit drove asset prices or vice versa.

2.3 Data

In the empirical part of this chapter it will be tested whether housing prices have driven mortgage credit or vice versa. Co-integration relationships between housing values and mortgage credit will be estimated and a test for weak exogeneity will be conducted.

The main problem as far as the data is concerned is the compatibility of the credit series and the housing price series. While there is a wide variety of housing price series available, there is only one measure of mortgage credit available that measures all mortgages in the US economy, the change in mortgages outstanding provided by the Federal Reserve’s Flow of Funds. It measures *net* mortgage changes, i.e. gross mortgages created in a period minus repayments.

In principle, the increase in *gross* mortgages would be better suited when the influence on mortgage credit on housing values is analyzed. For instance, if an existing house is sold by household *A* which pays off its outstanding mortgage, the purchasing household *B* might take out a new mortgage to finance the purchase. The net measure of mortgage borrowing could increase, decrease or stay the same:

a) it could increase if *B*’s new mortgage would be higher than *A*’s repayment, for instance because *B* needs less equity and/or *A* has already paid off a part of its mortgage credit;

b) it could decrease if *B* has more equity and needs a smaller mortgage credit than *A* pays off;

c) or net mortgage borrowing might not increase at all since the sum paid off by *A* is equal to *B*'s new mortgage.

However, for practical purposes, it is likely that case a) holds: if there are newly constructed houses on the market which are not sold by a former owner, the net measure is likely to increase since new additional mortgages are taken out by the buyers and no repayment due to a housing purchase takes place. But even if no additional houses are constructed, a housing price change is likely to be associated with a change of net mortgages in the same direction since even if repayment and the new mortgage were equal at the former price, the new price leads to a change in mortgages.

In order to choose an appropriate housing price measure, it is important to note that mortgage credit finances the *value* of a house, i.e. its price times its quantity (price per square feet times number of square feet). This means that price-only measures (like the Shiller-Case index) cannot be used in order to gauge the effect of credit on housing values.

This is why two housing value measures will be used here and two different models with those measures will be estimated. First, the National Association of Realtors (NAR) publishes a measure of average housing prices of existing houses sold in a period. No new houses are contained in the series. Second, the US Census bureau publishes data on the average value only of new houses sold.[1] Both measures can be used as value or price measures: They measure the average price of a house, but the house can have different square feet. So we will use the term "housing value" and "housing price" interchangeably for those measures.

After estimating models with mortgage credit and housing prices, the models will be re-estimated adding two different interest rates, the short term effective federal funds rate and the interest rate on 30 year conventional fixed rate mortgages. This specific long-term rate of course has become less relevant for mortgage markets since the deregulation of mortgage markets has led to more mortgages with shorter maturities and flexible interest rates. However, it is reasonable to assume that the rate on conventional mortgages is a reference point for the interest rates on less conventional mortgages. Both interest rates have been transformed into real rates by subtracting the current consumer price inflation rate.

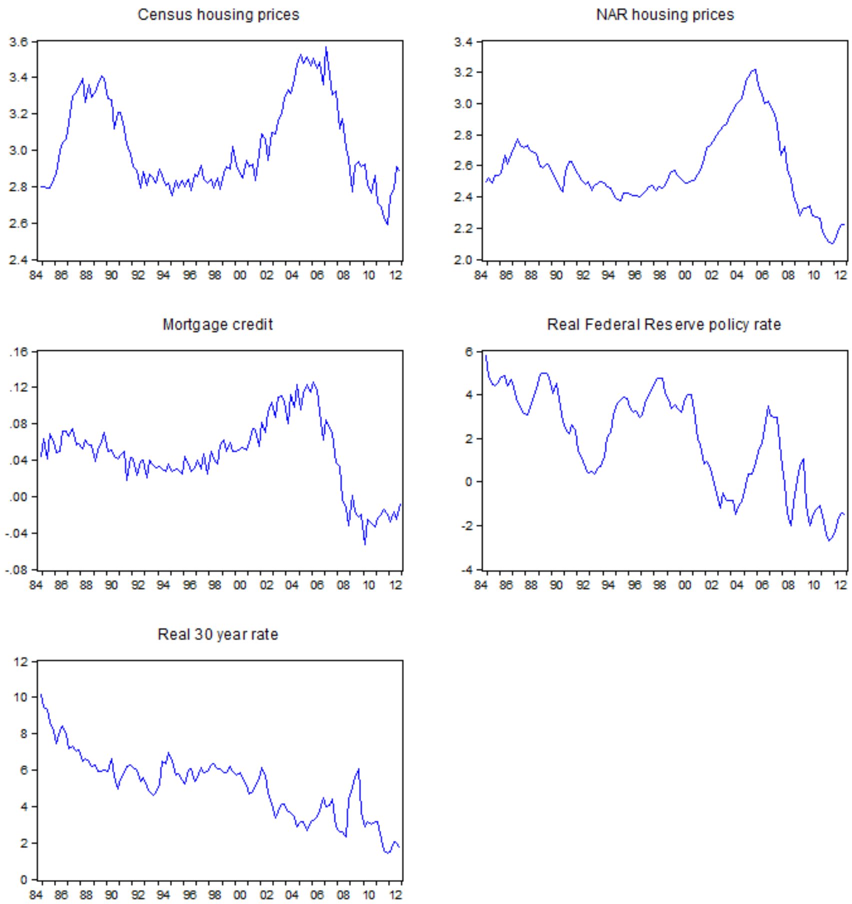
In order to avoid problems of heteroskedasticity, the mortgage data has been divided by disposable household income; the NAR and Census average housing price measures

[1] I have also tried a third housing value series, namely newly built single-family structures that are part of residential investment. In contrast to the NAR and Census data, no co-integration between single-family structures and mortgage credit could be established so that tests for weak exogeneity could not be performed. The data has thus not been used.

are divided by disposable household income per household. The income measure has been divided by the number of households because both housing price measures capture the average price of one house and houses are sold to households. All data is seasonally adjusted by the arima x-12 procedure. Figure 2.6 shows the data.

The division by household income also has the advantage that the resulting housing price to income ratio can be seen as an indicator for a housing price bubble: when housing prices diverge too markedly from income, it is likely (although not necessary) that a bubble builds up (McCarthy and Peach, 2004; Himmelberg et al., 2005). The same applies to the credit to income ratio.

Figure 2.6: Data



Source: Federal Reserve Flow of Funds, U.S. Census, National Association of Realtors, Bureau of Economic Analysis, own calculations.

The sample's beginning is set at the first quarter of 1984 and its end at the fourth quarter of 2012. As has been shown in the previous section, this is the phase in which mortgage markets were liberalized and in which moral hazard is likely to have increased.

Figure 2.6 shows two housing bubble episodes, one from the mid-1980s to 1990 and then from 2001/2002 to 2005/2006. In the Census data, the 1980s bubble is more evident while it is more muted in the NAR data. One can also see a similar development in the mortgage data where there is a hump in the 1980s and the 2000s.

2.4 Estimation

In the following section, the long-term relationship between mortgage credit and housing prices will be estimated using a vector autoregression error correction model (VECM). By using this method, one can test for strong and weak exogeneity and thus how the variables interact.

By testing for weak exogeneity, one can test which of the variables adjusts to the long-run relationship between the variables. The variables that do not adjust are weakly exogenous (Engle et al., 1983). A variable's weak exogeneity does not exclude that it can still be predicted and perhaps driven by other variables in the system, i.e. it could still be Granger-caused by those variables. Only if a variable is both weakly exogenous and is not Granger-caused by other variables, it can be said to be strongly exogenous, i.e. not to be caused by any of the lags of the levels or changes of another variable.

This is why both tests for weak exogeneity and tests for Granger causality will be conducted in order to discern the interaction of the variables. Formally, a test for weak exogeneity can be conducted if there is a co-integration relationship between variables. In terms of housing price (hp) and mortgage credit (mc), a vector error correction model can be written if the variables are co-integrated:

$$\begin{pmatrix} \Delta hp_t \\ \Delta mc_t \end{pmatrix} = \mathbf{\Pi} \begin{pmatrix} hp_{t-1} \\ mc_{t-1} \end{pmatrix} + \sum_{i=1}^{k} \mathbf{\Gamma}_i \begin{pmatrix} \Delta hp_{t-i} \\ \Delta mc_{t-i} \end{pmatrix} + u_t \tag{2.1}$$

$\mathbf{\Pi}$ and $\mathbf{\Gamma}$ are coefficient matrices. $\mathbf{\Pi}$ can be further decomposed thus:

$$\mathbf{\Pi} = \boldsymbol{\alpha}\boldsymbol{\beta}' \tag{2.2}$$

The vector $\boldsymbol{\alpha}$ contains the short-run adjustment coefficients, vector $\boldsymbol{\beta}$ captures the long run co-integration coefficients. A test for the significance of the respective elements of $\boldsymbol{\alpha}$

is a test for weak exogeneity. A test for weak exogeneity is a t-test for a single coefficient being zero. If weak exogeneity is not rejected, a single-equation estimation can be used without loss of information (Engle et al., 1983).

Granger non-causality means that a variable cannot be predicted by the past values of the levels or changes of another variable (Johansen, 1992). This can be tested by a Wald test for the joint significance of the various respective coefficients contained in the $\mathbf{\Pi}$ and $\mathbf{\Gamma}$ matrices.

2.4.1 Co-integration relationships

Before estimating the co-integration relationship, the variables' order of integration has to be established. To this end, augmented dickey fuller tests for the existence of a unit root are conducted. For the housing price measures and mortgage credit a constant is used but no trend since the variables do not seem to have a deterministic trend as can be seen from figure 2.6. On the other hand, for the two interest rates a constant and a trend is used due to their clearly visible trend. The lag length is established by the modified Akaike criterion (Ng and Perron, 2001). As table 2.1 shows, for all variables the null hypothesis of a unit root is accepted in levels but rejected in first differences. I thus assume the variables to be integrated at order one.

Table 2.1: Unit root tests

Variable		t-statistic	p-value*
NAR housing prices	level, 2 lags	-1.69	0.44
	first difference, 9 lags	-2.27	0.02
Census housing prices	level, 2 lags	-1.86	0.35
	first difference, 11 lags	-2.29	0.02
Mortgage credit	level, 1 lag	-0.97	0.76
	first difference, 8 lags	-2.23	0.03
Federal Fund rate	level, 4 lags	-2.24	0.46
	first difference, 0 lags	-7.73	0.00
30 year conventional rate	level, 4 lags	-2.81	0.20
	first difference, 0 lags	-9.63	0.00

* MacKinnon (1996) one-sided p-values

Next, it will be tested whether the variables are co-integrated using the Johansen procedure (Johansen, 1991). For each model, two lags are chosen. This lag length eliminates serial correlation. Table 2.2 shows the results of the Trace and Lmax test. Both tests indicate a single co-integration relation between the two variables in both models.

Table 2.3 shows the results of the residual tests. The residuals do not show autocorrelation. However, in the model using the NAR data, the normality of the residuals is rejected and there is evidence for heteroskedasticity.

Table 2.2: Johanson co-integration tests

Rank	Eigenvalue	Trace-test	p-value*	Lmax-test	p-value*
		With NAR data			
0	0.18	27.08	0.00	22.89	0.00
1	0.04	4.19	0.38	4.19	0.38
		With Census data			
0	0.13	20.51	0.05	16.58	0.04
1	0.03	3.93	0.42	3.93	0.42

*MacKinnon-Haug-Michelis (1999) p-values

Table 2.3: Residual tests

	Autocorrelation, 3 lags LM-Stat	Normality Jarque Bera joint test	Homoskedasticity White test (χ^2)
NAR data	2.19 (0.70)	52.21 (0.00)	53.46 (0.00)
Census data	5.30 (0.26)	8.77 (0.46)	37.49 (0.16)

Finally, table 2.4 shows the coefficients for the long-run relation, as contained in vector $\boldsymbol{\beta}$, and for the short run coefficients from vector $\boldsymbol{\alpha}$ for the two models. Note that the coefficient for the respective housing price measure is normalized to one and thus not reported here.

Table 2.4: Normalized long-term relations and adjustment parameters (t-values in parantheses)

cointegrating coefficients		Adjustment coefficients	
mc	c	Δhp	Δmc
	NAR data		
-6.25	-2.28	-0.19	-0.01
(-11.23)	(-69.31)	(-4.91)	(-0.58)
	Census data		
-5.25	-2.78	-0.15	-0.01
(-4.64)	(-41.93)	(-3.68)	(-1.93)

One can see that the quantitative results for the NAR and the Census data are similar. This indicates that the results of the models are mutually consistent although both housing price variables measure different concepts (existing houses with the NAR, new houses with the Census data) and come from different sources.

In the models, the respective housing price measure adjusts to the long-run relation and is thus endogenous. In the model with the NAR data, the adjustment coefficient in the equation for changes in mortgage borrowing is both small and not significant so that weak exogeneity cannot be rejected.

The model with the Census data is more problematic: the adjustment coefficient for changes in mortgages is negative, so that mortgage borrowing increases when the level of mortgage borrowing overshoots its equilibrium relation with housing prices. This means that it plays a destabilizing role for the long-run relationship.[2] However, given the small sign of the coefficient and that it is only significant at the 10 % level, the problem does not appear to be big. Later results will confirm that mortgage credit does not seem to play a big role in the Census model, so that mortgage credit can be assumed to be weakly exogenous in both models.

Further, Granger tests for the significance of the lagged variables in the co-integration model are conducted in order to establish whether the variables Granger-cause each other. With two lags, the co-integrated system consists of those two equations:

$$\begin{aligned}\Delta hp_t &= \alpha_1(1 - \beta_1 mc_{t-1} - \beta_2)+ \\ &\gamma_{1,1}\Delta hp_{t-1} + \gamma_{1,2}\Delta hp_{t-2} + \gamma_{1,3}\Delta mc_{t-1} + \gamma_{1,4}\Delta mc_{t-2}\end{aligned} \tag{2.3}$$

and

$$\begin{aligned}\Delta mc_t &= \alpha_2(1 - \beta_1 mc_{t-1} - \beta_2)+ \\ &\gamma_{2,1}\Delta hp_{t-1} + \gamma_{2,2}\Delta hp_{t-2} + \gamma_{2,3}\Delta mc_{t-1} + \gamma_{2,4}\Delta mc_{t-2}\end{aligned} \tag{2.4}$$

For the housing price equation, the test for Granger non-causation is a Wald test for the joint significance of the coefficients $\alpha_1\beta_1$, $\gamma_{1,3}$ and $\gamma_{1,4}$. Equivalently, the Wald test for mortgage credit is a test for joint significance of α_2, $\gamma_{2,1}$ and $\gamma_{2,2}$. Table 2.5 shows the test results. As can be seen, Granger non-causality is rejected for all variables in both models so that no strong exogeneity of mortgage credit can be established.

Table 2.5: Granger tests (χ^2 statistic), p-values in parantheses

Dependent variable	NAR data	Census data
Δhp	18.06 (0.00)	9.33 (0.03)
Δmc	11.01 (0.01)	7.03 (0.07)

To conclude so far, it seems that housing prices adjust to the long-run relationship while housing prices do not. This does not exclude that lagged levels and differences of housing prices have a role for mortgage credit however. One cannot conclude that mortgage credit is driving housing prices so far. This is why some more tests and exercises with the data will be conducted to better gauge the interaction between the two variables.

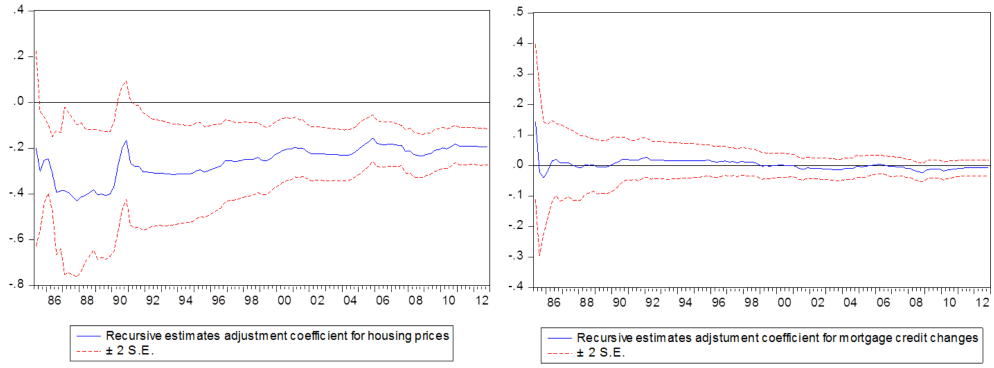
[2]Note that in the long-run relation, the coefficient have been normalized so that the coefficient for housing prices is unity. Consequently, a *negative* adjustment coefficient for housing price changes and a *positive* coefficient for changes in mortgage borrowing indicate the right adjustment.

2.4.2 Stability

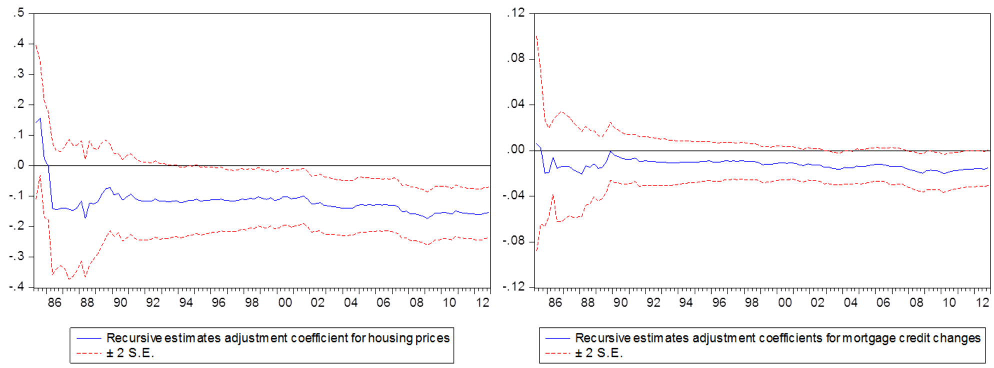
In order to see whether there were structural changes in the relationships between the variables, a stability analysis will be conducted. In order to do that, the models' adjustment coefficients are recursively estimated. Figures 2.8a and 2.8b show the recursive estimates. On the figures' left hand side are the adjustment coefficients for the changes in housing prices, on the right hand are the adjustment coefficients for changes in mortgage borrowing (the coefficients for the difference lagged variables are not shown).

Figure 2.7: Stability of adjustment coefficients

(a) NAR model



(b) Census model



The adjustment coefficients seem reasonably stable and confirm the implications of the co-integration model. As far as the adjustment coefficients for housing prices are concerned, in the NAR model, the adjustment becomes weaker in time, while it becomes larger with Census data. While the adjustment coefficients for mortgage credit are also quite stable, they are much closer to zero. In the NAR model, the value zero is always within the confidence interval. In the Census model, the confidence interval is only slightly below zero after 2006. This further hints to the validity the previous assumption that mortgage credit is weakly exogenous in the Census model.

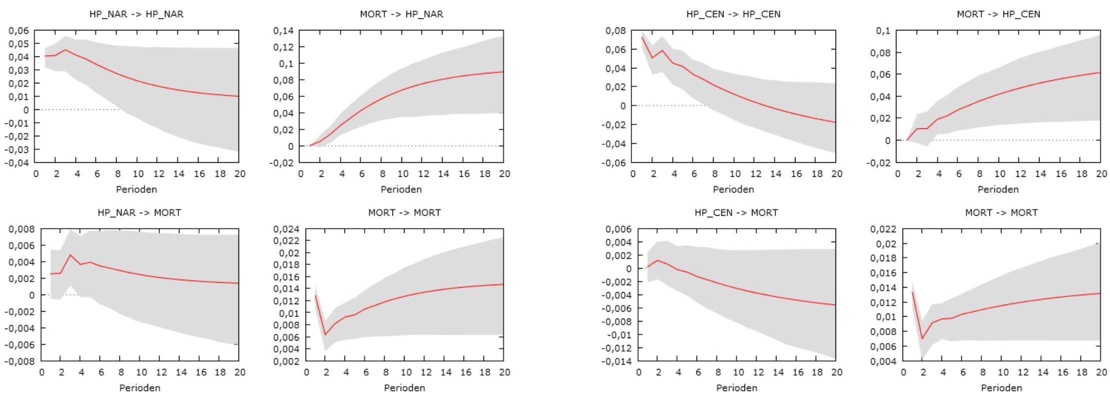
2.4.3 Impulse-response functions and variance decomposition

In order to better gauge the dynamics of the housing price / mortgage credit interaction, impulse response functions and variance decompositions are computed. Figures 2.9a and 2.9b show the impulse-response functions. The Cholesky ordering is that housing prices have a contemporaneous effect on mortgage credit but not vice versa. This ordering does not affect the results.

In both models, a one-time mortgage shock leads to a permanent increase in housing prices. On the other hand, a housing price shock does not significantly affect mortgages (although in the NAR model, there is a significant and positive influence once in the third quarter after the shock). While not significant, in the Census model, a housing price shock leads to a *fall* of mortgage borrowing. The wrong sign for the adjustment of mortgage borrowing in the Census model does not destabilize the relationship: all variables in the Census model converge to a fixed long-term value after the shock.

Figure 2.8: Impulse-Response functions with 95 % confidence interval

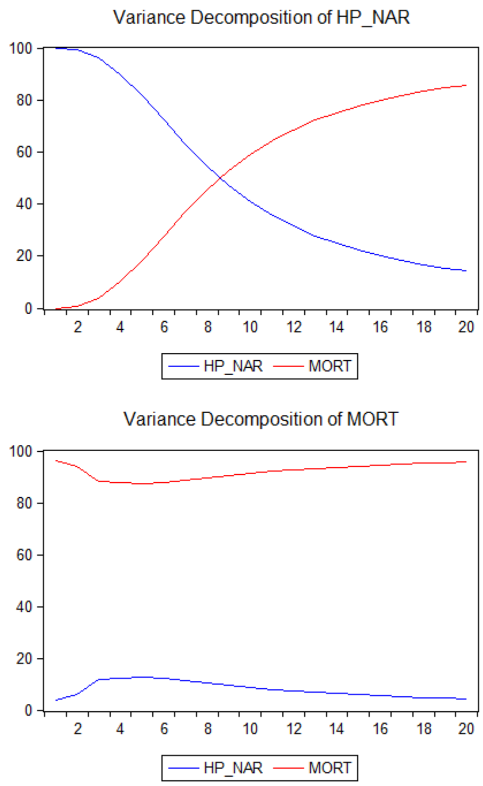
(a) NAR model **(b)** Census model



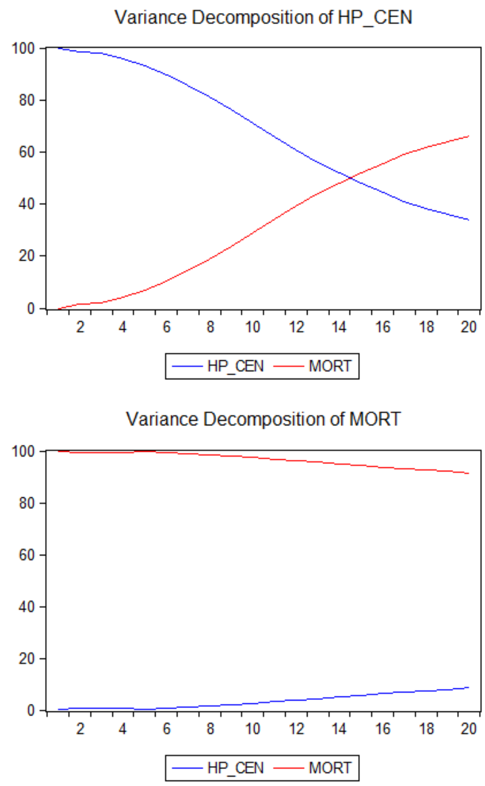
Figures 2.10a and 2.10b show the variance decompositions, using the same ordering as in the impulse-response functions. In both the NAR and the Census model, the variation of mortgages explain a large part of the variation of housing prices while housing price variation does hardly explain the variation of mortgages. As with the test for weak exogeneity, those results hint to the more important role of mortgage prices in driving the housing price dynamic than vice versa.

Figure 2.9: Variance decompositions

(a) NAR model



(b) Census model



2.4.4 Out of sample forecast

A further test is to use an out-of-sample forecast for the two variables. Using this exercice one can see which of the two variables can be better forecast using the respective other variable.

For the forecast, the models are re-estimated and the sample is shortened so that it ends at the fourth quarter of 2001. This is before both the built up and the subsequent bust of the housing price bubble. Housing prices and mortgage credit are then forecast until the fourth quarter of 2012.

Note however that this is not a strict out-of-sample forecast. The forecasts will be done using the single equations of the two system equation. Not the entire system will be used for the forecast: in the equation for housing prices, actual mortgage credit is used as the exogenous variable; in the equation for mortgage credit, actual housing prices are used as the exogenous variable. But the lags of the respective endogenous variable are the past forecast values, not the actual values.

By this exercise, the stability of the system can be further tested and the degree to which a variable explains the other variable can be better evaluated. The coefficients of the estimation until the fourth quarter of 2001 are shown in table 2.6. In the NAR model, mortgage borrowing is again weakly exogenous, like in the full sample (table 2.4). The Johansen test accepts co-integration at the 5 % level (not reported). In contrast to the full sample estimation, in the Census model, mortgage borrowing is not at all significant and thus weakly exogenous. But the variables in the Census model are hardly co-integrated anymore (slightly higher than the 10 % level).

Table 2.6: Normalized long-term relations and adjustment parameters (t-values in parantheses), 1984q1 - 2001q4

cointegrating coefficients		Adjustment coefficients	
mc	*c*	Δhp	Δmc
NAR data			
-7.13	-2.20	-0.29	-0.00
(-6.01)	(-38.99)	(-4.31)	(-0.10)
Census data			
-17.69	-2.17	-0.15	-0.00
(-4.03)	(-10.41)	(-3.70)	(-0.13)

Both models (figures 2.11a and 2.11b) predict a strong rise in housing prices and also the subsequent bust. Housing prices are well forecast in the NAR model although actual housing prices are above the confidence intervals when prices peak. The strong decline when the bubble burst is well captured. But predicted prices undershoot actual prices from 2009 until the sample's end.

In the Census model, predicted housing prices both significantly overshoot actual prices when the bubble built up and undershoot it afterward. This is likely to be the result of the hump from the mid-1980s to the early 1990s in the Census data (figure 2.6) which is less big in the NAR housing price measure and might have led to a too high estimated sensitivity of housing prices to mortgage borrowing in the sample.

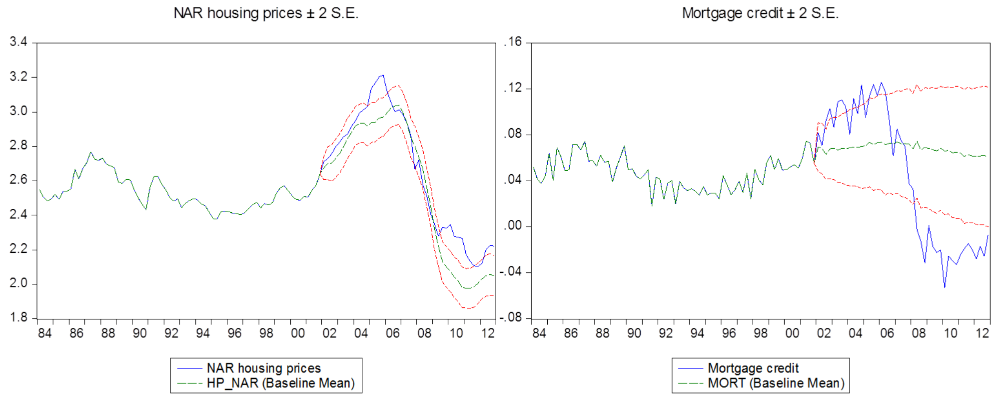
The models have a harder time to forecast mortgage credit based on housing prices. In both models, the forecast mortgage credit hardly moves at all and the strong boom-bust dynamic of the actual mortgage credit development cannot be seen. Overall, those results further indicate that mortgage credit is more likely to drive housing prices than vice versa.

2.4.5 The role of interest rates

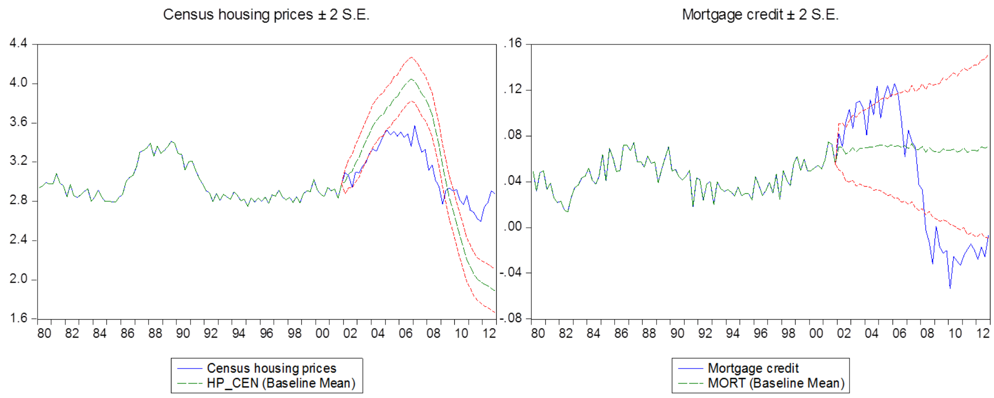
In the following section, the role of interest rates is more closely looked at. The models have been estimated in the same way as before, only adding the short term effective federal funds rate and the 30 year interest rate for conventional fixed rate mortgages, respectively.

Figure 2.10: Forecasts

(a) NAR model



(b) Census model



Remember that housing prices and mortgage credit are expressed as a share of disposable income. Adding interest rates to the model means that they are used not to explain credit and/or housing prices as such, but both as a share of disposable income. The housing price / income ratio has the advantage that it can be used as a proxy for housing price bubbles: if housing prices increase more than disposable income, this might indicate a housing price bubble.

Table 2.7 shows the results. The coefficients from the model with and without interest rates hardly differ (compare to table 2.3). In all models, interest rates have the expected (negative) sign. But only in the NAR model do interest rates enter the long-run relation significantly. Further, in all models, interest rates do not adjust to the long-run relation since the adjustment coefficient is not significant at all. Also, tests for co-integration (not reported) show that the variables in the NAR model are still co-integrated with both interest rates; in the Census model, only the model with short-term interest rates shows co-integration.

Table 2.7: Normalized cointegrating coefficients (t-values in parentheses)

cointegrating coefficients			Adjustment coefficients		
mc	*i*	*c*	Δhp	Δmc	Δi
NAR data, short term rate					
-6.57	0.02	-2.32	-0.27	-0.01	-0.02
(-16.57)	(3.71)	(-95.34)	(-5.98)	(-0.47)	(-0.04)
NAR data, long term rate					
-6.44	0.02	-2.38	-0.22	-0.00	-0.34
(-13.30)	(2.05)	(-41.34)	(-4.92)	(-0.14)	(-0.56)
Census data, short term rate					
-5.46	0.02	-2.83	-0.18	-0.02	0.07
(-5.35)	(1.28)	(-45.53)	(-4.12)	(-1.96)	(0.19)
Census data, long term rate					
-5.33	0.02	-2.86	-0.17	-0.01	-0.07
(-4.95)	(0.81)	(-22.50)	(-3.73)	(-1.78)	(-0.22)

Given the very low coefficient of interest rates, it seems that they hardly play a role in the model. To evaluate the effect of an alternative path of monetary policy rates, a counter-factual scenario is computed based on the housing price equation in the NAR model. The alternative interest rate, i, is computed according to the Taylor rule (2007) and computed thus:

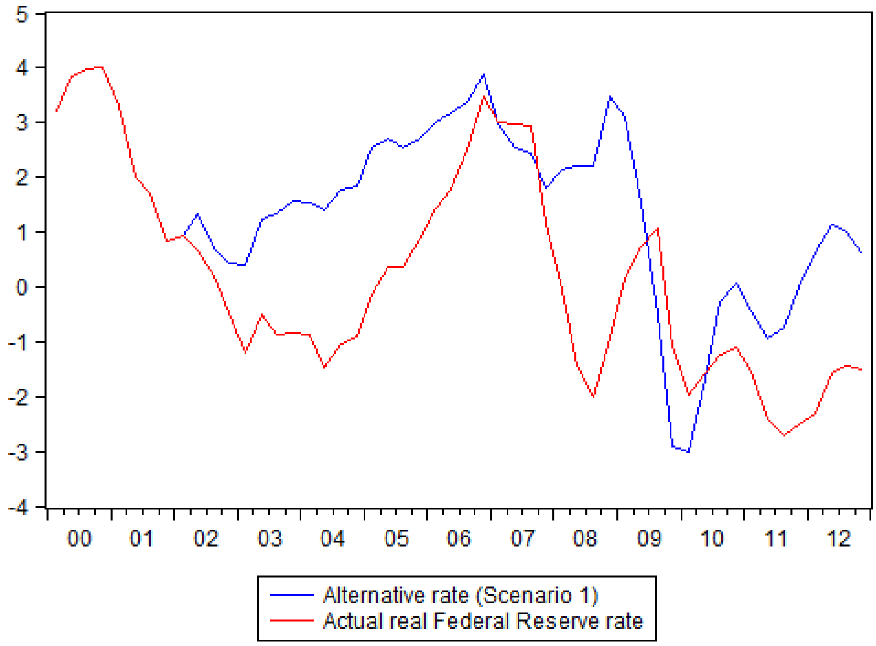
$$i = c + 1.5\pi + 0.5(\frac{y - y*}{y*}) \tag{2.5}$$

Here, y is GDP and $y*$ is potential GDP as computed by the Congressional Budget Office (CBO, 2014). The constant c is chosen - as in Taylor - so as to equate the actual and the alternative interest rate in the first quarter of 2002. Since the Federal Reserve sets interest rates relatively smoothly and does not mechanically adjust interest rates in accordance with a Taylor rule, the alternative interest rate has been smoothed by using a four-quarter moving average. Since real interest rates have been used in the estimation, the actual inflation rate is also subtracted from the alternative interest rate path.

This is obviously problematic since an alternative interest rate path would also have changed inflation. But results hardly differ if the above model is estimated with nominal interest rates and an alternative nominal monetary interest rate path is chosen. Further, the counter-factual model is only computed to better understand the magnitudes involved of alternative interest rates and less as a rigorous counter-factual exercise. The actual and the alternative interest rate path are shown in figure 2.11.

Figure 2.12 shows actual NAR housing prices, the baseline scenario in which housing prices are dynamically forecast given actual interest rates and mortgage credit and the scenario with the alternative interest rate path. One can clearly see that there are hardly any differences between the baseline scenario and the alternative scenario although short

Figure 2.11: Alternative monetary policy interest rates

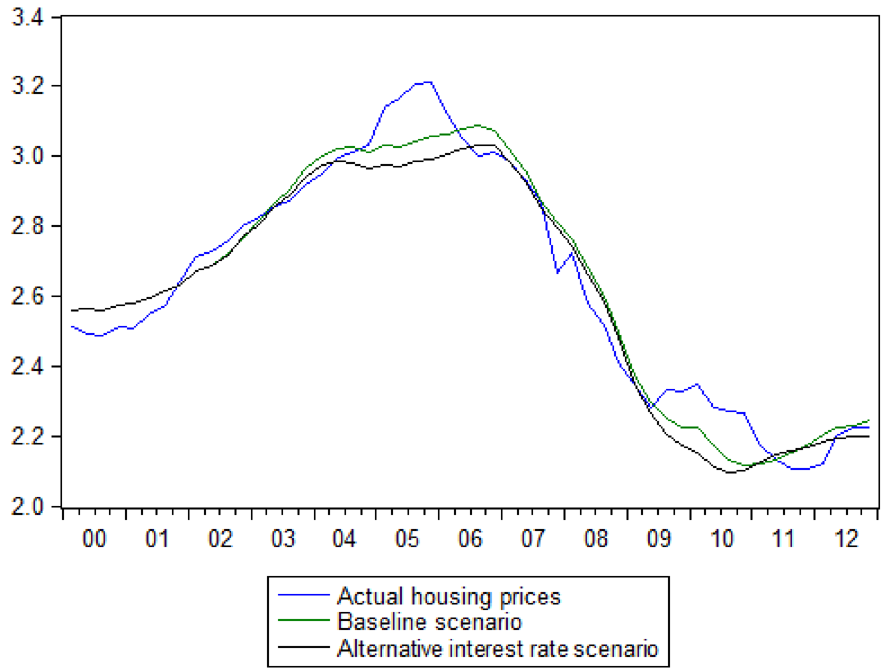


term interest rates differ markedly. Neither the boom nor the subsequent bust would have been avoided.

This contrasts sharply with Taylor's conclusion that interest rates were key to understanding the housing boom. This might have different reasons. First, Taylor did not look at housing prices, but at the number of housing starts. No prices were used in his estimation but housing starts were strongly correlated with prices. Second, Taylor did not use mortgage credit in his specification. Further, since he did not publish his specification, it is also not clear how he reached his results. Different lag length, the use or non-use of lagged endogenous variables etc. are likely to make a difference for his results and for his counterfactual simulation. As already indicated, Taylor's results on the role of monetary policy are also in stark contrast to findings by many other authors who hardly find an important role for monetary policy rates (Gerlach and Peng, 2005; Del Negro and Otrok, 2007; Boivin et al., 2010; Dokko et al., 2011).

To conclude, the use of interest rates in the estimations does not improve markedly the explanatory power of the model and does not seem to be a key to understand the boom and bust in housing prices. The finding could be explained by a strong role of non-interest related conditions and standards for both the demand and supply of mortgage credit. Those could be income, maximum loan-to-value and income-to-value ratios

Figure 2.12: Counter-factual interest rate path and housing prices



etc., i.e. by variations of credit rationing. This is consistent with the argument that the deregulation of mortgage markets reduced exactly this rationing of credit as the shift from the conventional mortgage to more exotic mortgages in the last 30 years has shown.

2.5 Conclusion

The chapter has investigated the question whether housing prices have driven mortgage credit or vice versa since the liberalization of the US mortgage market at the beginning of the 1980s. It has been argued that the liberalization is likely to have led to problems of moral hazard which is likely to have made it more attractive for lenders to increase their credit supply. This in turn might have incited purchasers of houses to increase their demand for housing beyond the point where housing prices are justified by fundamental values. Liberalized mortgage markets are thus likely to have led to the housing price bubble.

To test this hypothesis, two different models have been estimated with two different housing value measures. The results seems to vindicate the view that mortgage credit has indeed driven housing prices. Mortgage credit is weakly exogenous and does not adjust to the long-run relation between housing prices and credit. This indicates that it drives the long-run relation. But housing prices still Granger-cause mortgage credit so that there is no one-way interaction.

Impulse-response functions show that mortgage price shocks cause a response by housing prices but not vice versa. A variance decomposition shows that the variance of housing prices is due to mortgage credit but not the other way around. Finally, a forecast test shows that the dynamic of housing prices is better forecast when explained by mortgage credit than if mortgage credit is forecast by housing prices.

Contrary to assertions by Taylor (2007; 2009) or Leamer (2007), neither short-term monetary policy interest rates nor long-term mortgage market interest rates have an important effect on housing prices or mortgages, at least in the specification chosen. This is a finding that is consistent with the literature (Gerlach and Peng, 2005; Del Negro and Otrok, 2007; Boivin et al., 2010; Dokko et al., 2011).

Overall, more research is necessary to better understand the link between housing and the mortgage market. Especially important would be more disaggregated mortgage measures to better distinguish the effect of gross mortgages and repayments on housing markets.

3 Decomposing the German Employment Miracle in the Great Recession

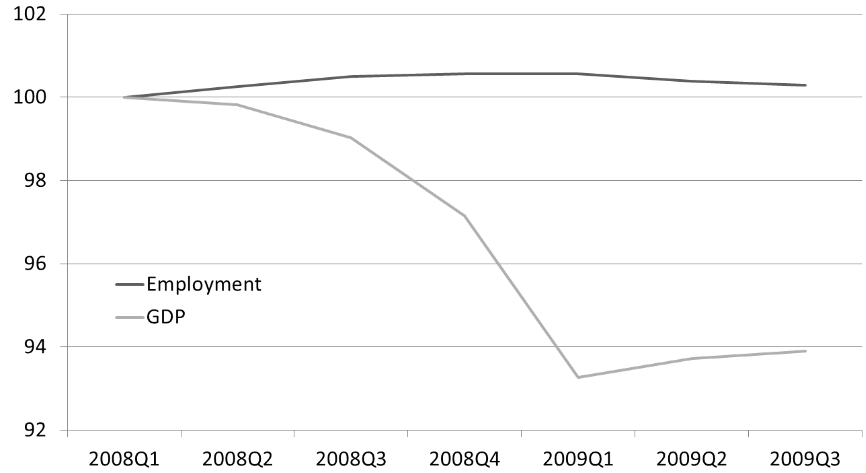
In 2008 to 2009 Germany experienced the deepest recession in its post-war history. GDP dropped by 6.1 % from its cyclical peak in the first quarter of 2008 to its cyclical trough in the third quarter of 2009. Germany had one of the deepest recessions of all the countries hit by the crisis (Amable and Mayhew, 2011). However, the sharp decline in output was not followed by significant job losses and rising unemployment. In fact, employment was even higher after the recession than before (Figure 3.1), while unemployment was lower. This remarkable stability of the German labor market has been called a "labour market miracle" by some commentators (Krugman, 2009; Möller, 2010). The present chapter tries to understand in what the miracle consisted, i.e. what accounted for the unexpected safeguarding of employment in the Great Recession?

In general, two factors can mitigate the effect of output on employment and unemployment: First, employers can "hoard" labor, i.e. keep employees employed although sales decrease. In the data, labor hoarding shows up as a pro-cyclical development of labor productivity per hour since employees stay employed but production decreases. Second, average labor hours can change, which is called "work sharing" and shows up in the data as pro-cyclical movements of average hours.

Most authors have stressed the importance of work sharing in the crisis (Möller, 2010; Bosch, 2011; Boulin and Cette, 2013) through the use of working time accounts and short time work. Consequently, much of the empirical literature has looked at micro-data and the determinants of both short-time work and working time accounts (Boeri and Bruecker, 2011; Bohachova et al., 2011; Bellmann et al., 2012; Herzog-Stein and Zapf, 2012; Balleer et al., 2013).

However, much less effort has been made to differentiate between the respective role of work sharing and labor hoarding in the crisis, based on a macro-economic analysis. An exception is Burda and Hunt (2011). They argue that the reduction of working time was

Figure 3.1: GDP and employment in the Great Recession, 2008q1=100



Source: Destatis, own calculation

in line with previous downturns so that - given the drop in output - it could have been expected and was thus not at the heart of the German labor market miracle. In contrast, labor hoarding must have been at the center of labor market miracle. According to Burda and Hunt, labor hoarding was due to a lack of hiring before the crisis because employers were skeptical about the permanence of the upswing, and wage restraint.

But there are many problems with Burda and Hunt's paper. First, they de-emphasize the role of work-sharing in the crisis by estimating and then forecasting a working time equation with wages and output as the independent variables. But they do not estimate a similar equation for productivity. Thus, they implicitly conclude that cyclical reductions in productivity - labor hoarding - and not working time reductions were the key to Germany's labor market miracle. But without a comparison between a the forecasts and the quality of the forecast for both variables, it is not clear whether just one equation can be used to establish their finding. For instance, if they would find that labor productivity is also well forecast by their model, there would be no miracle at all - or they would have to check their econometric model.

The problem with their model is that they just assume a linear trend in average working time and do not discuss the possibility of alternative trends, for instance log-linear or time-varying trends. Both are likely to change their conclusions. Further, while they estimate models both for the aggregate economy and for different economic sectors, they use different models and exogenous variables in both kinds of estimation although all variables are available both at the aggregate as well as the sectoral level. This makes it hard to compare their results for the different sectors to the results for the aggregate economy.

Building on earlier work of ours (Herzog-Stein et al., 2010, 2013), the present chapter also tries to disentangle the respective role of labor hoarding and work sharing in the crisis but on a more systematic basis than Burda and Hunt. Specifically - and in contrast to Burda and Hunt - , we will systematically look at the cyclical variations of the important variables (employment, output, hourly productivity, average hours worked), i.e. their deviations from trend.

We are mainly interested in the business cycle and not the determinants of trends in the labor market like the participation rate, emigration, sectoral shifts etc. To this end, we decompose all time series that we use into a trend and a cycle. We use a time-varying trend in contrast to Burda and Hunt who used a linear trend. The analysis then mainly looks at the cyclical variations. Doing otherwise is likely to mislead interpretations. For instance, in the recession of 1973q2 to 1975q2, real GDP dropped by 0.5 %, which might be seen as a moderate decrease. The output gap, however, dropped by 5.6 %, which made the recession the biggest recession in post-war German history before the Great Recession struck.

In the first instance, we decompose the respective role of cyclical changes in labor productivity and average working hours using simple accounting rules in all German downswings since 1970. We conduct this accounting exercise for the aggregate economy and then for the manufacturing sector and the rest of the economy in order to understand the composition of the aggregate effect.

Then, we estimate two models, one in which the labor productivity gap is explained by the output gap and one in which the average working time gap is explained by the output gap. The model is estimated until the beginning of 2005 when the upswing before the Great Recession started. Based on this estimation, both the labor productivity and the working time gap will be forecast until 2012 in order to see whether the actual development after 2005 was consistent with historical experience - captured in the estimation results - or not. Significant deviations between forecast and the actual development then constitute the "miracle" on the German labor market, i.e. the labor market's unexpected development. We estimate the models for the aggregate economy and then separately for the manufacturing sector and the rest of the economy in order to see whether there are systematic differences between the sectors.

We find that in the aggregate economy, working time and not labor productivity was the variable that developed in an unexpected way. Working time increased more than predicted before the crisis and at its start and fell more than predicted during the crisis.

In the sectoral models, the picture is more nuanced: in the manufacturing sector productivity decreased more than anticipated; in the rest of the economy it decreased less than anticipated. Both effects compensated each other on the aggregate level.

On the other hand, in both sectors, working time decreased more than anticipated, much more though in the rest of the economy than in the manufacturing sector. It thus seems that the employment miracle was mostly stemming not from the manufacturing but from the non-manufacturing sector. Tests for structural change in the reaction of working time and productivity to the output gap confirm that there was indeed a structural break between 2006 and 2008, indicating a change in the labor market reaction.

3.1 Okun's law, labor hoarding and work sharing

In his classic article, Arthur Okun (1962) established what would subsequently be known as "Okun's law", the relation between changes in unemployment and changes in GDP. For the US, he estimated that a change in GDP by one percent roughly changes unemployment by -0.3 to -0.4 %. Since there is no one-to-one relation between output and unemployment, other factors must buffer the effect of changes in output to unemployment. Those buffers are variations in hourly labor productivity and average hours worked per employee.

This can be easily shown by a simple "output identity" which is implicit in Okun's work (Gordon, 1993, 2010). GDP (Y) can be decomposed into total employment (E), average hours worked per employee ($WT \equiv H/E$) and labor productivity, i.e. output per hour worked ($LP \equiv Y/H$) :

$$Y = E * WT * LP \tag{3.1}$$

We will focus on total employment, not on the unemployment rate as Okun did. Unemployment is a less straight forward concept than employment since the concept of unemployment depends heavily on legal and institutional peculiarities.[1]

This can also be expressed in growth rates g, so that:[2]

$$g_Y \approx g_E + g_{WT} + g_{LP} \tag{3.2}$$

[1] With unemployment U being roughly equal to the difference of the labor force, L, and employment ($U = L-E$), one can write: $Y = (L-U)*WT*LP$. If one assumes the labor force to stay constant, writing the equation in terms of growth rates and solving for unemployment, yields: $g_U \approx -g_Y + g_{WT} + g_{LP}$.

[2] For continuous growth rates, the relation presented in the following equation holds with equality. However, for discrete growth rates, it only holds approximately. The approximate case is chosen because quarterly growth rates are used.

Solving for employment growth shows that employment depends positively on GDP growth and negatively on working time and productivity growth:

$$g_E \approx g_Y - g_{WT} - g_{LP} \tag{3.3}$$

All the above equations are of course only accounting identities. However, Okun's law interprets equation (3.3) causally, i.e. it takes the Keynesian assumption that changes in output are causing changes in (un-)employment. In the Keynesian interpretation, there are almost always slack resources both in terms of equipment (capital) and labor. The demand for labor is derived from the demand for goods and services so that higher demand on the goods and services markets also leads to higher demand for labor, mitigated by changes in working time and productivity.

In the Keynesian interpretation, a pro-cyclical reaction of hourly labor productivity - which is a stylized fact for the US and many other economies (Fair, 1985; Fay and Medoff, 1985; Bernanke, 1991) - is interpreted as "labor hoarding", i.e. the decision of firms to keep labor even though sales have fallen. It is not primarily due to the decision of workers to keep supplying their labor when output falls. Such labor hoarding is motivated if labor cannot be adjusted costlessly (Becker, 1962; Oi, 1962; Rosen, 1968) or if there is some needed overhead labor which is independent of current production (Bernanke, 1991).

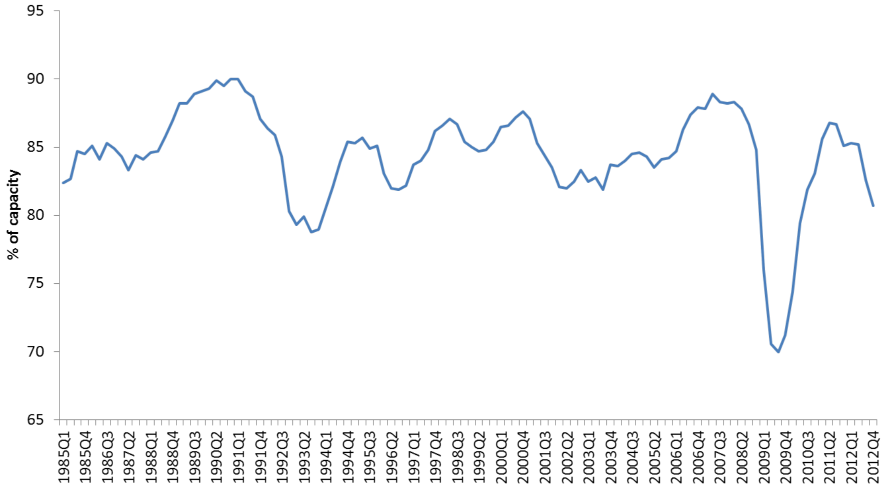
Also, the change in average working time in the Keynesian perspective is not primarily due to the voluntary decision of workers to change their labor supply, but to institutions of "work sharing", i.e. the decision of employers to keep workers employed but reduce their average working time.

On the other hand, if one assumes capacities to be optimally and fully used all of the time, one might argue that the causality runs from workers' decision to supply their labor to output and not vice versa. Then, equation (3.2) is used as a causal relation. This is the view of Real Business Cycle (RBC) theorists (Prescott, 1986).

In the RBC approach, changes in total hours worked ($H = WT * L$) are subject to the choices of households (Prescott, 2004). Pro-cyclical changes in labor productivity are due to technological shocks. When there is a pro-cyclical change in productivity, this is mostly due to workers supplying more labor when technological conditions are good in order to reap higher real wages; when technological conditions are bad, wages are lower and workers react by supplying less of their labor.

Here is not the place to extensively evaluate the merit of the Keynesian vs. the RBC model. Suffice is to say that Keynesian theory applies to an economy in which productive capacities are not at their full use and the dominant constraint for firms is the demand

Figure 3.2a: Capacity utilization in German industry



Source: Eurostat

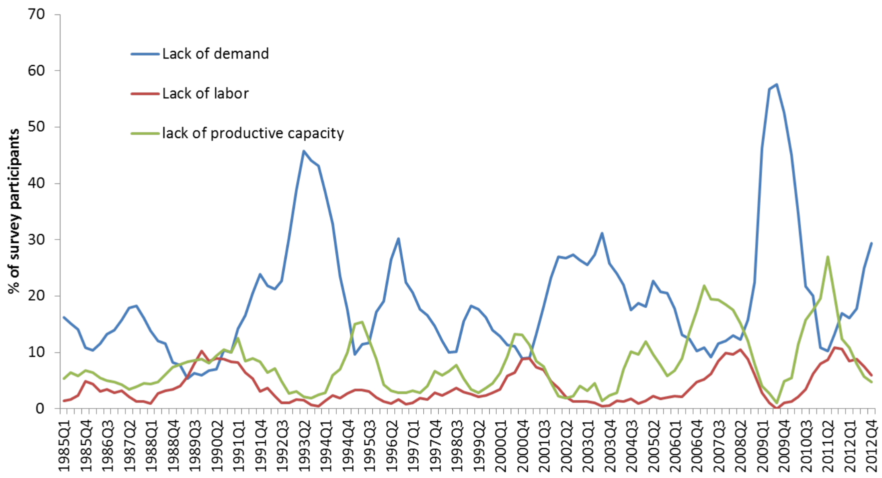
for their output. RBC theory applies to economies in which there is full employment and firms are resource-constrained, i.e. constrained by the availability of capital and/or labor.

Based on surveys among German industry regularly conducted by Eurostat, figure 3.2a shows German industry's capacity utilization. Capacity is almost never fully used, the maximum of use being 90 % in the re-unification boom. Figure 3.2b shows the percentage of surveyed German industry as to what hinders them in their production: a lack of demand, a lack of labor or a lack of productive capacity (material, equipment etc.). It is clearly visible that except in upswings, demand constraints are the dominant constraint for firms.

For the following discussion, we will thus use the Keynesian interpretation that (3.3) can also be used as a causal equation in which the change of the amount of persons employed depends on changes in output. This is also consistent with much empirical research on the U.S. (Fay and Medoff, 1985; Bernanke, 1991; Burnside et al., 1993; Sbordone, 1997). This implies that we will interpret pro-cyclical changes in hourly productivity and working time as "labor hoarding" and "work sharing" and not as productivity shocks and voluntary decisions of workers to change their labor supply.

Note that this does not exclude that both voluntary decisions to change labor supply and productivity shocks can occur. But those are processes that are more likely to form part of the long-run trend and not of the short-run cyclical variations which we are interested in. For instance, Solow noted in 1987 that "You can see the computer age everywhere but in the productivity statistics." Now, the computer is likely to have had a significant influence

Figure 3.2b: What hinders industry in its production in % of survey participants



Source: Eurostat

on the productivity trend since 1987. But it is hardly likely that the computer caused a productivity "shock" from one quarter to the next.

In the next sections, the theoretical reasons for labor hoarding and work sharing will be discussed in more detail.

Reasons for Labor Hoarding

Early theoretical work on the rationality of "labor hoarding" by Becker (1962) and Oi (1962) emphasizes firm specific knowledge and skills acquired by on-the-job-training. This training is an investment of both the firms and workers which increases workers' human capital. To protect their investment, long-term contracts with such workers are in the interest of the firm. This is why they would not easily lay off workers with firm-specific skills in a downturn.

The sociological literature on "varieties of capitalism" (VOC)(Hall and Soskice, eds, 2001) has further developed this theory. The "varieties of capitalism" are so called "co-ordinated market economies" (CMEs) and "liberal market economies" (LMEs). CMEs tend to have more on-the-job training, a high incidence of firm and industry specific skills and stronger employment protection. LMEs on the other hand tend to have more general training provided outside the job, at school and university, and less stricter employment protection.

Estevez-Abe et al. (2001) and Harcourt and Wood (2007) look at workers' incentive to invest in specific, not easily transferable skills in both CMEs and LMEs. With a high risk of unemployment and income variability, workers would not ex ante commit to acquire firm specific skills. Without those skills, firms could not produce products that rely on firm-specific skills. Firms are thus likely to accept both long-term contracts and high legal employment protection as the price to pay for inciting workers to invest in those skills. In the high specialization/high employment protection regime of the CMEs, lay-offs will be less likely in recessions and thus alternative adjustment measures like labor hoarding and/or the use of work sharing are more likely.

On the other hand, in LMEs in which skills are more general and thus more easily transferable, firms' specialization is less dependent on firm-specific skills than in CMEs. Workers do not have to commit to one specific firm or industry. Employers have lower incentives to protect workers' skills while workers have less incentive to invest in firm specific skills. Employment protection and long-term contracts are then less likely to be in place, and in times of recessions firms will make more use of layoffs.

Reasons for work sharing

The literature on "labor hoarding" to keep employment constant in recessions has hardly looked at changes in average hours worked per person although this mechanism might also be important when labor adjustment is costly. For instance, Okun (1962) hardly discusses pro-cyclical changes in hours worked and only looks at long run trends of working time.

That the use of "work sharing" in recessions has been neglected in much of the literature might be due to the fact that most of the empirical literature has looked at the US where average hours worked are much less responsive to output changes than in continental European countries or Japan (Burdett and Wright, 1989; Abraham and Houseman, 1993, 1994; Schaz and Spitznagel, 2010).

However, most of the arguments rationalizing labor hoarding might also be applicable to the reliance on the use of work sharing. From the employer's perspective, work sharing is in principle advantageous to labor hoarding because costs due to the reduction in hours worked are reduced. The greater the demand shock, the less likely is it that firms will hoard labor. When revenues decrease and the wage bill stays the same, firms' likelihood of bankruptcy increases. Firms are then more likely to rely on a reduction of work input, either by layoffs or by a reduction in (paid) hours worked.

From the point of view of employees, work sharing is of course advantageous to being laid off since unemployment increases the risk of not finding new employment and losing acquired skills. Employers should ex ante be indifferent to a reduction in hours worked or layoffs if both reduce the wage bill by the same amount (Burdett and Wright, 1989). But the more valuable their workers' skill capital, the more likely will they also favor hours reduction to keep specific skills in the firm and avoid uncertain and costly later re-hiring.

Work sharing needs coordination devices - rules and institutions - that are in place before a recession hits since a reduction of the hours worked implies also a reduction in monthly wages. Some workers might not accept such a cut so that other workers might be laid off in order to reduce a firm's costs and thus risk of bankruptcy. Ex ante regulation as to who bears the costs of work sharing has to be in place to make it efficient.

Such institutions for work-sharing can be both private and public. In many countries, public short-time work (STW) programs have been installed (Boeri and Bruecker, 2011) with Germany being the first country that has introduced short-time work in the 1920s (Brautzsch and Will, 2010; Will, 2010; Brenke et al., 2011). In those programs, workers can reduce their working time and get a public subsidy in order to avoid a too strong decrease of their monthly earnings. Examples for private work-sharing arrangements are working time accounts (Boeri and Bruecker, 2011) and variations in standard agreed-upon hours in Germany (Groß, 2013).

From the preceding discussion, it is clear that Germany is likely to have a high incidence of labor hoarding and/or work sharing since Germany is a classic CME country, especially its manufacturing sector. In the German manufacturing sector, highly specialized workers have often learned in their respective firm through the vocational training system (the "duale Ausbildung") and are protected by high legal employment protection (Yamamura and Streeck, 2001; Blyth, 2003).

Previous empirical reasearch has shown that Germany indeed has a higher incidence of work sharing compared to the classic LME, the United States, (Burdett and Wright, 1989; Abraham and Houseman, 1994; Eichhorst et al., 2009) and also a higher incidence of labor hoarding (Schaz and Spitznagel, 2010). Consequently, the IMF (2010) found German unemployment to be much less reactive to output changes than unemployment in other OECD countries.

Given that, in what respect did the German labor market reacted differently in the Great Recession than previously? Is there really a miracle or did the German labor market react in a usual way?

3.2 Safeguarding employment in downturns: a historical comparison

As a first approximation to the labor market development in the Great Recession, we compare the development of GDP, hourly productivity, working hours per employee and employment in major German recessions for which quarterly data are available. This is done both for the aggregate economy and then for the manufacturing sector and the rest of the economy. The distinction between the manufacturing sector and the rest of the economy is chosen for two reasons.

First, the manufacturing sector is special in that it is the core sector of the German economy that contains the institutions typical for the CME like highly specialized export-oriented firms, a labor force with firm-specific skills and strong corporatist institutions. Second, since the manufacturing sector depends heavily on export markets, it is strongly cyclical. It is thus here that the most of labor saving through work sharing and/or labor hording can be expected. The manufacturing sector is also the sector most hit by the Great Recession.

The rest of the economy is not further differentiated since over the period under consideration, the classifications have changed so that data on the the sub-sectors of the non-manufacturing sector for West Germany before 1991 and all of Germany after 1991 are hardly comparable. However, in both periods, the service sector was the major sector in the non-manufacturing sector.

In order to compare the actual importance of the reactions of GDP, employment, average working time, and hourly productivity with earlier downturns, we take account of trend growth in these periods and then compare the cyclical variations (see Herzog-Stein and Seifert (2010)).

To distinguish between the cycle and the trend one can apply equation (3.3) to trend growth rates, $\overline{g}$:

$$\overline{g}_E \approx \overline{g}_Y - \overline{g}_{WT} - \overline{g}_{LP} \tag{3.4}$$

Then, the cyclical rate of change in employment, $\widehat{g}_E$ is the actual employment growth less its trend growth:

$$\widehat{g}_E = (g_E - \overline{g}_E) \approx \widehat{g}_Y - \widehat{g}_{WT} - \widehat{g}_{LP} = (g_Y - \overline{g}_Y) - (g_{WT} - \overline{g}_{WT}) - (g_{LP} - \overline{g}_{LP}) \tag{3.5}$$

Equation (3.5) shows that a deviation of employment growth from its long term trend can be decomposed into trend-deviations in GDP growth, working time growth, and the growth of hourly labor productivity.

All variables are seasonally adjusted with BV4.1, a seasonal adjustment procedure used by the German statistical office which is less reliant on the setting of specific parameters than Arima X-12 (Speth, 2004). For all data, the trend is calculated by applying a Hodrick-Prescott filter with the standard smoothing parameter of λ=1600.[3] Quarterly data are used, which are available from 1970q1 onwards. For the period until the fourth quarter of 1990 a different trend is used than for the period starting in 1991 in order to distinguish pre- and after-unification Germany.[4]

The decision about what kind of trend to use is of course a critical assumption since the trend represents the "normal" use of labor to which cyclical changes are related (Felices, 2003). We use a time-varying trend in order to capture both the decline over time in productivity growth and the less steep decline in working hours since 2003.

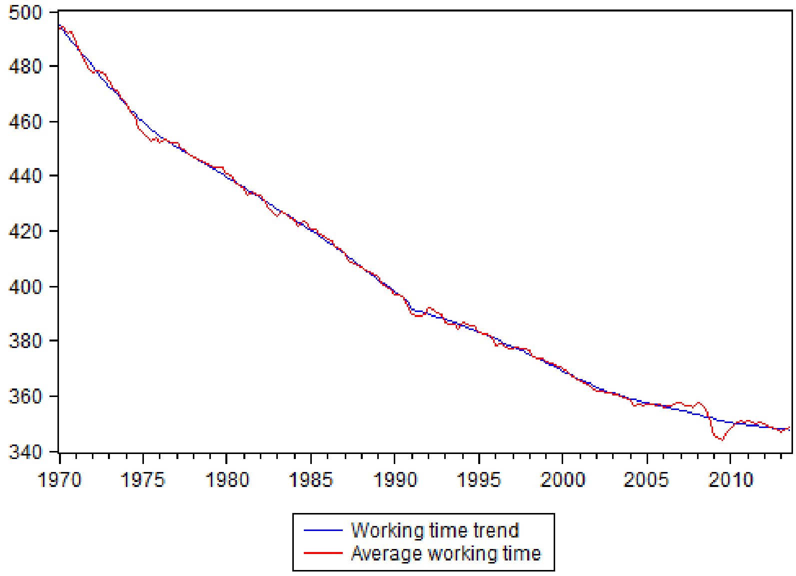
Other time-varying trends would also be possible. For instance, Gordon (1993) uses log-linear trends that he draws through selected benchmark quarters. By this, he is able to make use of outside information like unemployment or capacity utilization. While the use of outside information certainly has its advantages, it nevertheless opens up the determination of trends and cyclical variations to the discretion of the researcher and thus needs very careful justification for each benchmark quarter chosen etc. We abstain from this by using the standard de-trending technique, knowing that we fall in the opposite trap of not using outside information at all.

On the other hand, Burda and Hunt (2011) assumed the working time trend to be linear and not time-varying at all, which is not borne out by the data (figure 3.3). It is no wonder that by using this kind of trend, they find that working time declined significantly in their out of sample forecasts after 2003. They then claim that working time did not change extraordinarily compared to earlier downswings. But this finding is implicit in their use of the trend. To us, a time-varying trend seems to have more advantages than a linear trend. Further, since they did not look at productivity explicitly, they did not make any trend assumption there.

[3]The results do not differ fundamentally when higher values are used.

[4]In order to deal with the end-value problem of the HP filter, the HP filter for West Germany has been applied to the period from 1970 to 1991, the last year for which West German data is available. For unified Germany, data starts in 1990.

Figure 3.3: Working time per employed person and working time trend in the aggregate economy



Source: Destatis, own calculation

In a second step, the downturn periods to which this decomposition is applied have to be identified. Economic downturns are determined with the help of the business cycle dating procedure developed by the German Council of Economic Experts (SVR).[5] Using this procedure, five economic downturns can be identified since 1970.

However, in what follows, we will only analyze four cycles. The downturn beginning in 1991 bears data problems because it is the period of German unification: before 1991, data is only available for West Germany while after 1991 all of Germany is covered.

Thus, four recessions are covered, among them those due to the oil price shocks in the 1970s, as well as the long economic downswing of the first half of the 2000s and the Great Recession. The dating of the four cycles analyzed in the chapter is shown in table 3.1.

[5]The method is described in detail in SVR (2007/08) and is applied in Herzog-Stein and Seifert (2010), Sturn and van Treeck (2010). The output gap is generally defined as the percentage deviation of actual GDP from its long-term trend. A downturn ends and an upturn starts when the output gap reaches its local minimum, after which it closes and has to be positive for four quarters. This potential output is estimated using various statistical filtering techniques. Like the German Council of Economic Experts (SVR) we use the average of four filter procedures (Hodrick-Prescott, Baxter-King, Bandpass and Low-pass) to compute trend GDP (2007/08, p. 326). This evens out the variations produced by each of the filter procedures used. The starting point of the downturn is defined as the quarter in which the value of the output gap reaches a local maximum, after which the output gap closes, to be followed by four quarters where it is negative. This is an analogous process to that used by the SVR in defining an upturn (2007/08, p. 325ff).

Table 3.1: Economic downturns

	Peak	Trough	GDP change	Output gap change
Downturn I	1973q2	1975q2	-0.5	-5.6
Downturn II	1979q4	1982q4	-0.9	-3.4
Downturn III	2001q1	2005q2	0.8	-4.0
Downturn IV	2008q1	2009q3	-6.1	-7.4

Source: Destatis, own calculation

Table 3.2 applies the decomposition of GDP according to equation (3.5) to the identified downturn episodes for the whole German economy; table 3.4 shows the decomposition for the manufacturing sector and all other sectors. Note that for sectoral output, no GDP, but only value added is available.[6]

For all series - employment, output, hourly labor productivity and working time - the actual development from the seasonally adjusted data is shown, the trend development and the difference between the two, i.e. the cyclical development. The table shows both the rate of change in % and the change in 1000s of persons. By expressing labor productivity, working time and output in terms of persons, one can directly compare the amount of employment that was saved / not saved by the various developments.

First, we look at the aggregate economy: table 3.2 shows that GDP fell sharply in relation to trend in all economic downturns. In the first downturn, the cyclical decline of GDP from its peak to its trough was 5.6 %, in the second downturn 3.4 %, in the third 4.0 %, and in the fourth - the Great Recession - 7,4 %. Without cyclical adjustments in working time or labor productivity, this would have led to an equally sharp fall in employment.

In order to grasp the relative contributions of productivity and working time to the safeguarding of employment, table 3.3 shows the cyclical changes of productivity and working time in % of the cyclical change of GDP.

The data show that until the Great Recession, labor hoarding was the more important mechanism to save employment, with 33 % to 55 % of the cyclical decline in GDP saved. In Downturn I and II, cyclical reductions in working time amounted only to around 20 % while in Downturn III - the early 2000s downturn - cyclical increases in working time even cost employment.

The Great Recession is indeed special in that almost 90 % of the cyclical downturn in GDP was compensated by labor hoarding and work sharing - and work sharing was much higher than in the preceding downturns. This implies that - as many authors argue - work

[6] GDP is value added plus taxes net of subsidies so that value added measures output before taxes are paid and subsidies received.

Table 3.2: Contributions to safeguarding employment in downturns, aggregate economy

		Downturn I 1973q2 - 1975q2		Downturn II 1979q4 - 1982q4		Downturn III 2001q1 - 2005q2		Downturn IV 2008q1 - 2009q3	
		rate of change	Persons in 1000	rate of change	Persons in 1000	rate of change	Persons in 1000	rate of change	Persons in 1000
L	Actual	-3.3%	-901	-0.3%	-78	-1.4%	-567	0.3%	113
	Trend	-0.8%	-230	1.2%	323	0.5%	192	1.3%	508
	Cycle	-2.5%	-671	-1.5%	-401	-1.9%	-759	-1.0%	-395
Y	Actual	-0.5%	-131	-0.9%	-240	0.8%	304	-6.1%	-2451
	Trend	5.2%	1401	4.2%	1132	4.7%	1875	1.3%	534
	Cycle	-5.6%	-1532	-5.0%	-1372	-4.0%	-1570	-7.4%	-2984
LP	Actual	7.0%	1911	3.3%	895	4.6%	1822	-2.6%	-1047
	Trend	8.9%	2417	5.8%	1579	6.8%	2687	0.8%	303
	Cycle	-1.9%	-507	-2.5%	-686	-2.2%	-865	-3.4%	-1350
WT	Actual	-3.8%	-1041	-3.8%	-1024	-2.3%	-897	-3.9%	-1549
	Trend	-2.7%	-722	-2.6%	-715	-2.4%	-959	-0.7%	-274
	Cycle	-1.2%	-319	-1.1%	-308	0.2%	62	-3.2%	-1275

Remarks: The deviations of the numbers presented in the table from the accounting identity (3.5) is due, first, to the individual trend calculation of each time series without taking into accounting equation (3.4) and, second, to the fact that each time series in the German national accounts is individually seasonally adjusted. Third, rounding differences also lead to deviations from the accounting identity.(3.3).
Source: Federal Statistical Office (Statistisches Bundesamt); own calculations.

sharing was responsible for the German employment miracle, at least at the aggregate level.

Table 3.3: Share of jobs destroyed and saved in % of cyclical output decline, aggregate economy

	Downturn I	Downturn II	Downturn III	Downturn IV
	Jobs destroyed due to cyclical decline in Y			
	46.1	27.6	48.9	12.0
	Share of jobs saved due to			
LP	33.1	49.9	55.1	45.2
WT	20.8	22.5	-3.9	42.7
Sum	53.9	72.4	51.1	88.0

Tables 3.4 and 3.5 show the same decompositions, but now differentiated by the manufacturing sector and the non-manufacturing sector. As can be seen from table 3.4, manufacturing is a highly cyclical sector. The amount of the cyclical decline in output is higher in every downturn than in the rest of the economy. Further, the Great Recession mainly hit the manufacturing sector whose cyclical output declined by 19.8 % while the cyclical output of the non-manufacturing sector declined by only 3.8 %.

Table 3.5 shows that the share of employment saved by pro-cyclical productivity and working time adjustments in the manufacturing sector is higher in almost every downturn than it is for the non-manufacturing sector, the first downturn of the 1970s being the exception but only slightly.

Table 3.4: Contributions to safeguarding employment in downturns, manufacturing and non-manufacturing sectors

		Downturn I 1973q2 - 1975q2		Downturn II 1979q4 - 1982q4		Downturn III 2001q1 - 2005q2		Downturn IV 2008q1 - 2009q3	
		rate of change	Persons in 1000	rate of change	Persons in 1000	rate of change	Persons in 1000	rate of change	Persons in 1000
		Manufacturing sector							
L	Actual	-7.5%	-744	-5.1%	-463	-7.8%	-658	-2.8%	-220
	Trend	-4.2%	-404	-2.6%	-229	-5.0%	-416	-0.2%	-17
	Cycle	-3.4%	-340	-2.5%	-234	-2.8%	-242	-2.6%	-203
Y	Actual	-4.4%	-439	-8.2%	-743	3.8%	323	-19.4%	-1528
	Trend	3.5%	338	0.6%	52	9.5%	788	0.4%	34
	Cycle	-7.9%	-776	-8.8%	-795	-5.7%	-466	-19.8%	-1563
LP	Actual	9.2%	907	2.2%	169	14.2%	1195	-9.0%	-706
	Trend	10.6%	1027	5.8%	516	16.9%	1397	1.7%	131
	Cycle	-1.4%	-120	-3.6%	-320	-2.7%	-202	-10.6%	-837
WT	Actual	-5.4%	-528	-5.3%	-481	-2.1%	-178	-8.9%	-703
	Trend	-2.5%	-238	-2.2%	-200	-1.2%	-102	-1.0%	-80
	Cycle	-2.9%	-290	-3.1%	-281	-0.9%	-77	-7.9%	-622
		Other sectors							
L	Actual	-0.9%	-157	2.1%	385	0.3%	91	1.0%	333
	Trend	1.0%	178	3.0%	548	2.0%	606	1.6%	521
	Cycle	-1.9%	-335	-0.9%	-163	-1.7%	-515	-0.6%	-188
Y	Actual	1.4%	251	3.3%	599	2.3%	727	-2.0%	-650
	Trend	6.2%	1051	6.1%	1092	4.9%	1503	1.8%	591
	Cycle	-4.7%	-800	-2.8%	-493	-2.5%	-777	-3.8%	-1241
LP	Actual	5.7%	993	4.4%	802	4.6%	1435	-0.4%	-145
	Trend	8.1%	1388	6.0%	1085	5.7%	1746	0.8%	262
	Cycle	-2.4%	-394	-1.6%	-282	-1.1%	-312	-1.3%	-407
WT	Actual	-3.2%	-551	-3.1%	-568	-2.5%	-766	-2.6%	-832
	Trend	-2.9%	-487	-2.9%	-514	-2.7%	-832	-0.6%	-187
	Cycle	-0.3%	-64	-0.3%	-54	0.2%	66	-2.0%	-644

Remarks: See table 3.2.
Source: Federal Statistical Office (Statistisches Bundesamt); own calculations.

Table 3.5: Share of jobs destroyed and saved in % of cyclical output decline, manufacturing and non-manufacturing sectors

	Downturn I	Downturn II	Downturn III	Downturn IV
	Manufacturing sector			
	Jobs destroyed due to cyclical decline in Y			
	45.8	23.8	37.0	6.6
	Share of jobs saved due to			
LP	17.8	41.4	47.5	53.7
WT	36.4	34.8	15.5	39.7
Sum	54.2	76.2	63.0	93.4
	Other sectors			
	Jobs destroyed due to cyclical decline in Y			
	42.2	32.2	67.9	15.5
	Share of jobs saved due to			
LP	50.8	58.0	41.6	32.8
WT	7.0	9.8	-9.4	51.7
Sum	57.8	67.8	32.1	84.5

In the Great Recession, both labor hoarding and work sharing in the manufacturing sector were higher than in the previous recessions which saved an unprecendented 93 % of jobs relative to the cyclical output decline. However, while work sharing was indeed at its highest level, it was not much higher than in downturns I and II in the early and late 1970s. Labor hoarding on the other hand was much higher than before, saving 54 % of jobs.

In the non-manufacturing sector it was the reverse: while work sharing played almost no role before the Great Recession - with a maximum of 10 % in employment saved in downturn II - work sharing saved an unprecedented 52 % of employment. With 33 %, labor hoarding on the other hand was much weaker in the Great Recession than in previous downturns in the non-manufacturing sector.

That means that a differentiated analysis of the sectors reveals that the labor market development in the Great Recession was different, labor hoarding being exceptionally high in the manufacturing sector but exceptionally low in the non-manufacturing sector; and work sharing being exceptionally high in the non-manufacturing sector but roughly in line with historical experience in the manufacturing sector.

The effect for the aggregate economy - shown in table 3.3 - is then due to the composition of cyclical downturns of output in the two sectors. Table 3.6 shows the percentage of the decline in total output due to the manufacturing sector. The manufacturing sector was especially hard hit in the Great Recession, especially compared to downturn III in the 2000s when the rest of the economy was harder hit by the downturn. However, manufacturing made up even more of the downturn in downturn II in the late 1970s/early 1980s.

Table 3.6: Percentage of output decline in manufacturing in total output decline

Downturn I	Downturn II	Downturn III	Downturn IV
49.2	61.7	37.5	55.7

The high incidence of labor hoarding during the Great Recession in the manufacturing sector and its low incidence in the non-manufacturing sector compensate each other so that no extraordinary development in labor hoarding appears on aggregate. Work sharing on the other hand, being high both in the manufacturing and in the non-manufacturing sector adds up to an extraordinarily high level in the aggregate data. This is why the development of working time will be analyzed in more detail in the next section.

Work sharing instruments

Based on data from the Institute of Employment Research (IAB) (Bach and Koch, 2003; Wanger, 2013) one can further analyze the instruments of work sharing that were employed in the various German downswings. Herzog-Stein and Seifert (2010) identified four instruments of work sharing: short-time work, changes in overtime, temporary reductions in collectively agreed/regular working hours per employee, and working time accounts.

Short-time work is the most prominent instrument. It is a publicly subsidized form of work sharing in which employees subject to social security contributions receive 60 % (67 % if they have children) of their net-wage for all hours not worked from the government. The payment of the subsidy is conditional on economic problems related to the business cycle.

The other three instruments are privately negotiated instruments. Paid overtime can be quickly reduced if there is no need for it. Changes in collectively agreed/regular working time reductions comprise, first, generally agreed reductions in working time that may be independent from the economic cycle and, second, changes that are ex ante agreed upon if some contingency realizes.

With working time accounts, employees can "save" working time. If they work more, the accounts are filled but no overtime is paid; if they work less, accounts are emptied or working time debits increase, but pay does not decrease (Bauer et al., 2004; Gerner, 2010).

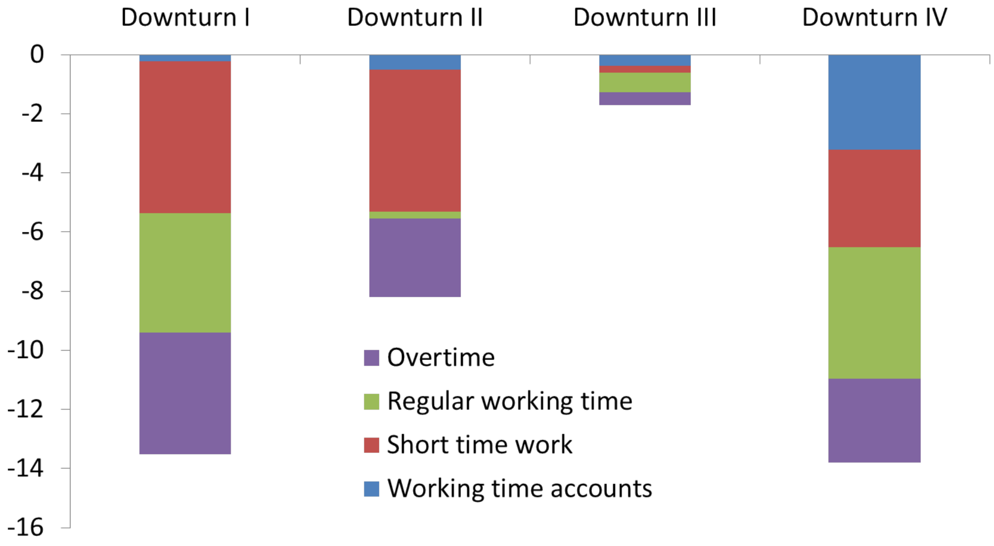
Figure 3.4 shows the changes in hours worked per employee of those instruments for each downswing. The different working time instruments are seasonally adjusted and individually computed H-P trends have been subtracted from overtime and regular working time.[7] Short time work and working time accounts do not have a trend so that no trend has been subtracted.

One sees clear differences both in the extensiveness of the use of work sharing and the composition between the different instruments. As already shown, the downturn of the early 2000s - downturn III - was the downturn with the least decrease in working time of all downturns.

Further, the use of short time work and reductions in overtime are present in downturns I, II and IV. But reductions in regular working time were only significant in the first downturn of the early 1970s and in the Great Recession. Also, the Great Recession was

[7] The change in regular working time is the sum of cyclical changes in full time and part time jobs. Both have been individually de-trended because there is a trend decline in average full time working hours but a trend increase in part-time work.

Figure 3.4: De-trended working time instruments, hours per employee, cyclical change between peak and trough quarter



Source: IAB; own calculations.

the first downturn in which working time accounts were extensively used to decrease employees' working time.

The reduction in collectively agreed working time had different reasons in the 1970s and the Great Recession. In the Great Recession, this reduction was a discretionary reaction in order to save employment in the recession. Many collective agreements in Germany today allow regular working time to be changed in line with the economic situation within the framework of so-called working-time corridor arrangements (Bispinck, 2009).

In the 1970s however, the reduction in regular working time was mainly the result of a coincidence, namely the introduction of the 40-hour week in 1974 which continued to apply after the slump had ended but was independent of the crisis (Herzog-Stein and Seifert, 2010). The Great Recession is special in that it is the first time that the change in regular working hours has been deliberately used as a work sharing instrument.

Working time accounts played an unprecedented role in the Great Recession. The share of employees covered by working time accounts was only 14 % in 1987 and 28 % in 1995 (Groß, 2013). In 2009 however, roughly 50 % of all employees were covered (Zapf and Brehmer, 2010).

Like in downswings I and II, short-time work was again used in the Great Recession. Its extension has been massively widened by the government: the maximum entitlement period of six months was extended to 24 months by statutory order of the Federal Minister of Labor. In January 2009, employers were required to pay only half of the social security contributions (and even nothing if the employee participates in certain vocational training programs during that time). Normally, employers have to pay full social security contributions. Further, temporary workers, a relatively new phenomena in the German labor market, have been allowed to participate in short-time work programs.

The instrument was also flexibly used in the past and its legal basis regularly changed in and between economic-downturn periods (Bogedan, 2010). That short-time work did play no role in Downturn III might be due to the discredit of this instrument due to the view at the time that it was excessively used to cushion the impact of re-unification in East Germany (Bogedan, 2010).

Most of the instruments used to adjust working hours were negotiated in a framework of corporatist industrial relations, and not implemented by the government. The existence of working time accounts is an outcome of collective bargaining between employers and unions and were implemented within the framework of collective and company agreements (Groß et al., 2000). The reduction of weekly working hours at the company level was further supported by collective agreements that allowed companies together with trade unions to reduce their regular working time substantially in the recession (Bispinck, 2009).

Prima facie, the finding from the preceding descriptive analysis that working time cushioned the effect of a GDP shock on employment more in the Great Recession than before is vindicated by the more intensive use of instruments of discretionary working time reduction like working time accounts and changes in regular working time.

In order to check for the robustness of this finding, in the next section econometric models are estimated to test whether the conclusions drawn so far hold up to more rigorous scrutiny.

3.3 Econometric evidence on safeguarding labor in the Great Recession

In the following section, we estimate two models in which relative deviations from trend of hourly productivity and working time are explained by the output gap. After estimating single equations until the beginning of the upswing in the second quarter of 2005 before the Great Recession, hourly productivity and working time are forecast until the fourth quarter of 2012. The comparison of the forecasts and the actual developments of both time series will provide evidence how they developed relative to the historical evidence and what accounts for the employment “miracle”, i.e. deviations from the historical experience.

This will be done with data for the aggregate economy and then separately for the manufacturing sector and the rest of the economy (the non-manufacturing sector). This procedure allows us to address the question as to what extent cyclical reductions in productivity and/or working time can explain the German labor market miracle and in which sector they took place.

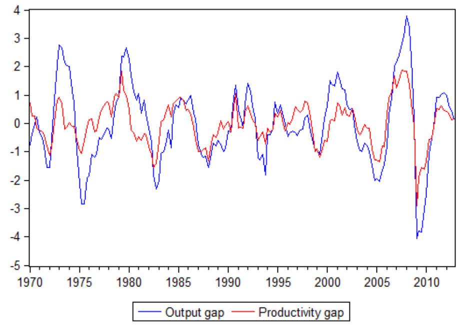
Since we are interested in the cyclical behavior of productivity and working time, we de-trend all time series, and construct relative deviations from their trend which we call “gaps”. The hourly productivity gap, working time gap and output gap have been computed as:

$$X^{gap} = \frac{X_t - \overline{X}_t}{\overline{X}_t} \tag{3.6}$$

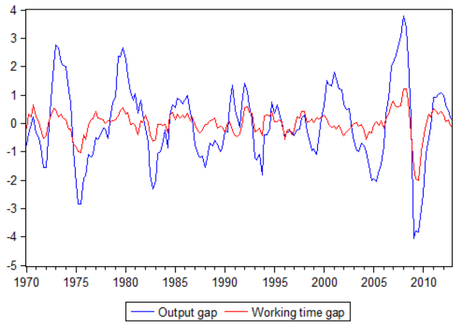
where X_t is the respective variable, and $\overline{X}_t$ is its trend value. The trend of all variables is the same trend that has already been computed for the above tables 3.2 and 3.4. Figures 3.6a to 3.6f present the productivity per hour-gap and working time-gap plotted against the output-gap for the entire economy, the manufacturing sector and the rest of the economy.

Figure 3.5: Data

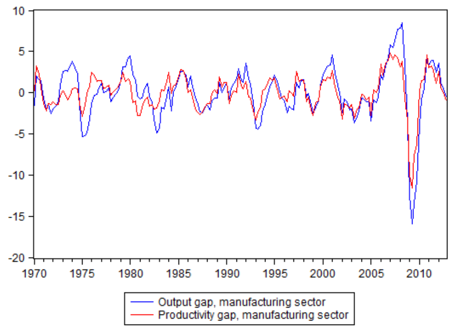
(a) Productivity gap and output gap, aggregate economy, 1970q1-2012q4



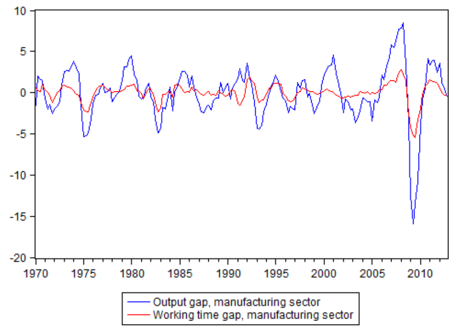
(b) Working time gap and output gap, aggregate economy, 1970q1-2012q4



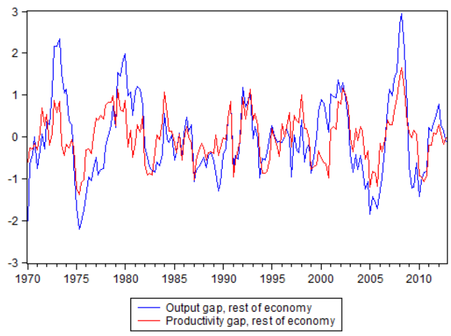
(c) Productivity gap and output gap, manufacturing sector, 1970q1-2012q4



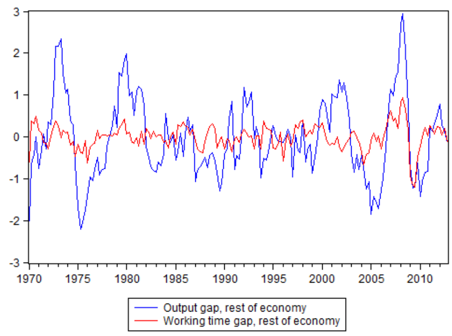
(d) Working time gap and output gap, manufacturing sector, 1970q1-2012q4



(e) Productivity gap and output gap, rest of economy, 1970q1-2012q4



(f) Working time gap and output gap, rest of economy, 1970q1-2012q4



We estimate two ADL models. In the first, the hourly productivity gap, LP^{gap}, is explained by the output gap, Y^{gap}, and various of its lags as well as the lagged endogenous variable. In the second, the working time gap, WT^{gap}, is explained by the output gap, its lags and lags of the endogenous variable:

$$LP_t^{gap} = \sum_{k=1}^{n} \alpha_{1,k} LP_{t-k}^{gap} + \sum_{j=0}^{n} \alpha_{2,j} Y_{t-j}^{gap} + u_t^{LP} \tag{3.7}$$

and

$$WT_t^{gap} = \sum_{k=1}^{n} \beta_{1,k} WT_{t-k}^{gap} + \sum_{j=0}^{n} \beta_{2,j} Y_{t-j}^{gap} + u_t^{WT} \tag{3.8}$$

The αs and βs are coefficients and u^{LP} and u^{WT} are error terms for the productivity and the working time estimation respectively. The coefficient $\alpha_{2,0}$ is the impact effect of the output gap for the productivity gap, and $\beta_{2,0}$ is the impact effect of the output gap for the working time gap. The impact effects show the direct contemporaneous effect of the variables on the respective dependent variable.

The long run effect for the productivity gap of a permanent change in the output gap is given by:

$$\frac{\sum_{j=0}^{n} \alpha_{2,j}}{1 - \sum_{k=1}^{n} \alpha_{1,k}} \tag{3.9}$$

For the working time gap, the long run effect of permanent changes in the output gap is given by:

$$\frac{\sum_{j=0}^{n} \beta_{2,j}}{1 - \sum_{k=1}^{n} \beta_{1,k}} \tag{3.10}$$

To avoid an endogeneity bias in the estimation, the contemporary German output gap is instrumented by the contemporary world output gap. Due to its strong export orientation, German economic performance heavily depends on global economic activity but Germany's economy is not large enough to determine world economic growth itself. This is why it makes sense to assume that the world output gap is independent of Germany's output gap but not vice versa. Further, the world output gap is not likely to be influenced by changes in German working time or hourly productivity. This is why the world output gap constitutes a suitable instrument.

To construct the world output gap, we used quarterly world GDP as estimated by the IMF and made a seasonal adjustment with the BV4.1 procedure. The world output gap and the output gap for the entire German economy are highly correlated with a correlation coefficient of 0.71; the world output gap and the German output gap in the manufacturing sector are correlated with a coefficient of 0.67 and 0.63 for the non-manufacturing sector. We estimate equation (3.7) and (3.8) with a two stage least squares estimator where in the first stage, all variables from the second step are used as instruments except the contemporary German output gap which is substituted by the contemporary world output gap.

In all estimations, the deviation of compensations per employee from its trend for the respective sectors have also been used as a variable in order to check for the effect of wages on working time and productivity. However, nowhere did they have any significant effect. This is why results with this variable are not reported here.

Further, in each estimation, a reunification dummy has been tried. The dummy takes a value of one in all four quarters of 1991 and zero for all other quarters. Whenever it was significant, it staid in the regression, if not, it was removed.

3.3.1 Estimates for the aggregate economy

In order to select the lag length, serial correlation tests have been used and insignificant lags have been left out of the equation. The approach followed in the estimation process is general-to-specific so that the lags with the highest p-values have been dropped until those with a significance level of ten per cent or less remain. First, models (3.7) and (3.8) are estimated for the entire German economy. Estimation results are shown in table 3.7.

Table 3.7: Aggregate economy

Variable	Coefficient	p-value
Y_t^{gap}	0.66***	(0.00)
Y_{t-1}^{gap}	-0.75***	(0.00)
Y_{t-3}^{gap}	0.14***	(0.00)
LP_{t-1}^{gap}	0.94***	(0.00)
LP_{t-4}^{gap}	-0.11***	(0.01)
R^2	0.89	
N	138	

(a) Productivity gap, sample: 1971q1-2005q2

Variable	Coefficient	p-value
Y_t^{gap}	0.23	(0.00)
Y_{t-1}^{gap}	-0.19***	(0.01)
WT_{t-1}^{gap}	0.69***	(0.00)
WT_{t-4}^{gap}	-0.27***	(0.01)
WT_{t-5}^{gap}	0.14*	(0.08)
WT_{t-8}^{gap}	-0.10**	(0.04)
R^2	0.74	
N	134	

(b) Working time gap, sample: 1972q1-2005q2

Residuals in both models do not show any serial correlation or heteroskedasticity. In both models, the impact effects (the coefficients of the contemporary output gap) are positive. In order to see whether there is a significant long-term effect, Wald tests have been conducted to test whether the coefficients of the output gap and its lags sum to zero. Both in the productivity gap model and in the working time model, Wald tests reject that the coefficients sum to zero at the 5 % level. This means that long-term effects according to equations (3.9) and (3.10) can be computed. The long-term effect for the productivity gap is 0.34 and 0.07 for the working time gap for the aggregate economy. This indicates that labor hoarding might have played a larger role in the long run than variations in working time.

The estimation results are used to create forecasts of the productivity and working time gap based on the actual output gap for the period 2005q3 to 2012q4. The beginning of the sample period is the beginning of the upswing before the Great Recession. This date is chosen because Burda and Hunt argue that the preceding upswing was special in that less employees were hired in comparison to other upswings so that the safeguarding of employment in the downswing was a reaction to employers' reticence to hire before.

Before computing the forecasts, one remark is in order. While we forecast the productivity and output gap out of sample (but using the actual output gap), some information of those variables is already contained in the values of the two gaps before the forecasting period. This is due to the use of the Hodrick-Prescott filter which has been used to compute the trend. The filter uses information of the whole sample so that the trend value and thus the different gaps before the forecast period are not independent from the gaps in the forecast period. However, we see no possibility to circumvent this problem because of the end-value problem of the H-P filter.

For robustness, a trend has been computed for the sample until the second quarter of 2005. The results and forecasts based on this trend did hardly differ from the results when the whole sample is used to compute the trend.

The results of the forecast are presented in figure 3.6. With respect to the productivity per hour-gap for the aggregate economy, shown in figure 3.7a, the forecast development tracks the actual development very closely. The actual development is always within the confidence band of two standard errors.

This suggests that the size of the output-shock is sufficient to explain the strong reduction in cyclical productivity in the Great Recession. While the cyclical reaction of productivity significantly contributed to safe jobs in the downturn, the size of this contribution is in line with historical experience and cannot explain the "miracle" of German employment in the Great Recession.

On the other hand, the actual development of working time departed significantly from the forecast development (figure 3.7b). While in the upswing before the Great Recession, especially since the end of 2006, cyclical working time was higher than expected, it decreased much stronger than predicted in the Great Recession.

At the end of the forecast horizon, the actual and forecast working-time gaps are almost identical. These results suggest that the German employment miracle is mainly caused by unusually strong temporary working time reductions in the recession. But it also suggests that much of the safeguarding of employment just compensated the lack of hiring in the preceding upswing in which average working time has been more increased than predicted. That employment increased less than predicted is consistent with Burda and Hunt's finding. However, the cause - unexpected increases in working time - is different.

Figure 3.6: Actual and forecast developments in percentage points, aggregate economy, 2005q3-2012q4

(a) Productivity gap **(b)** Working time gap

The effect on employment can be made explicit by computing a counter factual employment gap that would have been obtained if working time and hourly productivity would have behaved as they did historically according to our estimates. The counter factual employment gap, $L^{gap,c}$, is computed by using the actual output gap, Y^{gap}, and subtracting from it the forecasted values of working time ($WT^{gap,f}$) and hourly productivity ($LP^{gap,f}$) from the third quarter of 2005 onwards:[8]

$$L^{gap,c} = Y^{gap} - WT^{gap,f} - LP^{gap,f} \tag{3.11}$$

[8]This would again only hold with equality with continuous growth rates. But differences between continuous and discrete growth rates are minimal.

The development of the level of actual absolute employment can be computed by multiplying the equation by the employment trend and then adding the employment trend:[9]

$$L^c = (Y^{gap} - WT^{gap,f} - LP^{gap,f})\overline{L}_t + \overline{L}_t \tag{3.12}$$

The result is shown in figure 3.8a. As can be seen, if hourly productivity and working time had reacted as predicted from past data, employment would have been considerably higher before and lower after the crisis. According to this counter factual development, in the Great Recession from the first quarter of 2008 to the third quarter of 2009, actual employment would not have *increased* by 113.000 persons (table 3.2) but *decreased* by 545.000 persons.

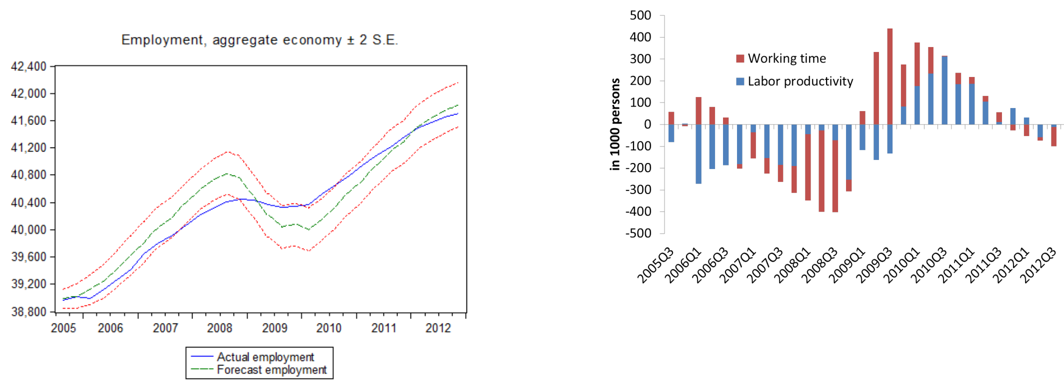
Figure 3.8b shows the difference between actual and predicted employment in 1000s of persons, differentiated by the contribution of the forecasting errors for the labor productivity and working time gap. Positive values mean that more (less) employment has been saved than expected, i.e. cyclical working time and labor productivity have decreased more (less) than expected.

It clearly shows that working time during and after the recession was the major contribution to both a lower than expected increase in employment before and during the recession and a lower than expected fall in the recession. From 2005 until the recession's end in the third quarter of 2009, labor hoarding was less than predicted, thus costing more employment than predicted.

Figure 3.7: Consequences for employment in 1000 persons, aggregate economy

(a) Actual and predicted employment

(b) Difference between actual and predicted value of working time and productivity gap



[9] Since $L^{gap,c} = \frac{L - \overline{L}}{\overline{L}}$

However, from those estimates is not yet clear which sectors were responsible for the unexpected fall in working time in the Great Recession. This will be looked at in more detail in the next section.

3.3.2 Estimates for the manufacturing sector and the rest of the economy

Here, the same models which have been estimated for the aggregate economy will also be estimated for the manufacturing sector and the rest of the economy. Again, the contemporary output gap for the respective sectors is instrumented by the world output gap.

Estimation results for the manufacturing sector are given in table 3.8. For the rest of the economy, results are given in table 3.9. All models have well behaved residuals, with neither heteroskedasticity nor serial correlation present in the residuals.

Table 3.8: Manufacturing sector

Variable	Coefficient	p-value
$Y_t^{m,gap}$	0.64***	(0.00)
$Y_{t-1}^{m,gap}$	-0.75***	(0.00)
$Y_{t-3}^{m,gap}$	0.14***	(0.00)
$Y_{t-5}^{m,gap}$	-0.10**	(0.08)
$Y_{t-7}^{m,gap}$	0.24***	(0.00)
$Y_{t-8}^{m,gap}$	-0.14***	(0.00)
$LP_{t-1}^{m,gap}$	0.93***	(0.00)
$LP_{t-4}^{m,gap}$	-0.27***	(0.00)
$LP_{t-5}^{m,gap}$	0.33***	(0.00)
$LP_{t-6}^{m,gap}$	-0.09**	(0.05)
$LP_{t-7}^{m,gap}$	-0.15***	(0.00)
R^2	0.94	
N	134	

(a) Productivity gap, 1972q1 - 2005q2

Variable	Coefficient	p-value
$Y_t^{m,gap}$	0.26***	(0.00)
$Y_{t-1}^{m,gap}$	-0.20***	(0.00)
$Y_{t-4}^{m,gap}$	0.13***	(0.00)
$Y_{t-5}^{m,gap}$	-0.19***	(0.00)
$Y_{t-6}^{m,gap}$	0.10***	(0.00)
WT_{t-1}^{gap}	0.96***	(0.00)
WT_{t-2}^{gap}	-0.24***	(0.00)
WT_{t-4}^{gap}	-0.44***	(0.00)
WT_{t-5}^{gap}	0.63***	(0.00)
WT_{t-6}^{gap}	-0.39***	(0.00)
$DUMMY$	-0.02***	(0.00)
R^2	0.84	
N	136	

(b) Working time gap, 1971q3 - 2005q2

Table 3.9: Rest of the economy

Variable	Coefficient	p-value
$Y_t^{r,gap}$	0.78***	(0.00)
$Y_{t-1}^{r,gap}$	-0.76***	(0.00)
$Y_{t-3}^{r,gap}$	0.09**	(0.02)
$Y_{t-7}^{r,gap}$	0.07**	(0.02)
$LP_{t-1}^{r,gap}$	0.86***	(0.00)
$LP_{t-4}^{r,gap}$	-0.13***	(0.00)
$LP_{t-8}^{r,gap}$	-0.16***	(0.00)
R^2	0.85	
N	134	

(a) Productivity gap, 1972q1 - 2005q2

Variable	Coefficient	p-value
$Y_{t-2}^{r,gap}$	0.03*	(0.09)
$Y_{t-7}^{r,gap}$	-0.04**	(0.02)
$WT_{t-1}^{r,gap}$	0.43***	(0.00)
$WT_{t-2}^{r,gap}$	0.21**	(0.02)
$WT_{t-4}^{r,gap}$	-0.31***	(0.00)
R^2	0.37	
N	135	

(b) Working time gap, 1971q4 - 2005q2

In the manufacturing sector, the impact effect of the output gap is positive both for the productivity and working time gap. However, in the rest of the economy, only productivity is contemporaneously positively affected by the output gap. The contemporary output gap does not have an impact on the working time gap in the rest of the economy.

For all models, Wald tests for the sum of the output gap coefficients and its lags being zero have been conducted in order to evaluate whether long-run effects can be computed. In the manufacturing sector, the sum of the output gap coefficients in the productivity equation is not statistically different from zero so that no long-run effect can be computed. On the other hand, the sum of output gap coefficients are different from zero in the working time gap equation. The long-run effect of a permanent output gap change on working time is 0.21 in the manufacturing sector.

While the output gap has no significant long-run effect on the productivity gap, it is still important in order to explain the dynamics of the productivity gap. With the output gap and its lags, the R^2 of the estimation is 0.94, without the output gaps, it is only 0.66, lower by almost a third. This means that the output gaps do indeed explain much of the variance of the productivity gap. The intuition behind this finding might be that manufacturing firms hoard labor until they can initiate work sharing programs which then are used for long-run adjustment.

In the rest of the economy, it is the reverse: the output gap has a significant long-run effect on the productivity gap but not on the working time gap. The output gap and its lags are different from zero at the 1 % level in the productivity gap estimation. The long-term effect of a permanent change in the output gap is 0.42.

The output gaps in the rest of the economy are not jointly significant for the working time gap. The presence of the output gap in the estimation does also not seem to contribute much of explanatory power to the model. With the output gap in the estimation, the R^2 is 0.37, without it, it is 0.33, only slightly lower.

This means that the dominant adjustment mechanism in the rest of the economy, both in the short and in the long run, is an adjustment of labor hoarding while working time changes do not seem to play any role. This is in contrast to the manufacturing sector where labor hoarding does seem to play a role in the short-run, but not the long-run while work sharing plays a role both in short and in the long run.

Based on the estimations, figure 3.8 shows the forecast values of the productivity and working time gaps for the manufacturing sector and figure 3.9 shows the forecast values for the rest of the economy.

Figure 3.8: Actual and forecast development in percentage points, manufacturing sector, 2005q3-2012q4

(a) Productivity gap **(b)** Working time gap

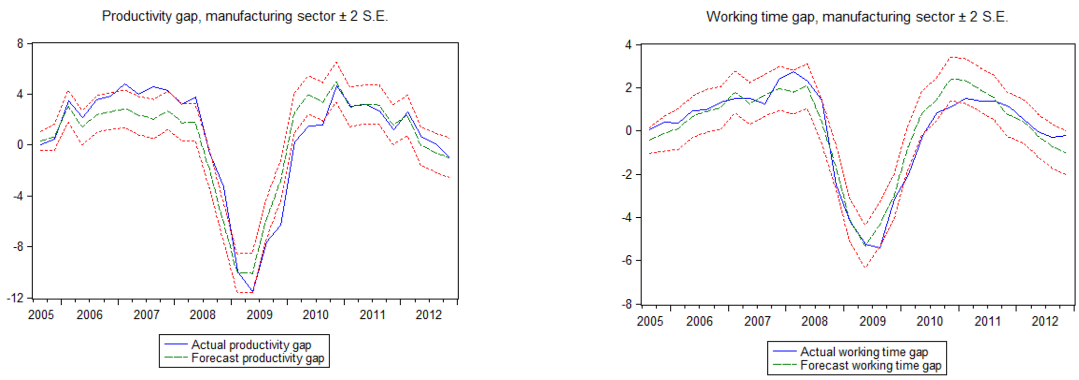
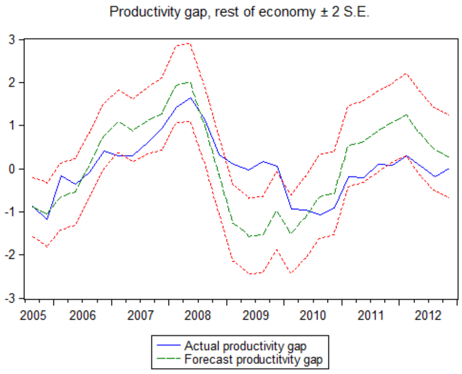
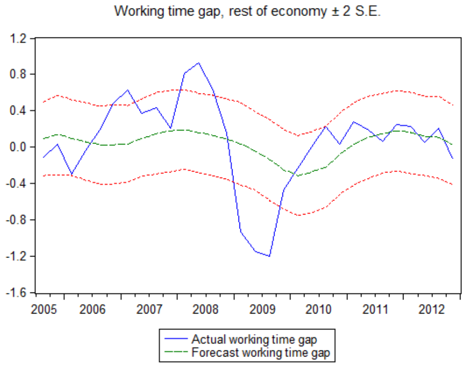


Figure 3.9: Actual and forecasted development in percentage points, rest of the economy, 2005q3-2012q4

(a) Productivity gap



(b) Working time gap



In the manufacturing sector, the actual productivity gap overshoots the predicted gap almost the whole time until the fourth quarter of 2008 when it begins to undershoot the actual gap. It leaves the two standard error band in the fourth quarter of 2009, stabilizing employment more than predicted until the third quarter of 2010. Then, it begins to coincide with the actual development.

The working time gap in the manufacturing sector is more often within the two standard error band than the productivity gap and only significantly diverges from the actual path at the end of 2010.

In figure 3.11a, the counter factual development of employment in manufacturing is shown. One sees that employment would have been higher before the crisis hit and lower afterwards, i.e. employment would have been more reactive to the output gap than it actually was. In the Great Recession from the first quarter of 2008 to the third quarter of 2009, actual employment in manufacturing would not have fallen by 220.000 persons but by 627.000 persons.

Figure 3.12a shows the decomposition of the employment forecast error into the error from the working time and the productivity gap in manufacturing. One can clearly see that unexpected changes in employment mostly came from errors in forecasting labor productivity and much less from forecasting working time. Labor hoarding in the recession was higher than predicted - and much lower in the preceding upswing than predicted.

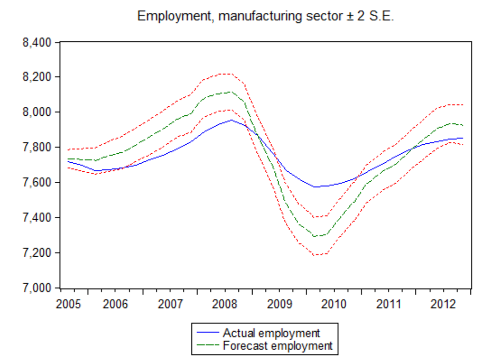
For the rest of the economy figure 3.9 shows that the forecast productivity gap fell more than the actual gap, implying that there was *less* labor hoarding in the rest of the economy than historically, i.e. the reverse of the manufacturing sector. The working time gap behaved in strong contrast to the historical record, rising much more in the upswing and falling much more in the recession than predicted.

The worse than expected productivity gap and the better than expected working time gap in the rest of the economy roughly compensated each other: The actual and the counter factual development of employment (shown in figure 3.11b) are within the two error confidence band although the point forecasts of employment are somewhat higher than actual employment.

The forecast error for employment in the non-manufacturing sector, decomposed into the forecast error of working time and labor productivity (figure 3.12b) shows that unexpected decreases in working time were more than compensated by unexpected increases in labor productivity. This means that firms in the non-manufacturing sectors seem to have substituted working time adjustment for cyclical labor hoarding.

Figure 3.10: Counter factual employment in 1000 persons

(a) Manufacturing sector



(b) Rest of economy

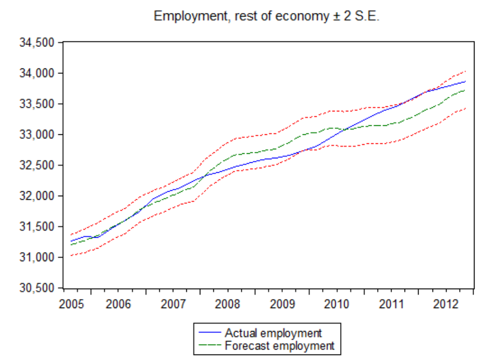
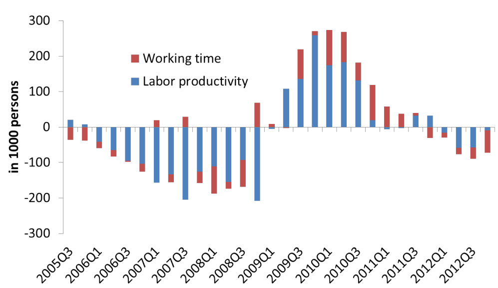
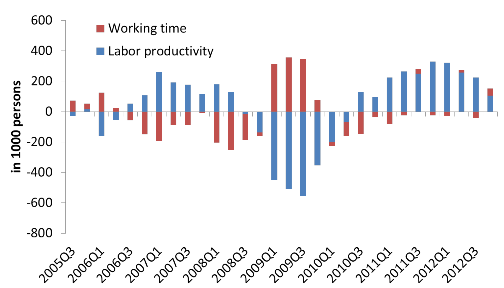


Figure 3.11: Difference between actual and predicted value of working time and productivity gap in 1000 persons

(a) Manufacturing sector



(b) Rest of economy



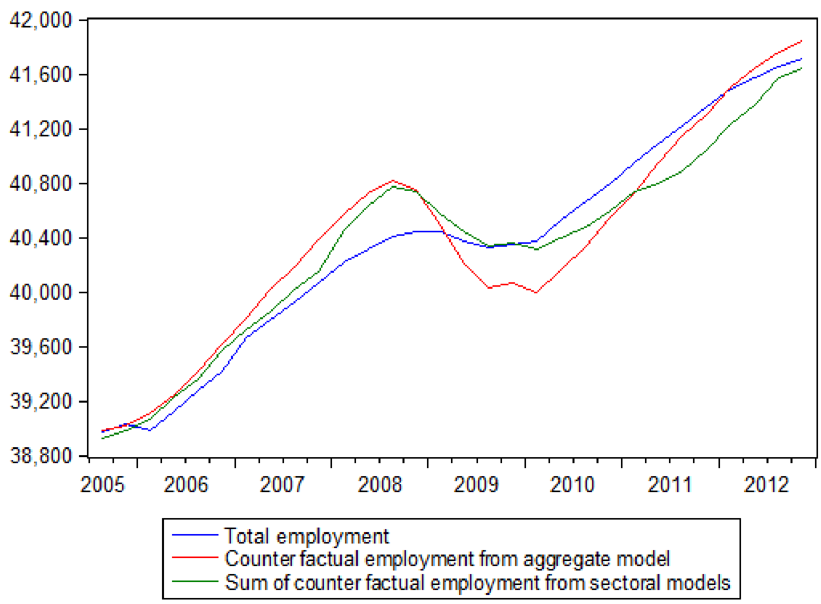
Thus, the results from the econometric exercise are consistent with the previous descriptive analysis. The unexpected stronger than predicted decrease in productivity in the manufacturing sector and the unexpected stronger decrease in the non-manufacturing sector compensated each other. But in the Great Recession, the working time gap decreased stronger in both sectors, mainly driven by the non-manufacturing sector. This explains the unexpected development of working time in the aggregate economy.

3.3.3 Comparing the aggregate and the sectoral forecasts

In the following section, the results from the aggregate and the sectoral forecasts are compared in order to check for the consistency or inconsistency of the results. Figure 3.12 compares actual employment to the counter factual employment of the aggregate model and the sum of counter factual employment in the sectoral models (i.e. counter factual manufacturing and non-manufacturing employment) .

While both models predict that employment would have risen much more until 2008 than it actually did, they strongly differ in the amount of employment lost in the crisis. In the period of the Great Recession, employment predicted by the aggregate model would have fallen by 438.000 persons more than predicted by the sectoral models. This shows the amount of uncertainty already within this relatively consistent estimation setting.

Figure 3.12: Employment forecast from aggregate and sectoral models in 1000 persons



In order to understand the difference between the counter factual employment developments in the two kinds of models, figure 3.13 compares the forecast errors for the productivity and the working time gap for the aggregate model and the sum of the sectoral models. Both are transformed into 1000s of persons.

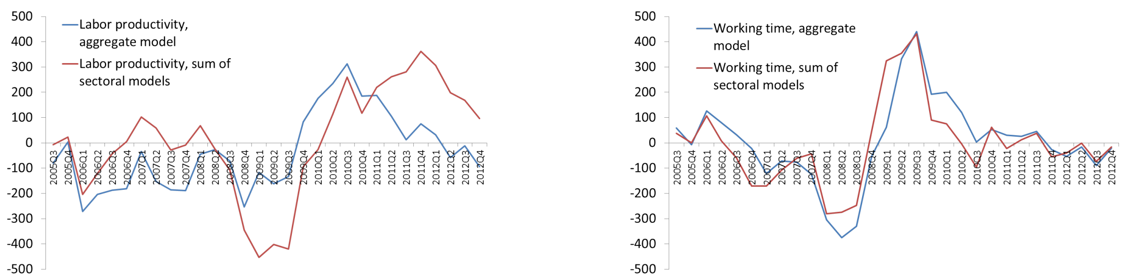
As can be seen, the different employment dynamics of the aggregate and sectoral models are mainly due to the productivity gap forecast errors (figure 3.14a). The forecast errors for the working time gap are very similar (figure 3.14b).

In the recession, the sum of employment predicted by the sectoral models is closer to actual employment because the positive effect of an unexpected decrease in working time is compensated by a negative effect of higher than expected productivity. In the aggregate model, the forecast error for the productivity gap is less negative so that the unexpected decrease in working time leads to a better than forecast employment development.

Figure 3.13: Forecast errors of aggregate and sectoral models in 1000 persons

(a) Productivity gap

(b) Working time gap



3.3.4 Accounting for unexpected working time and productivity developments

Since the forecast errors for the working time gap are consistent between the two models, one can compare them to the development of the work sharing instruments which have been discussed in section 3.2. The question is whether one of the working time instruments is correlated with the forecast error. Figure 3.14 shows the development of all working time instruments before and in the downswing. While all instruments were used to decrease average working time in 2009, only regular working time markedly *increased* when the downswing had already started in 2008.

Figure 3.14: De-trended working time instruments, average hours

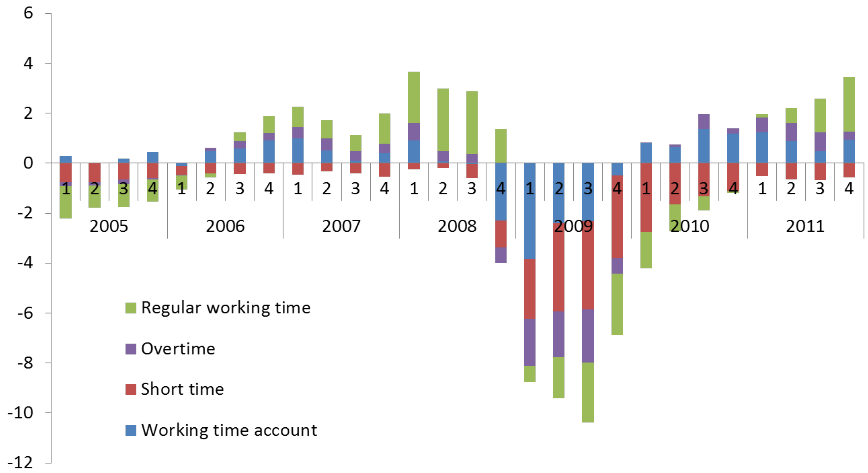


Figure 3.15: Working time forecast errors and working time instruments

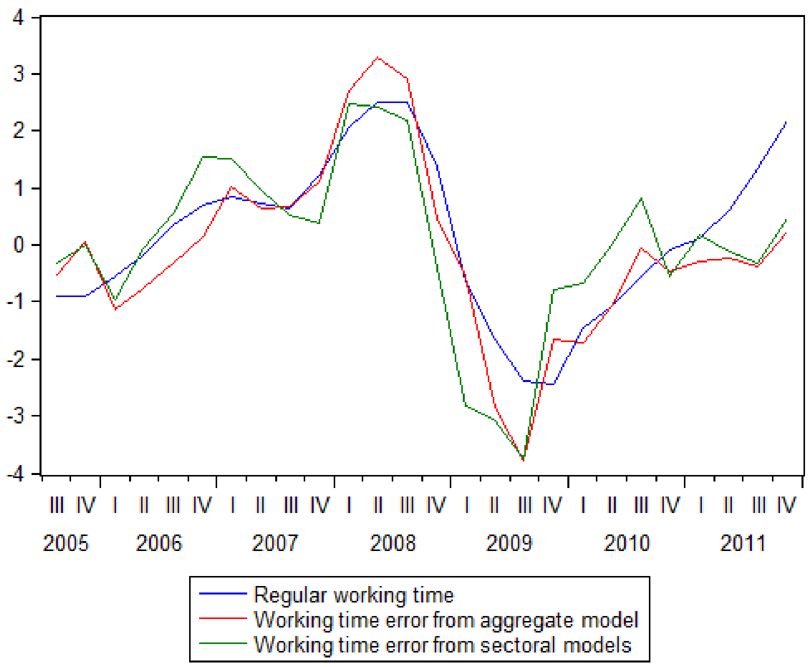


Figure 3.15 compares the working time error in percentage points to the development of regular working time from figure 3.14. For the comparison, the working time error

is multiplied by the trend in working time so that it is expressed in average hours per employed person:

$$(WT^{gap} - WT^{gap,f})\overline{WT}_t \tag{3.13}$$

One can clearly see that there is a high correlation between the development of cyclical regular working time and the working time errors. For the reduction in working time in 2009 this correlation cannot be taken as an indication for the dominant role of reductions of regular working time since all working time instruments have decreased at that time. But cyclical regular working time was the only component of working time that increased before the downswing. It is thus safe to say that the unexpected increase in working time which initially cost employment is mainly due to cyclical increases in regular working time.

In order to further analyze this point, a sectoral decomposition of the developments of the different working time instruments would be helpful since the unexpected working time increase mainly took place in the non-manufacturing sector. Unfortunately, such data is not available.

On the other hand, what might have accounted for the change in the behavior of productivity in the non-manufacturing sector? One might think that the weaker than expected decline might be attributable to the liberalization of fixed-term contracts in 2004. After those changes fixed-term employment steadily increased as a share of employment (Hohendanner, 2010), from 6.3 % of all employees subject to social contributions to 9.3 % in 2008. This increase in fixed-term contracts was mainly concentrated in the non-manufacturing sector.

However, fixed-term contracts were hardly affected by the Great Recession (Hohendanner, 2010). The form of employment that declined most was agency work (Mai, 2010). Agency work is not based on fixed-term contracts since agency workers continue working for their agency even when they are not leased out (Burda and Kvasnicka, 2006). Further, the use of agency work was deregulated in 2003 which led to a strong increase in agency work before the crisis. Between July 2008 and spring 2009, agency work declined by roughly a quarter million persons, from 823.100 to 600.000. The decline was so steep because agency workers are mainly employed in the manufacturing sector (Mai, 2008) which was most hit by the recession although they are counted as part of the service sector to which work leasing firms belong.

This might explain why the decline in non-manufacturing output was not sufficient to forecast the productivity gap: a part of its labor force did not depend on non-manufacturing output, but on output in the manufacturing sector. That the non-manufacturing sector decreased its employment more than expected might just be a compositional effect: a part of employment that would have belonged to the manufacturing sector before the liberalization of agency work now is statistically but not actually part of the service sector.

3.3.5 Stability

Until now, we have assumed that there is not structural break. On the other hand, it seems that there was a structural break after 2005 since we have found different dynamics, especially of working time. Here, possible structural breaks are tested for. All models have been re-estimated for the whole sample period, i.e. from the first quarter of 1970 to the fourth quarter of 2012 and Andrew-Quandt tests have been conducted for a structural break in the influence of the output gap and its lags on the productivity and working time gap.

Table 3.10: Andrew-Quandt test for unknown structural break

	Model	Sample	Break point	F-Statistic	p-value
Aggregate model	WT^{gap}	1974q2 - 2010q4	2006q1	22.67	(0.00)
	LP^{gap}	1973q2 - 2010q4	1987q3	16.86	(0.02)
Manufacturing	WT^{gap}	1973q4 - 2010q4	2006q4	20.64	(0.03)
	LP^{gap}	1974q2 - 2010q4	1983q1	28.21	(0.00)
Rest of economy	WT^{gap}	1974q1 - 2010q4	2008q4	13.28	(0.04)
	LP^{gap}	1974q2 - 2010q4	2006q2	15.90	(0.09)

The Andrew-Quandt test is a test for an unknown structural break. The sample has been trimmed at the beginning and end by 2.5 % because values at the beginning and end might yield degenerate test statistics. Table 3.10 shows the results. In both the aggregate model and the sectoral models, the structural break for the working time gap is between 2006 and 2008, i.e. after 2005. This indicates that there indeed was structural change in that period which took place before the Great Recession.

Results are less consistent for the productivity gap estimations. In the aggregate model, a break-point for the productivity gap is found in 1987. But in the manufacturing model, a break-point is found in 1983; and in the the non-manufacturing model, the break-point is found in 2006.

For the aggregate economy and for the manufacturing sector, the productivity model does not show any significant difference if the model are re-estimated with the sample beginning in the third quarter of 1987 and the first quarter of 1983 respectively. For the non-manufacturing sector, the timing of break point is indeed consistent with the timing of the liberalization of fixed-term contracts and the strong increase especially of agency work after this liberalization.

3.4 Conclusion

The chapter analyzed the German "employment miracle" in the Great Recession by looking at the development of average working hours and productivity per hour before and in the Great Recession. The analysis shows that the development of average working time in the aggregate economy indeed was responsible for the miracle in the Great Recession. It decreased more strongly than anticipated based on historical experience.

However, before the recession hit, average working hours increased stronger than anticipated. This means that much of the labor market miracle can be explained as a smoothing of employment over the business cycle: While employment did not fall as strongly as expected in the crisis, it did not increase as strongly as expected before the crisis. This finding is consistent with Burda and Hunts' finding of employment smoothing. But the mechanism is different. Burda and Hunt emphasized labor hoarding and not work sharing as the dominant mechanism that smoothed employment.

When looking at the sectoral development of average working time and hourly productivity, the chapter finds that the difference between expected and actual working time mainly took place in the non-manufacturing sector in which changes in working time hardly played a role to smooth the employment cycle before the Great Recession. However, it seems that instruments of working time flexibility in the non-manufacturing sector mainly compensated lower than expected labor hoarding.

The less than expected labor hoarding in the non-manufacturing sector was compensated by higher than expected labor hoarding in the manufacturing sector. Working time developed roughly as predicted in the manufacturing sector. On the aggregate level, the lower than expected labor hoarding in the non-manufacturing sector and the higher than anticipated labor hoarding in the manufacturing sector compensated each other so that the irregular behavior of working time in the non-manufacturing sector became dominant for the aggregate economy.

Since new instruments of working time adjustment - discretionary changes in regular working time and working time accounts - were used, it is likely that the unexpected decrease in working time mainly stems from those instruments. Also, it seems that discretionary increases in regular working time before the crisis were responsible for the lower than expected increase in employment. One would need more data on the sectoral composition of the different working time instruments to better understand their role for the unexpected decline in working time in the non-manufacturing sector.

Thus, the German experience in the Great Recession shows the importance of work sharing in stabilizing employment in a downturn. But cyclical work sharing might also have positive long-run impacts on the labor market. First, the stabilization of employment in economic downturns prevents unemployment hysteresis (Røed, 1997). Second, work sharing might contribute to the overall flexibility of labor markets in some countries, and therefore lowers structural unemployment caused by macroeconomic shocks and rigid labor markets (Sturn, 2013).

For instance, Eichhorst et al. (2009) find that corporatist countries like Austria, Denmark, Finland, Germany, the Netherlands, and Sweden have much greater overall labor market flexibility when not only the the ease with which firms can lay-off workers is looked at but also the possibility of adjusting hours worked by work sharing. This suggests that cyclical work sharing is positively correlated with corporatism and that corporatist industrial relations might be a necessary institutional pre-condition for high degrees of hours adjustment.

Also, there seems to be a certain cross-country trade-off between low employment protection regulation and high variability of average hours worked (OECD, 2010). This suggests that a certain external rigidity of the labor market, especially in the form of employment protection legislation which prohibits firms from quickly laying off workers in downturns, might be supportive for the emergence of internal flexibility, if combined with well-functioning corporatist structures.

These arguments are consistent with the German experience, where working time accounts and the reduction of weekly working hours at the company level were an outcome of collective bargaining between employers and unions in an environment of strict employment protection legislation.

Because of these stabilizing cyclical effects of internal flexibility and its potential positive long-run outcomes, we conclude that there are good reasons for academic researchers to focus more on the quantification, causes and consequences of high internal labor market flexibility, beyond the German experience in the Great Recession. While the impact of external flexibility on unemployment has been heavily researched since the 1990ies (see OECD (2006) for a survey), by now there exists only very few data and literature on internal flexibility.

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Ehrenwörtliche Erklärung

Ich habe die vorgelegte Dissertation selbst verfasst und dabei nur die von mir angegebenen Quellen und Hilfsmittel benutzt. Alle Textstellen, die wörtlich oder sinngemäß aus veröffentlichten oder nicht veröffentlichten Schriften entnommen sind, sowie alle Angaben, die auf mündlichen Auskünften beruhen, sind als solche kenntlich gemacht.

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