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General introduction

The dissertation at hand is comprised of four chapters. In the next three chapters, I focus on how public pension wealth impacts on the behavior of mothers in Germany. More precisely, I examine the employment, old-age savings and retirement behavior in response to child care pension benefits (*Kindererziehungszeiten*) in the German public pension system.

Public pension wealth is part of total private wealth. However, since measuring pension wealth is difficult, many surveys on private wealth do not provide information on individual pension wealth. This is also the case in the last chapter, which sheds light on the top tail of the wealth distribution, based on survey data.

The comparison of employment biographies of mothers to those of childless women shows that child birth leads to employment interruptions, which typically take up to several years (OECD, 2007; Schönberg and Ludsteck, 2014). In the months that follow child birth many mothers focus on child care while dedicating less time to paid work. After child birth, families in Germany are supported by different kinds of public transfers. In order to compensate parents for the immediate drop in family income, several policies are in place (for instance the child allowance (*Kindergeld*) or the recently introduced Parental Leave Benefit (*Eltern-*

geld)).[1] While an employment break immediately lowers family income, it also has long-lasting effects on the pension entitlements of a mother. In periods of child care, a mother does not pay compulsory pension contributions from employment and hence her pension entitlements stagnate. In order to compensate mothers[2] for child-rearing, policy makers introduced child care pension benefits *(Kindererziehungszeiten)* in 1986 (Schmähl et al., 2006). The child care pension benefit increases pension entitlements of mothers when periods of child care precluded employment. However, it also provides economic incentives that affect employment, old-age savings and retirement. Therefore, the overall assessment of the impact of child care pension benefits on a mother's old-age income has also to take into account potential behavioral reactions.

Each year, the federal government transfers about €10 to 11 billion to the German Statutory Pension Insurance to cover expenses related to child care pension benefits (Deutsche Rentenversicherung Bund, 2015). Today 8 of 10 women raised a child and usually they are entitled to child care pension benefits.[3] Furthermore, the recent pension reform in 2014 (the so-called 'Pension Package') expanded the child care pension benefit for child births prior to January 1992, which emphasizes the political relevance. Besides its quantitative economic importance, child care pension benefits are special in its temporal dimension. In contrast to other family benefits and transfers in Germany, like the child allowance or the parental leave benefit that are paid upon child birth, child care pension benefits become effective at the verge of retirement many years after accrual. Whether or not a

[1] Spiess and Wrohlich (2008) describe in detail the parental leave reform in 2007, which introduced the new parental leave benefit.

[2] In principle, fathers can be entitled to the child care pension benefit as well, however the corresponding share of fathers is very low.

[3] Based on mothers at retirement age (Statistisches Bundesamt, 2012).

mother considers the economic implications of child care pension benefits in her decisions crucially depends on the length of her planning horizon. A perfectly rational mother would fully take into account child care pension benefits when she, for instance, chooses to take-up a job or not. However, for a mother with a short planning horizon, child care pension benefits are of lesser importance. In the light of the above, the next three chapters focus on the behavioral and distributional effects of child care pension benefits.

In the first chapter, I exploit variation in the child care pension benefits to analyze the impact of maternal pension wealth on the employment decision in the years following child birth. This contributes to a large body of literature that has investigated the impact of public benefits and transfers on female labor supply.
One strand of literature focuses on employment responses to parental leave policies. The empirical evidence on parental leave policies is mixed. Several studies for the United States find only weak effects of parental leave policies on maternal labor supply (Baum and Charles, 2003; Klerman and Leibowitz, 1999; Waldfogel, 1999). When rather generous parental leave policies are concerned, the literature finds in part substantial employment reductions due to (paid) parental leave (Lalive and Zweimüller, 2009; Lalive et al., 2014; Bergemann and Riphahn, 2010; Geyer et al., 2014; Schönberg and Ludsteck, 2014). For Germany, Schönberg and Ludsteck (2014) document that mothers reduce their labor supply in the short-term but not in the long-term, when focusing on several changes to the parental leave scheme .
Another strand of literature looks at the impact of child care policies on maternal labor supply. A summary of the literature is provided by Blau and Currie

(2006) or Blau and Tekin (2007). Since the take-up of child care is often endogenous, several studies rely on quasi-experimental approaches (see e.g. Havnes and Mogstad (2011) or Cascio (2009)) or on structural models (Haan and Wrohlich, 2011; Guner et al., 2014) to estimate the impact on maternal employment. For instance, Haan and Wrohlich (2011) find that higher subsidized child care, that is granted conditional on employment, notably increases maternal employment and fertility of childless and highly educated women for Germany .

However, in contrast to most papers I analyze the employment effect of a benefit at the time of accrual that becomes effective many years later. To evaluate the employment effects of higher maternal pension wealth - through the increase in child care pension benefits in 1992 - I use administrative Biographical Data of Social Insurance Agencies in Germany (*Biographiedaten ausgewälter Sozialversicherungsträger in Deutschland, BASiD*) and apply a quasi-experimental method, namely the 'Regression Discontinuity Design' (RDD).[4] To evaluate the impact of an intervention, e.g. a policy reform, quasi-experimental methods typically compare the outcome across two groups. Individuals in the treatment group are affected by the intervention, whereas individuals in the control group are not. The RDD exploits the fact that the assignment into the treatment group is a discontinuous function of an underlying continuous variable. More precisely, it compares individuals who share similar values of the underlying assignment variable but belong to the treatment or the control groups. The appealing feature of the RDD is the fact that it provides variation that is as good as random if individuals have no perfect control over the selection rule into either the treatment or control groups (Lee and Lemieux, 2010, p. 282). Random assignment of individuals into the

[4]Thistlethwaite and Campbell (1960) introduced the Regression Discontinuity Design when they analyzed the impact of merit awards on academic outcomes.

treatment and control groups allows to attribute differences in the outcome to the treatment. In chapter 1 (and in chapter 2), mothers are assigned into the treatment group if their child was born in January 1992 or later. If their child was born in December 1991 or before, they are assigned into the control group. Since parents have no perfect control over their child's birth date, the RDD can identify causal effects for the respective groups. However in 1992, policy makers not only increased child care pension benefits, but also the parental leave duration for child births in January 1992 or later. Since parental leave has an evident impact on maternal employment (Schönberg and Ludsteck, 2014), I select the sample such that mothers are only affected by the longer provision period of child care pension benefits, but not by the longer parental leave duration.[5] The findings suggest that the change in pension wealth did not affect maternal employment, neither in the short- nor in the long-term.

While at retirement the largest share of old-age income in Germany stems from public pension payments (Frommert and Himmelreicher, 2013), another source is non-pension wealth. One of the first studies that looked at the link of pension wealth and non-pension wealth was Feldstein (1974). He argues that pension wealth can, in general, have two effects on savings: The induced retirement effect and the wealth replacement effect. The induced retirement effect states that higher pension wealth can lead to earlier retirement which would increase the incentives to accumulate more non-pension wealth, since individuals remain longer in retirement. In contrast, the wealth replacement effect leads to lower old-age savings since non-pension wealth is replaced by the higher pension wealth. Which effect

[5]More precisely, I only consider mothers who had not been employed in the three months prior to child birth.

dominates is an empirical question (see e.g. Zhiyang and Weizhen (2012) or Lachowska and Myck (2015), for a survey). From a methodological point of view, in addition to the difficulty to measure individual pension wealth, many early studies share the problem of pension wealth being endogenous. In particular, households with higher tastes for savings accumulate more wealth in all forms. Therefore, more recent studies rely on exogenous variation in pension wealth to estimate the impact on savings (see e.g. Attanasio and Brugiavini (2003) or Attanasio and Rohwedder (2003)).

Chapter 2 investigates the impact of maternal pension wealth on family savings applying the regression discontinuity design. To credibly identify the impact of maternal pension wealth on family old-age savings, I also exploit exogenous variation, provided by the increase of the child care pension benefits in 1992. As in chapter 1, the regression discontinuity design provides only valid results if the simultaneously expanded parental leave did not affect old-age savings. To validate the identification, I use a previous parental leave expansion in 1986 to test its impact on family savings. In the empirical analysis, I combine three waves of the Expenditure and Consumption Survey (*Einkommens- und Verbrauchsstichprobe, EVS*) in 1998, 2003 and 2008. Overall, the empirical findings show that the increase in maternal pension wealth does not crowd-out family old-age savings among couples. Furthermore, the analysis of subgroups along the family net wealth or income quartiles confirm these findings. Moreover, among single mothers, whose relative increase in pension wealth is stronger compared to couple families, the findings are in line with those of couple families: Higher maternal pension wealth does not crowd-out old-age savings of single mothers.

Finally, in chapter 3 we investigate how maternal pension wealth affects retirement of mothers. Several studies have researched the link between retirement and pension wealth. Mitchell and Fields (1981) provide a thorough overview of early studies. Many of them face the problem of external factors, such as tastes for work, having a direct impact on retirement and the level of pension wealth, which renders pension wealth being endogenous. To address this identification difficulty, scholars started to exploit exogenous variation in pension wealth to estimate its impact on retirement (e.g. Krueger and Pischke (1992)). More recently, two different structural approaches are common in the literature: The dynamic programming and the option value approach. The dynamic programming method has been applied e.g. by Rust (1990), Berkovec and Stern (1991) or Heyma (2004), among others. Whereas, the option value model has been applied for Germany, by e.g. Börsch-Supan (2000) or Berkel and Börsch-Supan (2004). Both methods rely on implicit behavioral economic models to estimate the structural parameters, underlying the impact of pension wealth on retirement. If the assumptions correctly apply, then structural econometric models allow to conduct *ex-ante* simulations of hypothetical reforms. While the dynamic programming approach - a method that recursively determines the optimal solution to a problem - is more complex and computationally demanding, the option value model is less sophisticated. In the option value model, an individual compares pension wealth at each potential retirement date to the highest value of pension wealth in case of postponing retirement (Stock and Wise, 1990). As long as the 'option value' of postponing retirement is positive, an individual does not retire.

We follow Coile and Gruber (2001) and employ a modified version of the option value model, namely the 'peak value' to identify the relationship of maternal pen-

sion wealth and retirement using the administrative BASiD, as in chapter 1. Further, we exploit exogenous variation in pension wealth through the implementation of birth-cohort specific deduction factors for the 'women's old-age pension' (pension reforms 1992 and 1996) to address the endogeneity issue of pension wealth. After estimating the structural model, we perform a hypothetical policy simulation that raises child care pension benefits moderately. The findings show that mothers retire only slightly earlier, by about two and a half months. The simulated expansions of child care pension benefits also affect the distribution of maternal pension payments. It increases average annual pension payments from €8,560 to €9,630. However, compared to childless women, pension payments of affected mothers are still considerably lower.

The first three chapters are interconnected since they all focus on behavioral responses to child care pension benefits: Employment, old-age savings and retirement. The political goal of child care pension benefits is to compensate mothers for periods of child care that precluded employment by increasing their individual old-age income. Strong behavioral responses of mothers could lower their old-age income. Considering the findings from the different chapters together, child care pension benefits do neither affect maternal employment nor family old-age savings. These findings are in line with two potential explanations: Mothers do either not consider economic incentives in their decision or they heavily discount future income. When we focus on retirement, the empirical findings show that mothers hardly retire earlier in response to a reasonable increase in child care pension benefits.

Hence, from a political perspective child care pension benefits are one measure

to increase maternal old-age income, since they increase pension wealth without causing considerable behavioral reactions. Nevertheless, average monthly pension payments of mothers are still considerably lower - after simulating a moderate increase of child care pension benefits - compared to those of childless women. Therefore, solely child care pension benefits cannot provide an individual old-age income of mothers that secures reasonable living conditions. In the lights of changing family patterns, separations and non-married couples being more common, it becomes increasingly important to secure old-age income through individual pension entitlements. Because the main reason for these pension gaps are child-birth related career breaks, policy makers should support policies that promote maternal (full time) employment without long employment interruptions. Providing more public child care and reducing labor market entry barriers for mothers, such as joint taxation in Germany (Steiner and Wrohlich, 2004), are potential options.

In contrast to the previous three chapters of the dissertation, in chapter 4 we focus not on pension wealth but on the distribution of total wealth. However, since it is difficult to measure, survey data provides often only information on private wealth, excluding pension wealth. Augmenting survey information with pension wealth can substantially affect the distribution and explain cross-country differences (Feldstein, 1976).[6]

Rising inequality in income and wealth is increasingly gaining attention, both in the public debate and in academic research. The book by Piketty (2014) spurred many researchers to shed more light on the causes and consequences of inequality. However, the main difficulty in the analysis of inequality in the wealth distribution

[6]Rasner et al. (2011) show for Germany that augmenting survey wealth data with pension wealth substantially reduces inequality measures.

is the lack of good data. Survey data typically suffers from non-response bias.[7] Even if very rich households are selected into the sample of a survey, they are less likely to respond to a questionnaire (Vermeulen, 2014). In chapter 4, we use survey data from the Household Finance and Consumption Survey (HFCS) that provides household information on income and wealth for most Euro-zone countries. However, one way to better capture the missing rich is to estimate the top of the wealth distribution by relying on functional form assumptions on the shape of the top tail distribution (Vermeulen, 2014; Bach et al., 2014). Assuming that the top tail is Pareto-distributed, we estimate the shape parameters and replace it by an imputed tail based on the Pareto distribution. More precisely, we estimate the Pareto distribution of the top tail of the wealth distribution relying not only on the HFCS but also on national rich lists (e.g. for Germany, we rely on the *manager magazine* list (Manager magazin, 2011)). While being contentious, national rich lists are the only source that provides information about the wealth concentration in the very top. In Germany, the impact of correcting for the missing rich is very large: The top percentile share of household wealth jumps up from 24 percent in HFCS to 33 percent after performing the top wealth imputation. The Gini-coefficient increases from 0.75 to 0.78. For France and Spain, we find only a small effect of the imputation since rich households are better represented in the survey. The resulting database can be used for detailed distribution analysis or micro-simulation studies. For Germany, we used the adjusted wealth distribution in micro-simulation analysis to quantify the impact of an inheritance tax (Bach and Thiemann, 2016a) and a wealth tax (Bach and Thiemann, 2016b).

[7]Potential alternative data sources are: wealth information based on national aggregates or administrative wealth tax data. While macro data is not suitable for distributional analysis, information on wealth or estate taxation is problematic as well due to selectivity caused by tax rules.

Chapter 1

Pension wealth and maternal employment: Evidence from a reform of the German child care pension benefit[1]

1.1 Introduction

Child birth causes a natural interruption of employment of mothers. In the months following child birth many mothers focus on child care while dedicating less time to paid work (cf. Schönberg and Ludsteck (2014)). These employment interruptions reduce paid pension contributions and, ultimately, increase the risk of old-age poverty among mothers. In order to mitigate this risk, Germany introduced the

[1] A similar version of this chapter has been published as a *DIW Discussion Paper*, see Thiemann (2015). Furthermore, I have been invited to revise and resubmit the paper for publication in the *Journal of Pension Economics and Finance*.

child care pension benefit in 1986. Since then, the benefit increases a mother's pension entitlements in compensation for periods when child care precluded work. However, despite the positive impact on old-age income, the child care pension benefit introduces negative work incentives to mothers. Mothers whose pension entitlements are already higher through benefit accrual, do not have to become employed in order to accumulate the same amount of pension entitlements through compulsory pension contributions. Furthermore, pension entitlements from employment were withdrawn against those based on the child care pension benefit in the first decade after its introduction. A large employment reduction due to the benefit provision would counteract the intended positive impact of the child care pension benefit on old-age income of mothers.

This paper tests whether mothers react to an increase in pension wealth by reducing employment based on administrative data. Exploiting an extension of the child care pension benefit in 1992 as a natural experiment, I estimate short- and medium-run employment effects. Looking at early employment responses is particularly important, as the length of employment interruptions paves the way for the individual long-term earnings potential. An extended absenteeism from the labor market generally lowers a mother's lifetime earnings through human capital depreciation and lower accumulated work experience (Shapiro and Mott, 1994; Mincer and Ofek, 1982; Albrecht et al., 1999).

The identification strategy exploits the pension reform in 1992 in a regression discontinuity design. The reform prolonged the provision period of the child care pension benefit from one to three years for all newborns starting from January 1992. The implied economic gain for a 30-years old mother amounts up to €2,500,

in net present values.[2] However, in 1992 not only the child care pension benefit but also parental leave was extended, affecting maternal employment as well. Parental leave increased from 18 to 36 months for the same newborns from January 1992. Therefore, this paper has to disentangle the employment effect of the extended child care pension benefit from the parental leave extension. Schönberg and Ludsteck (2014) investigated how mothers changed their employment in response to the parental leave extension in 1992, finding a short-run employment reduction. To disentangle the effects of the two reforms, I focus on mothers who were not employed three months prior to giving birth. This group of mothers was only affected by the longer provision of the child care pension benefit. Then, I compare the employment behavior of mothers who had a child in the last months of 1991 - subject to the old child care pension benefit regulation - to those who had a child early in 1992 - benefiting from the extended benefit duration - to identify the causal short- and medium-run employment response of mothers to the child care pension benefit.

Most family benefits and transfers in Germany become effective shortly after child birth. Among them the child allowance (*Kindergeld*) is a prime example.[3] Parents are entitled upon child birth and it is generally granted until a child turns 18 years old, without means-testing. Rainer et al. (2012) analyzed the impact of the child allowance on maternal employment. They find that the child allowance tends to reduce maternal employment, particularly among mothers with a low earnings po-

[2]The calculation assumes retirement at 65 and death at 83 and compares the economic consequences of having a child in January 1992 compared to December 1991. Appendix 1.7 provides the details.

[3]In 2013 the child allowance amounted to EUR 184 for the first and second child, EUR 190 for the fourth and EUR 215 for each subsequent child. (`http://www.arbeitsagentur.de/web/content/DE/BuergerinnenUndBuerger/FamilieundKinder/KindergeldKinderzuschlag/Detail/index.htm?dfContentId=L6019022DSTBAI486116`).

tential.

In contrast to most family benefits and transfers, the child care pension benefit, however, becomes effective at the verge of retirement and not when it is accrued. Hence, a mother's employment response to these dynamic incentives depends on her discounting behavior. Imagine a rational forward-looking young mother, she would fully consider the impact of the child care pension benefit on old-age income in her decision to re-enter employment after child birth. However, a mother with a short planning horizon or a high personal discount factor is less affected by the child care pension benefit.

The results of the paper can be summarized as follows: The empirical findings suggest that the change in pension wealth does not affect maternal employment, which is not in line with a forward looking rational behavior. Therefore, the child care pension benefit increases maternal old-age income without causing negative employment reactions. The remainder of the paper proceeds as follows: The next section introduces the institutional background of the pension reform. Then, the economic incentives are explained in detail. Section 1.4 presents the identification strategy. Next, the data set is described and the empirical results are discussed. The final section concludes.

1.2 Related literature

Different strands of literature are related to this paper. First, it is linked to the literature that looks at the impact of family policies on mothers' employment. As examples of family policies, I focus on parental leave and child care policies. However, since the timing of when the benefit becomes effective differs from most family policies, the second part of this literature review focuses on individual re-

sponses to the public pension system and discounting behavior.

Parental leave and maternal employment

A cross-country study by Ruhm (1998) finds that a moderate parental leave duration is associated with a stronger labor market attachment of mothers. Several studies report only weak or no significant effects of parental leave on maternal employment (Baum and Charles, 2003; Klerman and Leibowitz, 1999; Waldfogel, 1999). However, they focus on the US maternity leave scheme, which exhibits a rather short provision period compared to parental leave durations in other Western countries. Studies find indeed that mothers tend to adjust their employment behavior when (paid) parental leave is provided (Lalive and Zweimüller, 2009; Lalive et al., 2014; Bergemann and Riphahn, 2010; Kluve and Tamm, 2009; Geyer et al., 2014; Schönberg and Ludsteck, 2014).

Lalive and Zweimüller (2009) exploit two subsequent parental leave reforms in Austria as natural experiments. They find that an extension of the parental leave duration reduces substantially short-run labor supply of mothers. In the long-run, however, the longer absenteeism from the labor market does not seem to harm employment and earnings of mothers. Lalive et al. (2014) show that a combination of job-protection and cash benefits is most effective to encourage mothers in returning to the labor market after childbirth.

In Germany, several studies exploit the parental leave reform in 2007 that halved the duration of paid parental leave while substantially increasing the cash benefit. Bergemann and Riphahn (2010) and Kluve and Tamm (2009) exploit it as a natural experiment and find that the parental leave reform increased the mother's willingness to (re-)enter employment in the second year after child birth. Geyer et al. (2014) document an employment reduction of mothers in the first year after

child birth due to the parental leave reform in 2007. In the second year, however, only certain subgroups of mothers (low-income and East-Germans) increased employment.

For the identification strategy that I apply in this paper the work by Schönberg and Ludsteck (2014) and Dustmann and Schönberg (2011) is most related. They evaluate the impact of several major expansions in parental leave coverage in Germany between 1973 and 1993 on mothers' labor market outcomes as natural experiments. Overall, they find that mothers respond to extensions of parental leave by reducing labor supply in the short-run, but not in the long-run. Dustmann and Schönberg (2011) document that these parental leave expansions did not improve long-run outcomes of children. The extension of parental leave from 18 to 36 months in 1992 is particularly relevant for this paper as both, the extension of parental leave and of the child care pension benefit, became effective simultaneously in January 1992. Schönberg and Ludsteck (2014) find that mothers substantially reduced labor supply in the short-run in response to this parental leave expansion in 1992.

Child care policies and maternal employment

A large body of literature investigates the impact of child care provision on maternal employment. Summaries of empirical studies are provided by Anderson and Levine (1999), Blau and Currie (2006) and Blau and Tekin (2007). The first set of studies relies on structural models (Guner et al., 2014; Geyer et al., 2014; Haan and Wrohlich, 2011). For the United States, Guner et al. (2014) find that a hypothetical fully subsidized provision of child care to all households would substantially increase participation rates among married females by 10 percent. For Germany, Haan and Wrohlich (2011) find that higher subsidized child care, conditional on employment, increases maternal employment.

The main difficulty in the identification of employment effects is the endogeneity of child care. Many studies rely therefore on quasi-experimental approaches, mainly the difference-in-difference method, often exploiting an expansion of subsidized child care as a natural experiment (Havnes and Mogstad, 2011; Cascio, 2009; Bauernschuster and Schlotter, 2013; Givord and Marbot, 2013; Nollenberger and Rodriguez-Planas, 2011; Bettendorf et al., 2012; Lefebvre et al., 2009; Lundin et al., 2008; Fitzpatrick, 2010). Cascio (2009) exploits the large expansion of kindergarten seats for five-year old children, offered by public schools since the mid 1960s in the US, as a natural experiment. He finds that single mothers substantially increased their labor supply, while married mothers did not respond. In a similar vein, Havnes and Mogstad (2011) rely on large expansion of subsidized childcare in Norway. Estimating employment responses, they exploit spatial and temporal variation on the municipality level. Their empirical analysis is conducted using administrative data that covers the entire Norwegian population over the relevant period. In contrast to the previous study, however, they find only little empirical support for the hypothesis that subsidized childcare increases maternal employment. Finally, a recent German study exploits the introduction of the legal claim to a place in kindergarten for three- to six-year old children in 1996 in West Germany to estimate the effect on maternal employment (Bauernschuster and Schlotter, 2013). Results from two different quasi-experimental approaches consistently document large positive effects on employment among mothers whose youngest child is three to four years old.

To sum up, there is substantial evidence on how maternal employment is affected by parental leave and child care policies. The degree of the employment response of mothers to family policies depends on the financial incentives and the institu-

tional design. However, since the timing of becoming effective of the child care pension benefit differs to most family benefits, the extend to which mothers adjust employment to the pension benefit remains an empirical question.

Public pension system and individual decisions

Next, this paper relates to the literature that investigates the impact of public pension systems on individual behavior. Gruber and Wise (2002) summarize the results from a large international cross-country research project based on micro-data. The authors emphasize that the provision of social security programs is a key determinant of the retirement decision.

The link between social security wealth and retirement has been investigated for Germany (Berkel and Börsch-Supan (2004); Geyer and Steiner (2014); Hanel (2010)). Applying an option value model, Berkel and Börsch-Supan (2004) simulate individual retirement responses to various pension reform options in Germany. They predict that the introduction of an early-retirement disincentive in 1992, a reduction of pension payments by about 3.6 percent for each year of early retirement, delays effective retirement by almost two years among men. Hanel (2010) exploits the implementation of the adjustment factors in 1992 as a natural experiment when estimating its long-term impact on retirement. In line with the previous paper, she finds that individuals notably retire later.

Overall, the literature shows the link between the provision of public pensions and the individual retirement decision. However, there is little evidence on the impact of the pension system on employment when being younger. This paper adds to this literature by analyzing the impact of a pension benefit on the employment decision of young mothers.

Finally, the extent to which changes in social security wealth affect the behavior of

individuals depends on the individual adjustment horizon. Gale (1998) emphasize the importance of the remaining adjustment period until retirement, when estimating the savings response to a change in social security wealth. A young worker has, on average, more time to adjust individual savings to the change in social security wealth, compared to a 60-years-old. Further, the planning horizon as well as the individual discounting behavior determines the extend to which individuals react to changes in social security wealth. Gustman and Steinmeier (2005) incorporate individual-specific time preferences in their model of retirement and saving in order to obtain a better representation of actual individual behavior. Further, individual discount rates tend to decline when education increases. To sum up, these studies document that the extend to which individuals respond to changes in their social security wealth depends *inter alia* on individual discounting.

1.3 Institutional background

1.3.1 Child care pension benefits

This section describes the accumulation of pension entitlements in the German pension system (GRV) and further introduces the institutional setting of the child care pension benefit. The GRV links the amount of pension payments to the value of a pensioner's accumulated pension contributions over working life. Pension payments are calculated based on a formula that incorporates accumulated pension contributions, the timing of retirement, an adjustment factor and the current value of pension contributions. The formula that calculates the pension benefits is described in detail by Börsch-Supan and Wilke (2004). The main determinant of pension payments is the sum of individual accumulated pension points *(Entgelt-*

punkte). One pension point represents annual pension contributions made by a reference contributor earning the average income. Upon retirement, one pension point corresponds to pension payments of €28 per month (West-Germany, July 2012 values).[4] The monetary equivalent of a pension point is adjusted each year according to change of average gross earnings and several adjustment factors. Faik and Köhler-Rama (2009) describe the adjustment mechanism in detail.

Table 1.1: Child care pension benefit in the German pension system 1986-1999

Reform	Child care pension benefit (maximum benefit)	Duration
1986	0.75 pension points (PP)	1 year
1992	0.75 PP	3 years
1999	1PP + additivity against pension from employment	3 years

Source: Own illustration.

After this brief introduction into the German pension system, we focus on the child care pension benefit. Table 1.1 depicts the development of the child care pension benefit from its introduction in 1986 til 1999. In general, child care pension benefits can be regarded as pension contributions in periods of child care that are made by the State. Hence, the child care pension benefit increases total pension entitlements of recipients. From 1986 till 1992, mothers accrued a maxi-

[4] `http://www.deutsche-rentenversicherung.de/cae/servlet/contentblob/238644/publicationFile/52076/aktuelle_daten_2013.pdf`

mum of 0.75 pension points in the first year following child birth.[5] However, the benefit was granted conditional on employment. In particular, pension contributions stemming from child care periods were fully withdrawn against compulsory contributions from employment. Accordingly, an employed mother with earnings equivalent to 50 percent of the average only received 0.25 pension points due to the child care pension benefit. The remaining 0.5 pension points were withdrawn against the compulsory pension contributions from employment. Therefore, a mother only gained from the child care pension benefit if she was either not employed or if she earned less than 75 percent of the average (corresponding to 0.75 pension points) in the first year after child birth.

The first change of the child care pension benefit was adopted in December 1989[6] and implemented two years later in January 1992. The reform tripled the child care pension benefit duration from one to three years, but only for newborns born on or after January 1, 1992. Hence, women with a child meeting this condition were entitled to the maximum benefit of 2.25 pension points (three years x 0.75 pension points) instead of 0.75 pension points, granted for births on or before December 31, 1991. Converted into pecuniary values of 2012, the maximum gain of 1.5 additional pension points results in a monthly payment of €42 upon retirement til death. As an example, the maximum gain from the reform of a mother, aged 30 years in January 1992, amounts to €2640 (expressed in 2012 net present discounted values). The underlying calculation assumes that the mother retires at the age of 65 with a life expectancy of 83 years, based on a discount rate of three percent (details are provided in Appendix 1.7). Since pension contributions

[5]The benefit was only granted to mothers born after 1921. In principle, also fathers are entitled. However, predominantly mothers are recipients of the child care pension benefit.

[6] by the Pension Reform Law 1992 *(Rentenreformgesetz 1992)*.

stemming from employment were still offset against those from child care pension benefits, mothers were only entitled to the full child care pension benefit if they were not being employed in the three years after child birth.

Since subsequent reforms changed the incentives for all mothers, regardless of a child's date of birth, I use only the variation that is implied by the child care pension benefit reform of 1992. Therefore, only the time period before 1999 is considered in the empirical analysis. This allows to study the short- and medium-run employment effects of the child care pension benefit extension in 1992. Nevertheless, the 1999 reform of the child care pension benefit, described here, consisted of two main changes: First, it increased the generosity of the child care pension benefit from 0.75 to one pension point. Second, it removed the employment penalty. Pension contributions from employment were not withdrawn anymore against those from child care periods if the sum of both did not exceed the contributions based on the contribution ceiling.

1.3.2 Economic incentives

This section illustrates by a simple example how the extension of the child raising pension benefit in 1992 affects the employment decision of mothers. In general, the degree to which mothers consider the economic incentives in their employment decision depends on the individual discounting behavior. While mothers with a high discount rate or a short decision-making horizon are less prone to react to the benefit provision, perfectly rational mothers would fully incorporate the future implications of the pension benefit. In principle, the extension of child care pension benefits from one to three years in 1992 lowered the incentives for mothers to (re-)enter the labor market during the three years following child birth.

Since pension contributions are accumulated through child care pension benefits, no compulsory pension contributions - resulting from employment - had to be made. To illustrate the economic incentives, let us consider the following example of two young mothers: While the first mother (A) has her child in December 1991, the second mother (B) has her child in January 1992. In addition, I assume that only the accrual of pension contributions matters for a mother's employment decision. Then, mother B has no incentive to (re-)enter employment in year two and three after child-birth if she would earn less than 75 percent of the average since those pension contributions would be fully withdrawn. In contrast, mother A faces positive work incentives in that period because child care pension benefits expire after the first year. The accrual of pension entitlements is clearly not the only determinant of a mother's employment decision. Nevertheless, this example illustrates that a mother who did not benefit from the child care pension benefit extension has an incentive to return earlier into employment.

1.4 Identification

This paper analyzes the impact of an extension of the child care pension benefit on mothers' employment in a regression discontinuity design. The identification exploits the specific design of the pension reform in 1992. In order to identify the reform effect, I construct two groups. The control group consists of mothers who had a child shortly before the policy change was implemented (in 1991 Q4). These mothers are entitled to one year of child care pension benefits. The treatment group is based on mothers who had a child shortly after the implementation of the reform (in 1992 Q1) and thus they are entitled to three years of child care

pension benefits. Comparing mothers who had a child close[7] to this cut off date January 1, 1992, the only institutional discontinuity between the treatment and control groups is the different duration of child care pension benefits. In this way, a difference in the employment behavior across both groups can be attributed to the longer duration of the child care pension benefit. In comparison with other 'typical natural experiment strategies' (e.g. differences-in-differences or instrumental variables), the regression discontinuity design requires only mild assumptions and isolates 'treatment variation that is as good as randomized' (Lee and Lemieux, 2010, p. 282). In recent years, economists increasingly adopted the regression discontinuity design to a broad range of economic problems.[8] This paper analyzes the employment response of mothers to the extension of child care pension benefits. Therefore, the dependent variable is the binary employment status. A mother can either be employed (one) or not (zero). The corresponding probit model is defined as follows:[9]

$$Pr(employed_{it}) = \Phi(\alpha + \beta_1 post_i + \gamma' X_{it}) \tag{1.2}$$

where Φ is the cumulative distribution function of the standard normal distribution, i indicates the mother and t the age of a child. *post* is one if a mother is in

[7] In the baseline specification 'close to the cut-off date' refers to having a child in the last quarter 1991 vs. the first quarter 1992. As a robustness check, however, I expand the the bandwidth to ± six months.

[8] Angrist and Lavy (1999) apply the identification strategy in estimating the impact of class size on student test scores in Israel. Oreopoulos (2006) estimates the returns to education by exploiting the design of a compulsory schooling law in the UK. Geyer et al. (2014) estimate the impact of the German parental leave reform 2007 on maternal employment using a regression discontinuity strategy. An overview of the application of regression discontinuity designs to economic problems is given by Lee and Lemieux (2010).

[9] The OLS model is specified analogously by

$$Employed_{it} = \alpha_0 + \phi post_i + \gamma' X_{it} + e_{it} \tag{1.1}$$

where the variables are defined as in the probit model and e captures the error term.

the treatment group, and zero if she is in the control group. X is a vector of control variables: *Age, age*^{2}*, education, region, number of children, prior employment* and *German nationality*. On the basis of β_1 the marginal effect, that captures the impact of the child care pension benefit extension in 1992, can be calculated. Since mothers are observed in the entire period following child birth, the model can be estimated for the identical sample at various points in time. In the following, it is estimated at a child age of 18, 28, 36, 60 and 120 months. Estimating the model conditional on child age ensures that at month t all mothers had been entitled to t months of child care pension benefits, regardless of the calender month.

For assigning mothers into treatment and control groups conditional on their child's birth date, the crucial prerequisite is that other pension reforms were dependent on the mother's and not the child's date of birth. Therefore, other pension reforms would have affected mothers in both groups in the same way. Further, only mothers who gave birth to their last child are considered since subsequent births naturally would reduce a mother's propensity to (re-)enter employment. Then, to disentangle the impact of the child care pension benefit reform on maternal employment from the parental leave reform, I only consider mothers who were not employed three months prior to child birth. In general they cannot benefit from parental leave, since there is no pre-child birth employment they could return to. However, theoretically a mother could have been entitled to prolonged parental leave from an earlier child birth if she had given birth to the subsequent child within 18 months. To ensure that the results are not confounded, I re-estimate the model based on a sample of mothers who had a child in 1991Q4 or 1992Q1, but not in the 18 months before. To sum up, the baseline sample is based on mothers who had their last child in 1991Q4 or in 1992Q1 and who were not employed three

months prior to child birth.

The identification strategy is only valid if a mother cannot self-select into the treatment group by strategically choosing her child's date of birth. Mothers principally have an incentive to self-select into the treatment group to take advantage of the longer benefit provision. Since the child care pension benefit extension was adopted by the parliament in December 1989 two years before becoming effective, parents theoretically could self-select into the treatment group by strategically choosing 1992 instead of 1991 as their child's year of birth. The literature documents a strategic timing of births for several policy changes (Neugart and Ohlsson, 2013; Gans and Leigh, 2009; Tamm, 2012). Nevertheless, a child's birth date can only partially be controlled by parents. Ekberg et al. (2013) emphasize that birth, as such, is a 'random event', since parents cannot completely control the timing of conception. The duration of pregnancy follows a normal distribution of 40 weeks and a standard deviation of two weeks (Ekberg et al., 2013, p. 135). In addition, parents who strategically chose 1992 as a child's year of birth, most likely prefer a birth date not in the first quarter to prevent the risk of having a premature baby in 1991. However, it might still be possible that particularly around the cut-off date (1/1/1992) births have been postponed. In order to address that concern, Dustmann and Schönberg (2008, Appendix A) analyze the timing of births shortly around the turn of the year 1991/92. They find no evidence that there has been a strategic timing of births around the turn of the year 1991/92. As an additional robustness check, I exclude births in January and December from the sample and re-estimate the model.[10] Further, I compare the total number of births around (± six months) the turn of the year 1991/92 with the two subsequent years,

[10]The results are in documented in section 1.5.4.

without finding a strategic timing of birth behavior. The results are described in detail in Appendix 1.7. Furthermore, to check for random selection into treatment and control group, I investigate if the distribution of observable characteristics differs across both groups. This is the standard test in empirical work to check for random assignment of individuals into treatment and control groups (Lee and Lemieux, 2010, p. 296). The descriptive comparison of observable characteristics, in section 1.5.2, shows a similar distribution across both groups. This provides evidence against a non-random selection of mothers into the treatment and control groups.

The identification strategy implicitly assumes that mothers are aware of the extension of the child care pension benefit. It is an assumption inherent in all quasi-experimental designs that evaluate the impact of policy changes on individual behavior. I have anecdotal evidence that the German Pension Insurance increased substantially their effort to inform about the child care pension benefit extension in 1992 by publishing brochures and providing information to the media.

1.5 Data and results

Next, this section describes the data and sample selection followed by the discussion of results.

1.5.1 Data

This paper relies on the administrative Biographical Data of Social Insurance Agencies in Germany (BASiD, version 1951-2009).[11] The data results from a linkage of two administrative data sources from the Statutory Pension Insurance and the Federal Employment Agency. The two data sets are merged via the identical social security number that serves as the unique individual identifier (Hochfellner et al., 2012). First, a sample was selected from the Sample of Insured Persons and their Insurance Accounts (VSKT) 2007 of the German pension system. Then, this sample was enriched with individual information from the Federal Employment Agency. The joint data set provides spell information about the employment history for each individual on a daily level from the first entry until 2007. In addition, BASiD contains information about education[12], birth dates of children and several individual and work-related characteristics. However, for some individuals not all information is available. Mainly the educational degree is missing. About 35 percent of all mothers in the sample lack information about education. Therefore, the estimation results are displayed for specifications with and without covariates.

In comparison with other data sources, BASiD has several advantages. Survey data, e.g. the German Socio Economic Panel (GSOEP), is not applicable since the sample size would be too small to apply the regression discontinuity design. Most other administrative data sets are based on Social Security Records. Schönberg and Ludsteck (2014) rely on them in their evaluation of the parental leave expansion in 1992. While Social Security Records provide large samples of per-

[11] The weakly anonymized version of BASiD was accessed at the Data Research Center of the Federal Statistical Office in Berlin and provided by the Institute for Employment Research (IAB) in Nuremberg.

[12] In order to improve quality of the education variable, the imputation procedure, suggested by Fitzenberger et al. (2005), is applied.

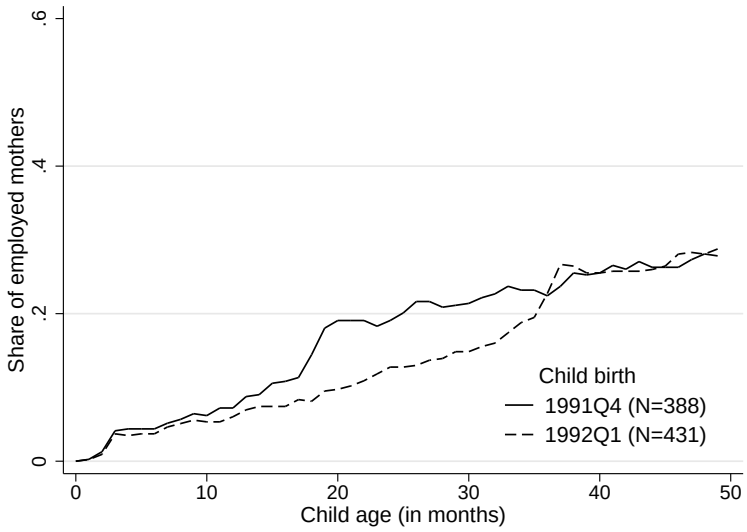
sons who were employed or searching for a job, they are less representative for mothers with a weaker link to the labor market. In particular, the correct child's birth date can only be deduced based on maternity leave usage (Schönberg and Ludsteck, 2014). Consequently, a mother who was not employed prior to having a child cannot be identified as a mother based on the Social Security Records. In contrast, since BASiD is based on a sample of the VSKT of the German pension system, a mother who was not employed prior to child birth or later is part of the sample. Hence, BASiD covers the large group of mothers with a weaker link to the labor market better than the Social Security Records.

The sample is based only on West-German mothers, since fertility dropped substantially in East Germany after the re-unification. Selective fertility in East Germany would be particularly problematic since the empirical analysis relies on births shortly after the German re-unification. Further, I exclude all mothers who are coded as miners and crafts-persons, who partially have separate pension funds. In addition, the sample relies only on 'validated' pension accounts. For these accounts, the self-declared information of the insured was cross-checked by the German pension Insurance to ensure its reliability. However, the share of 'non-validated' accounts is only 10 percent in BASiD. Finally, a mother is only selected into the sample if she was not younger than 18 and not older than 45 years at delivery. The baseline sample consists of 553 (328 when including covariates) mothers.

1.5.2 Descriptive evidence

This section provides first descriptive results and it further compares the distribution of observable characteristics across the treatment and the control groups. The

Figure 1-1: Maternal employment by child age, based on all mothers independent of pre-child birth employment (total sample)

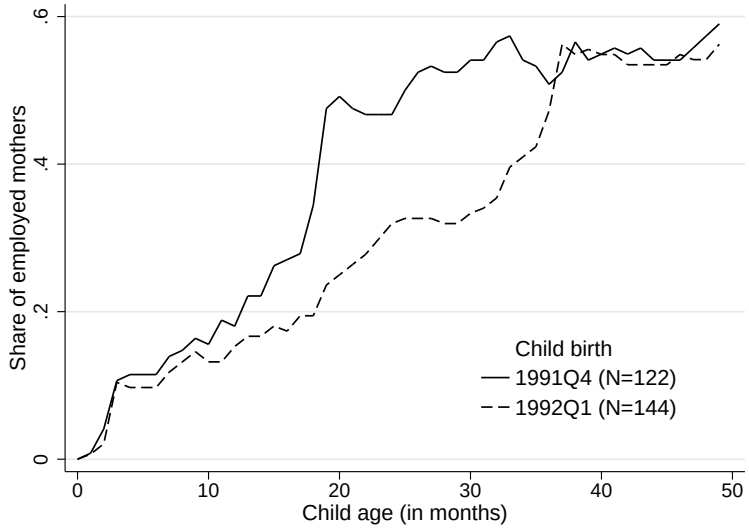


Data source: BASiD (version 1951-2009).

share of employed mothers is plotted by child age, separately for three different samples of mothers who had their last child in 1991Q4 or in 1992Q1. The first sample is based on all mothers independent of their employment status prior to child birth (total sample). The total sample can then be split up into mothers who were employed three months before child birth (employed sample) and mothers who were not employed three months before child birth (baseline sample). Within each of the three samples, the employment quota is plotted separately for mothers who had their child in 1991Q4 relative to mothers with a child birth in 1992Q1.

Figure 1-1 plots the employment pattern for the total sample by child age in months. Around child birth maternal employment is practically zero, since the German maternity leave regulation prohibits employment in the first eight weeks

Figure 1-2: Maternal employment by child age, based on mothers who were employed three months prior to child birth (employed sample)



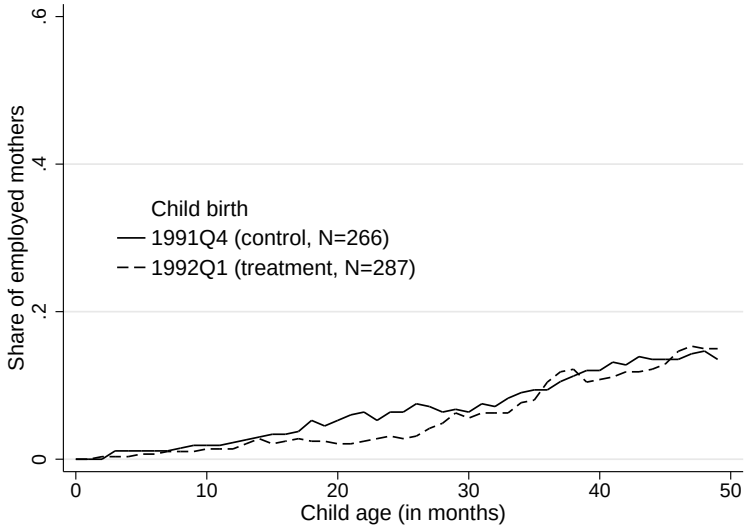
Data source: BASiD (version 1951-2009).

of a newborn. Then, the share of employed mothers increases steadily for all mothers to around 10 percent. However, from 15-18 months the quota increases strongly and remains higher until month 36 among mothers who had a child in 1991Q4 compared to mothers with a child birth in 1992Q1. This employment pattern is in line with the response to the parental leave extension in 1992 that was documented by Schönberg and Ludsteck (2014).[13] Mothers with a child birth in 1992Q1 who were employed prior to delivery could take advantage of the extension of parental leave from 18 to 36 months.

When restricting the total sample to employed mothers three months before child birth (employed sample) in Figure 1-2, the parental leave reform effect becomes

[13]In order to replicate their results based on BASiD, I re-estimate the model by Schönberg and Ludsteck (2014), obtaining similar results.The findings are in Table 1.11 in Appendix 1.7.

Figure 1-3: Maternal employment by child age, based on mothers who were not employed three months prior to child birth (baseline sample)



Data source: BASiD (version 1951-2009).

even more pronounced. Between month 15 to 36 the employment quota is substantially higher among mothers who had their last child in 1991Q4 relative to mothers with a child birth in 1992Q1. In the employed sample, all mothers who had a child in 1992Q1 relative to 1991Q4 gained from the parental leave extension, which indicates a stronger reaction to the parental leave reform. Overall, since mothers are selected conditional on being employed before child-birth, it is not surprising that the share of mothers in employment is generally higher and increases faster for all mothers than in the total sample. To sum up, this descriptive analysis of maternal employment in the total and the employed sample underlines the importance to separate the impact of the child care pension benefit extension on a mother's employment decision from the simultaneous parental leave reform.

Finally, Figure 1-3 plots the employment pattern for the treatment and control groups of the baseline sample. First of all, the share of employed mothers generally remains lower until month 50 than in the total- and the employed sample since only mothers who were not employed three months before child birth are selected into the baseline sample. The child care pension benefit extension in 1992 provides incentives to the treatment group to postpone the employment entry after child birth. The plot shows that the employment pattern is similar across treatment and control groups, independent of child age. Nevertheless, between month 17 and 29, mothers in the control group appear to be more likely to be employed than in the treatment group. But this difference is not statistically significant. Summing up, these descriptive findings provide first evidence against an employment response of mothers to the child care pension benefit extension in 1992.

In the next step, we focus on the distribution of observable characteristics across treatment and control groups in Table 1.2. If mothers are randomly assigned into treatment and control groups, then we would expect a similar distribution of covariates across both groups. While the first two columns compare the observable characteristics across both groups, the third column reports the corresponding mean difference. For all variables the mean difference is statistically insignificant, indicating a similar distribution across both groups. Mothers in both groups had been employed on average for about four years before the birth of their last child. Looking at nationality, the share of German mothers is similar in the treatment (73 percent) and in the control group (75 percent). Next, we focus on the distribution of education across both groups. Higher education indicates whether a mother holds a secondary, intermediate school leaving certificate with completed vocational training or a higher degree. While the share of mothers with higher

Table 1.2: Comparison of observable characteristics across treatment and control groups

	Treatment group (N=172)				Control group (N=156)				Diff.[a]
	Mean	SD	Min	Max	Mean	SD	Min	Max	
Prior employment (years)	3.77	3.83	0	14.1	3.72	3.8	0	22.	0.05
Mother's age at delivery	28.6	4.36	20	41	29.1	5.00	18	42	-0.5
Number of children	1.99	0.98	1	7	2.08	1.15	1	8	-0.09
German (0/1)	0.73		0	1	0.75		0	1	-0.02
Higher education (0/1)	0.15		0	1	0.13		0	1	0.02
Region									
North	0.15		0	1	0.15		0	1	0
Middle	0.47		0	1	0.55		0	1	-0.08
South	0.37		0	1	0.30		0	1	0.07

Notes: Mothers who had a child in 1991Q4 (control) or in 1992Q1 (treatment) are in the baseline sample. Higher education indicates a secondary, intermediate school leaving certificate with completed vocational training or a higher education level. Region captures the different regions of residence based on the states of residence: North (Schleswig-Holstein, Hamburg, Bremen, Lower Saxony), Middle (North Rhine-Westphalia) and South (Baden-Wuerttemberg and Bavaria).
a) For all variables the group difference is not statistically significant.
Data source: BASiD (version 1951-2009).

education is relatively low in both groups, it is slightly higher (15 percent) in the treatment than in the control group (13 percent). However, the difference is not statistically significant. Region is constructed based on the state of residence: North (Schleswig-Holstein, Hamburg, Bremen, Lower Saxony), Middle (North Rhine-Westphalia) and South (Baden-Wuerttemberg and Bavaria). While Region varies somewhat across both groups, the difference is statistically insignificant. In conclusion, mothers in the treatment and the control group share relatively similar observable characteristics.

1.5.3 Main estimation results

This section discusses the estimation results, which suggest that the child care pension benefit has no impact on maternal employment. I report estimates for the probit and the OLS model and differentiate by the inclusion of the control variables. Since all mothers in the sample are observed in the entire time span, I can estimate the model at different child ages, i.e. at 19, 28, 36, 60 and 120 months. Repeating the estimation at different points in time allows for the distinction between short- and medium-run employment effects among mothers. Table 1.3 reports the treatment estimates that refer to the impact of the child care pension benefit extension in 1992 on mothers' employment. While the OLS model reports the estimated treatment coefficient, the Probit model shows the average marginal effect. The complete estimation results, including estimates for controls are reported in Appendix 1.7 (Table 1.7 contains OLS results and Table 1.6 the results of the probit model). In the following, I focus only on specifications that include control variables.

Beginning at a child age of 19 months, the estimated treatment effect, taken at face value, implies a three percentage points reduction of the employment probability due to the extended provision of the child care pension benefit. In the light of the low employment share among mothers - when a child is 19 months old - a three percentage point increase would imply a large employment reduction. However, the estimated reform effect is statistically insignificant. Despite the limited sample size, the standard errors are still moderate. Next, after the child turns 28 months old, the point estimate is virtually zero. However, the standard error is still very high, indicating an imprecise estimate. After the child turns three and five years old the point estimates become relatively large and positive, which is not in line

Table 1.3: Estimated employment response of mothers to the child care pension benefit expansion in 1992 (baseline sample)

Child age (in months)	19		28		36		60		120	
Probit	-0.0208	-0.0306	-0.0151	0.0025	0.0106	0.0417	-0.0054	0.0322	0.0040	-0.0105
	[0.0160]	[0.0235]	[0.0196]	[0.0262]	[0.0255]	[0.0350]	[0.0317]	[0.0406]	[0.0420]	[0.0537]
OLS	-0.0207	-0.0322	-0.0151	0.0021	0.0105	0.0385	-0.0054	0.0326	0.0040	-0.0111
	[0.0157]	[0.0230]	[0.0197]	[0.0269]	[0.0255]	[0.0355]	[0.0318]	[0.0410]	[0.0421]	[0.0540]
Controls		✓		✓		✓		✓		✓
N	553	328	553	328	553	328	553	328	553	328

Note: The table reports the estimated impact of the child care pension benefit expansion on mothers' employment; While the Probit row reports the estimated average marginal effect, the OLS row shows the estimated coefficient. The baseline sample consists of mothers who had their last child in 1991Q4 or 1992Q1, while not being employed three months prior to child birth. */**/*** Statistically significant at the 10%/5%/1%-level. The standard error is reported in brackets.

Data source: BASiD (version, 1951-2009).

with our initial hypothesis. This would imply that mothers who face negative employment incentives are more likely to become employed. But, the estimates remain statistically insignificant, based on moderate standard errors. Ten years after childbirth, the estimates are again close to zero and statistically insignificant. As expected, at all different child ages estimates based on the Probit and the OLS model are very similar. While the exclusion of control variables influences the size of the point estimate somewhat, the general results are stable. Considering these empirical findings jointly, mothers do not respond to the child care pension benefit extension in 1992 neither in the short- nor in the medium-run.

Why did mothers not react to the negative employment incentives, implied by the extension of the child care pension benefit? There are two potential channels that could explain such a behavior: A high discount factor and a short planning horizon. First, a mother with a high discount factor faces a much smaller gain from the child care pension benefit extension in 1992 compared to a mother with a low discount factor. For her, the 'treatment' was simply to small in magnitude. Secondly, a mother with a short planning horizon would just not consider the dynamic impact of today's employment decision on future old-age income since her planning horizon does not cover the period when the pension benefit becomes effective.

1.5.4 Robustness checks

Next, Table 1.4 shows the findings from several robustness checks. For brevity reasons, only estimates of the treatment effect are reported for specifications that include control variables. Detailed estimation results for all separate robustness checks are documented in the Appendix. Summarizing the results, none of the

specification tests provides empirical evidence against the previous findings that the child care pension benefit does not affect a mother's employment decision in the short- or medium-run.

Bandwidth variation

First, not finding statistically significant treatment effects could potentially be driven by the small number of observations. In the baseline model, the treatment and control group consist of mothers who had a child ± three months around the cut-off-date January 1, 1992. While it is well known that a larger sample increases efficiency, comparing mothers who gave birth to their last child further away from the cut-off date of the reform (1/1/1992) is less desirable. Those mothers are more likely to differ in more dimensions than in the child care pension benefit scheme. Nevertheless, for the purpose of this robustness check a range of two quarters around the cut-off-date seems acceptable. Hence, mothers who gave birth to a child in the second half of 1991 (control group) are compared to all mothers who delivered a child in the first six months in 1992 (treatment group). A comparison of control variables across the new treatment and control group are provided by Table 1.5 in Appendix 1.7. The control variables are similarly distributed across both groups, indicating a random selection of mothers into the two groups. Panel B in Table 1.4 reports the reform effect estimates based on the larger sample. The sample size becomes twice as large as in the baseline specification, as depicted in panel A. Depending on child age, the point estimates differ from those that are based on the baseline sample. In line with the baseline sample and regardless of child age, they are never statistically significantly different from zero.

Strategic timing of child birth

Table 1.4: Estimated employment response of mothers to the child care pension benefit extension in 1992 (alternative samples)

Child age (in months)	19	28	36	60	120
A) Baseline sample					
Treatment	-0.0306	0.0025	0.0417	0.0322	-0.0105
	[0.0235]	[0.0262]	[0.0350]	[0.0406]	[0.0537]
N	328	328	328	328	328
B) Larger bandwidth (± 6 months)					
Treatment	-0.0194	-0.0067	0.0081	-0.0119	0.0121
	[0.0170]	[0.0209]	[0.0242]	[0.0288]	[0.0371]
N	690	690	690	690	690
C) Exclusion of births around cut-off					
Treatment	-0.0097	-0.0092	0.0102	-0.0120	0.0211
	[0.0287]	[0.0328]	[0.0429]	[0.0500]	[0.0643]
N	229	229	229	229	229
D) Control for seasonal differences					
Treatment	-0.0097	0.0152	0.0689	0.1410**	-0.0420
	[0.0327]	[0.0385]	[0.0460]	[0.0549]	[0.0760]
N	656	656	656	656	656
E) Parental leave reform sensitivity sample					
Treatment	-0.0088	0.0070	0.0125	0.0197	-0.0179
	[0.0220]	[0.0261]	[0.0351]	[0.0406]	[0.0593]
N	266	266	266	266	266
Controls	✓	✓	✓	✓	✓

Note: The treatment estimate refers to the average marginal effect, based on the probit model, depicted by equation 1.2. Only panel D) is based on difference-in-difference-regression-discontinuity probit model, depicted by equation 1.4. All specifications include control variables (German, number of children, education, age, age squared, region, prior employment) and a constant term. */**/*** Statistically significant at the 10%/5%/1%-level. The standard error is reported in brackets.
The different samples are all based on mothers who had their last child around the turn of the year 1991/92 and who were not employed three months before child birth (except panel E). The baseline sample A) consists of mothers who had a child in 1991Q4 or 1992Q1; B) is based on mothers with child birth in 1991H2 or 1992H1; C) is identical to A) while excluding births in December and January; D) is based on mothers who a child in 1991Q4 or 1992Q1 compared to mothers with a child in 1990Q4 or 1991Q1; E) is based on mothers who had a child in 1991Q4 or 1992Q1, but not in 1991Q1-1991Q3 nor in 1990.
Data source: BASiD (version, 1951-2009).

Next, I control for the potential strategic timing of a child's date of birth. Pregnant women who expected the delivery around the turn of the year 1991/92 could have tried to postpone child birth to the first week of January 1992. As mentioned before, Dustmann and Schönberg (2008, Appendix A) investigate the birth patterns around the turn of the year 1991/92 without detecting irregularities. Nevertheless, parents who expected a child birth around the turn of the year 1991/92 might have wished to postpone delivery from December 1991 to January 1992. Such a behavior would invalidate the identification strategy if parents who strategically choose the child's date of birth differed systematically in terms of the employment behavior from the remaining parents. To account for this potential bias, I follow the literature (Kluve and Tamm, 2009) and re-estimate the baseline model under the exclusion of mothers who had a child either in December 1991 or in January 1992. The treatment estimates are reported in Panel C of Table 1.4. The point estimates differ to those based on the baseline sample. However, regardless of child age in none of the five different estimations the estimated treatment effect is statistically significantly different from zero, as in the baseline model. Consequently, the potential strategic timing of births does not impose a risk to the identification strategy.

Seasonal systematic differences

There are concerns about potential systematic differences among mothers, depending on the birth season of their child (Buckles and Hungerman, 2008). To address this issue, mothers from the baseline sample are compared to mothers who had a child in the same period around the turn of the year before, 1990/91, when no child care pension benefit reform was implemented. Following the literature, I estimate the model that has already been applied by Lalive et al. (2014) or Schönberg and

Ludsteck (2014). This *difference-in-difference-regression-discontinuity* model can be formulated in the following way:

$$\begin{aligned} Pr(employed_{it}) = \Phi(\alpha + \beta_1 turn91/92_i + \beta_2 beginning_i + \\ \beta_3 turn9192_i * beginning_i \\ + \gamma' X_{it}) \end{aligned} \tag{1.3}$$

where i represents the mother and t child age in months. Φ is the cumulative distribution function of the standard normal distribution. As in the baseline model, *employed* indicates the maternal employment status, one being employed and zero not employed. *turn91/92* indicates whether a child was born around the turn of the year 1991/92 (one) or in the corresponding period the year before 1990/91 (zero). *beginning* equals to one if the child birth occurred in the first quarter of a year, and zero if a child was born in the last quarter. X captures the vector of control variables, as in the baseline model: *Age*, age^2*, education, region, number of children, prior employment and German nationality.* Panel D of Table 1.4 depicts the results. For brevity reasons it only reports the treatment effect estimate that correspond to the average marginal effect based on the interaction term $turn9192_i * beginning_i$. For all five different child ages, the point estimates have the same sign and broadly a similar magnitude as the results from the baseline sample. Further, in all (except at child age of 60 months) the estimated coefficients are not statistically significantly different from zero, as in the baseline model. The only exception is five years after child birth, when the estimated treatment effect is only weakly statistically significant. All in all, the results suggest that systematic differences among mothers according to the season of birth do not seem to impose a risk for the identification strategy.

Eligibility to parental leave

In order to disentangle the impact of the child care pension benefit extension in 1992 from the impact of the simultaneously implemented parental leave expansion, I only compare mothers who were not employed in the three months prior to child birth in the baseline sample. These mothers simply do not have an employer they could return to. However, if a mother had a second child, while being on parental leave, the eligibility for parental leave was extended. Prior to 1992, parental leave was generally granted for the first 18 months after child birth. Hence, having a child in these 18 months would generally extend parental leave entitlements by another 18 months upon the subsequent child birth. In order to control for this potential source of bias, I re-estimate the model, considering only mothers who had no child in 1990 (nor in 1991 if they belong to the treatment group). These mothers could not benefit from a potential extension of the eligibility for parental leave due giving birth to another child. The treatment estimates are reported in Panel E of Table 1.4. At all five different child ages, the point estimates share the same sign and a similar magnitude with the baseline sample. In addition, all estimates remain statistically insignificant. However, the lower sample size increases the standard errors somewhat. Nevertheless, these results indicate that the theoretical parental leave eligibility of mothers in the baseline sample is unlikely and therefore it does not impose a thread to the identification strategy.

1.6 Discussion and conclusion

In this paper, I estimate the effect of pension wealth on maternal employment in the period following child birth. For this purpose, I exploit a variation in pension wealth given by the extension of the German child care pension benefit in 1992 as

a natural experiment. Child care pension benefits generally increase a mother's pension entitlements in periods when child care precludes work.

The pension reform 1992 extended the provision period of the child care pension benefit from one to three years for all newborns, starting in January 1992. This reform design allows comparing the employment status of mothers who had a child in the last quarter 1991 to mothers who had a child in the first quarter 1992. While all mothers had a child around the turn of the year 1991/1992, only the latter group could take advantage of the longer provision period of the child care pension benefit. However, the child care pension benefit reform coincided with the extension of parental leave for child births from January 1992. To isolate the effect from the two reforms, I only compare mothers who were not employed three months prior to child birth. They are generally only affected by the change in child care pension benefits. While this strategy restricts the sample slightly, the findings are still representative for the large group of mothers with a weaker attachment to the labor market.

The results indicate that the child care pension benefit does not affect mothers' employment, neither in the short- nor in the medium-run. However, some caution has to be applied due to the limited sample size. The analysis of employment reactions to family benefits granted upon child birth is particularly important as the length of employment interruptions pave the way for the individual long-term earnings potential. Not finding negative employment reactions to higher pension wealth can therefore be deemed positive since it does not harm a mother's earnings perspective.

In addition, the findings can be interpreted as empirical evidence against rational behavior among mothers. A rational mother would have reduced her employment

in response to the economic incentives of the child care pension benefit. Potential explanations could be a large discount factor of future pension benefits or a short planning horizon.

Finally from a policy perspective, the empirical results are important. Child care pension benefits are designed to compensate mothers for pension entitlements that could not be accrued because periods of child care precluded employment. The empirical findings show that the child care pension benefit compensates mothers by increasing their old-age income without causing negative employment reactions in the short- and medium-run.

1.7 Appendix

Calculation of the net present value of the gain from the child care pension benefit extension in 1992

This section calculates the maximum gain from the child care pension benefit extension in 1992 for a reference mother in net present values (NPV) in 1992. It compares the monetary equivalent of the child care pension benefit at retirement of a mother who has a child shortly after the date of reform implementation, i.e. after January 1, 1992 to having the child shortly before that date, e.g. in December 1991. The calculation is based on the following scenario:

- The legal framework that was in place in 1992.
- A mother is entitled to old-age pension.
- She is 30 years old at the date of child birth.

- She retires at the age of 65.
- Her life expectancy is set to 83 years.[14]
- The discount rate z is set to 0.03.
- The maximum gain from the reform in pension points is 1.5 per month. In 2012, a pension point translates into EUR 28 per month. Hence the annual gain, in 2012 values, is EUR 28 * 1.5 *12 = EUR 504.

$$NPV_{reformgain} = \frac{504}{(1+z)^{35}} + \frac{504}{(1+z)^{36}} + ... + \frac{504}{(1+z)^{53}} = \sum_{t=35}^{53} \frac{504}{(1+z)^t} = 2,642.5[EUR]$$

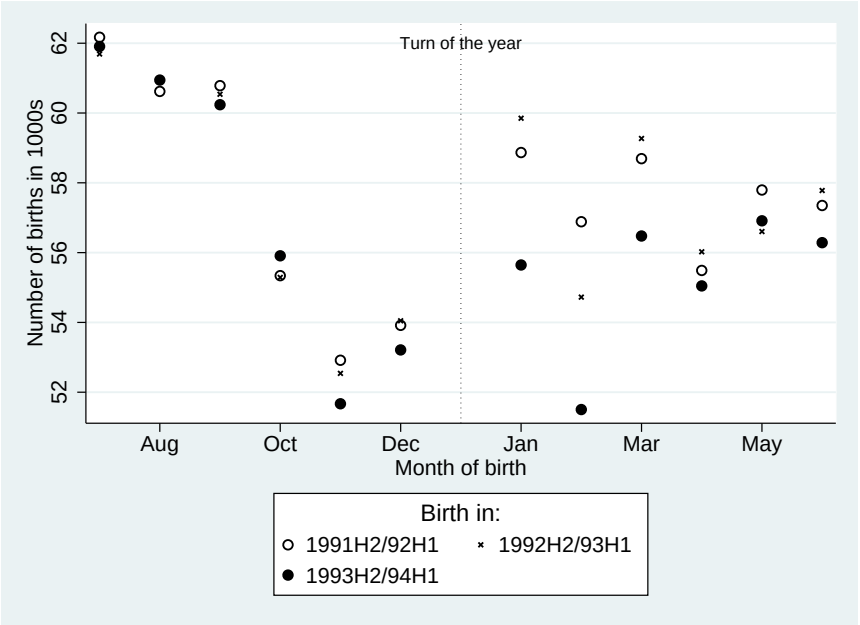
The maximum gain due to the child care pension benefit extension is EUR 2,643.

[14] According to calculations of the Federal Statistical Office, life expectancy of a women born in 1969 amounts to 83 - 84 years (`https://www.destatis.de/DE/ZahlenFakten/GesellschaftStaat/Bevoelkerung/Sterbefaelle/Tabellen/ModellrechnungLebenserwartung.html`).

Did the child care pension benefit extension 1992 affect timing of births?

This section investigates birth patterns around (± 6 months) the extension of the child care pension benefit in 1992 and subsequent years. The reform provides incentives for parents to have a child after December 1991. If parents strongly respond to the reform by strategically adjusting the timing of child births, then we would expect to find such a behavior in the birth statistics. The following analysis compares the birth pattern between July 1991 and June 1994 based on the vital statistics 1991, 1992, 1993 and 1994. The data covers all registered births in West Germany. Figure 1-4 shows the absolute number of births per month. Parents who wanted to strategically select into the treatment group would prefer to have their child after December 1991. Hence, in the first series 1991H2/92H1 we would expect lower birth rates in the months before and higher rates after the turn of the year compared to the subsequent periods. Focusing on the second half-year 1991, the distribution of births per months is similar across the three years. This is also true for the first half-year 1992. Hence, the plot does not provide evidence for a systematic difference in the birth pattern across the period of analysis. However, the comparison based solely on the absolute number of births could lead to false conclusions if the total number of births differed substantially across the years. Hence, Figure 1-5 relates the number of monthly births to the period average. Accordingly, the y-axis reports the monthly share of total births in the period. In comparison, to Figure 1-4 the general pattern persists. The plot confirms the previous result. There is no evidence indicating that birth in 1991H2/92H1 differing systematically from the subsequent years. These findings are in line with Dustmann and Schönberg (2008). They, compare births shortly

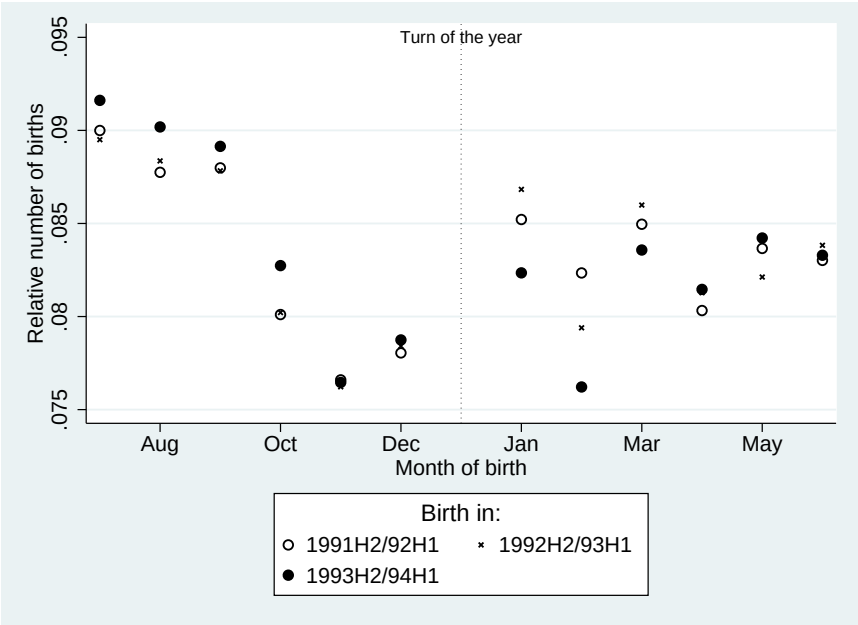
Figure 1-4: Number of births by month, July 1991 - June 1994



Notes: The data covers all births between July 1991 and June 1994 in West Germany.
Data source: Vital statistics 1991, 1992, 1993 and 1994.

around the turn of the year 1991/92 based on vital statistics for the West German states Bavaria, Hesse, and Schleswig-Holstein.

Figure 1-5: Relative number of births by month, July 1991 - June 1994



Notes: The data covers all births between July 1991 and June 1994 in West Germany. Monthly number of births are divided by the group average.
Data source: Vital statistics 1991, 1992, 1993 and 1994.

Further descriptives

Table 1.5: Comparison of observable characteristics across treatment- and control group based on a larger bandwidth (births around January 1, 1992 ± 6 months)

	Treatment group (N=352)				Control Group (N=338)				Diff.[a]
	Mean	SD	Min	Max	Mean	SD	Min	Max	
Prior employment (years)	3.56	4.11	0	28	3.88	4.09	0	24	-0.32
Mother's age at delivery	28.7	5.20	18	43	28.3	4.84	19	44	0.40
German (0/1)	0.72		0	1	0.75		0	1	-0.03
Number of children	2.09	1.18	1	7	2.01	.99	1	8	0.08
Higher education (0/1)	0.13		0	1	0.15		0	1	-0.02
Region									
North (0/1)	0.16		0	1	0.20		0	1	-0.04
Middle (0/1)	0.49		0	1	0.45		0	1	0.04
South (0/1)	0.35		0	1	0.35		0	1	0.00

Notes: Only mothers who had their last child and who were not employed three months prior to child birth are part of the sample. The treatment group consists of mothers who had a child in 1992H1 and in the control group are mothers who had their child in 1991H2. Higher education indicates a secondary, intermediate school leaving certificate with completed vocational training or a higher education level. Region captures the different regions of residence based on the states of residence: North (Schleswig-Holstein, Hamburg, Bremen, Lower Saxony), Middle (North Rhine-Westphalia) and South (Baden-Wuerttemberg and Bavaria).
a) None of the variables is statistically significantly different across the two groups (95 %-level).
Data source: BASiD (version, 1951-2009).

Supplementary regression results

Re-estimation of the model of Schönberg and Ludsteck (2014)

In this section, I re-estimate the model of Schönberg and Ludsteck (2014, cf. Table 1, reform 4, p. 487) that evaluates the German parental leave extension from 18 to 36 months in 1992 using BASiD.[15] While the BASiD data set is relatively similar to the Social Security Records that Schönberg and Ludsteck (2014) use, there is a striking difference. The latter has a larger sample size of more than 200,000 mothers, while BASiD is substantially smaller. Despite that, the data sets are relatively similar since BASiD is constructed based on several administrative data sets, and the Social Security Records data is one of them (vom Berge et al., 2013; Hochfellner et al., 2012). If the estimation of the model based on BASiD leads to similar results, this would support the presumption that results based on BASiD are indeed comparable to empirical findings based on the Social Security Records. I follow Schönberg and Ludsteck (2014) and select mothers who had their last child in 1991Q4 or 1992Q1, respectively in 1990Q4 or 1991Q1 - independent on their pre-child birth employment status - into the sample. Table 1.11 reports the results. According the estimates based on BASiD, mothers have on average a 12 percentage points lower employment probability when a child is 19 months old, if

[15] Precisely, I re-estimate the following OLS model:

$$Pr(employed_{it}) = \delta_0 + \delta_1 turn91/92_i + \delta_2 beginning_i + \delta_3 turn9192_i * beginning_i + \eta' X_{it} + \epsilon_{it}. \quad (1.4)$$

where i indicates the mother and t child age in months. *turn91/92* indicates whether a child was born around the turn of the year 1991/92 (one) or in the corresponding period the year before 1990/91 (zero). *beginning* captures the impact of being born in the first quarter, in comparison to being born in the last quarter. X captures the same vector of control variables as in the baseline model, as described before. The interaction term $turn91/92 * beginning$ captures the impact of being affected by the parental leave expansion on maternal employment. ϵ is the error term.

they experience the extended parental leave duration. In comparison, Schönberg and Ludsteck (2014, Table 1, Reform 4, p. 487) obtain an estimate of about -10 percentage points. While, the standard errors are larger due to the smaller sample, the point estimates are broadly in line with Schönberg and Ludsteck (2014) at later child ages.

Table 1.6: The estimated employment response of mothers to the child care pension benefit extension in 1992 (baseline sample; Probit model)

Child age (in months)	19		28		36		60		120	
Post	-0.0208	-0.0306	-0.0151	0.0025	0.0106	0.0417	-0.0054	0.0322	0.0040	-0.0105
	[0.0160]	[0.0235]	[0.0196]	[0.0262]	[0.0255]	[0.0350]	[0.0317]	[0.0406]	[0.0420]	[0.0537]
German		-0.0593**		-0.0802***		-0.1046***		-0.1577***		0.0491
		[0.0272]		[0.0301]		[0.0400]		[0.0445]		[0.0653]
Number of children		-0.0133		-0.0039		-0.0180		-0.0543**		-0.0084
		[0.0136]		[0.0146]		[0.0181]		[0.0238]		[0.0269]
Educ2		-0.0008		-0.0228		0.0615		0.0479		0.1858**
		[0.0342]		[0.0444]		[0.0466]		[0.0559]		[0.0774]
Age		0.0170		-0.0401		-0.0082		0.0110		0.1625**
		[0.0294]		[0.0276]		[0.0386]		[0.0477]		[0.0781]
Age2		-0.0003		0.0005		0.0001		-0.0002		-0.0022**
		[0.0005]		[0.0004]		[0.0006]		[0.0007]		[0.0010]
North		0.0345		0.0488		0.0045		-0.1043		-0.0338
		[0.0347]		[0.0385]		[0.0584]		[0.0728]		[0.0833]
Middle		0.0285		0.0295		0.0553		0.0349		0.0246
		[0.0267]		[0.0304]		[0.0391]		[0.0438]		[0.0601]
Prior employment		0.0078**		0.0099**		0.0133**		0.0089		0.0051
		[0.0038]		[0.0043]		[0.0052]		[0.0061]		[0.0083]
N	553	328	553	328	553	328	553	328	553	328

Note: The baseline sample consists of mothers who had their last child in 1991Q4 (control) or in 1992Q1 (treatment) and who were not employed three months prior to child birth. The table shows average marginal effects and all specifications include a constant term. Post is one if a mother is in the treatment group, and zero if she is in the control group. Higher education indicates a secondary, intermediate school leaving certificate with completed vocational training or a higher education level. Region captures the different regions of residence based on the states of residence: North (Schleswig-Holstein, Hamburg, Bremen, Lower Saxony), Middle (North Rhine-Westphalia) and South (Baden-Wuerttemberg and Bavaria). */**/*** Statistically significant at the 10%/5%/1%-level. The standard error is reported in brackets.
Data source: BASiD (version, 1951-2009).

Table 1.7: The estimated employment response of mothers to the child care pension benefit extension in 1992 (baseline sample; OLS model)

Child age (in months)	19		28		36		60		120	
Post	-0.0207	-0.0322	-0.0151	0.0021	0.0105	0.0385	-0.0054	0.0326	0.0040	-0.0111
	[0.0157]	[0.0230]	[0.0197]	[0.0269]	[0.0255]	[0.0355]	[0.0318]	[0.0410]	[0.0421]	[0.0540]
German		-0.0736**		-0.0951**		-0.1168**		-0.1746***		0.0471
		[0.0374]		[0.0437]		[0.0501]		[0.0576]		[0.0664]
Number of children		-0.0111		-0.0027		-0.0162		-0.0421***		-0.0097
		[0.0119]		[0.0103]		[0.0163]		[0.0161]		[0.0252]
Educ2		-0.0007		-0.0154		0.0664		0.0516		0.1876**
		[0.0365]		[0.0347]		[0.0621]		[0.0679]		[0.0835]
Age		0.0094		-0.0541		-0.0052		0.0037		0.1394**
		[0.0295]		[0.0354]		[0.0384]		[0.0523]		[0.0640]
Age2		-0.0002		0.0007		0.0000		-0.0001		-0.0019**
		[0.0004]		[0.0005]		[0.0006]		[0.0007]		[0.0008]
North		0.0503		0.0500		0.0138		-0.0723		-0.0313
		[0.0404]		[0.0482]		[0.0501]		[0.0527]		[0.0830]
Middle		0.0410		0.0392		0.0593		0.0344		0.0239
		[0.0274]		[0.0309]		[0.0414]		[0.0484]		[0.0612]
Prior employment		0.0083**		0.0099**		0.0140***		0.0088		0.0048
		[0.0041]		[0.0041]		[0.0053]		[0.0063]		[0.0081]
N	553	328	553	328	553	328	553	328	553	328

Note: The baseline sample consists of mothers who had their last child in 1991Q4 (control) or in 1992Q1 (treatment) and who were not employed three months prior to child birth. The table shows estimated coefficients and all specifications include a constant term. Post is one if a mother is in the treatment group, and zero if she is in the control group. Higher education indicates a secondary, intermediate school leaving certificate with completed vocational training or a higher education level. Region captures the different regions of residence based on the states of residence: North (Schleswig-Holstein, Hamburg, Bremen, Lower Saxony), Middle (North Rhine-Westphalia) and South (Baden-Wuerttemberg and Bavaria). */**/*** Statistically significant at the 10%/5%/1%-level. The standard error is reported in brackets.
Data source: BASiD (version, 1951-2009).

Table 1.8: Estimated employment response to the extension of the child care pension benefit in 1992 based on the extended baseline sample (births around January 1, 1992 ±6 months; Probit model)

Child age (in months)	19		28		36		60		120	
Post	-0.0192	-0.0194	-0.0240	-0.0067	-0.0036	0.0081	-0.0058	-0.0119	0.0349	0.0121
	[0.0123]	[0.0170]	[0.0153]	[0.0209]	[0.0178]	[0.0242]	[0.0223]	[0.0288]	[0.0288]	[0.0371]
German		-0.0333*		-0.0636***		-0.0695**		-0.0587*		-0.0140
		[0.0195]		[0.0239]		[0.0278]		[0.0332]		[0.0442]
Number of children		-0.0122		-0.0038		-0.0065		-0.0332**		0.0190
		[0.0096]		[0.0117]		[0.0128]		[0.0162]		[0.0185]
Higher education		0.0019		-0.0119		0.0805**		0.0764*		0.1994***
		[0.0277]		[0.0377]		[0.0360]		[0.0440]		[0.0577]
Age		0.0093		-0.0229		0.0027		-0.0686**		0.0274
		[0.0170]		[0.0202]		[0.0250]		[0.0289]		[0.0456]
Age2		-0.0002		0.0002		-0.0002		0.0008**		-0.0006
		[0.0003]		[0.0003]		[0.0004]		[0.0004]		[0.0006]
North		0.0199		0.0539*		0.0436		-0.0353		-0.0518
		[0.0247]		[0.0293]		[0.0356]		[0.0442]		[0.0539]
Middle		0.0251		0.0293		0.0498*		0.0382		-0.0571
		[0.0194]		[0.0241]		[0.0278]		[0.0321]		[0.0415]
Prior employment		0.0070***		0.0127***		0.0145***		0.0130***		0.0247***
		[0.0025]		[0.0033]		[0.0035]		[0.0041]		[0.0052]
N	1186	690	1186	690	1186	690	1186	690	1186	690

Note: The extended baseline sample consists of mothers who had their last child in 1991H2 (control) or in 1992H1 (treatment) and who were not employed three months prior to child birth. The table shows the average marginal effects on the employment status and all specifications include a constant term. Post is one if a mother is in the treatment group, and zero if she is in the control group. Higher education indicates a secondary, intermediate school leaving certificate with completed vocational training or a higher education level. Region captures the different regions of residence based on the states of residence: North (Schleswig-Holstein, Hamburg, Bremen, Lower Saxony), Middle (North Rhine-Westphalia) and South (Baden-Wuerttemberg and Bavaria). */**/*** Statistically significant at the 10%/5%/1%-level. Standard errors are in reported in brackets. *Data source*: BASiD (version, 1951-2009).

Table 1.9: Estimated employment response to the extension of the child care pension benefit in 1992, excluding births in December 1991 and January 1992 (Probit model)

Child age (in months)	19		28		36		60		120	
Post	-0.0106	-0.0095	-0.0050	-0.0055	0.0167	0.0544	0.0116	0.0377	-0.0032	0.0070
	[0.0199]	[0.0287]	[0.0249]	[0.0328]	[0.0317]	[0.0429]	[0.0390]	[0.0500]	[0.0509]	[0.0643]
German		-0.0541		-0.0659*		-0.1111**		-0.1107**		0.0593
		[0.0331]		[0.0373]		[0.0481]		[0.0555]		[0.0760]
Number of children		-0.0458**		-0.0018		-0.0418		-0.0666**		0.0068
		[0.0230]		[0.0188]		[0.0255]		[0.0316]		[0.0347]
Higher education		0.0102		-0.0078		0.0797		0.0643		0.1785**
		[0.0397]		[0.0513]		[0.0543]		[0.0672]		[0.0899]
Age		0.0221		-0.0562*		-0.0172		-0.0073		0.1912*
		[0.0370]		[0.0323]		[0.0462]		[0.0585]		[0.0978]
Age2		-0.0004		0.0008		0.0003		0.0001		-0.0026**
		[0.0006]		[0.0005]		[0.0007]		[0.0008]		[0.0012]
North		0.0600		0.0643		0.0142		-0.1301		0.0163
		[0.0433]		[0.0468]		[0.0668]		[0.0878]		[0.0977]
Middle		0.0400		0.0146		0.0197		0.0084		0.0072
		[0.0353]		[0.0387]		[0.0474]		[0.0537]		[0.0722]
Prior employment		0.0095**		0.0106**		0.0169***		0.0089		0.0078
		[0.0046]		[0.0054]		[0.0065]		[0.0076]		[0.0098]
N	373	229	373	229	373	229	373	229	373	229

Note: The sample is based on mothers who had their last child in October or November 1991 (control group) or in February or March 1992 (treatment group) and who were not employed three months prior to child birth. The table shows the estimated average marginal effects on the employment status and all specifications include a constant term. Post is one if a mother is in the treatment group, and zero if she is in the control group. Higher education indicates a secondary, intermediate school leaving certificate with completed vocational training or a higher education level. Region captures the different regions of residence based on the states of residence: North (Schleswig-Holstein, Hamburg, Bremen, Lower Saxony), Middle (North Rhine-Westphalia) and South (Baden-Wuerttemberg and Bavaria). */**/*** Statistically significant at the 10%/5%/1%-level. Standard errors are reported in brackets.
Data source: BASiD (version, 1951-2009).

Table 1.10: Estimated employment response to the extension of the child care pension benefit in 1992, controlling for seasonal differences (Probit model)

Child age (in months)	19		28		36		60		120	
Turn91/92 * Beginning	-0.0128	-0.0097	-0.0014	0.0152	0.0276	0.0689	0.0531	0.1410**	-0.0455	-0.0420
	[0.0238]	[0.0327]	[0.0291]	[0.0385]	[0.0344]	[0.0460]	[0.0429]	[0.0549]	[0.0595]	[0.0760]
Turn91/92	-0.0048	0.0035	-0.0111	-0.0121	0.0070	-0.0023	0.0092	-0.0147	0.0009	-0.0302
	[0.0157]	[0.0209]	[0.0201]	[0.0271]	[0.0244]	[0.0325]	[0.0298]	[0.0372]	[0.0428]	[0.0548]
Beginning	-0.0110	-0.0232	-0.0154	-0.0143	-0.0185	-0.0365	-0.0593*	-0.1149***	0.0464	0.0291
	[0.0159]	[0.0232]	[0.0199]	[0.0270]	[0.0251]	[0.0343]	[0.0312]	[0.0410]	[0.0419]	[0.0538]
German		-0.0307*		-0.0444**		-0.0548**		-0.0978***		0.0217
		[0.0181]		[0.0213]		[0.0255]		[0.0301]		[0.0444]
Number of children		-0.0142		-0.0091		-0.0248*		-0.0450***		0.0079
		[0.0102]		[0.0120]		[0.0134]		[0.0168]		[0.0207]
Higher education		-0.0017		0.0280		0.0721**		0.0680*		0.1540***
		[0.0260]		[0.0287]		[0.0306]		[0.0382]		[0.0571]
Age		-0.0108		-0.0305		-0.0114		-0.0146		0.1063**
		[0.0157]		[0.0194]		[0.0237]		[0.0308]		[0.0528]
Age2		0.0002		0.0004		0.0002		0.0002		-0.0014*
		[0.0003]		[0.0003]		[0.0004]		[0.0005]		[0.0007]
North		0.0059		0.0045		-0.0103		-0.0386		-0.0909
		[0.0249]		[0.0290]		[0.0382]		[0.0438]		[0.0595]
Middle		0.0045		-0.0117		0.0294		-0.0003		-0.0602
		[0.0179]		[0.0213]		[0.0256]		[0.0301]		[0.0429]
Prior employment		0.0066***		0.0104***		0.0102***		0.0105***		0.0146**
		[0.0024]		[0.0030]		[0.0033]		[0.0040]		[0.0057]
N	1108	656	1108	656	1108	656	1108	656	1108	656

Note: The sample consists of mothers who had their last child in 1990Q4/1991Q1 or in 1991Q4/1992Q1 and who were not employed three months prior to child birth. The table shows the average marginal effects on the employment status and all specifications include a constant term. Beginning equals indicates a child birth in the first quarter, zero if it occurred in the last quarter. Turn91/92 is one if the child was born between October 1991 and March 1992. Higher education indicates a secondary, intermediate school leaving certificate with completed vocational training or a higher education level. Region captures the different regions of residence based on the states of residence: North (Schleswig-Holstein, Hamburg, Bremen, Lower Saxony), Middle (North Rhine-Westphalia) and South (Baden-Wuerttemberg and Bavaria). */**/*** Statistically significant at the 10%/5%/1%-level. Standard errors are reported in brackets.
Data source: BASiD (version, 1951-2009).

Table 1.11: Re-estimation of the model by Schönberg and Ludsteck (2014) based on BASiD

Child age (in months)	19		28		36		60		120	
Turn91/92 * Beginning	-0.0680*	-0.1236***	-0.0431	-0.0525	0.0366	0.0417	0.0162	0.0489	-0.0179	-0.0351
	[0.0356]	[0.0447]	[0.0392]	[0.0480]	[0.0411]	[0.0514]	[0.0446]	[0.0551]	[0.0492]	[0.0625]
Turn91/92	-0.0016	0.0327	-0.0277	-0.0321	-0.0169	-0.0118	0.0045	-0.0136	0.0031	-0.0278
	[0.0272]	[0.0349]	[0.0294]	[0.0358]	[0.0298]	[0.0372]	[0.0326]	[0.0404]	[0.0352]	[0.0447]
Beginning	-0.0182	-0.0152	-0.0275	-0.0112	-0.0346	-0.0274	-0.0487	-0.0635*	0.0096	0.0094
	[0.0262]	[0.0315]	[0.0288]	[0.0347]	[0.0288]	[0.0352]	[0.0310]	[0.0378]	[0.0345]	[0.0431]
German		-0.0898***		-0.0614**		-0.0857***		-0.1005***		0.0189
		[0.0263]		[0.0277]		[0.0300]		[0.0320]		[0.0359]
Number of children		-0.0072		-0.0085		-0.0290**		-0.0380***		-0.0015
		[0.0117]		[0.0121]		[0.0132]		[0.0139]		[0.0171]
Higher education		-0.0021		0.0265		0.0750*		0.0588		0.1081**
		[0.0316]		[0.0369]		[0.0430]		[0.0445]		[0.0517]
Age		-0.0182		-0.0140		-0.0109		0.0138		0.1148***
		[0.0248]		[0.0266]		[0.0270]		[0.0337]		[0.0407]
Age2		0.0002		0.0000		0.0000		-0.0003		-0.0015***
		[0.0004]		[0.0004]		[0.0004]		[0.0005]		[0.0005]
North		0.1160***		0.0578		0.0295		0.0006		-0.1078**
		[0.0357]		[0.0379]		[0.0389]		[0.0419]		[0.0477]
Middle		0.0705***		0.0210		0.0185		-0.0127		-0.1026***
		[0.0249]		[0.0273]		[0.0292]		[0.0310]		[0.0348]
Prior employment		0.0295***		0.0317***		0.0315***		0.0313***		0.0220***
		[0.0031]		[0.0032]		[0.0033]		[0.0035]		[0.0039]
N	1657	980	1657	980	1657	980	1657	980	1657	980

Note: The sample is based on all mothers - independent of the pre-child birth employment status - who had a child in 1991Q4 or 1992Q1, who are compared to mothers who had a child in 1990Q4 or 1991Q1. The table shows the estimated coefficients and all specifications include a constant term. Beginning equals indicates a child birth in the first quarter, zero if it occurred in the last quarter. Turn91/92 is one if the child was born between October 1991 and March 1992. Higher education indicates a secondary, intermediate school leaving certificate with completed vocational training or a higher education level. Region captures the different regions of residence based on the states of residence: North (Schleswig-Holstein, Hamburg, Bremen, Lower Saxony), Middle (North Rhine-Westphalia) and South (Baden-Wuerttemberg and Bavaria). */**/*** Statistically significant at the 10%/5%/1%-level. Robust standard errors are in brackets.
Data source: BASiD (version, 1951-2009).

Table 1.12: Estimated employment response to the extension of the child care pension benefit in 1992, controlling for a theoretical parental leave extension (Probit model)

Child age (in months)	19		28		36		60		120	
Post	-0.0156	-0.0088	-0.0128	0.0070	-0.0112	0.0125	-0.0118	0.0197	0.0049	-0.0179
	[0.0161]	[0.0220]	[0.0202]	[0.0261]	[0.0256]	[0.0351]	[0.0326]	[0.0406]	[0.0462]	[0.0593]
German		-0.0356		-0.0547*		-0.0695		-0.1533***		0.0906
		[0.0287]		[0.0319]		[0.0437]		[0.0460]		[0.0752]
Number of children		-0.0614**		-0.0115		-0.0187		-0.0415*		-0.0072
		[0.0284]		[0.0161]		[0.0187]		[0.0239]		[0.0297]
Higher education		-0.0199		-0.0305		0.0655		0.0707		0.2202***
		[0.0352]		[0.0480]		[0.0456]		[0.0529]		[0.0853]
Age		0.0033		-0.0444*		-0.0171		-0.0428		0.1144
		[0.0240]		[0.0247]		[0.0371]		[0.0433]		[0.0828]
Age2		-0.0001		0.0006		0.0002		0.0006		-0.0016
		[0.0004]		[0.0004]		[0.0006]		[0.0006]		[0.0010]
North		0.0275		0.0549		0.0470		-0.0824		-0.0834
		[0.0356]		[0.0377]		[0.0585]		[0.0803]		[0.0940]
Middle		0.0376		0.0289		0.0701*		0.0568		0.0243
		[0.0282]		[0.0307]		[0.0415]		[0.0443]		[0.0663]
Prior employment		0.0086**		0.0079		0.0106*		0.0062		0.0036
		[0.0044]		[0.0048]		[0.0059]		[0.0069]		[0.0095]
N	455	266	455	266	455	266	455	266	455	266

Note: The sample is based on mothers who had their last child in October or November 1991 (control group) or in February or March 1992 (treatment group) and who were not employed three months prior to child birth. Further, mothers are excluded if they had a earlier child in 1990 or 1991. The table shows the estimated average marginal effects on the employment status and all specifications include a constant term. Post is one if a mother is in the treatment group, and zero if she is in the control group. Higher education indicates a secondary, intermediate school leaving certificate with completed vocational training or a higher education level. Region captures the different regions of residence based on the states of residence: North (Schleswig-Holstein, Hamburg, Bremen, Lower Saxony), Middle (North Rhine-Westphalia) and South (Baden-Wuerttemberg and Bavaria). */**/*** Statistically significant at the 10%/5%/1%-level. Standard errors are reported in brackets.
Data source: BASiD (version, 1951-2009).

Chapter 2

How does maternal pension wealth affect family old-age savings in Germany?[1]

2.1 Introduction

Aging societies in many Western countries are putting financial pressure on public pension systems due to the increasing ratio of pensioners to contributors. Future pension entitlements will often be lower while the importance of old-age savings is growing. In addition, countries are implementing specific pension benefits that aim at bridging the gap in pension entitlements due to employment interruptions (OECD, 2013, 2015). In Germany, the child care pension benefit is granted to a

[1] An earlier version of the paper has been published as a *DIW Discussion Paper* (Thiemann, 2016).

mother[2] for child-raising periods that preclude employment (Schmähl et al., 2006). Hence, this benefit intends to increase a mother's old-age income through higher pension wealth. However, if families substitute old-age savings through the child care pension benefit, then - in the worst case - mothers would not be better off at retirement than without the benefit.

This paper exploits two increases in maternal pension wealth through reforms of the German child care pension benefit as natural experiments in order to examine whether public pension wealth crowds out the old-age savings of families. The pension reforms in 1992 and in 1999 are of particular interest, as they increased the generosity of the child care pension benefit for parents of children born after December 31, 1991. Using regression discontinuity design (RDD), the paper compares the savings behavior of families with a child born in 1992 to the behavior of families with a child born in 1991. The empirical analysis is based on three waves of the Expenditure and Consumption Survey (*Einkommens- und Verbrauchsstichprobe, EVS*) in 1998, 2003, and 2008. Observing the savings behavior of families over this time period allows for the evaluation of whether savings adjustments occurred gradually.

The pension reform in 1992 extended the provision period from one to three years from new births and the reform in 1999 increased its generosity. Taking, for example, 2000 as the reference year, child care pension benefits increased a mother's pension payments by up to €1,044 per year if her child was born after 1991 and by up to €348 if her child was born in 1991 or earlier.[3] The paper identifies the impact of this maximum annual difference of €696 per year on the savings behav-

[2]Fathers can principally be entitled to the benefit as well, however the share of fathers that receive child care pension benefits is very low.

[3]This paper omits the implications of the July 2014 child care pension benefit reform since the data does not cover that period. The details of the calculation are explained in Table 2.2.

ior of families.

Not only did the child care pension benefits increase for the parents of children born on or after January 1, 1992, but simultaneously the maximum parental leave duration increased from 18 to 36 months. Schönberg and Ludsteck (2014) show that due to the longer parental leave duration, mothers postponed their return into the labor market in the short-run. If the longer absenteeism of mothers from the labor market caused families to reduce their old-age savings, then this provides a threat to the identification strategy for this paper. In order to test whether longer parental leave durations impacted on family savings, I exploit an earlier increase of parental leave in 1986. The findings suggest that families do not respond to the longer parental leave by reducing savings.

Social security wealth can mainly affect private savings through two channels, as Feldstein (1974) states: The wealth replacement effect and the induced retirement effect. According to the wealth replacement effect, the accumulation of social security wealth negatively impacts private savings. Since the accumulation of public pension wealth increases old-age income through pensions, it substitutes for household assets. Very often public pensions provide incentives for individuals to retire earlier than they would have retired without the provision of public pensions. In order to compensate for the longer period of retirement these individuals would increase their private savings while working. The net effect of social security wealth on private savings is an empirical question. In his seminal paper, Feldstein (1974) analyzed the relationship between public pension wealth and private savings. He uses aggregate time series data from the United States from 1929 through 1971, excluding the WWII years, to estimate an aggregate consumption function that includes *inter alia* an estimate of household security wealth. He finds that the

wealth replacement effect strongly dominates the induced retirement effect. Social security wealth actually replaces 30 - 50 percent of private savings. However, these initial estimations of the displacement effect of public pension wealth on private savings might be inconsistent due to aggregation problems (Alessie et al., 2013; Feldstein and Liebman, 2002).

The seminal work by Feldstein (1974) was followed by several studies that relied on different sources of variation (e.g. Feldstein and Pellechio (1979); King and Dicks-Mireaux (1982); Hubbard (1986); Japelli (1995)). Feldstein and Pellechio (1979) find almost a one-to-one displacement effect of private assets with respect to Social Security Wealth based survey data from 1963 from the United States. Similarly, Hubbard (1986) finds a displacement effect of public pension wealth on private savings; however the effect is substantially smaller. Japelli (1995) constructs a measure of expected pension wealth based on survey information on retirement age and replacement rates for Italy. He finds that an additional lira of pension wealth replaces between 10% and 20% of private wealth, depending on the specification. Gale (1998) shows that most previous papers, which typically regress non-pension assets *inter alia* on cash wages and pension wealth, underestimate the displacement effect of pension wealth. He further elaborates that the offset of pension wealth on non-pension assets rises with age. As a consequence he suggests an adjustment factor for pension wealth to correct for the bias.

The previous papers rely either on aggregate data, which may be subject to aggregation difficulties, or on constructed measures of pension wealth based on self-reported information. Since differences in pension wealth could just reflect different tastes for old-age savings, using direct measures of pension wealth might not always lead to consistent results. More recent papers exploit exogenous variation in

pension wealth to estimate its impact on non-pension wealth. Attanasio and Rohwedder (2003) exploit three major U.K. pension reforms to estimate the impact of pension wealth on the savings rate using time series and cross-sectional variation based on the Family Expenditure Survey. They find no significant reactions to changes in the flat-rate Basic State Pension but substantial reductions of the savings rate due to changes in the earnings-related pension scheme. Similarly, Attanasio and Brugiavini (2003) estimate the impact of a large Italian pension reform in 1992 on the household savings rate in a difference-in-difference setting. Based on data from the Survey on Household Income and Wealth, they find that pension wealth can be interpreted as a substitute for private financial wealth, in particular for individuals aged 35-45. Using the same data set, Bottazzi et al. (2006) emphasize that expectations about an individual's pension wealth are important for the adjustment reaction. When estimating the combined impact of the three Italian pension reforms (1992, 1995 and 1997), they find a large displacement of private wealth by perceived pension wealth, especially when workers are well informed about their pension wealth. Finally, Lachowska and Myck (2015) exploit a Polish pension reform in 1999 using the Polish Household Budget Surveys to analyze the effect of pension wealth on household savings relying on a difference-in-differences design. They find that one additional Polish zloty of pension wealth crowds out about 0.24 Polish zloty of household savings. Focusing on highly educated and older households this effect is close to minus one.

Similar to these last studies, this paper also exploits exogenous variation in pension wealth. Nevertheless, this paper differs in various aspects. While most papers exploit large variations in pension wealth, the relative importance of the increase in pension entitlements through the child care pension benefit is typically lower.

Further, affected families can adjust their old-age savings over a longer time period before they enter retirement. Nevertheless, it is important to investigate if families adjust their savings even though the variation in their pension wealth is only moderate. The findings of the paper are as follows: The child care pension benefit increases a mother's pension wealth without crowding-out private old-age savings. Hence the child care pension benefit compensates mothers for employment interruptions by improving their old-age income.

The reminder of the paper is structured as follows: The next section describes the institutional background of the German pension system, in particular the role of child care pension benefits. Then, the identification strategy is described. Section 2.4 describes the data and sample construction. Section 2.5 covers the results. The final section concludes.

2.2 Institutional background

This section introduces the institutional background of the German Pension System, with specific background on the child care pension benefit.

The public pension plays a predominant role in the old-age income in Germany. Among retirees households, about two-thirds of household gross income originates from the public pension system.[4] Pension contributions are translated into so-called pension points. A pension point represents the annual pension contributions that are made by a worker who earns the average remuneration. Employees who earn a share of the average remuneration, accordingly contribute the corresponding share of a pension point. The value of the average remuneration is adjusted each year. At the verge of retirement, the amount of pension payments depends

[4]Based on households with the reference person being 65 years or older (BMAS, 2015).

essentially on the sum of accumulated pension points over the course of working life. Pension points that are accumulated early in life are treated the same way as pension points that were accrued shortly before retirement. In 2015, a pension point represents about €29 (West Germany) of monthly pension payments (assuming the basic old-age pension without deductions). This so-called 'current pension value' is adjusted each year.

While most pension entitlements stem from contributions from employment, there are a few exceptions. One of them are pension entitlements that are granted for child-raising periods that preclude employment.

Table 2.1: The Development of the German child care pension benefit 1986 - 1999

Reform	Maximum annual benefit	Duration	Affected child births
1986	0.75 PP[a]	1 year	all[b]
1992	0.75 PP	3 years	as of January 1992
1999	1 PP (employment penalty abolished)	3 years	Maximum benefit was gradually increased for all births.

a) Pension point. It represents the annual pension contributions made by a person who earns the average remuneration in a year.
b) Only mothers, born after 1921 were entitled. Mothers born before are entitled to a similar pension benefit scheme.
Source: Own illustration.

Table 2.1 sketches the development of the child care pension benefit from 1986 through 1999, following its introduction.[5] In 1986, the child care pension benefit was introduced to compensate mothers for child-raising periods that preclude employment. In this era, it granted 0.75 pension points per child to mothers for periods of child care.[6] Since the benefit was granted for one year, it increased

[5]Since the data period is restricted to from 1998 to 2008, the most recent reform in 2014 is not relevant for the analysis. In 2014, the duration of the child care pension benefit was extended retrospectively from one to two years for births prior to 1992.

[6]Mothers who were born before 1921 were not entitled. However, they were entitled to a similar pension benefit.

a mother's pension entitlements by 0.75 pension points. Translated into monetary values of 2015, 0.75 pension points increase annual pensions by about €260.[7] However, pension entitlements stemming from the child care pension benefit were reduced by compulsory pension entitlements from employment if a mother was employed in that year.

The pension reform in 1992 tripled the duration of the child care pension benefit from one to three years for all births on January 1, 1992, or later. Hence, the pension wealth of affected mothers increased by up to 2.25 pension points through the child care pension benefit. In monetary terms, this is equivalent to €780 per year. Compared to births prior to the cut-off date January 1, 1992, the child care pension benefit increased by 1.5 pension points.

The pension reform in 1999 increased gradually and retrospectively the generosity of the benefit for each year from 0.75 to one pension point.[8] Further, there was no longer an employment penalty if a mother became employed during periods for which the child care pension benefit was granted if the sum of pension entitlements from employment and the child care pension benefit did not exceed the pension entitlements based on the contribution ceiling. In 2015, the contribution ceiling amounts to twice the average remuneration or €72,600.

Old-age income typically stems from different sources such as the public pension fund, private pension schemes, transfers, private wealth and other sources. By increasing the monthly pension payments, the child care pension benefit lowers, *ceteris paribus*, the incentives for private old-age savings. Two children for instance, who are both born after 1991, would increase a mother's annual pension

[7] Assuming basic old-age retirement without deductions and West German pension values.

[8] The monthly value at retirement of the child care pension benefit was increased from July, 1998 to 0.85 pension points, from July, 1999 to 0.9 pension points and from July, 2000 to one pension point (§256d SGB VI).

payments by about €2,090 - at the most - through the child care pension benefit, based on 2015 West German pension values. However, since the generosity of the child care pension benefit depends on the date of child birth, mothers face different savings incentives depending on the child's date of birth. Comparing a mother A, whose child was born in 1991, to a mother B who had a child in 1992, then the negative old-age savings incentive is much stronger for mother B, since she benefits to a larger extend from the child care pension benefit.[9]

The previous example implicitly assumed that mothers do not retire earlier in response to the increase in their pension wealth. This induced retirement effect would motivate mothers to increase old-age savings to compensate for the longer period of retirement. Previous evidence suggests that the net old-age savings effect is negative, however the net effect is an empirical question.

2.3 Identification

The paper exploits the pension reforms in 1992 and 1999 as natural experiments to identify the impact of higher individual pension wealth on family savings. Table 2.2 shows the positive impact of the child care pension benefit on pension entitlements of mothers by the child's year of birth (1991 or 1992) and for two different points in time. While panel (A) reports the changes in pension entitlements measured in pension points, panel (B) shows their monetary equivalence. In general,

[9]It has to be mentioned that retirees can only take advantage of the child care pension benefit if their pension level exceeds the one that corresponds to the minimum pension. Otherwise, their pension payments would be increased in order to reach the minimum pension level. Then, the child care pension benefit would have no impact on the level of pension payments. However, the share of retirees who receive the minimum pension is very low. In 2011, the share of persons aged 65 or older who receive the minimum pension is 2.6% (Duschek and Lemmer, 2013). Further, to take advantage of the child care pension benefit a mother has to fulfill the general requirements of five years of contributions for being entitled to the old-age pension.

Table 2.2: Identification design

Child born in	Variation of a mother's pension entitlements due to changes in the child care pension benefit	
	in 1992 (January)	in 2000 (July)
	(A) in pension points (PP)	
1991	+ 0.75	+ 1.0
1992	+ 2.25	+ 3.0
	(B) in annual pension payments[a]	
1991	+ €261	+ €348
1992	+ €783	+ €1044

Note: The table reports the maximum change of a mother's pension entitlements by a child's year of birth (1991 or 1992) that is due to changes in the child care pension benefit.
a) Based on West German values of 2015 (1 PP ≅ €29/month), assuming that a mother enters retirement in 2015 and receives old-age pension without deductions. In this calculation, I ignore the reform of the child care pension benefit in 2014 because this it is not covered by the available time horizon of the data I use.
Source: Various German Federal Laws; Own illustration.

the pension entitlements of a *1992 mother* increase more strongly than those of a *1991 mother*. Based on the regulation of 1992, the child care pension benefit augments the annual pension payments of a mother by €261 if her child was born in 1991 and by €783 if it was born in the next calender year. The reform of the child care pension benefit in 1999, fully phased-in in July 2000, further strengthens the preferential treatment of *1992 mothers*. After July 2000 the maximum difference in pension entitlements through child care pension benefits between *1992 mothers* and *1991 mothers* is €696 per year. Can the impact of individual pension wealth on family saving be identified by comparing the savings behavior of *1992 mothers* and *1991 mothers*? Let us refer to *1991 mothers* as the control group and to *1992 mothers* as the treatment group. If mothers are randomly assigned into the two groups and if the only systematic difference is the higher generosity of the child

care pension benefit in the treatment group, then we can identify the impact of pension wealth on family savings.[10]

First, the assignment of a family either in the control or in the treatment group is determined by the child's year of birth. The increase in the child care pension benefit - granted to parents of babies born in January 1992 or later - provides an incentive for parents to have a child in 1992 instead of 1991. Since the German Parliament had already adopted the Pension Reform Act 1992 in December 1989, parents could theoretically have decided to have a child in 1992 instead of 1991. However, the exact timing of conception cannot perfectly be controlled by the parents. The duration of pregnancy follows a normal distribution of 40 weeks and a standard deviation of two weeks (Ekberg et al., 2013, p. 135). Nevertheless, the literature documents some shifting of births by parents for a few public benefits reforms that are based on a specific cut-off date (Neugart and Ohlsson, 2013; Gans and Leigh, 2009; Tamm, 2012). Whether child births might have been postponed and shifted from 1991 into 1992 was already investigated by Dustmann and Schönberg (2008, Appendix A). However, they do not find any evidence that child births were shifted around the turn of the year. Further, Thiemann (2015) investigates the birth patterns around the turn of the year 1991/92 and compares the total number of births with the two subsequent years based on the birth statistics for West Germany[11], without finding a strategic timing of birth behavior.

Second, a systematic difference could arise from the fact that a child born in 1991 is on average one year older than a child who was born in 1992. Ideally, one would compare parents who had a child shortly around the cut-off date 1/1/1992, e.g.

[10]The identification strategy of this paper follows closely Thiemann (2015), which investigates the impact of the child care pension benefits on maternal employment in the short- and medium run.

[11]The date does not contain births for Saarland.

based on child births in December 1991 and January 1992. However, the data set only provides information about the year of birth.[12] Therefore, the empirical model controls factors that are different across both groups as a result of this age difference, namely the parent's age and employment status. To cross-validate the assumption of random assignment, I perform a standard test in empirical work and compare the distribution of observable characteristics across both groups (Lee and Lemieux, 2010). The results do not provide evidence for a non-random selection (c.f. Table 2.3), apart from the difference in age of parents.

Third, is the more generous child care pension benefit the only systematic difference across treatment and control groups? Regarding institutional differences, other pension reforms were dependent on the mother's and not the child's date of birth. Therefore they identically affected mothers in the treatment and control groups. However, in 1992 not only the child-care pension benefit, but also parental leave was extended in the same discontinuous way. The reform extended the parental leave duration from 18 to 36 months for all newborns from January 1, 1992. The longer parental leave period for *1992 mothers* is a threat to the identification strategy if old-age savings behavior in the treatment group was affected by the policy change. Schönberg and Ludsteck (2014) document that mothers substantially postponed the return into the labor market after child birth in the short-run, but not in the long-run. Since mothers in the control group tend to return earlier into employment than mothers in the treatment group, they could accumulate more pension entitlements through compulsory pension contributions in this period. These additional pension entitlements would then reduce the positive savings incentive for *1991 mothers* relative to *1992 mothers*. However, this

[12] The data is explained in detail in section 2.4.

theoretical savings effect is likely to be rather small. First, mothers who re-entered employment at that time were very likely to work part-time (see e.g. Geisler and Kreyenfeld (2005)) and on average the amount of additional pension points they accrued relative to the treatment group would rather have been very small. Nevertheless, to assess the impact of the parental leave duration on old-age savings, I exploit a previous parental leave extension in 1986 to estimate its impact on savings. Despite the fact that the two parental leave extensions, in 1992 and in 1986, are not entirely comparable, this exercise provides evidence that the impact of the parental leave extension on family savings is rather low (c.f. Section 2.5.4). Further, the child care pension benefit could have had an indirect effect on old-age savings via employment. The more generous child care pension benefit for *1992 mothers* provides an incentive for mothers to return later into employment due to the higher pension wealth. If *1991 mothers* return earlier into employment and if employed mothers are more likely to contribute a higher fraction of income to family savings, then the identification strategy of this paper could not distinguish the direct impact of the child care pension benefit from its indirect effect through employment on family old-age savings. Thiemann (2015) studies how child care pension benefits affect the employment decision of mothers in the short- and the medium-run. However, the study does not find empirical support for the presumption that mothers return later into employment as a results of the more generous child care pension benefit.

The empirical method that underlies the identification strategy of this paper is the *regression discontinuity design*. If individuals cannot precisely control the assignment rule into the control and the treatment group, then this treatment variation is "as good as randomized." As a result, the regression discontinuity design (RDD),

if applicable, is often considered as potentially more credible than other research designs that exploit natural experiments (Lee and Lemieux, 2010, p. 282) and hence it is not surprising that it is applied in various economic and non-economic studies.[13]

The econometric model that investigates the impact of pension wealth on old-age savings is specified in the following way:

$$SV_{it} = \beta_0 + \beta_1 \, Treat_i + \beta_2 \, 2003_t + \beta_3 \, 2008_t + \sum_s \gamma_s \, mage_{si} + \; X_i'\delta + \epsilon_{it} \quad (2.1)$$

For the dependent savings variables SV, I rely on flow and stock information: Savings relative to gross income, savings relative to net income, and the stock of net wealth. For each concept, the model is estimated separately. i indicates the family and t determines the cross-section to which the family belongs to (1998, 2003 or 2008). *Treat* equals one if a family had a child in 1992, zero if their child was born in 1991. 2003 and 2008 are dummy variables that capture the effect of being interviewed in a particular year, where 1998 is the baseline category. X is a vector of control variables: *Family size, father's age, federal states, education of each parent, the binary employment status of each parent and the quarter of interview* and ϵ captures the error term. Finally, the indicators for the age of a mother control non-parametrically for the length of her adjustment horizon (the time until retirement). When a mother experiences a change of her pension wealth, the savings reaction tends to be the smaller the longer the period in which savings

[13] Thistlethwaite and Campbell (1960) introduced the method to investigate the impact of merit awards on future academic outcomes. Angrist and Lavy (1999) rely on the regression discontinuity design when they investigate how class size influences the test scores of students in Israel. Black (1999) studies how much parents are willing to pay in order to send their children into better schools. An overview of applications of the regression discontinuity design in economics is provided by Lee and Lemieux (2010).

can be adjusted and the further away she is from the expected retirement entry date. Hence, the savings response of a family with a young mother is usually, *ceteris paribus*, smaller than the response of a family with an older mother, based on the same variation in pension wealth (Gale, 1998). An alternative specification also includes interaction terms to control for the differential impact of being a *1992 mother* in different years:

$$\begin{aligned} SV_{it} = \alpha_0 + \alpha_1\, Treat_i + \alpha_2\, 2003_t + \alpha_3\, 2008_t + \alpha_4\, Treat_i * 2003_t \\ +\alpha_5\, Treat_i * 2008_t + \; X_i'\lambda + \sum_s \xi_s\, mage_{si} + \tilde{\epsilon}_{it}, \end{aligned} \tag{2.2}$$

where the additional interaction terms $2003 * Treat$ and $2008 * Treat$ capture the differential impact of a *1992 mother* in 2003 or 2008 relative to a *1992 mother* in 1998. The structure of the data does not allow for separating the effects for the two reforms of the child-care pension benefit in 1992 and 1999. Therefore, I interpret the two reforms as a "reform package" that favored *1992 mothers*.

2.4 Data

The empirical analysis relies on the Income and Consumption Survey (*Einkommens- und Verbrauchsstichprobe, EVS*). The EVS is based on a stratified quota sample of about 0.2 percent of private households and repeated every five years. In 2008, about 55,000 to 59,000 households participated, depending on the section of the survey. For a thorough description of the EVS, I refer to Statistisches Bundesamt (2013). In addition to socio-demographic information about household members, the data offers detailed information about income and expenditure and wealth

components[14] of German households. The EVS only covers households whose net earnings do not exceed €18,000 per month. However, this limitation is of minor concern as the share of households earning more than €18,000 per month is very small[15] and these households are most likely hardly affected by the child care pension benefit because the increase in pension wealth is very small relative to their monthly income. While the EVS contains the year of birth of household members, it does not inform about the precise month of birth. Therefore, the assignment of families into the control and treatment group must be made based on the child's year of birth. I rely on the scientific use files of the EVS: a 80% sub-sample, which provides information for more than 42,000 households per wave (Statistisches Bundesamt, 2013, 2005, 2002). I use three consecutive waves from 1998, 2003, and 2008. To harmonize them, the monetary values of 1998 are converted from Deutschmark into Euro using the official exchange rate of 1.95583 Deutschmark per Euro. Further, monetary values from 1998 and 2008 are deflated to prices of 2003 based on the Consumer Price Index.[16] In this paper, I define savings as net expenditures for the wealth accumulation and relate this measure to net income and to gross income. Net wealth is defined as the sum of real estate property and financial wealth. Further, the net wealth variable is divided by 1,000 for a more convenient representation.[17]

[14]While the EVS informs about real estate as well as financial wealth components, it does not provide sufficient information about business wealth.

[15]Based on the GSOEP (German Socio-Economic Panel) data, the share of households with a net income of at least €18,000 is less than 1% in 2008. For a description of the data, I refer to Wagner et al. (2007).

[16]I am grateful to Richard Ochmann for helpful code that facilitated the harmonization of the three waves of the EVS.

[17]Savings = accumulation of real assets - liquidation of real assets + accumulation of financial assets - liquidation of financial assets + repayment of loans - take-up of new loans. Households with implausible values of lower than -0.5 and higher than 0.5 of the savings quota are excluded. The financial wealth component in 1998 had to be adjusted for flows to guarantee comparability

Parents who had a child, either in 1991 or 1992, are selected into the sample, which is the case for 8,854 families. If parents had more than one child in 1991 or in 1992, they are excluded because pension entitlements of these mothers increased more because child care pension benefits are granted per child. I also exclude parents who had a child in 1991 and another one in 1992 because they had to be assigned into the treatment and control groups. In addition, families in which a mother is either self-employed, a freelancer, a civil servant or already retired are not considered since these mothers are less likely to be affected by the child care pension benefit. In Germany, many of these professions have separate pension schemes. Further, I only consider West German households since after re-unification in 1990, East Germany experienced a dramatic drop in fertility that is likely to have been selective (Chevalier and Olivier, 2015). Finally, I focus on couple families with no other household members than children. Hence, all households that are included are families where both parents are part of the same household.[18] The remaining final sample size is 5,450 families.

2.5 Results

Next, this section discusses the descriptive results and the findings from estimating the econometric model.

to 2003 and 2008. In contrast to the EVS 2003 and 2008, where financial wealth was recorded on January 1, in 1998 it was reported for the end of the interview quarter.

[18] In a further step, the paper estimates the savings responses for single mothers (section 2.5.3).

2.5.1 Descriptive results

Table 2.3 compares the different savings/wealth concepts and socio-demographic characteristics for the treatment and the control groups. Both savings rates - rel-

Table 2.3: Sample characteristics by treatment and control groups

	Control		Treatment		Difference
Variable	Mean	SD	Mean	SD	t-statistic
Savings and net wealth					
Savings/gross income	0.105	0.128	0.103	0.127	0.498
Savings/net income	0.132	0.158	0.130	0.159	0.533
Net wealth	186.7	211.5	170.5	179.3	3.046***
Socio-demographics					
Mother's age	40.08	5.600	39.23	5.665	5.533***
Father's age	42.93	6.297	41.99	6.693	5.362***
Mother employed	0.442	0.497	0.469	0.499	-1.958*
Father employed	0.943	0.232	0.945	0.229	-0.304
University degree (mother)	0.169	0.375	0.167	0.373	0.201
University degree (father)	0.344	0.475	0.336	0.472	0.598
Family size	4.224	0.636	4.214	0.651	0.570
Group size	2759		2691		

Notes: The sample is based on West German couple families who had a child either in 1991 (control group) or in 1992 (treatment group). Net wealth is measured in €100,000s. */**/*** Statistically significant at the 10%/5%/1%-level.
Data source: Income and Expenditure Survey (EVS) 1998, 2003 and 2008.

ative to gross income and relative to net income - are similar across treatment and control groups. On average, about 13% (10%) of household net income (gross income) is declared as savings. This provides some first indication that families in the treatment group tend not to substitute old-age savings with public pension wealth. Nevertheless, families in the control group hold more net wealth on average. But parents in the treatment group are - due to construction - about a year younger than in the control group. Further, the share of employed mothers seems

to be slightly higher in the treatment group. The remaining socio-demographic characteristics are very similar across treatment and control group. Most fathers are employed, with about one third holding a university degree. The corresponding share among women is 17%. Finally, families have, on average, about two children. To sum up, the comparison of the socio-demographic characteristics across treatment and control group suggests that families of *1991 mothers* and not systematically different in observable characteristics from families of *1992 mothers*.

2.5.2 Main results

Next, Table 2.4 provides an econometric assessment of the impact of pension wealth on old-age savings, exploiting the increase of the child care pension benefit. While in the left panel of the table savings is related to net income, in the right panel the savings rate is based on gross income. In the following, 'Treatment' is defined as the impact of being in the treatment group, i.e. families with a child birth in 1992, on a family's old-age savings.

Table 2.4: Savings reaction of couple families to the increase of the child care pension benefit

Outcome	Savings/net income				Savings/gross income			
	Base		Interaction		Base		Interaction	
Treat	-0.0022	-0.0022	-0.0092*	-0.0083	-0.0028	-0.0033	-0.0099	-0.0096
	(0.0034)	(0.0034)	(0.0053)	(0.0053)	(0.0043)	(0.0043)	(0.0066)	(0.0066)
Treat*2003			0.0148*	0.0128			0.0141	0.0125
			(0.0080)	(0.0079)			(0.0099)	(0.0098)
Treat*2008			0.0105	0.0090			0.0119	0.0103
			(0.0087)	(0.0087)			(0.0109)	(0.0109)
2003	-0.0122***	-0.0130***	-0.0194***	-0.0193***	-0.0130***	-0.0145**	-0.0199***	-0.0206***
	(0.0040)	(0.0046)	(0.0056)	(0.0060)	(0.0049)	(0.0057)	(0.0069)	(0.0074)
2008	-0.0272***	-0.0242***	-0.0325***	-0.0288***	-0.0305***	-0.0277***	-0.0364***	-0.0330***
	(0.0043)	(0.0061)	(0.0062)	(0.0076)	(0.0054)	(0.0075)	(0.0077)	(0.0094)
Controls	No	Yes	No	Yes	No	Yes	No	Yes
N	5450	5450	5450	5450	5450	5450	5450	5450

Notes: The sample is based on West German couple families who had one child either in 1991 (control group) or in 1992 (treatment group). */**/*** Statistically significant at the 10%/5%/1%-level, robust standard errors are reported in brackets.
The control variables contain the parent's education, the father's age, family size, as well as indicators for the federal states and the interview quarter. The specifications that include control variables also control non-parametrically for the age of the mother.
Data source: Income and Expenditure Survey (EVS) 1998, 2003 and 2008.

The results of the OLS estimation of equation 2.1 are displayed in the 'Base' columns and the results of the OLS estimation of equation 2.2 are shown in the 'Interaction' columns. Each first column provides an estimate without control variables, apart from year indicators. The specifications with controls include the parent's education, the father's age, the family size, as well as indicators for the federal states and for the quarter of interview. Further they control non-parametrically for a mother's age. First, we focus on the left panel that relates family savings to net income. In the Base model, the point estimate of the treatment effect is very small. Taking it at its face value, the increase in pension wealth - due to the more generous child care pension benefit - would reduce the savings rate by 0.22 percentage points. While the direction of the effect is in line with our expectations, the magnitude of the effect is literally zero. Furthermore, it is not statistically significant. The inclusion of control variables leaves the estimated effect unchanged. Considering the estimated treatment effect based on the interaction model, the estimated effect is negative with - 0.92 percentage points and only weakly statistically significant. However, controlling for socio-economic characteristics renders the effect statistically insignificant. The positive point estimates of the interaction terms suggest that families with *1992 mothers* tend to save more in 2003 and 2008 than in 1998. However, again after including controls in the model, this relationship vanishes. When looking at the right panel, which shows the estimates based on the savings rate relative to gross income, the findings are very similar to model that uses the savings rate relative to net income. Sign and magnitude of the effect estimates are almost identical and in none of the four specifications, the estimated relationship appears to be statistically significant. Considering all results together, it suggests that overall the more generous individual child care pension benefit had

no impact on family savings decisions.

Next, Table 2.5 focuses on the impact of the treatment on the stock of net wealth.

Table 2.5: The impact of of the increase in child care pension benefits on the net wealth of couple families

Outcome	Net wealth			
	Base		Interaction	
Treat	-15.0857***	-4.7010	-15.0017**	0.3357
	(5.2562)	(4.8711)	(6.0659)	(5.5976)
Treat*2003			-1.7503	-9.7316
			(12.8910)	(12.4216)
Treat*2008			2.0994	-8.6956
			(13.2035)	(12.5004)
2003	43.6087***	-5.6541	44.4512***	-0.8899
	(6.4734)	(6.3606)	(9.9502)	(9.4174)
2008	41.0248***	-48.8457***	40.0106***	-44.4733***
	(6.6105)	(9.7172)	(9.6078)	(11.8039)
Controls	No	Yes	No	Yes
N	5450	5450	5450	5450

Notes: The sample is based on West German couple families who had one child either in 1991 (control group) or in 1992 (treatment group). */**/*** Statistically significant at the 10%/5%/1%-level, robust standard errors are reported in brackets.
The control variables contain the parent's education, the father's age, family size, as well as indicators for the federal states and the interview quarter. The specifications that include control variables also control non-parametrically for the age of the mother. All specifications include a constant.
Data source: Income and Expenditure Survey (EVS) 1998, 2003, and 2008.

The OLS results are shown for Equation 2.1 and 2.2, with and without the inclusion of controls. In the first column, the base model predicts a very strong significant negative impact of treatment on the stock of net wealth. Accordingly, being in the treatment group would reduce net wealth substantially by about €15,000. Even though, this negative relationship is in line with our expectations, the effect size is very large. However, after adding controls the magnitude of the effect becomes

much smaller and it turns insignificant. Since, parents in the control group are on average about one year older, it seems quite plausible that their stock of wealth is higher.[19] However, this result stresses the importance of including the age of parents as regressors to account for this age difference between the two groups. The interaction model confirms these findings. Likewise, the interaction model without controls finds a strong negative and significant effect that vanishes after including controls into the model.

Considered together, the findings suggest that the negative savings incentives, implied by the more generous child care pension benefit, did not influence the savings behavior of affected parents.

What could be potential explanations for the lack of finding a savings response of parents? Parents could have a strong discount factor or a short decision-making horizon. For these parents the magnitude of the beneficial provision of the child care pension benefit would have been too small, since they value current income more strongly than future income. Alternatively, they might not have considered the impact of today's decision on future income. To test whether the relative importance of child care pension benefits in old-age income matters, one should divide the sample according to the level of the expected old-age income of a family and repeat the analysis. The maximum gain from the more generous child care pension benefit provision is generally not dependent on future old-age income. Hence, the relative importance of the child care pension benefits for old-age income diminishes with increasing expected old-age income. Since the data does not provide information about future old-age income, I split the sample according

[19]Figure 2-1 and Figure 2-2 (in the appendix) show the average net wealth by the age of a parent. The graphs show that net wealth increases by a parent's age, at least until the age of 50. After that age level the results become fuzzy due to the smaller number of observations.

to net income and net wealth, which seems to be a good proxy and repeat the analysis.

2.5.3 Heterogeneous effects

Table 2.6 shows the estimation results for the interaction model (equation 2.2), including controls, by quartiles of net income and by quartiles of net wealth. In the upper part, the outcome is the savings rate, based on net income.[20] The lower part focuses on the specification where the outcome is replaced by net wealth. From the comparison of the treatment effect by quartiles of family net income and net wealth, we can infer how the treatment effect evolves along the net income and wealth quartiles. First, we focus on the upper part of the table. Comparing the estimated treatment effect by quartiles of net income shows that the effect is not statistical significantly different from zero in any of the four quartiles. Apart from the second quartile, the point estimates are relatively small. However, the high standard errors indicate the large statistical uncertainty. Next, the sample is distinguished by the four different net wealth quartiles. Again, in three of the four quartiles the treatment effects are relatively small and statistically insignificant. Only for families whose net wealth falls in the second quartile is the treatment estimate negative and weakly significant. Accordingly, the more generous child care pension benefit lowers their savings rate moderately by about three percentage points. Now, we focus on the lower panel of the table, where the outcome is net wealth. Again, comparing the treatment effect by net income quartiles does not provide a clear pattern. All four separate treatment estimates are statistically insignificant. Repeating the exercise based on the net wealth quartiles shows that

[20] The results for the savings rate, based on gross income, are very similar and available upon request.

apart from the estimated treatment effect in the first quarter, which is only weakly statistically significant, all estimates are statistically insignificant.

Considered together, the findings suggest that families do not react differently to the more generous child care pension benefit, depending neither on their position in the net income nor net wealth distribution. Only families in the treatment group who are in the second net wealth quartile tend to save less in response to the more generous child care pension benefit.

Table 2.6: Savings reaction of couple families to the increase of the child care pension benefit by household net income and net wealth quartiles

Outcome	Savings/net income							
Sub-sample	*Net income quartiles*				*Net wealth quartiles*			
	Q1	*Q2*	*Q3*	*Q4*	*Q1*	*Q2*	*Q3*	*Q4*
Treat	0.0039	-0.0182	-0.0068	-0.0060	0.0050	-0.0324**	-0.0069	0.0003
	(0.0116)	(0.0126)	(0.0134)	(0.0151)	(0.0116)	(0.0134)	(0.0129)	(0.0155)
Treat*2003	-0.0187	0.0203	0.0163	0.0019	-0.0039	0.0284	0.0245	-0.0111
	(0.0208)	(0.0182)	(0.0192)	(0.0212)	(0.0192)	(0.0194)	(0.0197)	(0.0216)
Treat*2008	0.0284	0.0127	0.0042	-0.0044	0.0095	0.0399*	0.0108	-0.0223
	(0.0216)	(0.0208)	(0.0206)	(0.0243)	(0.0206)	(0.0213)	(0.0225)	(0.0245)
N	1362	1363	1363	1362	1362	1363	1363	1362
Outcome	Net wealth							
Sub-sample	*Net income quartiles*				*Net wealth quartiles*			
	Q1	*Q2*	*Q3*	*Q4*	*Q1*	*Q2*	*Q3*	*Q4*
Treat	13.0190	1.3925	-4.5665	8.5361	-2.9894*	-0.4093	-0.6284	23.0658
	(8.1169)	(9.5827)	(11.8541)	(15.0206)	(1.6667)	(2.3866)	(2.5058)	(14.4930)
Treat*2003	-18.4780	9.1969	-18.3571	-41.9489	2.0675	3.7293	-1.8408	-42.0127
	(15.3781)	(20.9549)	(26.8941)	(29.3954)	(4.5805)	(3.8376)	(4.0998)	(29.5804)
Treat*2008	-5.5279	12.4265	-22.0639	-27.9454	-1.3727	-2.5288	7.0925	-62.9179**
	(25.5685)	(21.6262)	(22.0902)	(29.2458)	(5.3714)	(4.3302)	(4.4134)	(28.9811)
N	1362	1363	1363	1362	1362	1363	1363	1362

Notes: The sample is based on West German couple families who had one child either in 1991 (control group) or in 1992 (treatment group). Net wealth is measured in €100,000s. */**/*** Statistically significant at the 10%/5%/1%-level, robust standard errors are reported in brackets.

All specifications are based on the model that is specified by equation 2, including control variables. They are the parent's education, the father's age, family size, as well as the federal states and the interview quarter. The specifications that include control variables also control non-parametrically for the age of the mother.

Data source: Income and Expenditure Survey (EVS) 1998, 2003, and 2008.

So far, the sample consists of families in which both parents were present. Next, I focus on a subgroup of the population that might have been affected in particular by the more generous child care pension benefit provision. In contrast to couple families, the old-age income of single mothers is based on their own pension wealth and old-age savings. Single mothers cannot pool their old-age income with a partner - if they remain single - and hence a change in their pension wealth might have a stronger impact on their savings behavior. Further, single mothers generally posses less wealth than couple families (see Table 2.3 and Table 2.15). Therefore, they belong to a more vulnerable subgroup of the population.

Table 2.7: Savings reaction of single mothers to the increase of the child care pension benefit

Outcome	Savings/net income				Net wealth			
Model	Base		Interaction		Base		Interaction	
Treat	-0.0026	-0.0025	-0.0262	-0.0302	-1.7760	0.4547	-5.0505	-2.6365
	(0.0119)	(0.0115)	(0.0190)	(0.0193)	(8.0746)	(7.9678)	(14.9830)	(14.8671)
Treat*2003			0.0160	0.0166			7.5054	0.8109
			(0.0298)	(0.0303)			(19.8736)	(19.8008)
Treat*2008			0.0532*	0.0638**			2.4009	8.0960
			(0.0275)	(0.0273)			(20.4317)	(20.0115)
2003	-0.0084	-0.0138	-0.0144	-0.0201	8.2954	-6.1484	4.5009	-6.2972
	(0.0148)	(0.0168)	(0.0218)	(0.0226)	(10.0793)	(11.2459)	(14.3041)	(15.7098)
2008	-0.0157	-0.0098	-0.0396**	-0.0397*	6.6152	-23.4751*	5.5824	-27.3215
	(0.0138)	(0.0197)	(0.0193)	(0.0227)	(10.3510)	(12.9394)	(14.9845)	(17.2322)
Controls	No	Yes	No	Yes	No	Yes	No	Yes
N	666	666	666	666	666	666	666	666

Notes: The sample is based on West-German single mothers who had one child either in 1991 (control group) or in 1992 (treatment group). Net wealth is measured in €100,000s. */**/*** Statistically significant at the 10%/5%/1%-level, robust standard errors are reported in brackets.

The control variables contain the mother's education, the mother's employment status, family size, as well as indicators for the federal states and the interview quarter. The specifications that include control variables also control non-parametrically for the age of the mother.

Data source: Income and Expenditure Survey (EVS) 1998, 2003, and 2008.

Table 2.15 compares the sample characteristics by the corresponding treatment and control groups that are constructed analogously to couple families. Mothers in the treatment group are not substantially different from mothers in the control group. Solely, *1991 mothers* tend to be more likely to be in employment compared to *1992 mothers*. However, for the purpose of this analysis the two groups seem to be comparable. Table 2.7 shows the treatment effect for single mothers. In the left part of the table, the outcome is defined as savings/net income.[21] In the right part, the outcome is defined as net wealth. In contrast to the previous econometric models, the control variables that are included are the mother's education, the mother's employment status, family size, the federal states and the the interview quarter. First, we focus on the left panel that relates family savings to net income. In the Base model, the estimated impact of being in the treatment group is negative and very small. Taking the point estimate at its face value, the increase in pension wealth - due to the more generous child care pension benefit - would reduce the savings rate by 0.26 percentage points. However, this relationship is not statistically significant. The inclusion of control variables does not affect the estimated effect. Considering the estimated impact based on the interaction model, the estimated effect is - 2.6 to -3 percentage points, but not statistically significant. The right panel shows the estimated treatment effect, when the outcome is net wealth. The first column of the base model predicts a moderate negative impact on net wealth. However, after including controls, the effect estimate turns even positive and its magnitude becomes much smaller. The same pattern is true for the interaction model. After including controls, the magnitude of the point estimate shrinks substantially. However, all point estimates are statistically in-

[21] Specifying the savings rate as savings relative to gross income leads to similar results.

significant, reflecting the statistical uncertainty due to the smaller sample size. Considering the findings for single mothers together, no reaction to the increase in their pension wealth due to the more generous child care pension benefit can be identified, neither for the savings rate nor for their stock of net wealth.

2.5.4 Sensitivity checks

This section tests the sensitivity of the empirical findings.

Parental Leave and family savings

As previously described, the parental leave extension that was introduced in 1992 for newborns - similar to the increase in the generosity of the child care pension benefit - imposes a threat to the identification strategy if families adjust their savings as a result of longer parental leave. To assess the potential impact of parental leave on savings, I exploit the parental leave expansion in 1986. Starting from January 1986, parental leave was expanded from 6 to 10 months and all mothers became entitled to maternity payment regardless of their employment status prior to child birth (Dustmann and Schönberg, 2011). Families who had a child in 1986 - being entitled to longer parental leave - are expected, *certeris paribus*, to increase old-age savings compared to mothers who had a child shortly before the policy change - being entitled to the shorter parental leave.

This institutional feature allows us to apply the same identification strategy, used in this paper. Mothers who had a child in 1986 - being affected by the parental leave expansion - are selected into a treatment group. Whereas families who had a child in 1985 - not affected by the parental leave expansion - are selected into a control group. The parental leave sample mimics the sample that is used in the

main part of the paper: It relies on West German couple families with a newborn in 1985 or 1986, while families with multiple births in 1985 or 1986 are excluded. In addition, families in which at least one of the parents is a self-employed farmer, a freelancer, a civil servant or already retired are removed from the sample. The final sample consists of 2,778 families.

Naturally, this identification strategy is only valid if parents in the treatment and the control group are in fact not systematically different. I check this by comparing observable characteristics across both groups based on the EVS 1998, 2003, and 2008.[22]

Table 2.8 shows the mean comparison of the sample characteristics across treatment and control groups. First, the savings rate based on net income is slightly but not statistically significant higher in the treatment group. Savings relative to gross income is about 10% in both groups and net wealth is about €220,000. Parents are statistically significant older in the control group. This is not surprising since children in the control group are on average one year older at the time of the interview. However, it is important to control for the parent's age in the regression analysis. The parent's employment status and share of parents holding a university degree does not differ between the treatment and the control groups. Finally, all families have on average two children at the time of the interview. To sum up, the comparison of the sample characteristics across the treatment and the control groups suggests that both groups are relatively similar.

Next, we focus on the results from the estimations depicted in Table 2.9. The first row contains the estimated impact of being in the treatment group on old-age

[22]Comparing births in 1985 and 1986 based on this data makes it more likely that some children are no longer living in the same household. However, this does not affect the identification since children leaving the household identically affects the treatment and control groups.

Table 2.8: Sample characteristics by treatment and control groups (analysis of the parental leave reform 1986)

	Control group		Treatment group		Difference
Variable	Mean	SD	Mean	SD	t-statistic
Savings and net wealth					
Savings/net income	0.125	0.161	0.133	0.156	-1.501
Savings/gross income	0.100	0.129	0.105	0.124	-1.215
Net wealth	224.8	255.8	215.1	226.2	1.246
Socio-demographics					
Father's age	47.16	6.545	46.40	6.667	3.534***
Mother's age	44.00	5.534	43.23	5.640	4.228***
Father employed	0.924	0.265	0.928	0.259	-0.413
Mother employed	0.487	0.500	0.510	0.500	-1.397
University degree (father)	0.322	0.467	0.325	0.468	-0.172
University degree (mother)	0.140	0.347	0.149	0.356	-0.746
Family size	4.125	0.719	4.164	0.689	-1.718*
Group size	1685		2167		

Notes: The sample is based on West German couple families who had a child in 1985 (control group) or in 1986 (treatment group). Net wealth is measured in €100,000s. */**/*** Statistically significant at the 10%/5%/1%-level.
Data source: Income and Expenditure Survey (EVS) 1998, 2003, and 2008.

savings. While in the base model, the treatment effect is captured by a single indicator, the interaction model allows for a differential treatment effect in the three different waves. When we do not include controls, the Treatment impact is positive and weakly statistically significant. After including controls, however, being in the treatment group does not affect family savings. To conclude, this analysis provides evidence that parents tend not to respond to an increase of parental leave by higher old-age savings.

Bandwidth variation

In order to test whether the empirical findings are sensitive to how the bandwidth around the reform cut-off date 1/1/1992 is defined, this section increases the sam-

Table 2.9: Estimation results - couples (analysis of the parental leave reform 1986)

	Base		Interaction	
Treat	0.0087*	0.0062	0.0117*	0.0089
	(0.0050)	(0.0051)	(0.0069)	(0.0070)
Treat*2003			-0.0037	-0.0037
			(0.0110)	(0.0109)
Treat*2008			-0.0143	-0.0120
			(0.0161)	(0.0160)
2003	-0.0152***	-0.0100	-0.0132	-0.0080
	(0.0054)	(0.0062)	(0.0084)	(0.0089)
2008	-0.0161**	0.0029	-0.0073	0.0103
	(0.0077)	(0.0098)	(0.0129)	(0.0145)
Controls	No	Yes	No	Yes
N	3850	3850	3850	3850

Notes: The sample is based on West German couple families who had a child in 1985 (control group) or in 1986 (treatment group). The control variables are the parent's age, education and the father's age and birth order of the child. The specifications that include control variables also control non-parametrically for the age of the mother. Net wealth is measured in €100,000s. */**/*** Statistically significant at the 10%/5%/1%-level, robust standard errors are reported in brackets.
Data source: Income and Expenditure Survey (EVS) 1998, 2003, and 2008.

ple and repeats the estimation. So far a family entered the treatment group if it had a child in 1992, hence benefiting from the longer duration of the child care pension benefit. Families who had a child in 1991 - being subject to the shorter child care pension benefit duration - are in the control group. While it is well known that a larger sample increases efficiency, comparing parents who had a child further away from the cut-off date of the reform (1/1/1992) is less desirable. Those families are more likely to differ in more dimensions than in the child care pension benefit scheme. Nevertheless, for the purpose of this sensitivity check a range of two years is chosen. Now families who had a child in 1990 or 1991 are in the

control group, while families who had a child in 1992 or 1993 are in the treatment group. Table 2.16 in the appendix provides a comparison of the observable characteristics across the two groups. The descriptive comparison does not provide evidence for a systematic difference across treatment and control groups, apart from parents in the control group being on average older and possessing higher levels of net wealth. Table 2.10 provides the estimated impact of the more gener-

Table 2.10: Savings reaction of couple families to the increase of the child care pension benefit after re-defining the treatment and control groups

Outcome	Savings/net income	Savings/gross income	Net wealth
Baseline scenario			
Treat	-0.0083	-0.0096	0.3357
	(0.0053)	(0.0066)	(5.5976)
Treat*2003	0.0128	0.0125	-9.7316
	(0.0079)	(0.0098)	(12.4216)
Treat*2008	0.0090	0.0103	-8.6956
	(0.0087)	(0.0109)	(12.5004)
N	5450	5450	5450
Larger bandwidth			
Treat	-0.0086	-0.0062	6.9111
	(0.0055)	(0.0045)	(4.9251)
Treat*2003	0.0111	0.0091	-14.7462
	(0.0082)	(0.0066)	(14.6564)
Treat*2008	0.0125	0.0104	-4.9221
	(0.0091)	(0.0073)	(10.5878)
N	7985	7985	7985

Notes: The Baseline scenario sample is based on West German couple families who had one child, either in 1991 (control group) or in 1992 (treatment group). The 'larger bandwidth' scenario sample is based on West German couple families who had one child, either in 1990/1991 (control group) or in 1992/1993 (treatment group). */**/*** statistically significant at the 10%/5%/1%-level, robust standard errors are reported in brackets. All specifications contain the following control variables: The parent's education, the father's age, family size, federal states and the quarter of interview. In addition, the specifications control non-parametrically for the age of a mother.
Data source: Income and Expenditure Survey (EVS) 1998, 2003, and 2008.

ous child care pension benefit on family old-age savings for two scenarios relying on the interaction model, including control variables (equation 2.2). Comparing

the estimated treatment effect from the larger bandwidth to the baseline scenario shows that both models lead to almost identical results even though the sample is nearly twice as large. As in the baseline model, the estimated savings responses are not statistically significant different from zero.

2.6 Discussion and conclusion

This paper investigates whether a mother's pension wealth crowds-out private savings of families. To identify causal effects I exploit variation in pension wealth given by two extensions of the German child care pension benefit in 1992 and in 1999 using a regression discontinuity design. Child care pension benefits generally increase a mother's pension entitlements in periods when child care precludes work.

The empirical results show that neither old-age savings nor net wealth of couple families that benefited from the more generous child care pension benefit is affected. The analysis of subgroups along the family net wealth or net income quartiles confirms the general findings. The savings response in the first quartile is not substantially different from the one of families in the top quartile. In contrast to couple families, where the relative importance of a mother's pension wealth is lower, single mothers are potentially more prone to be affected by the reforms of the child care pension benefit. However, when analyzing the savings response to the reforms of the child care pension benefit of single mothers, the findings are line with those for couple families. The higher pension wealth does equally not induce single mothers to adjust old-age savings.

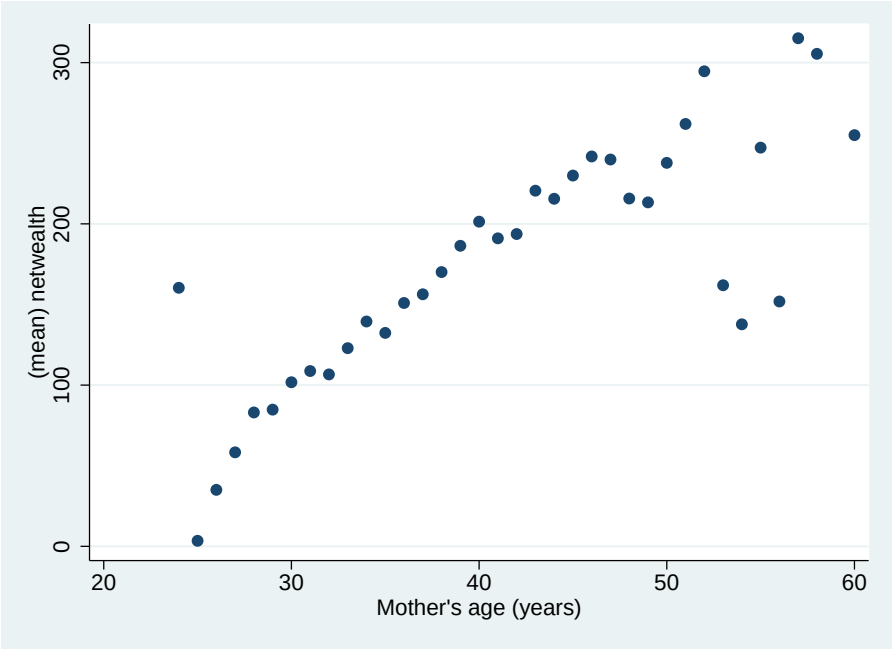
The main goal of child care pension benefits is to compensate mothers for child-raising periods that preclude employment. The empirical findings provide evidence

that child care pension benefits indeed increase pension wealth without crowding-out private old-age savings. Hence, the child care pension benefit compensates mothers for employment interruptions due to child-raising periods and hence improve the individual old-age income of mothers. A recent pension reform in 2014 increased the pension entitlements - through the child care pension benefit - that are granted to mothers for child births prior to 1992 from one to two years. Based on the findings of this paper, the new so called 'mother's pension' is unlikely to affect old-age savings of mothers.

Finally, old-age income of mothers can be affected in different ways. While the pension benefits do not only provide savings incentives, also the employment and retirement entry decision of mothers might be affected. Thiemann (2015) found that mothers do not reduce their employment in response to the longer provision of child care pension benefits. However, it is still an empirical question as to what way child care pension benefits influence the retirement date of mothers.

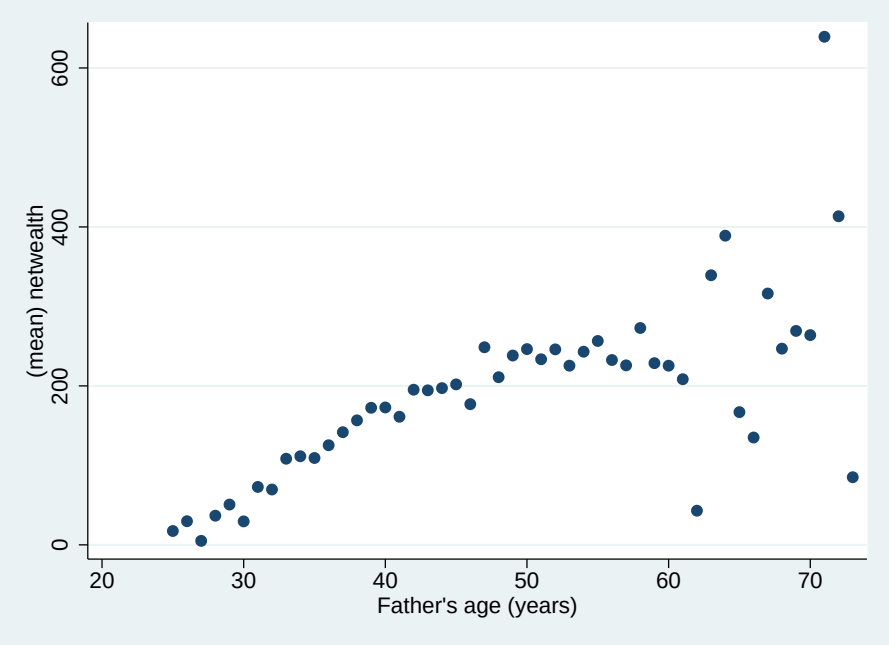
Appendix

Figure 2-1: Average net wealth by age of mothers (couple family sample)



Data source: Income and Expenditure Survey (EVS), own calculation.

Figure 2-2: Average net wealth by age of fathers (couple family sample)



Data source: Income and Expenditure Survey (EVS), own calculation.

Table 2.11: The savings reaction of couple families to the increase of child care pension benefits, including detailed estimation results

Outcome	Savings/gross income				Savings/net income			
Treat	-0.0022	-0.0022	-0.0092*	-0.0083	-0.0028	-0.0033	-0.0099	-0.0096
Treat*2003			0.0148*	0.0128			0.0141	0.0125
Treat*2008			0.0105	0.0090			0.0119	0.0103
2003	-0.0122***	-0.0130***	-0.0194***	-0.0193***	-0.0130***	-0.0145**	-0.0199***	-0.0206***
2008	-0.0272***	-0.0242***	-0.0325***	-0.0288***	-0.0305***	-0.0277***	-0.0364***	-0.0330***
Father age		0.0001		0.0001		-0.0000		-0.0000
Househ. size		0.0036		0.0035		-0.0004		-0.0004
Father empl.		0.0246***		0.0248***		0.0424***		0.0426***
Mother empl.		0.0128***		0.0128***		0.0233***		0.0233***
Mother educ.2		-0.0161*		-0.0160*		-0.0176		-0.0175
Mother educ.3		-0.0151*		-0.0150*		-0.0186*		-0.0185*
Mother educ.4		-0.0100		-0.0099		-0.0127		-0.0127
Mother educ.5		-0.0071		-0.0072		-0.0074		-0.0075
Mother educ.6		-0.0201		-0.0195		-0.0288		-0.0282
Mother educ.7		-0.0034		-0.0034		-0.0045		-0.0045
Father educ.2		0.0044		0.0044		0.0017		0.0017
Father educ.3		-0.0028		-0.0028		-0.0035		-0.0035
Father educ.4		-0.0096		-0.0095		-0.0124*		-0.0123*
Father educ.5		-0.0206		-0.0204		-0.0230		-0.0227
Father educ.6		-0.0723*		-0.0716*		-0.0769*		-0.0762*
Father educ.7		-0.0274*		-0.0275**		-0.0361**		-0.0363**
Intv. 2. quart.		-0.0043		-0.0043		-0.0048		-0.0048
Intv. 3. quart.		-0.0154***		-0.0154***		-0.0184***		-0.0184***
Intv. 4. quart.		0.0013		0.0014		0.0056		0.0058
Constant	0.1149***	0.1929***	0.1185***	0.1967***	0.1435***	0.2510***	0.1472***	0.2548***
Federal states	No	Yes	No	Yes	No	Yes	No	Yes
Mage dummies	No	Yes	No	Yes	No	Yes	No	Yes
N	5450	5450	5450	5450	5450	5450	5450	5450

Notes: The sample is based on West German couple families who had a child either in 1985 (control group) or in 1986 (treatment group). The specifications that include control variables also control non-parametrically for the age of the mother. The education variable definition is as follows: 1 (reference category) - 'university degree', 2 'technical college degree', 3 'senior clerk, technician, master craftsman', 4 'apprenticeship', 5 'other professional qualification', 6 'undergoing training', 7 'no degree'. */**/*** Statistically significant at the 10%/5%/1%-level.

Data source: Income and Expenditure Survey (EVS) 1998, 2003, and 2008.

Table 2.12: The impact of the increase in child care pension benefits on net wealth of couple families

Outcome	Net wealth			
Treat	-15.0857***	-4.7010	-15.0017**	0.3357
Treat*2003			-1.7503	-9.7316
Treat*2008			2.0994	-8.6956
2003	43.6087***	-5.6541	44.4512***	-0.8899
2008	41.0248***	-48.8457***	40.0106***	-44.4733***
Father age		5.3760***		5.3876***
Househ. size		17.1118***		17.1449***
Father empl.		50.9554***		50.7912***
Mother empl.		-6.3302		-6.3078
Mother educ.2		-8.2410		-8.3330
Mother educ.3		-10.6023		-10.7010
Mother educ.4		-13.0487		-13.0744
Mother educ.5		-65.6898***		-65.5971***
Mother educ.6		-66.9386***		-67.4251***
Mother educ.7		-59.2426***		-59.3070***
Father educ.2		18.4387*		18.4020*
Father educ.3		-2.0676		-2.0847
Father educ.4		-35.4073***		-35.4920***
Father educ.5		-61.3964***		-61.6282***
Father educ.6		6.6691		6.1077
Father educ.7		-71.1146***		-71.0262***
Intv. 2. quart.		9.2895		9.2952
Intv. 3. quart.		6.6170		6.6407
Intv. 4. quart.		-6.7401		-6.8820
Constant	163.1210***	-95.7238	163.0784***	-98.8131
Federal states	No	Yes	No	Yes
Mage dummies	No	Yes	No	Yes
N	5450	5450	5450	5450

Notes: The sample is based on West German couple families who had a child either in 1985 (control group) or in 1986 (treatment group). The specifications that include control variables also control non-parametrically for the age of the mother. The education variable definition is as follows: 1 (reference category) - 'university degree', 2 'technical college degree', 3 'senior clerk, technician, master craftsman', 4 'apprenticeship', 5 'other professional qualification', 6 'undergoing training', 7 'no degree'. */**/*** Statistically significant at the 10%/5%/1%-level. *Data source*: Income and Expenditure Survey (EVS) 1998, 2003, and 2008.

Table 2.13: The impact of a change in pension wealth on family net wealth among single mothers

	Savings/gross income				Savings/net income			
Treat	-0.0005	-0.0006	-0.0206	-0.0247	-0.0026	-0.0025	-0.0262	-0.0302
Treat*2003			0.0126	0.0148			0.0160	0.0166
Treat*2008			0.0460*	0.0553**			0.0532*	0.0638**
2003	-0.0081	-0.0106	-0.0128	-0.0163	-0.0084	-0.0138	-0.0144	-0.0201
2008	-0.0134	-0.0055	-0.0341**	-0.0315*	-0.0157	-0.0098	-0.0396**	-0.0397*
Mother empl.		0.0420***		0.0427***		0.0556***		0.0564***
Househ. size		0.0133**		0.0134**		0.0110		0.0111
Mother educ.2		-0.0382*		-0.0381*		-0.0524*		-0.0523*
Mother educ.3		-0.0063		-0.0057		-0.0134		-0.0127
Mother educ.4		-0.0264		-0.0270		-0.0397**		-0.0404**
Mother educ.5		-0.0380		-0.0390		-0.0543		-0.0554
Mother educ.6		0.0305		0.0339		0.0254		0.0295
Mother educ.7		-0.0078		-0.0055		-0.0112		-0.0085
Intv. 2. quart.		0.0048		0.0051		0.0060		0.0063
Intv. 3. quart.		0.0056		0.0064		0.0069		0.0079
Intv. 4. quart.		0.0248*		0.0245*		0.0353**		0.0350**
Constant	0.0505***	-0.0424	0.0593***	-0.0167	0.0628***	-0.0401	0.0732***	-0.0106
Federal states	No	Yes	No	Yes	No	Yes	No	Yes
Mage dummies	No	Yes	No	Yes	No	Yes	No	Yes
N	666	666	666	666	666	666	666	666

Notes: The sample is based on West German single mothers who had a child either in 1985 (control group) or in 1986 (treatment group). The specifications that include control variables also control non-parametrically for the age of the mother. The education variable definition is as follows: 1 (reference category) - 'university degree', 2 'technical college degree', 3 'senior clerk, technician, master craftsman', 4 'apprenticeship', 5 'other professional qualification', 6 'undergoing training', 7 'no degree'. */**/*** Statistically significant at the 10%/5%/1%-level.
Data source: Income and Expenditure Survey (EVS) 1998, 2003, and 2008.

Table 2.14: The impact of pension wealth on family savings among single mothers

Outcome	Net wealth			
Treat	-1.7760	0.4547	-5.0505	-2.6365
Treat*2003			7.5054	0.8109
Treat*2008			2.4009	8.0960
2003	8.2954	-6.1484	4.5009	-6.2972
2008	6.6152	-23.4751*	5.5824	-27.3215
Mother empl.		31.1840***		31.3159***
Househ. size		13.1172***		13.1297***
Mother educ.2		-12.2846		-12.3113
Mother educ.3		-40.5360**		-40.4278**
Mother educ.4		-23.3316		-23.4347
Mother educ.5		-84.8053***		-85.0711***
Mother educ.6		-64.9544***		-64.2682***
Mother educ.7		-46.3695**		-45.9146**
Intv. 2. quart.		14.1485		14.2405
Intv. 3. quart.		5.1937		5.3498
Intv. 4. quart.		7.5688		7.5363
Constant	49.4397***	19.5437	50.8751***	22.7747
Federal states	No	Yes	No	Yes
Mage dummies	No	Yes	No	Yes
N	666	666	666	666

Notes: The sample is based on West German single mothers who had a child either in 1985 (control group) or in 1986 (treatment group). The specifications that include control variables also control non-parametrically for the age of the mother. The education variable definition is as follows: 1 (reference category) - 'university degree', 2 'technical college degree', 3 'senior clerk, technician, master craftsman', 4 'apprenticeship', 5 'other professional qualification', 6 'undergoing training', 7 'no degree'. */**/*** Statistically significant at the 10%/5%/1%-level.
Data source: Income and Expenditure Survey (EVS) 1998, 2003, and 2008.

Table 2.15: Sample characteristics by treatment- and control groups (single mothers)

	Control group		Treatment group		Difference
Variable	Mean	SD	Mean	SD	t-statistic
Savings and net wealth					
Savings/gross income	0.043	0.131	0.043	0.126	0.085
Savings/net income	0.055	0.160	0.052	0.145	0.243
Net wealth	54.15	107.0	52.94	106.3	0.146
Socio-demographics					
Mother's age	41.03	6.07	41.22	5.83	-0.419
University degree	0.187	0.390	0.198	0.399	-0.377
Mother employed	0.746	0.436	0.672	0.470	2.122**
Family size	2.813	0.838	2.885	0.847	-1.103
Group size	343		323		

Notes: The sample is based on West German single mothers who had a child either in 1991 (control group) or in 1992 (treatment group). */**/*** Statistically significant at the 10%/5%/1%-level.

Data source: Income and Expenditure Survey (EVS) 1998, 2003, and 2008.

Table 2.16: Sample characteristics by treatment- and control groups (larger bandwidth)

	Control		Treatment		Difference
Variable	Mean	SD	Mean	SD	t-statistic
Savings/wealth					
Savings/gross income	0.103	0.128	0.104	0.126	-0.157
Savings/net income	0.132	0.159	0.131	0.157	0.110
Net wealth	189.5	319.6	167.2	178.5	3.856***
Socio-demographics					
Mother's age	40.85	5.774	38.86	5.762	15.39***
Father's age	43.81	6.538	41.64	6.702	14.63***
Mother employed	0.476	0.499	0.489	0.500	-1.121
Father employed	0.941	0.235	0.939	0.240	0.431
University degree (mother)	0.157	0.364	0.163	0.370	-0.702
University degree (father)	0.324	0.468	0.328	0.469	-0.284
Family size	4.111	0.670	4.118	0.658	-0.462
Group size	3977		4008		

Notes: The sample is based on West German couple families who had a child either in 1990/1991 (Control group) or in 1992/1993 (Treatment group). */**/*** Statistically significant at the 10%/5%/1%-level.
Data source: Income and Expenditure Survey (EVS) 1998, 2003, and 2008.

Chapter 3

Pension wealth and the retirement decision of mothers[1]

3.1 Introduction

In many Western countries, women receive substantially lower pension payments compared to men. According to the OECD, pension payments to individuals aged 65 and more were on average about 34% lower for women than for men in 2009 (OECD, 2012). The main reason for this phenomenon is differences in employment biographies. Women are more likely to face career breaks and to work part-time. In particular, mothers are prone to career breaks following child births (OECD, 2015). In Germany, the child care pension benefits (*Kindererziehungszeiten*) compensate mothers for employment interruptions due to child births that preclude employment by increasing maternal pension wealth (Schmähl et al., 2006). However, while increasing maternal pension wealth, child care pension benefits also

[1]This chapter is based on a joint project with Johannes Endler who contributed one half to the overall project. It has not been published yet.

provide incentives for early retirement, which in contrast reduces monthly pension payments. The extent to which maternal old-age income increases is an empirical question.

In this paper, we investigate how maternal pension wealth affects a mother's retirement decision using German administrative data, namely BASiD (Biographical Data of Social Insurance Agencies in Germany (*Biographiedaten ausgewählter Sozialversicherungsträger in Deutschland (BASiD)*). The empirical analysis relies on a discrete survival model that exploits additional exogenous variation in maternal pension wealth, provided by two pension reforms in 1992 and 1996. While the pension reform in 1992 introduced permanent pension deductions in case of early retirement, the reform in 1996 accelerated the transition period over which they were implemented. Hence, these two reforms provide cohort-specific exogenous variation in pension wealth in the transition period. To identify the structural relationship between maternal pension wealth and retirement, we follow Coile and Gruber (2001) and rely on the 'peak value' - a modified version of the option value model - to implement the incentives of the German public pension system into the model.

We contribute to the political debate of 'child-related pension benefits' by simulating the impact of higher German child care pension benefits. More precisely, we increase them by two pension points per child (about €700 p.a. in West Germany and €650 p.a. in East Germany)[2], as they are granted proportional to the number of children. Hence, we evaluate by how the increase in maternal pension wealth through higher child care pension benefits results in higher pension payments, taking into account potential earlier retirement. In the light of the last reform of

[2]This example is calculated based on no deductions of pension payments due to earlier retirement.

child care pension benefits in Germany in 2014 (called 'mother's pension' (*Mütterrente*)), quantifying its impact on early retirement is particularly interesting. In the empirical analysis, we focus on mothers who are entitled to the so-called 'women's old-age pension' (*Altersrente für Frauen*), since they are affected by the deductions of their pension payments in case of early retirement, mentioned before. We find that they do not retire much earlier due to the increase in maternal pension wealth. When we increase pension entitlements of mothers by two pension points per child, mothers retire only about two and a half months earlier. Thus, child care pension benefits increase the individual old-age income of mothers without leading to considerably earlier retirement. Further, as a result of higher maternal pension entitlements, the simulated reform increase the average pension payment from €714 to €810. Hence, the child care pension benefit increases maternal old-age income without substantial early retirement effects.

Various papers have focused on how pension wealth affect retirement. Mitchell and Fields (1981) give a thorough overview of early research, which analyzes the retirement decision dependent on pension and Social Security benefits in a life-cycle framework. One drawback of early research is mentioned by Moffitt (1987), criticizing studies using cross-sectional data. It remains unclear if labor supply and retirement decisions can be identified by variation in social security benefits in a cross-section since differences in Social Security benefits only reflect variance in other variables e.g. earnings, marital status etc. Those variables might have a direct effect on labor supply and thus on retirement timing. To get around this identification problem, Krueger and Pischke (1992) analyze the natural experiment of the so called notch babies. Amendments enacted in 1977 lowered Social Security benefits of individuals born 1917 onward, whereas individuals born before

1917 were not affected by these changes. Krueger and Pischke (1992) use the resulting exogenous variation in benefits to examine its effect on labor supply. They only found a modest impact of Social Security benefits.

There are two main approaches on how to implement the dynamic structure of Social Security benefits in the literature. The first is a dynamic programming approach and the second is the use of an option value model. Rust (1989) shows how to apply a dynamic programming model to examine the retirement behavior of older male workers and estimates the model in a subsequent study (Rust, 1990). Other studies that apply dynamic programming are Berkovec and Stern (1991), Rust and Phelan (1997), Karlstrom et al. (2004) and Heyma (2004) among others. Instead of using a dynamic programming approach, Stock and Wise (1990) develop a model, called the option value model. They calculate individual utility when retiring now or at any later point of time. The option value measures the difference between retiring now and when utility is maximized. A similar analysis is completed by Samwick (1998) using a broader data set of American workers. Instead of comparing utility levels, Coile and Gruber (2001) take the difference between present value of Social Security wealth when it would be maximized and today's present value of Social Security wealth. This incentive measure, called peak value, do not need any assumptions on preferences for leisure. The concepts of option value and peak value are used by several researchers to analyze how Social Security affects retirement in 12 countries (Gruber and Wise, 2004). Although, the effects varies in magnitude, they find large responses of workers labor supply to incentives of Social Security program in all countries. For the German case, Börsch-Supan et al. (2004) expects an increase in retirement age of 8 months due to 1992 pension reform. Using data, capturing entries into retirement of some

affected cohorts, Hanel (2010) finds a causal delay of entry into retirement of 14 months.

A comparison of both approaches, dynamic programming and option value, is done by Lumsdaine et al. (1992) and Burkhauser et al. (2004). Lumsdaine et al. (1992) mention, that the option value approach might underestimate future values as it is based on the maximum of the expected values of utility whereas the dynamic programming approach is based on the expected value of maximum utility. For the same reason, the dynamic programming approach is theoretically preferred (Burkhauser et al., 2004). However, Lumsdaine et al. (1992) and Burkhauser et al. (2004) find quite similar estimation results for the option value and the dynamic programming approach. Taking the complexity and computation intensity of the dynamic programming model into account, the option value model is often favored. Therefore, we rely on a modified version of the option value model, namely the peak value framework.

The remainder of the paper is as follows: In the next section, we provide an overview of the institutional background, describing the German public pension system and in particular child care pension benefits. Next, we describe the data, followed by discussing the estimation methodology. Then, we present the empirical results and discuss the implications of the policy scenario. The last section concludes.

3.2 Institutional background

In this section, we describe the public pension system in Germany, specifically focusing on its role for mothers. First, we discuss the basic features and examine two pension reforms, in 1992 and 1996, which provide additional exogenous variation in pension wealth by implementing a penalty on early retirement that differs by birth cohort. Second, we shed more light on child care pension benefits.

3.2.1 The German public pension system

The German pension scheme is based on three pillars: The public pension system, occupational pension schemes, and private pension investments. The most important pillar is the public pension insurance that is mandatory for employees. At retirement about two thirds of old-age income in Germany stems from public pension system (Frommert and Himmelreicher, 2013). Civil servants have a separate tax-financed insurance system and the self-employed are not obliged to participate, but they can voluntarily choose to participate. Civil servants and the self-employed who do not participate in the public pension insurance are not considered in this study. The public pension insurance is organized as a pay-as-you-go system, where employees and employers equally share the mandatory pension contributions of 18.7% (in February 2016), levied on gross wages up to a cap. This monthly contribution ceiling is €6,050 (€72,600 p.a.) in West Germany and €5,200 (€62,400 p.a.) in East Germany[3] or about twice the average remuneration (*Durchschnittsentgelt*). The annual pension contributions are measured in so-called 'pension points'. Pension contributions equivalent to those levied on the

[3]Laid down in the German Social Code (*Sozialgesetzbuch, SGB*), SGB VI, supplement 2 and 2b.

average remuneration value one pension point. If individual gross income, which is subject to social security contributions, is larger (smaller) than average gross income the amount of pension points increase (decrease) proportionally. On the verge of retirement, pension payments are calculated based on the sum of accumulated pension points over the life course. In 2015, one pension point increases monthly old-age pensions - not being subject to deductions - by about €29 in West Germany (€27 in East Germany).

Among the different types of old-age pensions, the 'regular old-age pension' is the most common one, which can be claimed after reaching the pension eligibility age of 65 years and four months (in 2015) with at least five years of contributions.[4] Among all women who retired in 2014, 45% claimed the regular old-age pension (Deutsche Rentenversicherung Bund, 2015, p.67).

Retirement prior to the pension eligibility age is only possible if an insured person qualifies for an early old-age retirement pension: 'Especially long-term insured' (*besonders langjährig Versichte*) and 'long-term insured' (*langjährig Versicherte*), having at least 45 or 35, respectively, years of contributions (*Wartezeit*), can retire at the age of 63. The 'early retirement pension for invalids' (*Altersrente für Schwerbehinderte*) allows to retire before reaching the pension eligibility age if certain invalidity requirements are met and if an insured person has at least 35 years of contributions.

Insured persons who were born before 1952, can claim the 'women's old-age pension' (*Altersrente für Frauen*) or the 'old-age pension for the unemployed' (*Al-*

[4]The pension eligibility age is being gradually raised from 65 years in 2011 to 67 years in 2031. It increases by one month per birth cohort, for those born before 1959: Those born in 1947 reach the pension eligibility age at 65 and one month, the subsequent birth cohort of 1948 at 65 and two months, etc. For birth cohorts from 1959, it increases by two months until it reaches 67 years for insured born in 1964 or later (SGB VI §235 and SGB VI §35).

tersrente bei Arbeitslosigkeit oder Altersteilzeit) , if they meet the requirements, between the ages of 60 to 65. Qualifying for the pension for the unemployed requires at least 15 contribution years, including eight contribution years in the last ten years before retirement. In addition, it requires being unemployment at retirement entry and having been unemployed for at least 52 weeks after turning 58 years and six months or having been 'partially retired' for at least 24 months.[5] A woman can claim women's old-age pension if she had at least 15 years of contributions, with ten years of compulsory pension contributions from work made after turning 40 years old and further she must be born before 1952. If a mother is eligible for both types of old-age pensions – the women's old-age pension and the pension for the unemployed – then it will always be beneficial to choose the women's old-age pension since it allows for an earlier retirement.[6] The women's old-age pension is of particular interest, since the empirical analysis focuses on mother's who are eligible for the women's old-age pension.

Until 2000, mothers who could take advantage of the women's old-age pension had a strong incentive for an early retirement at age 60 since they did not face any deductions on their pensions (Hanel, 2010). To make early retirement less attractive, the Pension Reform Act 1992 (*Rentenreformgesetz 1992*) implemented a gradual increase in the eligibility age for early retirement without deductions. The Growth- and Employment Promotion Act 1996 (*Wachstums- und Beschäftigungsförderungsgesetz*) accelerated the implementation of the increase in eligibility age.[7] Figure 3-1 shows the increase in eligibility age for the women's old-age pen-

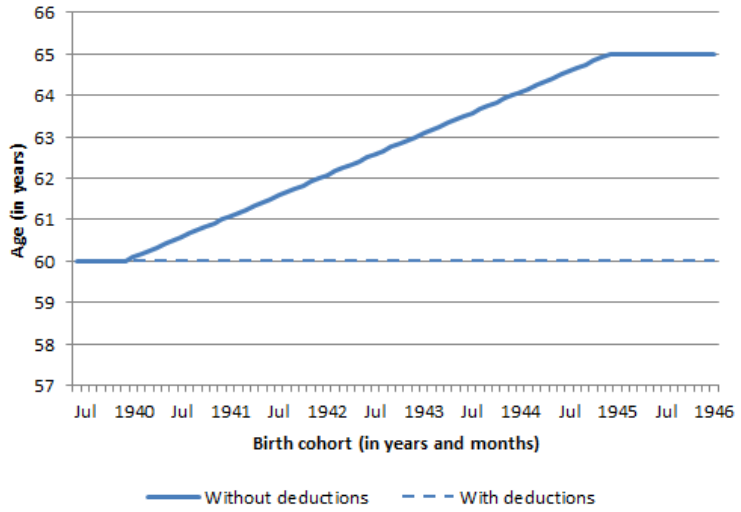
[5]Berg et al. (2015) describe in detail the institutional background of partial retirement in Germany.

[6]Based on the pension statistics, more than ten times more women retire through the women's old-age pension than the pension for the unemployed (Deutsche Rentenversicherung Bund, 2015).

[7]Haan and Prowse (2014) quantify deduction factors, for Germany, that ensure fiscal stability in the face of increasing life expectancy.

sion. Women who are born in January 1940 or later are affected by the increase

Figure 3-1: Eligibility age for the women's old-age pension by birth cohorts



Source: Growth- and Employment Promotion Act 1996 (*supplement 20*); adapted from Hanel (2010), own illustration.

in eligibility age, at which the pension can be claimed without deductions. Each subsequent month of birth raises the eligibility age for the women's old-age pension without deduction by a month. While a woman, born in January 1940, can claim full benefits at the age of 60 years and one month, a woman born a year later, in January 1941, can only claim the full pension at the age of 61 years and one month. For each month a woman claims the women's old-age pension before the deduction-free eligibility age, her pension payment is permanently reduced by 0.3 percentage points. The deductions are the strongest for women born in 1946 or later who enter retirement after turning 60: their monthly pensions are cut by 18 percentage points. We precisely exploit this exogenous variation in pension wealth that stems from differences in the birth cohorts, when we analyze how pension

wealth affects the retirement decision of mothers.

3.2.2 Child care pension benefits

Next, we describe 'child care pension benefits' (*Kindererziehungszeiten*) in the German public pension system. Employment interruptions due to child birth reduce labor earnings of mothers which in turn lead to decreasing pension entitlements. Based on retirement entries in 2014, monthly pension payments of women were €607 compared to €975 of men (Deutsche Rentenversicherung Bund, 2015). In the lights of changing family patterns, separations and non-married couples being more and more common, it becomes increasingly important to secure old-age income through individual pension entitlements. Therefore, child care pension benefits have been introduced in 1986 and expanded in several reforms to compensate mothers for periods of child care that precluded employment. Table 3.1 illustrates the evolution of child care pension benefits in the German pension system from 1986 until 2014 (c.f. Thiemann (2016)). From its introduction in 1986 until 1992, child care pension benefits granted 0.75 pension points per child to mothers for one year of child care.[8] In monetary terms, 0.75 pension points increase annual pension payments by about €261 in West Germany and by €243 in East Germany.[9]

The pension reform in 1992 tripled the duration of the child care pension benefit from one to three years for all births on January 1, 1992, or later. Hence, pension entitlements of affected mothers increased by up to 2.25 pension points through

[8] Mothers who were born before 1921 were not entitled. In principle, also fathers are entitled. However, predominantly mothers are recipients of the child care pension benefit.

[9] Assuming basic old-age retirement without deductions, based on 2016 pension values.

Table 3.1: The Development of the German child care pension benefit 1986 - 2014

Reform	Max. benefit (p.a.) in pension points	Duration	Child births
1986	0.75[a]	1 year	all[b]
1992	0.75	1 year 3 years	prior to Jan. 1992 as of Jan. 1992
1999	1.0[c]	1 year 3 years	prior to Jan. 1992 as of Jan. 1992
2014	1.0	2 years 3 years	prior to Jan. 1992 as of Jan. 1992

a) Pension point. It represents the annual pension contributions made by a person who earns the average remuneration in a year.
b) Only mothers, born after 1921 were entitled. Mothers born before are entitled to a similar pension benefit scheme.
c) The maximum benefit was gradually increased and in addition the employment penalty was abolished.
Source: Adopted from Thiemann (2016).

the child care pension benefit. In monetary terms, this is equivalent to an annual increase of pension payments of €783 in West Germany or to €729 in East Germany. Compared to births prior to the cut-off date January 1, 1992, the child care pension benefit increased by 1.5 pension points.

The pension reform in 1999 increased gradually and retrospectively the generosity of the benefit for each year from 0.75 to one pension point.[10] Further, there was no longer an employment penalty if a mother became employed during periods for which the child care pension benefit was granted if the sum of pension entitlements from employment and the child care pension benefit did not exceed the pension entitlements based on the contribution ceiling. In 2016, the contribution ceiling

[10]The monthly value at retirement of the child care pension benefit was increased from July, 1998 to 0.85 pension points, from July, 1999 to 0.9 pension points and from July, 2000 to one pension point (§256d SGB VI (German Social Code)).

amounts to twice the average remuneration or €72,600.

Finally, the most recent pension reform in 2014 expanded the provision period of the child care pension benefit for child births prior to January 1992 from one to two years. This increase, called 'mother's pension' (*Mütterrente*), partly offset the unequal treatment of child births - depending on the date of child birth - in the German pension system. Nevertheless, child births as of January 1992 still increase a mother's pension entitlements by up to three pension points, whereas the increase is only two pension points for earlier child births. In the policy scenario, we simulate an increase of child care pension benefits of two pension points per child and analyze its impact on maternal retirement and the distribution of pension payments (c.f. section 3.5.2). Since, the data covers the period until end of 2007, we implicitly simulate an equal treatment of children in terms of child care pension benefits in the German public pension system.

3.3 Data

The empirical analysis is based on the Scientific Use File of the Biographical Data of Social Insurance Agencies in Germany (*Biographiedaten ausgewählter Sozialversicherungsträger in Deutschland (BASiD)*, version 1951 - 2009), which is provided by the Research Data Center of the German Statutory Pension Insurance. The data is constructed by linking different administrative data sets via the unique social security number. First, a random sample is drawn among insured individuals in the Statutory Pension Insurance who are at least 15 years old but not older than 67 on the cut off date December 31, 2007. This sample is then combined with individual information from different data sources of the Federal Employment Agency. BASiD (SUF) provides information for about 60,000 individuals. It covers the entire employment biography of all individuals since the age of 14 until December 2007. In addition, it provides information on education, number and birth dates of children as well as employment-specific characteristics (Hochfellner et al., 2012).[11] In contrast to studies that rely on survey data, we do not have to approximate pension wealth but we can use the precise administrative information about individual monthly pension entitlements. In addition, BASiD does not suffer from panel attrition nor recall bias.

We select mothers who are born between 1940 and 1947, which leaves us with 5,870 mothers. In addition to observing actual retirement entries for these birth cohorts, we choose them because they are affected by the pension reform 1992 and the pension reform 1996. We exploit this exogenous variation in pension wealth, when estimating the impact of pension wealth on retirement. Otherwise, we would

[11] The education variable lacks information for several persons and spells. To improve the individual education information, we apply the imputation procedure by Fitzenberger et al. (2005).

have to assume that pension entitlements are uncorrelated with other factors that determine the retirement decision, e.g. tastes for work. By using only 'validated' pension accounts, we make sure that self-declared information was cross-checked by the German Pension Insurance to ensure accuracy. This drops 67 individuals from the sample. Further, we exclude all mothers who claim disability pensions, which lowers the sample to 5,498 mothers. Next, we select mothers who in principle are entitled to the women's old-age pension (*Altersrente für Frauen*), resulting in a sample size of 3,474 mothers.[12]

Mothers who are entitled to the women's old-age pension have a stronger labor market attachment than mothers who are not entitled, which shows their pension wealth: Measured at age 60, it amounts to about €140,000, whereas non-entitled mothers posess on average a pension wealth of about €50,000. Nevertheless, about 63% of all mothers can claim the women's old-age pension. Hence, they represent a large share of the population. Mothers can claim the women's old-age pension at the age of 60. Since, we estimate the impact of pension wealth on (early) retirement, we need to observe mothers who can retire through the women's old-age pension prior to the official pension eligibility age. Finally, 312 mothers are removed from the sample since the data set does not contain educational information for them. The final sample size is 3,130 mothers, who are included from age 60 onward until retirement entry or December 2007 if retirement is not observed. This results in 212,046 person-month-observations, with 2,509 retirement entries are observed. We count a mother as retired upon the first month she claims her

[12]In line with the law, we classify a mother as being entitled to the women's pension in the following way: We consider months for the calculation of the qualifying period (*Wartezeit*) if pension points were accumulated in that month (*'gmegptan'>0*). A mother qualifies for the women's pension if her qualifying period sums up to at least 15 years, while at least 10 years had to be accrued after the 40th birthday.

pension.

To capture the incentives of the public pension system we rely *inter alia* on a forward looking measure of public pension wealth. The calculation is based on individual pension points which are only observed before retirement[13]. At later months, we impute individual pension points by the average of the last 12 months until age 65[14].

In addition, we include factors that potentially are correlated with pension entitlements and the retirement decision in our analysis. We control for individual factors, such as education, 'East' and 'health problems'. We differentiate three levels of education. A mothers' education is low if she has no completed vocational training, education is medium if she has completed a vocational training and high if she holds a university (of applied sciences) degree. The East indicator is one if a mother accumulated pension entitlements in October 1989 or earlier in former East Germany and zero else. A mother with potential health problems, but who does not qualify for disability pensions might choose an early retirement entry. Following Hanel (2010), we measure health problems as reporting at least two months of sickness leave in the last three years.

To illustrate the characteristics of mothers in the sample, Table 3.2 shows their descriptive statistics by birth cohort. In all cohorts the majority has completed a vocational training. The share of mothers with a low level of education decreases in later birth years. On average the number of children varies between 1.94 and 2.23. Further, the share of East German mothers differs between 0.34 and 0.42 over the birth cohorts. Finally, only a small share of mothers faces health problems.

[13]See section 3.4 for details.

[14]Thus, we assume the retirement decision to be voluntary.

Table 3.2: Sample characteristics by birth cohort

Year of birth	1940	1941	1942	1943	1944	1945	1946	1947
Education								
Low	0.25	0.22	0.19	0.19	0.17	0.19	0.16	0.15
Medium	0.70	0.70	0.75	0.76	0.76	0.74	0.80	0.79
High	0.05	0.08	0.06	0.05	0.07	0.06	0.04	0.06
# of children	2.23	2.14	2.12	2.07	2.05	1.94	2.04	1.93
East	0.41	0.42	0.42	0.42	0.41	0.34	0.35	0.42
Bad Health	0.11	0.09	0.08	0.06	0.07	0.05	0.06	0.05
N	435	439	459	412	401	345	309	330

Notes: The comparison refers to the month a mother turns 60. Education is low if a mother has no completed vocational training, medium if she has completed a vocational training and high if she holds a university (of applied sciences) degree. East refers to contributions in October 1989 or earlier. Bad health is defined as being sick or unable to work for at least two months in the last three years. Income is predicted net income of the household.
Data source: BASiD (Scientific Use File 2007), own calculations.

3.4 Methodology

In this paper, we analyze how public pension wealth affects the retirement decision of mothers. In doing so, we exploit exogenous variation in public pension wealth, introduced through the pension reforms 1992 and 1996. Next, we describe the estimation strategy, followed by a detailed discussion of the variables that capture the incentives, inherent in the German public pension system.

Estimation strategy

To analyze the impact of public pension wealth on retirement, we estimate a discrete survival model, where the discrete time intervals are months.[15] Let N

[15] In particular, we follow Jenkins (1995).

individuals be observed monthly until entry into retirement or end of 2007.[16] Since we only consider mothers who are eligible for the women's old-age pension, the first observed month of an individual is when she turns 60 years old. Let the last observation of individual i be in month s_i and let T_i be the duration in month until retirement. When retirement is observed T_i equals s_i. The discrete time hazard rate $\theta_{it} = Pr(T_i = t|T_i \geq t)$ describes the probability of individual i to retire in month t, given individual i did not retired before t. Then, the (unconditional) probability of individual i to retire in month t is given by

$$Pr(T_i = t) = \theta_{it} \prod_{k=1}^{t-1}(1 - \theta_{ik}) = \frac{\theta_{it}}{(1 - \theta_{it})} \prod_{k=1}^{t}(1 - \theta_{ik}) \tag{3.1}$$

and the probability to retire later than t is given by

$$Pr(T_i > t) = \prod_{k=1}^{t}(1 - \theta_{ik}). \tag{3.2}$$

Therefore, the probability to observe retirement of individual i is

$$Pr(T_i = s_i) = \frac{\theta_{is_i}}{(1 - \theta_{is_i})} \prod_{t=1}^{s_i}(1 - \theta_{it}) \tag{3.3}$$

and the probability not to observe retirement of individual i is

$$Pr(T_i > s_i) = \prod_{t=1}^{s_i}(1 - \theta_{it}). \tag{3.4}$$

[16] Our data are right censored in December 2007. See section 3.3 for details about the data.

Let δ indicate if retirement is observed, i.e. $\delta_i = 1$ if $T_i = s_i$ and $\delta_i = 0$ otherwise. The likelihood of observing retirement of the whole sample is then

$$\mathcal{L} = \prod_{i=1}^{N} \left[\left[\frac{\theta_{is_i}}{(1-\theta_{is_i})} \right] \prod_{t=1}^{s_i} (1-\theta_{it}) \right]^{\delta_i} \left[\prod_{t=1}^{s_i} (1-\theta_{it}) \right]^{(1-\delta_i)}. \tag{3.5}$$

This gives the log-likelihood function

$$log\mathcal{L} = \sum_{i=1}^{N} \delta_i log \left[\frac{\theta_{is_i}}{(1-\theta_{is_i})} \right] + \sum_{i=1}^{N} \sum_{t=1}^{s_i} log(1-\theta_{it}). \tag{3.6}$$

Let $y_{it} = 1$ if $t = s_i$ and $\delta_i = 1$. Otherwise $y_{it} = 0$.

$$log\mathcal{L} = \sum_{i=1}^{N} \sum_{t=1}^{s_i} y_{it} log \left[\frac{\theta_{it}}{(1-\theta_{it})} \right] + \sum_{i=1}^{N} \sum_{t=1}^{s_i} log(1-\theta_{it}) \tag{3.7}$$

$$log\mathcal{L} = \sum_{i=1}^{N} \sum_{t=1}^{s_i} y_{it} log\theta_{it} + \sum_{i=1}^{N} \sum_{t=1}^{s_i} (1-y_{it}) log(1-\theta_{it}) \tag{3.8}$$

Assuming that the error terms of the hazard rate θ_{it} follow a logistic distribution[17] we can estimate the probability to retire in month t as a Logit model with

$$\theta_{it} = \frac{exp^{\alpha_t'\gamma + NPV_{it}'\beta_1 + PV_{it}'\beta_2 + X_{it}'\delta}}{1 + exp^{exp^{\alpha_t'\gamma + NPV_{it}'\beta_1 + PV_{it}'\beta_2 + X_{it}'\delta}}} \tag{3.9}$$

The set of monthly dummy variables α_t allows for a flexible baseline hazard[18], NPV_{it} and PV_{it} capture incentives to retire given by the Social Security system

[17] We also estimate the hazard rate θ_{it} based on normal and an extreme value distribution. The results do not substantially differ.

[18] When we do not observe at least one entry into retirement, we assume a piecewise constant hazard for this month, the month before and after. This applies only for some later months when most individuals in the sample are already retired.

and are explained in detail in the following paragraph. X_{it} is a vector of socio-demographic control variables and γ, β_1, β_2 and δ are parameter vectors that need to be estimated.

Incentive measures

Given individual pension entitlements, we calculate the net present value of pension benefits in every month of possible retirement to obtain the measure of pension wealth for each month. The calculation for individual i at month t follows equation 3.10:

$$NPV_{it} = (1 - R_{it}) \times \sum_{s=t}^{T} \Pi_t(s) \times \frac{PP_t}{(1+\delta)^{s-t}} \tag{3.10}$$

NPV_{it} is the net present value of pension benefits of individual i when retiring in month t. The individual deduction rate R_{it} depends on age of the mother and thus on the month t of benefit claiming. The sum of personal pension points is given by PP_{it}, discounted by $(1 + \delta)$ and multiplied by the survival probability, $\Pi_t(s)$, to be alive at month s.[19]

Not retiring in a given month has three effects: First, it can increase the sum of individual pension points, second, it reduces the deduction rate by 0.3 percentage points - if applicable - until the deduction-free eligibility age and third, it reduces the entitlement period. The first and the second effects increase monthly pension payments, which raises the net present value. In contrast, the latter effect reduces the net present value. The net effect of delaying retirement on the net present value of pension benefits is ambiguous.

Since, the retirement decision does not just depend on the value of pension wealth

[19] We calculate survival probabilities based on Statistisches Bundesamt (2011). Following Hanel (2010), we set δ to 0.03.

in a given month, but also on its future development, we follow Coile and Gruber (2001) and incorporate the 'peak value' as a forward-looking incentive measure. The peak value measures the difference between the net present value of pension payments - based on immediate retirement - and the net present value at its maximum in the future. After the maximum net present value has passed, the peak value measures the difference of the net present value between retiring now or in the next month.

Let NPV_{max} be the net present value at its maximum in the future:

$$NPV_{max} = \max\{NPV_{it+1}, .., NPV_{it=65}\} \tag{3.11}$$

Then, the calculation of the peak value PV_{it} of individual i in month t follows equation 3.12:

$$PV_{it} = \begin{cases} NPV_{max} - NPV_{it} & \text{if } NPV_{it} < NPV_{max} \\ NPV_{it+1} - NPV_{it} & \text{if } NPV_{it} \geq NPV_{max} \end{cases} \tag{3.12}$$

This incentive measure reflects individual changes in Social Security wealth over time and reflects an incentive to postpone retirement entry. The larger the value of PV_{it}, the larger is the gain in pension wealth when retirement is postponed. After an individual is beyond its maximum net present value, the peak value becomes negative and reflects an negative incentive to postpone retirement, i.e. an incentive to retire immediately.

In the following, we sketch the incentives to retire that are inherent in the public pension system, captured by PV_{it}. Imagine two mothers, born in different years, say January 1940 and January 1945 with an identical employment history and

earnings as well as the same number of children. They have a same net present value at age 65 ($NPV_{it=65}$) but different net present values in t (NPV_{it}) due to differences in deductions.[20] A delay of retirement increases the sum of pension points in the same amount whereas the deduction factor decrease only for the mother born in January 1945. Thus the values in PV_{it} differ. This illustrates the additional exogenous variation in PV_{it} and NPV_{it}, through the cohort-specific deduction factors, introduced by the pension reforms in 1992 and in 1996. We exploit this exogenous variation in estimating the relationship between maternal pension wealth and retirement.

[20]Figure 3-3 (appendix) shows that the retirement entry age increases for birth cohorts that are affected by the implementation of the deduction factors. Hence, this provides descriptive evidence that indeed mothers react to the this exogenous variation in their pension wealth through adjusting their retirement.

3.5 Results

This section shows the empirical assessment of how maternal pension wealth affects retirement. First, we show estimation results on the relationship between the variables that capture the impact of the German pension system and retirement. Then, we simulate the policy scenario that increases child care pension benefits and discuss the impact on maternal retirement. Finally, we focus on the implications for the distribution of maternal pension payments.

3.5.1 Model estimation

Table 3.3 shows the marginal effects, calculated at the mean, of the incentive variables as well as the control variables for different specifications. All specifications control flexibly for month-specific influences on retirement and cluster standard errors at the individual level.[21] While the first two specifications do not include interaction terms of the incentive variables and the East indicator, column (3) and (4) show the results when we include interaction terms. These interaction terms capture the differential impact of the two incentive variables on East German mothers. Since the estimated coefficient on the interaction terms is statistically significant, we choose the model with interaction terms as our preferred one. Further, we choose specification (4) as our preferred one, because we can control for factors that are correlated with transition probability and individual pension wealth. Overall, the results are fairly stable across the different specifications. To begin with, pension wealth is expected to increase the conditional probability to retire, since higher pension wealth implies higher old-age income. In fact, it

[21] In principle, the different specifications contain month indicators to capture the effect. Since, we do not observe retirement entries for each month from later months onwards, we aggregate several months to construct a piece-wise constant baseline hazard. Table 3.1 shows the full results

Table 3.3: Average marginal effects on the transition rate (Logit model)

Marginal effect (at the mean)				
Specification	(1)	(2)	(3)	(4)
Pension Wealth	0.0088***	0.0085***	0.0079***	0.0126***
	(0.0009)	(0.0010)	(0.0010)	(0.0017)
Peak Value	-0.4385***	-0.4156***	-0.4339***	-0.6879***
	(0.0348)	(0.0349)	(0.0274)	(0.0686)
East		0.0057***	0.0034**	0.0077***
		(0.0014)	(0.0015)	(0.0022)
Med. educ.		0.0003		0.0002
		(0.0016)		(0.0024)
High educ.		-0.0059**		-0.0081**
		(0.0023)		(0.0039)
Bad Health		0.0016		0.0022
		(0.0025)		(0.0036)
No. children		-0.0004		-0.0007
		(0.0006)		(0.0009)
With interactions[a]	No	No	Yes	Yes
N	48,426	48,426	48,426	48,426

Notes: Pension wealth is expressed in net present values [in €100,000s] based on the pension values in 2015. Education is low (reference category) if a mother has not completed vocational training, medium if she has completed a vocational training and high if she holds a university (of applied sciences) degree. Bad health indicates at least two months sickness leave in the last three years. All specifications control flexible for month-specific differences in the baseline hazard rate. The standard errors are clustered at the individual level.

a) The model includes interaction terms of East with pension wealth and East with the peak value.

Data source: BASiD (Scientific Use File 2007), own calculations.

is positively correlated with the transition rate. While being statistically significant, however, the estimated marginal effect is moderate. The second incentive variable, the 'Peak Value', reflects the potential gain in discounted future pension payments if retirement entry is postponed. The estimated marginal effect has the expected sign: If the peak value is positive, i.e. postponing retirement increases the net present value of future pension payments, then a mother postpones the retirement entry. Living in East Germany has a statistically significant positive but very small impact on the conditional probability to retire in a given month. If a mother lives in East Germany, then her hazard rate is about 0.77 percentage points higher than for West German mothers. Next, mothers with a university (or applied sciences) degree are less likely to retire in a given month, if they did not retire before, compared to mothers without completed vocational training. However, while being statistically significant, the impact is not very strong. Further, health problems or the number of children do not impact the transition rate.

3.5.2 Policy scenario

Next, we introduce the design of the policy scenario, followed by a discussion of the estimation results. Finally, we focus on the implications for the distribution of annual maternal pension payments.

Design and simulation

In this policy scenario, we increase the child care pension benefit by granting mothers two additional pension points for each child. Table 3.4 illustrates resulting higher maternal pension entitlements for two different retirement entry dates, based on a scenario in which the deductions on early retirement (0.3% per

month in case of retiring prior to age 65) have been fully implemented: Retiring immediately after turning 60 (subject to permanent deductions of 18%) and retiring after turning 65 (no deductions). In pecuniary terms, the policy scenario

Table 3.4: Increase in maternal pension entitlements through hypothetical reforms of child care pension benefits

Retirement entry age[a]	Benefit in € p.a. East/West	In percent[b] East	West
	Benefit per child		
60	€532/€575		
65	€650/€701		
	Average benefit per mother		
60	€1,096/€1,150	+14%	+17%
65	€1,339/€1,402		

Notes:
a) Based on the scenario of deductions on early retirement (0.3% per month in case of retiring prior to age 65) having been fully implemented.
b) Relative to total pension entitlements. The underlying sample of mothers is explained in detail in section 3.3.
Data source: BASiD (Scientific Use File 2007), own calculations.

increases a mother's annual pension payments per child by €532 in East Germany, respectively €575 in West Germany, when retiring at age 60. If mothers postpone retirement to the age of 65, their annual pension pension payments per child are €650 higher in East Germany, respectively €701 in West Germany, since no early retirement deductions are effective. To calculate the average benefit per mother, we multiply the benefit amount per child by the average number of children.[22] Increasing child care pension benefits leads on average to annual maternal pension

[22] Among mothers in the sample, those who live in East Germany had on average about 2.06 children, whereas West German mothers had about 2.00 children.

payments that are €1,096 (€1,339) higher in East Germany and €1,150 (€1,402) in West Germany if mothers retire at age 60 (65).[23] Relative to their total pension entitlements, mothers in West Germany benefit more (+14%) compared to East German mothers (+17%). This reflects that mothers in East Germany have higher pension entitlements due to a stronger attachment to the labor market in the former GDR.

To identify the impact of the increase in child care pension benefits, we compare maternal retirement behavior under a situation without any reform, called base setting, to maternal retirement behavior when child care pension benefits are increased, called reform setting. In each setting, all mothers have to face the same rules, although the rules change between the settings due to the reform in child care pension benefits. Therefore we apply the same deductions to all individuals independent of their actual date of birth, i.e. we assume all individuals are fully affected by pension reform 1992, respectively the pension reform 1996, described in section 3.2. Otherwise, we could not distinguish the impact of pension reforms 1992, respectively in 1996, from the impact of the hypothetical reforms. This allows us to calculate the values of NPV_{it} and PV_{it} using the same rules for all mothers in the base setting. In the next step, we predict the probability to retire in each month using the estimated coefficients. This delivers the retirement behavior in the base setting. For the reform setting we proceed in the following way. First, we increase the sum of personal pension points proportional to the number of children that a mother has. For each child, we add two pension points.

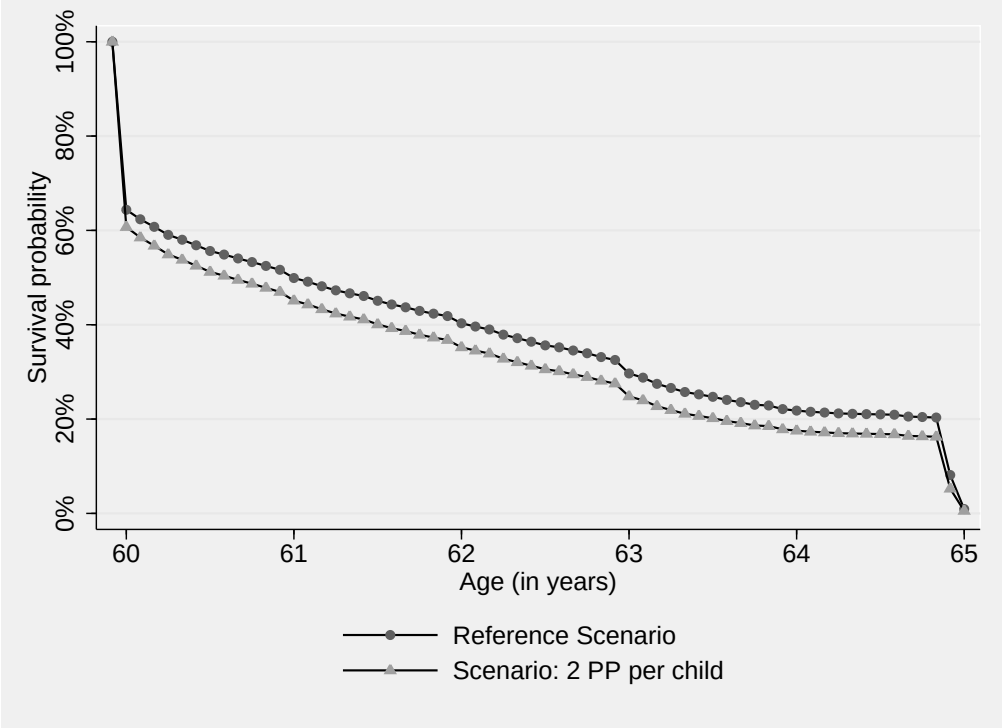
[23] While the reform increases a mother's individual pension entitlements, it does however not necessarily raise household net income by the same amount. If a mother qualifies for social assistance, the increase in pension payments would lower the level of social assistance she is entitled to. Nevertheless, the share of persons aged 65 or older who are entitled to social assistance is low, 2.8% in 2012 (Prinz and Lemmer, 2014).

This also changes the values of NPV_{it} and PV_{it} and thus the incentives to retire. Subsequently, we predict the probability to retire in each month. The difference in retirement behavior between the base setting and the reform setting is the impact of the increase in child care pension benefits on the retirement decision.

Figure 3-2 illustrates the impact of the simulated reform on the survival rate. In the reference scenario, the deductions on early retirement are set to 0.3% per month prior to age 65 - regardless of the birth cohort - if a mother claims the women's old age pension before the age that allows for deduction-free retirement (for details, see Section 3.2 and in particular Figure 3-1). Thus, the reference scenario is based on mothers after simulating the behavioral adjustments that are due to the deductions. Figure 3-2 shows the impact of the simulated reform on the survival rate. The survival rate is plotted from the month before a mother turns 60, which implies that anybody is "at risk" to retire, until 65, when most mothers have retired. The plot shows that the survival rate drops sharply in the first month that allows claiming the women's old-age pension. Followed by a steady decline until mothers reach the age 65, which allows for claiming the women's old-age pension without facing deductions, when the survival rate drops again sharply to almost zero. Further, in birth months, the transition rate is slightly higher, indicating that several mothers chose their birth month as the date of retirement. When considering the impact of the simulated reform, it becomes evident that the survival rate is hardly affected. Overall, it is slightly lower than in the reference situation. Hence, mothers tend to retire somewhat earlier due to the increase in their pension wealth through the simulated child care pension benefit reform. However, this early retirement effect is very small.

While inspecting the survival rate provides a graphical assessment of how higher

Figure 3-2: The impact of the simulated increase of child care pension benefits on the survival rate



Data source: BASiD (Scientific Use File 2007), own illustration based on the logit model.

child care pension benefits affect maternal retirement, it is not straightforward to infer its aggregate effect on retirement entry. In Table 3.5, we summarize by how much mothers choose an earlier retirement date due to the reform, for the total sample and subgroups. The calculation of the expected duration until retirement is based on the individual mean.[24] The first line reports the average duration upon turning 60 until retirement for the total sample. Mothers on average retire

[24]Since, the minimum of the survival function is not zero, but a small positive value, we assume in the calculation of the mean duration that the survival function reaches zero in the last month. This assumption allows calculating the mean duration until retirement. Alternatively, we could have relied on the the 'individual median' that is given for the month when the survival rate hits the 50% threshold. The results based on the individual median are available upon request.

Table 3.5: Impact of the policy scenario on the average duration until retirement from age 60

Sample	Pre	Post	Difference
Total	21.54	19.02	-2.53
Region			
West	24.24	21.55	-2.70
East	17.51	15.23	-2.27
Public pension wealth[a]			
below median	22.10	19.55	-2.55
above median	20.85	18.35	-2.49
Children			
one	20.68	19.37	-1.31
two	21.88	19.32	-2.56
three or more	22.01	18.05	-3.96

Notes: The 'Pre-scenario' implies the full implementation of permanent pension payments deductions if a mother claims the womenâĂŹs old age pension before the age that allows for a deduction-free retirement (for details, see Section 3.2 and in particular Figure 3-1). 'Post' implies the increas of a mother's pension wealth by the equivalent of two pension points per child.
a) Calculated in the month, when a mother turns 60.
Data source: BASiD (Scientific Use File 2007), own calculations based on the logit model.

22 months after being able to claim the women's old-age pension. When they are exposed to the increase of child care pension benefits, their retirement decision is only moderately affected: They retire about two and a half months earlier due to the increase in their pension wealth.

Next, we split the sample according to whether a mother lives in East or West Germany. Since mothers who live in East Germany have on average higher pension wealth and lower peak values, they tend to retire earlier than mothers who live in West Germany (see Table 3.3). The impact of the child care pension benefit increase is slightly stronger among West German mothers: They accelerate

retirement on average by 2.7 months, whereas mothers in East Germany retire 2.3 months earlier.

Then, we compare responses to the simulated reforms by level of public pension wealth, calculated in the month a mother turns 60. We compare mothers with public pension wealth below the median to mothers with public pension wealth above. The results show that public pension wealth position of a mother does not notably affect the reform impact.

Finally, we split the sample by number of children (one child, two children and three or more). This distinction is particularly interesting, since the increase in maternal pension wealth through the reforms is the greater the more children a mother has. Hence, differences in the simulated retirement months across the three subgroups can be driven subgroup-specific retirement pattern or from differences in the reform intensity: For instance, the pension wealth of a mother in the two children group increases by twice as much as pension wealth of a mother with a single child. The simulation shows that the early retirement effect induced by the child care pension benefit reform is substantially stronger for mothers with more than one child. We find that early retirement impact of the reform increases with the number of children: While the mothers with a single child retire on average about 1.3 months earlier, the early retirement response is about 2.6 month among mothers with two children and about four months among mothers with three and more children.

Distributional effects

Next, we investigate how policy scenario affects the distribution of pension payments. Ideally, we would like to analyze the impact of higher child care pension benefits on household net income. However, while BASiD provides detailed information on the entire employment biography, it does not contain information on household old-age income. Nevertheless, since maternal pension entitlements are essential to secure individual old-age income of mothers, we investigate how the policy scenario affects maternal pension payments.

First, we calculate the expected retirement date, as described before. Then, we simulate the distribution of annual pension payments, at the verge to retirement. Table 3.6 describes the distribution for the total sample of mothers, and distinguished by the number of children. For comparative purposes, we also show the distribution of pension payments for childless women. It reports the weighted mean pension payment by fractiles and the total average.

Table 3.6: The distribution of annual pension payments of mothers and childless women

Fractiles of pension payments	Total sample of mothers			One child		Two children		Three+ children		Childless[a]
	Children[b]	Ref.	Reform	Ref.	Reform	Ref.	Reform	Ref.	Reform	Ref.
		Mean		Mean		Mean		Mean		Mean
1st decile	2.33	3,370	4,590	3,810	4,410	3,290	4,470	3,260	5,200	4,490
2nd decile	2.21	4,920	6,190	5,720	6,300	4,800	5,960	4,420	6,510	6,910
3rd decile	2.29	5,910	7,120	6,820	7,380	5,760	6,890	5,310	7,290	8,370
4th decile	2.11	6,670	7,860	7,890	8,430	6,440	7,550	6,020	8,000	9,400
5th decile	2.10	7,570	8,740	8,860	9,400	7,250	8,330	6,700	8,650	10,480
6th decile	1.96	8,490	9,560	9,770	10,280	8,130	9,200	7,430	9,330	11,850
7th decile	2.00	9,560	10,550	10,770	11,270	9,130	10,170	8,300	10,140	12,980
8th decile	1.82	10,720	11,680	11,870	12,360	10,350	11,350	9,580	11,330	14,300
9th decile	1.69	12,400	13,270	13,370	13,830	12,070	13,020	10,950	12,720	15,850
10th decile	1.71	16,000	16,810	16,830	17,280	15,930	16,800	14,610	16,130	18,810
Total mean	2.02	8,560	9,630	9,560	10,080	8,310	9,370	7,650	9,520	11,330
N	3,130	3,130	3,130	980	980	1,357	1,357	793	793	498

Notes: In the reference scenario, we calculate the pension payments distribution after the full implementation of permanent pension payments deductions if a mother claims the womenâĂŹs old age pension before the age that allows for a deduction-free retirement (for details, see Section 3.2 and in particular Figure 1). The policy reform grants 2 PP per child to a mother. The calculation of pension payments is based on the pension values of 2015 (1 PP ≅ €29.21 in West Germany and €27.05 in East Germany).

a) The sample of childless women is identical to mothers, apart from the fact that they do not have children.

b) Weighted average number of children by fractiles of pension wealth, based on the total sample.

Data source: BASiD (Scientific Use File 2007), own calculations based on the logit model.

First, we focus on the left panel of the table, which provides the results for the total sample. The average number of children decreases with pension wealth, which indicates that more children imply a lower total lifetime employment (or less well-paid jobs). Further, mothers in the lower part of the distribution benefit more from an increase of child care pension payments. While mothers in the lowest decile receive €3,370 per year, mothers in the fifths decile receive an annual pension, worth about €7,570. If we compare the pension of mothers in the lowest to mothers in the top decile, whose annual pension payments amount to €16,000, more than four times as much, it becomes evident that average pension payments differ substantially across the distribution.

Next, we focus on how the policy reform scenario affect the distribution. The child care pension benefit reform increases maternal pension payments by a similar amount in all deciles, but its relative importance differs substantially by decile. The results show that particularly for mothers in the lower deciles, an increase in child care pension benefits substantially improves their individual old age income. The relative increase in pension payments through the child care pension benefit reform, for instance in the second decile, is 26 percent, while it is only five percent in the last decile. The overall mean increases from €8,560 to €9,630.

Next, we investigate differences in the distribution of annual pension payments, by the number of children. The higher the number of children, the lower is the average pension payment. In the reference scenario, the mean pension payment varies from €7,650 (three children) to €9,560 (one child). Further, since the increase in pension payments through the child care pension benefit is an increasing function of the number of children, mothers with three and more child experience substantially higher pension entitlements: Their average pension payments increase from €7,650

to €9,520 (+24%).

Finally, for purposes of comparison, we also calculate the distribution of pension payments for childless women.[25] Apart from the fact that these women have no children, their sample is defined and selected identically to the sample of mothers. When comparing average pension payments of childless women to mothers, it becomes evident that they are higher in all deciles. While childless women receive on average about €1,120 higher annual pension payments in the lowest decile, this difference is €2,810 in the top decile, and on average it amounts to €2,770. After simulating the moderate increase in child care pension benefits, the annual pension gap between mothers and childless women becomes smaller, but still remains (on average €1,700). These findings reflect the fact that childless women, in Germany, are more likely to be employed and less likely to work part-time in comparison to mothers (OECD, 2012, p. 163).

[25]To calculate the reactions of childless mothers to the deductions for early retirement, we re-estimated the logit model based on the total sample of mothers supplemented by childless women. The results are available upon request. Their distribution of pension payments is constructed analogously to the sample of mothers, as described before.

3.6 Discussion and conclusion

Women receive substantially lower pension payments than men. The main reason for this discrepancy are gender-specific differences in employment biographies: Women, in particular mothers, are more likely to face career breaks and work part-time. In Germany, child care pension benefits (*Kindererziehungszeiten*) compensate mothers for employment interruptions due to child births that preclude employment by increasing their pension entitlements. While child care pension benefits increase maternal pension wealth, they also provide incentives for an early retirement, which would in turn lower pension payments.

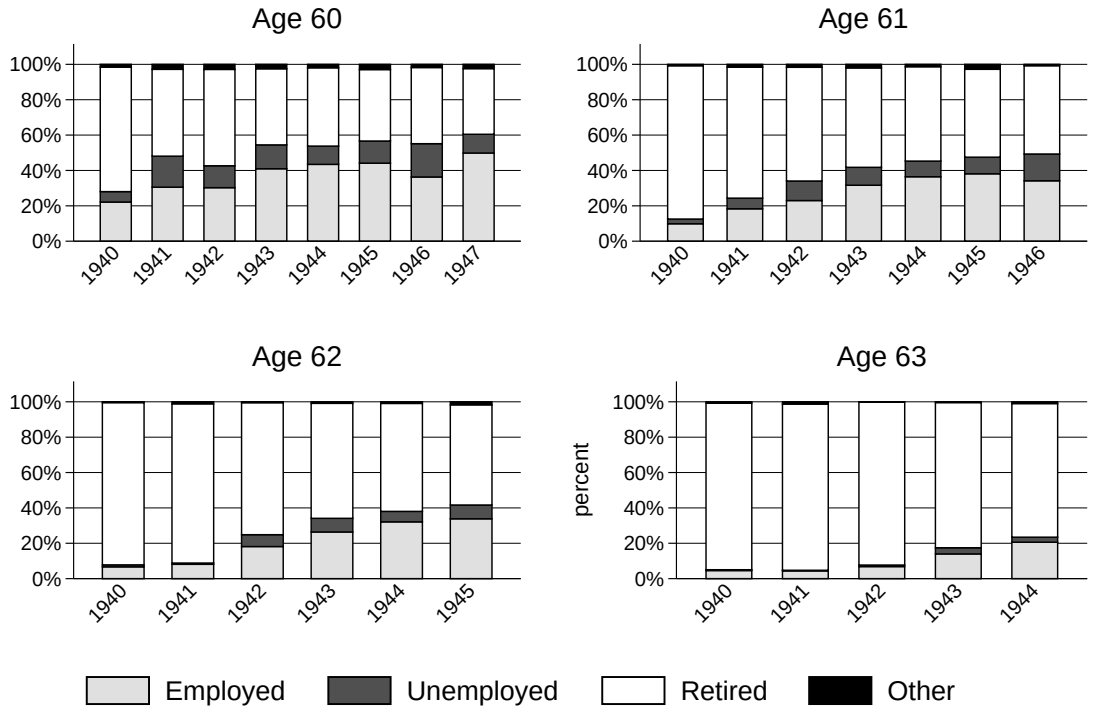
In this paper, we investigate how maternal pension wealth affects the retirement decision of mothers. To identify this relationship, we exploit exogenous variation in maternal pension wealth through two pension reforms in 1992 and in 1996. After estimating the empirical relationship in a discrete duration model, we simulate the impact of higher child care pension benefits. Next, we investigate how the policy scenario affects the distribution of maternal pension payments. In the empirical analysis, we rely on mothers who are eligible for the so-called women's old-age pension, and who are born between 1940 and 1947. Since about 60% of all mothers of the analyzed birth cohorts are entitled, they represent a large group.

We find that living in East Germany and the number of children decreases the transition rate into retirement, while higher education and pension wealth have a positive impact. Further, the incentive variable 'peak value', capturing the gain in pension wealth through postponing retirement, reduces the transition rate as expected. The simulation of moderately higher child care pension benefits shows that mothers retire on average only about two and a half months earlier due to the reform. While its impact on retirement is small, higher child care pension ben-

efits substantially affect the distribution of annual maternal pension payments: The mean increases from €8,560 to €9,630. All in all, the increase in maternal pension wealth through the child care pension benefit does not cause mothers to chose a substantially earlier retirement entry. Instead, it increases the individual old-age income of mothers. While the absolute gain is similar across all mothers, in particular mothers in the lowest deciles gain substantially in relative terms: the relative increase of monthly pension payments through the first reform amounts to 36 percent in the lowest decile.

In consideration of changing family patterns, separations and non-married couples are more common, it becomes increasingly important to secure the old-age income through individual pension entitlements. We show that a moderate increase of maternal pension wealth through child care pension benefits does not cause a substantial early retirement effect among mothers. Hence, child care pension benefits help to reduce the gap in pension payments of mothers and childless women. However, the main reason for this discrepancy in pension payments is the employment biography. Hence, in order to secure a reasonable individual old-age income of mothers, policies that promote maternal employment and reduce entry barriers into the labor market, such as the lack of sufficient child care or joint taxation in Germany (Steiner and Wrohlich, 2004), are important.

Figure 3-3: Labor force status by age and birth cohort



Data source: BASiD (Scientific Use File 2007), own calculations based on the logit model.

3.7 Appendix

Table 3.1: Estimated marginal effects on the transition rate into retirement

Specification	(1)	(2)	(3)	(4)
Pension Wealth	0.0088***	0.0085***	0.0079***	0.0126***
Peak Value	-0.4385***	-0.4156***	-0.4339***	-0.6879***
East		0.0057***	0.0034**	0.0077***
Med. educ.		0.0003		0.0002
High educ.		-0.0059**		-0.0081**
Bad health		0.0016		0.0022
No. children		-0.0004		-0.0007
d_2	-0.0146***	-0.0158***	-0.0173***	-0.0251***
d_3	-0.0849***	-0.0856***	-0.0861***	-0.1285***
d_4	-0.0903***	-0.0909***	-0.0914***	-0.1364***
d_5	-0.0881***	-0.0887***	-0.0892***	-0.1331***
d_6	-0.1000***	-0.1005***	-0.1010***	-0.1507***
d_7	-0.0967***	-0.0972***	-0.0978***	-0.1459***
d_8	-0.0954***	-0.0959***	-0.0964***	-0.1439***
d_9	-0.1070***	-0.1074***	-0.1078***	-0.1610***
d_10	-0.1046***	-0.1050***	-0.1055***	-0.1575***
d_11	-0.1063***	-0.1067***	-0.1071***	-0.1600***
d_12	-0.1047***	-0.1050***	-0.1055***	-0.1575***
d_13	-0.1042***	-0.1044***	-0.1050***	-0.1567***
d_14	-0.0852***	-0.0856***	-0.0862***	-0.1286***
d_15	-0.1050***	-0.1052***	-0.1056***	-0.1577***
d_16	-0.0995***	-0.0997***	-0.1002***	-0.1496***
d_17	-0.1018***	-0.1020***	-0.1025***	-0.1530***
d_18	-0.1095***	-0.1096***	-0.1100***	-0.1643***
d_19	-0.1121***	-0.1121***	-0.1126***	-0.1681***
d_20	-0.0975***	-0.0976***	-0.0982***	-0.1466***
d_21	-0.1040***	-0.1040***	-0.1046***	-0.1561***
d_22	-0.1102***	-0.1102***	-0.1107***	-0.1652***
d_23	-0.1040***	-0.1040***	-0.1046***	-0.1561***
d_24	-0.1106***	-0.1106***	-0.1110***	-0.1657***
d_25	-0.1136***	-0.1136***	-0.1140***	-0.1702***

Continued on next page

Specification	(1)	(2)	(3)	(4)
d_26	-0.0863***	-0.0863***	-0.0870***	-0.1297***
d_27	-0.1057***	-0.1056***	-0.1061***	-0.1584***
d_28	-0.1083***	-0.1082***	-0.1086***	-0.1623***
d_29	-0.0936***	-0.0936***	-0.0942***	-0.1405***
d_30	-0.1031***	-0.1029***	-0.1034***	-0.1544***
d_31	-0.1025***	-0.1023***	-0.1029***	-0.1535***
d_32	-0.1017***	-0.1015***	-0.1020***	-0.1522***
d_33	-0.1167***	-0.1163***	-0.1167***	-0.1743***
d_34	-0.1050***	-0.1047***	-0.1052***	-0.1570***
d_35	-0.1081***	-0.1077***	-0.1082***	-0.1615***
d_36	-0.0998***	-0.0994***	-0.1000***	-0.1492***
d_37	-0.1059***	-0.1055***	-0.1061***	-0.1583***
d_38	-0.0664***	-0.0662***	-0.0672***	-0.0999***
d_39	-0.0948***	-0.0943***	-0.0951***	-0.1417***
d_40	-0.0842***	-0.0837***	-0.0846***	-0.1259***
d_41	-0.0934***	-0.0929***	-0.0937***	-0.1396***
d_42	-0.0935***	-0.0931***	-0.0939***	-0.1399***
d_43	-0.1062***	-0.1057***	-0.1065***	-0.1587***
d_44	-0.1052***	-0.1047***	-0.1055***	-0.1572***
d_45	-0.0987***	-0.0983***	-0.0992***	-0.1478***
d_46	-0.1065***	-0.1061***	-0.1069***	-0.1593***
d_47	-0.1018***	-0.1014***	-0.1023***	-0.1524***
d_48	-0.1349***	-0.1344***	-0.1351***	-0.2016***
d_49	-0.0933***	-0.0930***	-0.0941***	-0.1401***
d_50	-0.1151***	-0.1147***	-0.1155***	-0.1722***
d_51	-0.1215***	-0.1210***	-0.1217***	-0.1816***
d_52	-0.1309***	-0.1304***	-0.1310***	-0.1956***
d_53	-0.1300***	-0.1295***	-0.1301***	-0.1942***
d_54	-0.1468***	-0.1462***	-0.1466***	-0.2190***
d_55_57	-0.1557***	-0.1550***	-0.1553***	-0.2321***
d_58	-0.1103***	-0.1099***	-0.1107***	-0.1651***
d_59	-0.1441***	-0.1436***	-0.1440***	-0.2151***
d_60	-0.1435***	-0.1431***	-0.1435***	-0.2143***
d_61	-0.0799***	-0.0799***	-0.0810***	-0.1205***
d_62	0.0616***	0.0612***	0.0590***	0.0898***

Continued on next page

Specification	(1)	(2)	(3)	(4)
With interactions[a]	No	No	Yes	Yes
N	48426	48426	48426	48426

Notes: Pension wealth is expressed in net present values [in €100,000s] based on the pension values in 2015. Peak value is a forward-looking incentive measure that measures the gain of postponing retirement to the month, which maximizes the net present value of future pension payments. Education is low (reference category) if a mother has not completed vocational training, medium if she has completed a vocational training and high if she holds a university (of applied sciences) degree. Bad health indicates at least two months sickness leave in the last three years. All specifications include month indicators, where d_2 indicates the month when an individual turns 60. Since, we do not observe retirement entries for each month from later months onwards, we aggregate several months to construct a piece-wise constant baseline hazard (e.g. d_55_57 indicates the months 55, 56 and 57). The standard errors are clustered at the individual level.
a) Pension wealth, measured when a mother turns 60.
Data source: BASiD (Scientific Use File 2007), own calculations based on the logit model.

Chapter 4

The Top Tail of the Wealth Distribution in Germany, France, Spain, and Greece[1]

4.1 Introduction

Rising inequality in income and wealth is increasingly gaining attention, both in the public debate and in academic research. The widespread discussion around the study of Piketty (2014) focuses on the concentration at the top and the underlying trends in modern capitalism. Economists and financial analysts are aware of increasing heterogeneity in income and wealth and their consequences for financial stability, savings and investment, employment and growth, and social cohesion. Against the backdrop of tax policy trends to reduce progressivity over the last

[1]This project is joint work with Stefan Bach and Aline Zucco who each contributed one third to the overall project. A similar version of this chapter has been published as a DIW Discussion Paper, see Bach et al. (2015)

decades (Förster et al., 2014) and high budget deficits after the financial crisis, tax increases on high capital income and top wealth are endorsed in many countries or even implemented. Thus, proper information on the distribution of capital income and wealth, in particular at the top, becomes increasingly important. However, we are still far from really understanding what is going on at the top tail of the wealth distribution. This study aims to shed light on the top wealth distribution in Germany, France, Spain, and Greece by integrating household survey data and rich lists of the big fortunes.

Household surveys describe the wealth distribution by socio-demographic characteristics (Davies et al., 2011). The Eurosystem's Household Finance and Consumption Survey (HFCS) (European Central Bank, 2013a), conducted in most countries of the Eurozone, provides comprehensive information on the wealth distribution in international comparison. For instance, the data reveal that Germany has one of the most unequal wealth distributions in Europe. However, with respect to the top wealth distribution, household surveys are plagued with serious drawbacks. Since personal wealth is typically much more concentrated than income it is hard to represent the top wealth distribution by small-scale voluntary surveys. The potential non-observation bias, i.e. the lack of reliability due to small sample sizes, could only partly be reduced by oversampling of the rich households. Moreover, a non-response bias is likely to occur as response rates presumably decrease with high income and wealth, in particular at the top (Vermeulen, 2014).

A viable solution to better capture the missing rich would be to estimate the top wealth concentration by relying on functional form assumptions on the shape of the top tail distribution. Traditionally, the Pareto distribution is used as it approximates well the top tail of income and wealth (Davies and Shorrocks, 2000).

In addition, more complex functional forms might be used (Clauset et al., 2009; Burkhauser et al., 2012; Brzezinski, 2014). Yet, the problem of biased wealth concentration remains if top wealth households are substantially underrepresented in survey data. A further alternative would be to use additional information at least for the super-rich households which is available for many countries by listings provided by business media. The most popular of these rich lists is the World's billionaires, published by the US economic magazine Forbes (2014). For larger countries there are national lists covering households or families up to a net wealth of hundreds of millions of dollars. Researchers used such lists to check top wealth estimates based on survey data or to augment survey data (see e.g., Davies (1993) for Canada, Bach et al. (2014) for Germany, or Eckerstorfer et al. (2015) for Austria).

Vermeulen (2014) provides a straightforward method to combine household survey data on wealth with rich lists of the big fortunes to jointly estimate a Pareto distribution for the top tail of wealth. He uses the US Survey of Consumer Finances (SCF) and the HFCS for the Eurozone countries and augments it with the Forbes list. He shows for the USA and nine Eurozone countries the potential under-representation of top wealth in the survey data. According to his results, differential non-response problems seem to be rather high in a number of Eurozone countries, in particular in Germany. This leads to underestimation of the top wealth shares when using only survey data to estimate top wealth without extreme tail observations.

We extend the study by Vermeulen (2014) and use country specific information in addition to the Forbes list. In particular, we construct an integrated database for Germany, France, Spain, and Greece that better represents the top wealth concen-

tration. In doing so, we use the HFCS survey data, combined with national lists of the richest persons or families of these countries, provided by the media. Based on these data we refer to the approach of Vermeulen (2014) to jointly estimate a Pareto distribution for each country and impute the missing rich. Instead of the Forbes list we mainly rely on national rich lists since they represent a broader base for the big fortunes. Especially for France and Spain the Forbes list contains only few observations. The resulting database could be used for detailed distribution analyses or micro-simulation studies.

Our estimations are broadly in line with the findings of Vermeulen (2014). However, the inclusion of the national rich lists instead of the Forbes list substantially increases the top wealth concentration. We find that the top percentile share of household wealth in Germany jumps up from 24 percent based on the HFCS alone to 32 percent after top wealth imputation. The Gini coefficient for the wealth distribution increases from 0.75 to 0.77. For France and Spain we find only a small effect of the imputation since rich households are better captured in the survey. The top percentile share of net wealth increases from 18 to 21 percent in France, and from 15 to 17 percent in Spain. The Gini coefficient increases from 0.67 to 0.69 in France and from 0.57 to 0.58 in Spain. The results for Greece are ambiguous since the data do not show clear concentration patterns. The remainder of the paper proceeds as follows: Section 4.2 describes the data used. The methodology of estimation and imputation of the top wealth distribution is presented in Section 4.3. Section 4.4 shows the results of the top wealth imputation on the wealth distribution. Section 4.5 concludes.

4.2 Data

This study on the wealth distribution in Germany, France, Spain, and Greece is based on different data sets: The Eurosystem's Household Finance and Consumption Survey (HFCS) and rich lists for these countries. In this section we will have a deeper look at these data sets.

4.2.1 2.1 Household Finance and Consumption Survey (HFCS)

The HFCS is a decentralized household survey for the Eurozone. It is conducted by the national central banks of the Eurosystem. The idea of this survey is to collect information about the consumption behavior and the financial situations of households in the Eurozone countries. Our analysis bases on the information of the first wave which was collected between 2008 and 2011 (European Central Bank, 2013a, p. 8). In future, the survey shall be conducted every two to three years. The data contains information of households in Belgium, Germany, Spain, France, Italy, Greece, Cyprus, Luxembourg, Malta, Netherlands, Austria, Portugal, Slovenia, Slovakia, and Finland. The HFCS over-samples wealthy households to deal with potential non-observation bias, whereas the criteria for oversampling vary across countries (European Central Bank, 2013a, p. 9).

Table 4.1 shows the gross sample size, the number of interviewed households, the response rate and the effective oversampling rate of the top 10 percent by country. The effective oversampling rate describes to which extent the ratio of the top 10 percent is oversampled compared to its share in the population(European Central Bank, 2013a, p. 36). The samples are weighted in a way that the total number corresponds to the official number of households which is based on adjusted information from, depending on the country, population registers and statistics, current

Table 4.1: Sample size and oversampling rate in the HFCS

Countries	Gross sample size	Interviewed households	Response rate, in percent	Effective oversampling rate of the top 10 %, in percent
Austria	4,436	2,380	56	1
Belgium	11,376	2,364	22	47
Cyprus	3,938	1,237	31	81
Finland	13,525	10,989	82	68
France	21,627	15,006	69	129
Germany	20,501	3,565	19	117
Greece	6,354	2,971	47	-2
Italy	15,592	7,951	52	4
Luxembourg	5,000	950	20	55
Malta	3,000	843	30	-5
Netherlands	2,263	1,301	58	87
Portugal	8,000	4,404	64	16
Slovakia	n.a.	2,057	n.a.	-11
Slovenia	965	343	36	22
Spain	11,782	6,197	57	192

Source: ECB (2013a: 41).

population surveys, household and labor force surveys, social security registers, and tax registers (European Central Bank, 2013b, p. 13). For item non-response, i.e. participants refuse or are unable to answer certain questions, the editors of the database provide five implicates inserted by multiple imputation (European Central Bank, 2013a, p. 39). For our analysis we use the mean of the five implicates. We have not yet analyzed the impact of the multiple imputation that might increase the standard errors somewhat. Nevertheless, it must be mentioned that a decentralized survey is also combined with the difficulty to compare cross-country results. By comparing the survey methodology of the countries of interest, we see some country specific differences. First of all, the response rate between both countries varies from 69.0 percent in France to 18.7 percent in Germany. This is mainly caused by the fact that the survey participation in France is compulsory,

while in the three other countries it is voluntary (European Central Bank, 2013a, p. 41). Furthermore, Germany and Spain exclude homeless and the institutionalized population, Greece in addition excludes also smaller villages while France excludes the institutionalized population only (European Central Bank, 2013a, p. 33). The most important difference for our analysis might be the oversampling of the rich. The basis for the oversampling in Germany is the geographic information about taxable income, whereas the French oversampling is based on the individual information about taxable net wealth. Finally, the surveys differ in time and duration of the reference period. While the Spanish survey refers to the period from November 2008 to July 2009, the relevant period for the Greek fieldwork is from June to September 2009. In France the survey was conducted between October 2009 and February 2010, while the reference period in Germany is September 2010 to July 2011 (Tiefensee and Grabka, 2014). It is important to keep these differences in survey methodology in mind when comparing the results of our four countries. The HFCS collects households' assets and liabilities in detail. Net wealth is measured as the sum of real estate properties, business properties, financial assets and corporate shares, the main household assets such as cars, less liabilities. Claims to social security or occupational and private pensions and healthcare plans are not included in household net wealth. Net wealth is based on self-assessed property valuations of the survey respondents. We have no evidence of systematic biases in this respect.

4.2.2 Rich lists

Since decades, business media and researchers provide listings of the big fortunes held by the super-rich. We use the *World's billionaires* of Forbes (2014) and na-

tional lists of the richest persons or families of the selected countries, provided by the media. We refer to the annual issue of the rich lists for the year in which the HFCS survey was conducted in the countries (Table 4.2).

The reliability of these lists is contentious since the data are not surveyed by a consistent method but collected from different sources and compiled by different methods. Information is collected from public registers, financial markets, business media, and through interviews of wealthy individuals themselves. The completeness of the lists is unclear. In particular with respect to smaller fortunes which are often dominated by non-quoted corporate shares or other assets measurement errors are likely to be higher. Accordingly, the selectivity of the listings might strongly increase with lower ranks. "Heaping effect", i.e. many observations at round numbers, underline this presumption.

In many cases the wealth is reported for "families", for instance entrepreneurial families that actually might consist of many households. Especially in Germany there are many successful firms of the "German Mittelstand" or even major enterprises which are family-owned for generations. Likewise, in the other countries there are wealthy families consisting of many members. Insofar the top wealth concentration could be overrepresented in the listings. We correct the German national list by using public available information on the number of shareholders of the respective family-owned firms (see below). Moreover, we remove households from the list that are obviously living abroad. For the other countries we disregard these issues.

The listings presumably ignore private assets or liabilities beside corporate wealth. Typically, many top-wealth households should have real estate properties and financial portfolios, thus leading to an underestimation of the top wealth concentra-

tion. In some cases, however, corporate investments might be leveraged by private debt although this would have unfavorable tax consequences.

Evaluations with administrative data from wealth taxation are rare since recurrent taxes on personal net wealth have been discarded in most OECD counties over the last decades. Among the four countries that we focus on, France and Spain still raise a recurrent wealth tax.[2] Inheritance, gift and estate taxes, which still exist in the main OECD countries, only capture inter-generational transfers whose concentration deviate from personal top wealth concentration due to different numbers of heirs and anticipated inheritance by gifts and legacies. Generally, top wealth information from tax files could be strongly flawed because of explicit tax privileges, in particular for small and medium sized firms or donations to non-profit organizations, or favorable valuation procedures for real estate and business properties that systematically underestimate the market value.[3]

Manager magazin list of the richest households in Germany

The *manager magazin* publishes annually a list of the richest persons or families in Germany. From 2000 to 2009 the magazine named the 300 wealthiest Germans (and their wealth), since 2010 even the 500 richest. Their net wealth is estimated based on information from archives, registers, stock markets, lawyers, asset managers and the wealthy people themselves (Manager magazin, 2011). The editors of the list indicate that in some cases persons concerned claimed to be removed from the list for reasons of privacy and security.

[2]Zucman (2008) uses tabulations of the French wealth tax base 1995 to analyze top wealth distribution. Alvaredo and Saez (2009) use tabulations of the Spanish wealth tax base up to 2005 to estimate top wealth shares.

[3]Researchers from the US federal tax authority IRS compared the estate tax files of deceased persons and the Forbes list (Raub et al., 2010). They discovered that the list overestimated net worth by approximately 50 percent, primarily due to valuation difficulties and tax exemptions, but also due to family relations (individuals vs. couples) and other structural differences.

Presumably, the incompleteness and selectivity of the list increase with lower ranks since there is scarce information for households holding non-quoted firms or other assets. "Heaping effects" underline this presumption (see section 4.3.2). Therefore, we only use the top 200 of the German list. The wealth is reported for "families" which could consist of many households in the case of firms or foundations that are family-owned firms for generations. We correct the respective observations by using public available information on the number of shareholders. This is possible for the top 150 of the list by thorough internet research. However, measurement errors might clearly remain since there is often scarce information on the ownership structure provided by financial accounts and other companies' disclosures. Generally, German entrepreneurs of the "Mittelstand" are rather reserved in providing information on their financial affairs and anxious to keep capital markets and external investors out of their firms. In the case of the lower-ranked families we generally assume 4 households per family. Moreover, we generally assume equal shares of the estimated households per family. We also remove households from the list that are obviously non-residents. The corrections are of limited impact on the descriptives of the 200 richest households (Table 4.2) and the top concentration analyses below.

Table 4.2: Summary statistics of the national rich lists in Germany, France, Spain and Greece

In billion Euro

Country	Rich list	N	Mean	Std. Deviation	Min.	Max.
Germany	mm200 (corrected)	200	1.52	1.87	0.56	17
	mm200 (original)	200	1.91	2.29	0.55	17
	Forbes	52	3.27	3.22	0.76	18
France	Challenge 200	200	1.08	2.60	0.16	23
	Forbes	11	5.47	6.35	0.81	20
Spain	El mundo	74	1.49	2.06	0.50	16
	Forbes	12	2.06	3.29	0.679	12
Greece	Greek Rich list	29	0.194	0.331	0.038	2
	Forbes	18	2.14	1.91	0.48	7

Source: Manager magazin (2011), the corrected mm200 adjusts the rich list entries by the number of households per entry, Challenge (2010), El mundo (2009), Greek Rich List (2009) and Forbes (2009, 2010, 2011, 2014), own calculations.

Challenges list of the richest households in France

Since 1996, the Challenges magazine publishes annually a list that contains the 500 richest households in France. Their net wealth is estimated based on a large database, constructed and updated by a team of journalists of Challenges. It relies on various sources of information: Public data on share ownership and accounts, investigations of the ownership structure of unlisted companies, professional publications, seminars, award ceremonies and surveys send to rich households directly (Treguier, 2012). Similar to the German case we finally use the top 100-300 observations of the Challenges (2010) list.

El mundo list of the richest households in Spain

In Spain, we rely on national rich lists compiled by the third largest newspaper *el mundo*. Since 2006, the newspaper publishes two lists based on the top 100 richest individuals. The first list of the top 50 "visible fortunes" is based on public information on share ownership from stock markets. The second list of the top 50 "estimated fortunes" is based on estimations of shares in unlisted companies, mainly. The estimation was based on information about purchase-sales of shares, venture capital investments and direct estimations of fortunes. The joint list for 2009 we use in the paper is based on the top 50 "visible fortunes" and the 27 top "estimated fortunes", where the last entry from the latter list reports the same net wealth as the poorest person from the first list. Hence, the final list contains the 74 richest Spanish individuals (Elmundo, 2009).

Greek Rich List of the richest persons in Greece

Since 2007, the Greek Rich List magazine publishes annually a list of the wealthiest Greek individuals. Their net wealth is estimated based on public information about stock holdings, information from the Foundation of the Hellenic World and from research companies and analysts. The rich list 2009/2010 contains information about 29 wealthy Greeks (Greek Rich List 2009/10, 2010).

Forbes list of World's billionaires

To make it on the Forbes billionaire list the personal net wealth is estimated to be above 1 billion dollar. Similar to the lists described above, Forbes reporters compiled available information on the big fortunes worldwide (Forbes, 2014). Compared to the national lists, the Forbes list seems to be more reliable as it focuses on the super-rich, for which reliable information is easier to collect. Moreover, many billionaires cooperate with the editors. However, distortions regarding the

incompleteness and selectivity of the list likely remain when comparing the Forbes list with the national lists. For our analysis we recalculate the wealth in Euro. For Greece we used the 2014 billionaire list since the 2010 list does not contain one Greek observation. As a rough estimation we deduct 20 percent of the 2014 values of wealth.

4.3 Methodology of estimation and imputation of the top wealth distribution

This section describes how we construct the adjusted wealth distribution for Germany and France. First, the theoretical background underlying the approach is briefly sketched. Based on this, we then estimate the Pareto coefficients for both countries, relying on the HFCS and the corresponding national rich lists. Finally, we impute synthetic household net wealth for the missing wealth based on the Pareto coefficients for each country.

4.3.1 Theoretical background

This paper relies on the Pareto distribution which is mostly used in the literature to approximate the top tail of the wealth distribution.[4] In the following, we define

[4]For the following see Vermeulen (2014), Cowell (2009), Gabaix (2009), Clauset et al. (2009), KIeiber and Kotz (2003), Davies and Shorrocks (1999), Embrechts et al. (1997).

the wealth threshold that determines the top tail as w_{min}. The tail density function of the Pareto distribution is given by

$$f(w_i) = \begin{cases} \frac{\alpha w_{min}^{\alpha}}{w_i^{\alpha+1}} & if\ w_i \geq w_{min} \\ 0 & if\ w_i < w_{min} \end{cases} \tag{4.1}$$

where w_i determines the wealth of household i and α denotes the Pareto coefficient. Thus the distribution function can be estimated subject to (4.2) and (4.3):

$$P(W \leq w_i) = F(w_i) = \int_{w_{min}}^{w} f(t)\, dt = 1 - (\frac{w_{min}}{w_i})^{\alpha};\ \forall w_i \geq w_{min} \tag{4.2}$$

$$P(W > w_i) = 1 - P(W \leq w_i) = (\frac{w_{min}}{w_i})^{\alpha};\ \forall w_i \geq w_{min} \tag{4.3}$$

Equation 4.3 represents the "complementary cumulative distribution function" (ccdf) which describes the probability of wealth above w_i, defined on the interval $[w_{min}, \infty]$. The Pareto coefficient α, also called tail index, determines the fatness of the tail. Note that the lower α the fatter the tail and the more concentrated is wealth.

According to Zipf's law, which gives the inverse function of the Pareto distribution, we formalize the probability by the rank of the household wealth compared to the wealth of the other households (above w_{min}). Therefore, households are ranked by their wealth such that the richest household in the sample above w_{min} has the rank 1 and the poorest the rank n. In the following, the rank will be formalized as $n(w_i)$. The sum of households, that possess wealth higher than w_{min}, we call n. To account for the complex survey structure, we follow (Vermeulen, 2014, p. 18) and

take into account the survey weights when calculating the rank of a household. The households from the corresponding national rich lists are assigned a weight of one. This leads to(4.4) where the ranking and (4.3) are combined (Vermeulen, 2014, p. 17)

$$\frac{n(w_i)}{n} \cong (\frac{w_{min}}{w_i})^{\alpha};\ w_i \geq w_{min} \tag{4.4}$$

The Pareto coefficient α can be estimated by taking the logarithm of (4.4):

$$ln\frac{n(w_i)}{n} = -\alpha ln\frac{w_i}{w_{min}} \tag{4.5}$$

Now, the Pareto coefficient α can be estimated by OLS. In addition, (Vermeulen, 2014, p. 16) introduces a more theoretical estimator of the Pareto coefficient α, which he calls the *maximum likelihood estimator*. He derives this estimator directly from (4.1) which is valid for a simple random sample with n observations. The ML estimator is given in (4.6)

$$\tilde{\alpha_{ml}} = [\sum_{i=1}^{n} \frac{1}{n} ln(\frac{w_i}{w_{min}})]^{-1} \tag{4.6}$$

However, (Vermeulen, 2014, p. 16) emphasizes that this estimator is biased when the calculation is based on complex survey data. As the sampling method cannot be observed completely, the i.i.d. assumption does not apply. For this reason he recommends to use the survey weights to calculate the pseudo maximum likelihood estimator. Then, the rank is denoted subject to its weight. Thus N_1 is the survey weight of the household with highest wealth, N_2, the survey weight for the second richest household, and so forth. Finally, N_n is the survey weight of the poorest household above w_{min}. N denotes the total amount of weights above the minimum

wealth. The *pseudo maximum likelihood* estimate for the Pareto coefficient α is given by (4.7)

$$\tilde{\alpha_{pml}} = [\sum_{i=1}^{n} \frac{N_i}{N} ln(\frac{w_i}{w_{min}})]^{-1} \tag{4.7}$$

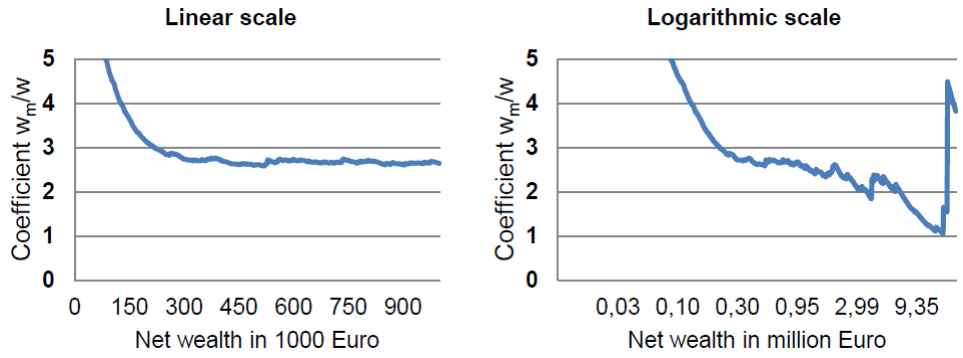
4.3.2 Estimation of the Pareto coefficient

To calculate values of α, we combine the HFCS data with information from national rich lists or from the Forbes World's Billionaires list. As depicted by equation 4.5, the estimation of α depends on how we set w_{min} and further, according to our integration approach, on the specification of the rich list data. To obtain the proper cutoff point within the HFCS data we refer to the distinctive property of the Pareto distribution that the average wealth w_m above any wealth threshold w is a constant multiple of that threshold, which is labeled as "van der Wijk's law" (see Cowell (2011); Embrechts et al. (1997)). The coefficient of the "mean excess function" $\frac{w_m}{w}$ is labeled as inverted Pareto-Lorenz coefficient β and equals to $\alpha/(\alpha - 1)$. Based on the HFCS data, we plot the coefficient $\frac{w_m}{w}$ for wealth thresholds above 100,000 Euros for the four countries in Figure 4-1 - Figure 4-4, given in linear scale up to 1 million Euros and in log scale up to 20 million Euros. The graphs suggest a good representation of the Pareto distribution for household wealth above 500,000 Euros, which is around the 90% percentile in Germany, France, and Spain.[5] Therefore, we set the cut-off point of the Pareto distribution to 500,000 Euros.[6] We also use this cut-off point for Greece, although there is no clear stable trend of $\frac{w_m}{w}$. To choose the optimal combination of w_{min} and the rich

[5]Eckerstorfer et al. (2015) propose an advanced method to obtain the cut-off point above which wealth follows a Pareto distribution. They suggest identifying suitable parameter combinations of maximum-likelihood estimates and goodness-of-fit tests.

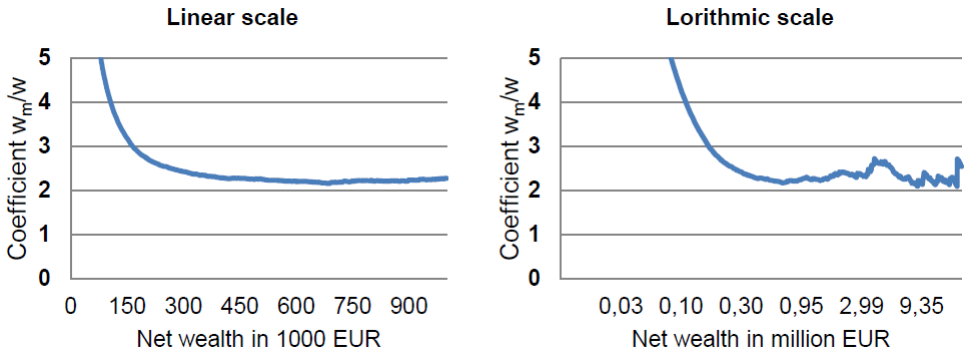
[6]The spike at the far right end of Figure 4-1 for Germany is driven by a small number of households and has no meaningful interpretation.

Figure 4-1: Ratio mean wealth above w, divided by w, w_m/w, Germany



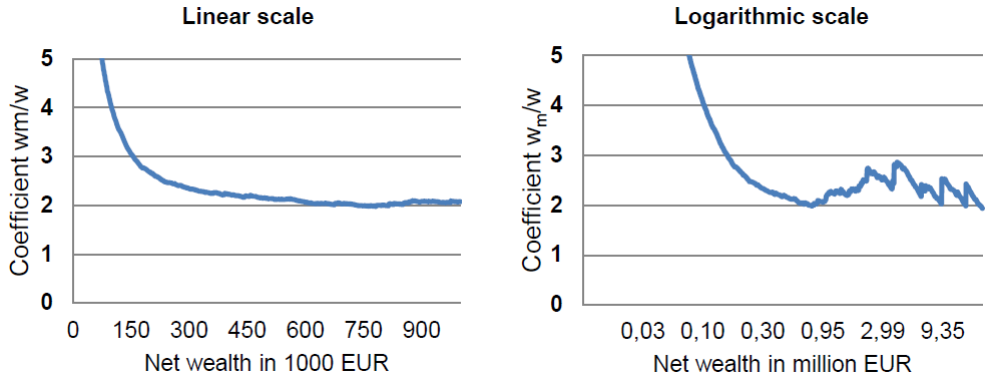
Data source: HFCS, own calculations

Figure 4-2: Ratio mean wealth above w, divided by w, w_m/w, France



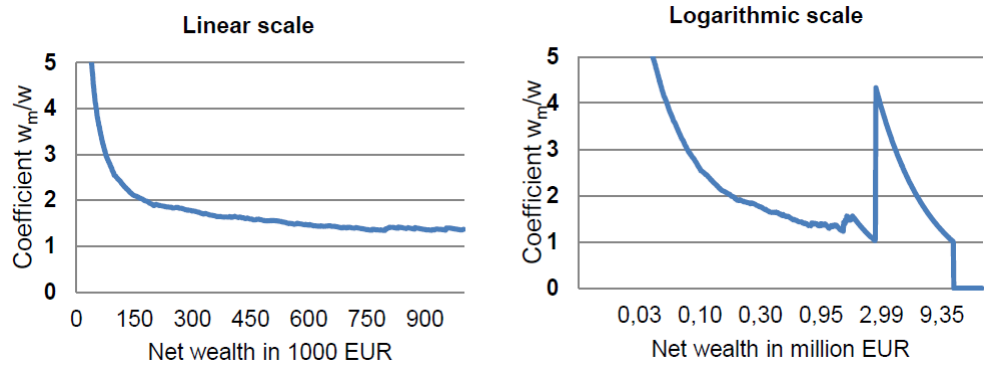
Data source: HFCS, own calculations

Figure 4-3: Ratio mean wealth above w, divided by w, w_m/w, Spain



Data source: HFCS, own calculations

Figure 4-4: Ratio mean wealth above w, divided by w, w_m/w, Greece



Data source: HFCS, own calculations

Table 4.3: Estimated α-coefficients for different subsamples, Germany

W_{min} (in €)	Excluding the rich list		Including the rich list			
			MM top300	MM top200	MM top100	Forbes top52
	α_{pml}	α_{reg}	α_{reg}	α_{reg}	α_{reg}	α_{reg}
0.5 million	1.597	1.535	1.374	1.370	1.378	1.408
		(0.042)	(0.001)	(0.001)	(0.003)	(0.005)
1 million	1.451	1.613	1.361	1.358	1.365	1.396
		(0.094)	(.002)	(.002)	(.003)	(.005)
2 million	1.342	1.767	1.342	1.340	1.347	1.379
		(0.186)	(0.005)	(0.005)	(0.005)	(0.006)

Robust standard errors are reported in brackets.
α_{pml} refers to the Pseudo-ML estimate and α_{reg} to the estimate based on OLS.

list, we follow Vermeulen (2014) who experimented with 0.5, 1 and 2 million Euros as minimum wealth thresholds. For Germany and France we consider the top 300, top 200, top 100 and Forbes entries of the national rich lists. We neglect the lower ranks due to potential "heaping effects" (see above, section 4.2.2). We assume that each entry in the corresponding rich list represents a household. For Germany, we use the corrected list for households instead of "families" provided by the list, and remove households that are obviously living abroad. For the other countries we disregard these issues. Based on the formulas (4.5) and (4.7), we calculate the Pareto coefficient for these subsamples per country. Table 4.3 - Table 4.6 show the estimated coefficients by country and Figure 4-5 and Figure 4-6 illustrate them graphically for Germany and France.

Comparing Table 4.3, Table 4.4 and Table 4.5, it becomes evident that the estimated α-coefficients are larger in almost all subsamples in France and Spain than in Germany. This is a first indication for a stronger concentration in the German top tail wealth distribution, as lower values of α indicate a stronger wealth

Table 4.4: Estimated α-coefficients for different subsamples, France

W_{min} (in EUR)	Excluding the rich list		Including the rich list			
			Chall. top300	Chall. top200	Chall. top100	Forbes top11
	α_{pml}	α_{reg}	α_{reg}	α_{reg}	α_{reg}	α_{reg}
0.5 million	1.783	1.819	1.569	1.545	1.534	1.722
		(0.006)	(0.008)	(0.008)	(0.011)	(0.026)
1 million	1.804	1.763	1.506	1.473	1.443	1.613
		(0.011)	(0.008)	(0.008)	(0.009)	(0.033)
2 million	1.689	1.650	1.437	1.403	1.362	1.487
		(0.019)	(0.009)	(0.008)	(0.008)	(0.033)

Robust standard errors are reported in brackets.
α_{pml} refers to the Pseudo-ML estimate and α_{reg} to the estimate based on OLS.

Table 4.5: Estimated α-coefficients for different subsamples, Spain

W_{min} (in EUR)	Excluding the rich list		Including the rich list	
			El mundo top74	Forbes top12
	α_{pml}	α_{reg}	α_{reg}	α_{reg}
0.5 million	1.858	1.880	1.569	1.812
		(0.010)	(0.013)	(0.019)
1 million	2.152	1.761	1.445	1.689
		(0.013)	(0.010)	(0.021)
2 million	1.809	1.651	1.345	1.590
		(0.022)	(0.06)	(0.025)

Robust standard errors are reported in brackets.
α_{pml} refers to the Pseudo-ML estimate and α_{reg} to the estimate based on OLS.

Table 4.6: Estimated α-coefficients for different subsamples, Greece

W_{min} (in EUR)	Excluding the rich list		Including the rich list	
			Greek Rich list top29	Forbes top18
	α_{pml}	α_{reg}	α_{reg}	α_{reg}
0.5 million	2.638	3.117	1.720	1.220
		(0.071)	(0.033)	(0.017)
1 million	3.761	3.190	1.476	1.018
		(0.139)	(0.038)	(0.021)
2 million	11.378	3.069	1.083	0.738
		(0.345)	(0.094)	(0.091)

Robust standard errors are reported in brackets.
α_{pml} refers to the Pseudo-ML estimate and α_{reg} to the estimate based on OLS.

concentration at the top.[7]

Moreover, the inclusion of information from national rich lists substantially affects the estimates for α, resulting in a lower value and hence higher inequality in all subsamples for Germany, France and Spain. In Germany, increasing w_{min} from 0.5 million to 2 million Euro does only slightly decrease the estimated α-coefficient for the specifications that include the rich list. Restricting the entries from the German rich list to the top 200 or top 100 households has almost no impact on the estimated α-coefficients. In France and Spain, an increase in w_{min} leads to a moderate reduction of the estimated α-coefficients. The estimates based on the rich lists indicate a significantly lower level of α-coefficients which means a higher concentration of top wealth. The inclusion of the national rich lists instead of the Forbes list substantially increases the top wealth concentration, especially for France and Spain. The Forbes list comprises only few observations for these

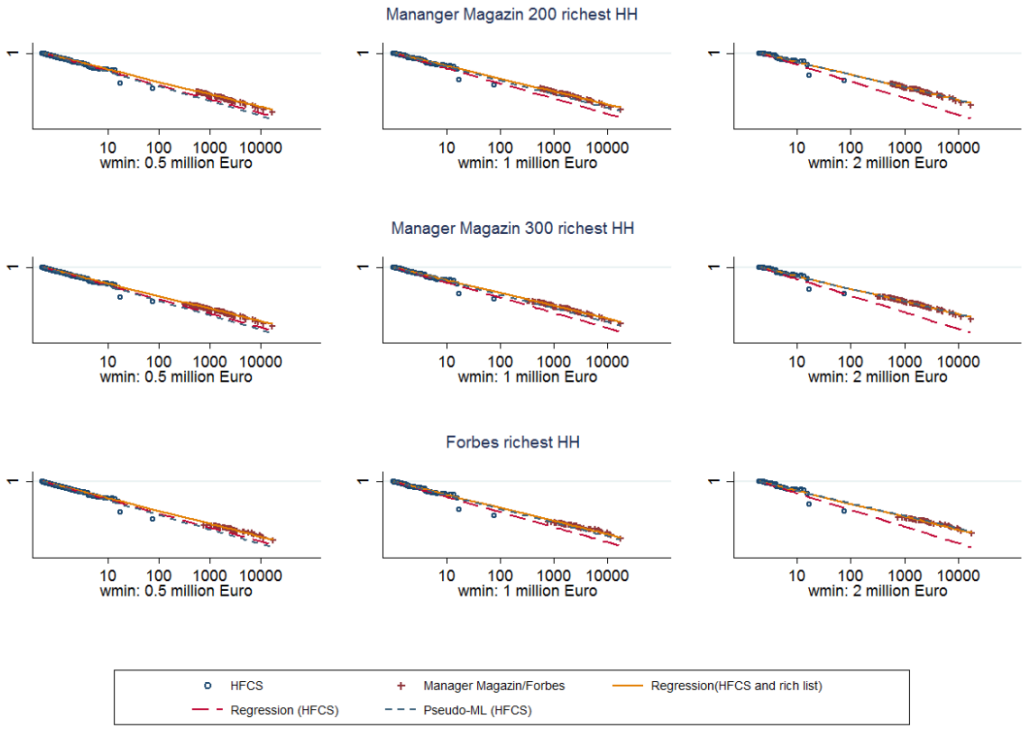
[7]Based on tabulated data from the French wealth tax assessment of 1995, Zucman (2008) estimates α-coefficients of 1.7 to 2.0 depending on the wealth strata or cut-off point respectively. For Spain, we found similar estimations based on tax files.

countries, 11 for France and 12 for Spain.

For Greece, the estimated α-coefficients, based on the HFCS data, suggest a much less unequal distribution of wealth compared to the three other countries (Table 4.6). However, the data quality seems to be lower. With the HFCS there is a substantially lower oversampling probability of the rich in Greece (European Central Bank, 2013a). The low number of households reporting a net wealth of one or two million Euro increases the imprecision of the estimates. Moreover, the rich lists for Greece include a small number of observations and seem to be less reliable. The data for Greece do not show clear concentration patterns (Table 4.6). Therefore, the results for Greece have to be considered with caution and should not be over interpreted.

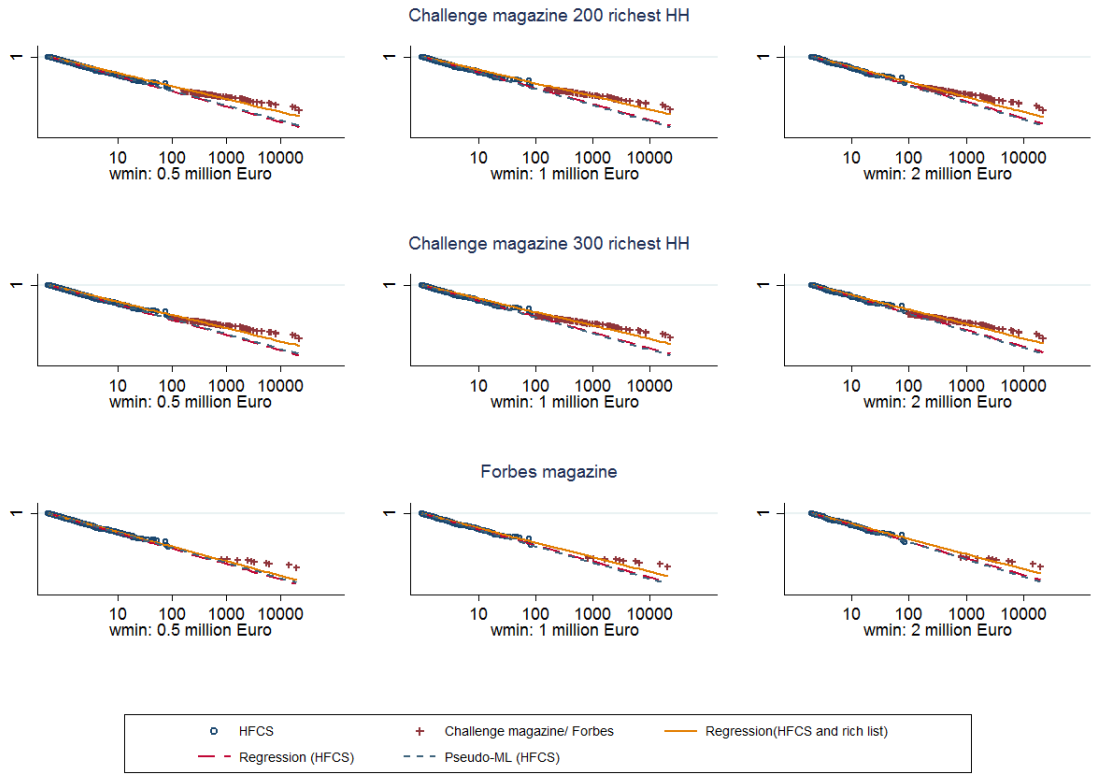
Figure 4-5 and Figure 4-6 illustrate the tail wealth distribution for Germany and France, distinguished by the type of rich list and the three cut-off points w_{min} chosen. Following the literature we present the complementary cumulative distribution function (ccdf, equation 4.3), both the empirical distribution and the estimated Pareto distribution. We present the tail distribution for the HFCS and the rich lists, where the first row augments the survey data with the top 300 richest households of the corresponding national rich lists, the second row with the top 200 richest households of the national rich lists, and the third row with the national entries at the *Forbes World's Billionaires* list. The first column shows the tail distribution for a lower bound for household wealth of 500 thousand Euros, the second for w_{min} of 1 million Euros, and the third column for w_{min} of 2 million Euros. In addition, all graphs contain the estimated relationship on the log-log scale based on different samples (HFCS only and HFCS jointly with the rich list).

Figure 4-5: Tail wealth distribution by rich list and minimum wealth, Germany



Data source: HFCS, manager magazin and Forbes list; own calculations.
Note: wealth in million Euros.

Figure 4-6: Tail wealth distribution by rich list and minimum wealth, France



Data source: HFCS, Challenges and Forbes list; own calculations.
Note: wealth in million Euros.

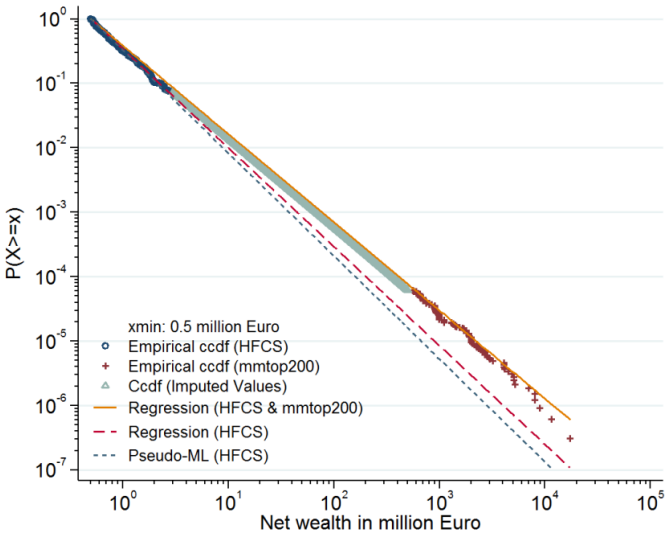
By comparing the plots for the top 300, top 200, and the Forbes rich list, we observe that the top 200 provides a good fit to the Pareto lines for Germany and France, including HFCS and the national rich list. Therefore, we choose the top 200 households of the corresponding rich lists for Germany and France as baseline specification. Including more households from the national rich list would increase the risk of the "heaping effect" and the wealth information becomes less reliable. At the same time, we aim to use as much information from the rich list as possible and therefore prefer the top 200 over the top 100 rich list. For Spain and Greece, we rely on the entire national rich list.

4.3.3 Imputation of the missing rich households

This section describes the imputation of the missing rich households. For Germany, Figure 4-5 shows a large gap between the richest household in the HFCS and the poorest household in the corresponding rich lists. In France, this gap is substantially smaller as illustrated by Figure 4-6, reflecting the better representation of wealthy households in the French part of the survey. This is also the case for Spain. The aim of the imputation is to create households that are representative for this gap.

Furthermore, Figure 4-5 and Figure 4-6 show that HFCS observations with high wealth tend to deviate more strongly from the Pareto line, in particular for Germany. Obviously, high levels of household wealth are more prone to sampling error and selectivity due to non-response. Therefore, we decided to cut off all households in the HFCS that exceed the threshold of 3 million Euros (Germany, France and Spain) and 1 million Euros (Greece) respectively. Next, we calculate the complementary cumulative distribution function (ccdf) of the Pareto distribution, based

Figure 4-7: Adjusted tail wealth distribution, Germany

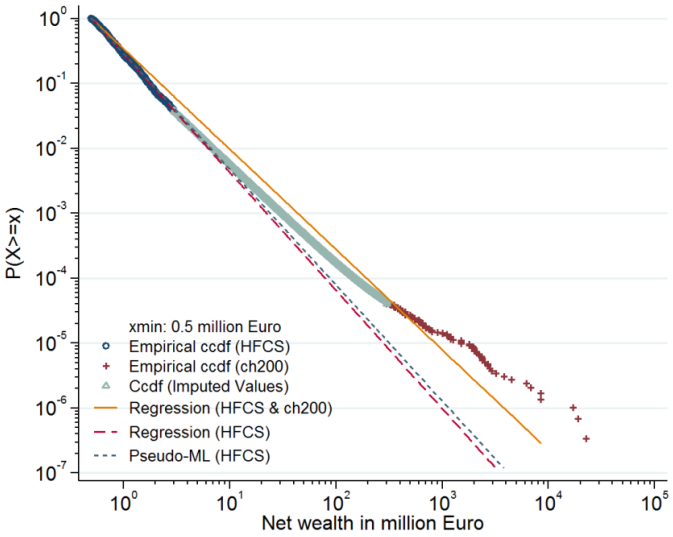


Data source: HFCS, manager magazin and Forbes list; own calculations.

on the chosen parameters with w_{min} of 500 thousand Euros and α of 1.37 for Germany, 1.55 for France, 1.57 for Spain, and 1.22 for Greece, Table 4.3 - Table 4.6. The imputed households were weighted such that they match the total sum of household weights in the HFCS with wealth higher than the mentioned threshold. We restrict the range of imputed households to values from this threshold to the poorest household from the national rich list.[8] The joint tail wealth distributions for the four countries are plotted by Figure 4-7 - Figure 4-10. Note that the steeper the Pareto line the lower is the wealth concentration.

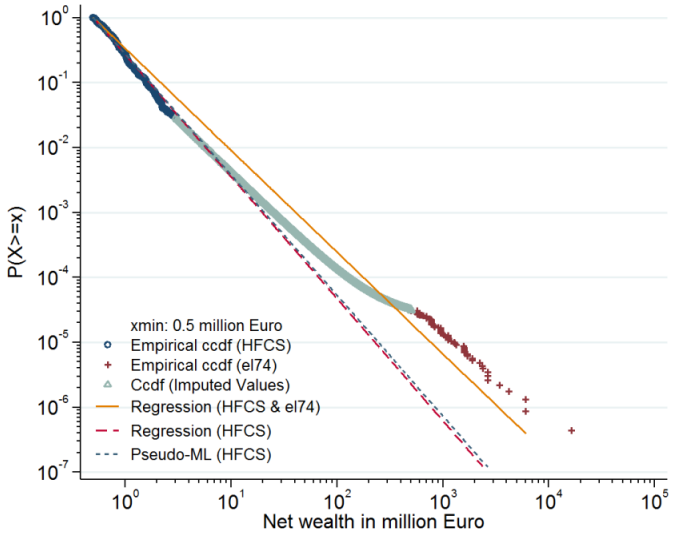
[8]In Germany and Spain, we impute households in the range of three to 500 million Euros net wealth. In France, households are imputed in the range of three to 300 million Euros of net wealth. The imputed households in Greece own net wealth between one million and 100 million Euros.

Figure 4-8: Adjusted tail wealth distribution, France



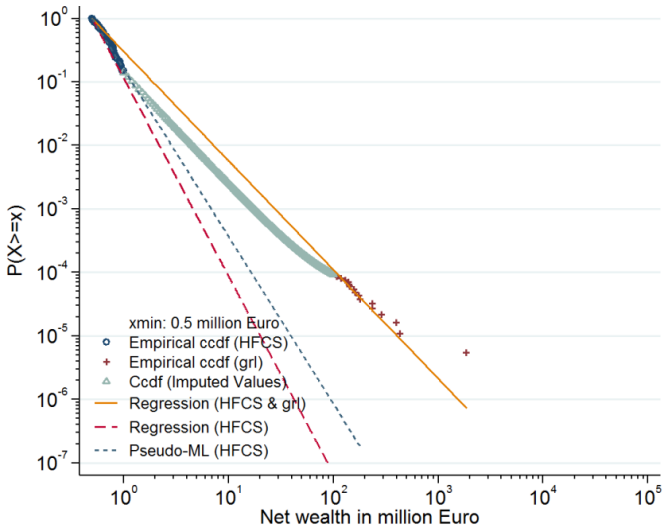
Data source: HFCS, Challenges and Forbes list; own calculations.

Figure 4-9: Adjusted tail wealth distribution, Spain



Data source: HFCS, El mundo and Forbes list; own calculations.

Figure 4-10: Adjusted tail wealth distribution, Greece



Data source: HFCS, Greek rich list and Forbes list; own calculations.

4.4 Results: Impact of correcting for the missing top wealth on the wealth distribution

Based on the integrated data sets, which contain the households from the HFCS, from the imputation, and from the corresponding national rich lists we analyze the impact of correcting for the missing rich on the wealth distribution.

Table 4.7 shows the German household net wealth distribution before and after top wealth imputation. The left part covers the distribution that is based only on the HFCS, while the right part shows the adjusted household net wealth distribution, consisting of the HFCS, the imputed cases and households from the manager magazin. The lower section provides summary inequality measures of household net wealth. Focusing on the left part, the household net wealth distribution exhibits a large concentration of wealth in the top decile. While the poorest 50 percent of

all households in Germany hold less than 3 percent of total net wealth, the share of the richest 10 percent hikes to almost 60 percent. Among them, the richest 1 percent of all households owns about 24 percent of total wealth, based solely on the HFCS data. After adjusting the net wealth distribution for the missing rich, the total household net wealth increases by 1,000 billion Euros to 8,755 billion Euros (+13 percent). The adjustment substantially affects the wealth concentration. The share of household net wealth, held by the top decile, increases by 5 percentage points to 64 percent, while the share of the richest 1 percent climbs up by 9 percentage points to 33 percent. The wealth share of the top 0.1 percent increases most strongly from 4 percent to 17 percent since the imputation mainly affects this wealth quantile.

The considerable increase in wealth concentration due to the adjustment of the household net wealth distribution is also reflected in the standard inequality measures. The Gini coefficient which is relatively sensitive to changes in the middle of the distribution increases from 0.75 to 0.78. In the calculation of the Gini coefficient, we set negative or zero net wealth to one Euro, however smaller positive values do not affect the results.[9] The GE(2) measure, which strongly responds to changes at the top of the distribution, skyrockets.

Table 4.8 and Table 4.9 provide the corresponding French and Spanish household net wealth distribution.[10] Again, the left part covers the distribution that is based only on the HFCS, while the right part shows the adjusted household net wealth distribution, consisting of the HFCS, the imputed cases from the Challenges (France) or El mundo (Spain) rich lists. Both countries show a substantial wealth

[9] In Germany, the share of households holding zero or negative net wealth is 6.2 percent (in France: 2.6 percent, Spain: 2.4 percent, Greece: 6.5 percent).

[10] Azpitarte (2010) analyzes the Spanish household net wealth distribution based on the Spanish Survey of Household Finances (EFF) 2002.

Table 4.7: The distribution of household net wealth in Germany

Fractiles household net wealth	Database HFCS			Database HFCS including imputed top wealth distribution		
	Percentile 1000 EUR	Total bill. Euro	%	Percentile 1000 EUR	Total bill. Euro	%
1st - 5th decile	\	222	2.9	\	222	2.6
6th decile	52	294	3.8	52	294	3.4
7h decile	99	501	6.5	99	501	5.8
8th decile	165	847	10.9	165	847	9.8
9th decile	262	1 313	17.0	262	1 313	15.2
10th decile	438	4 567	59.0	438	5 489	63.3
Total	\	7 743	100.0	\	8 665	100.0
Top 7,5%	525	4 061	52.5	525	4 984	57.5
Top 5%	668	3 517	45.4	668	4 440	51.2
Top 2,5%	1 063	2 694	34.8	1 063	3 616	41.7
Top 1%	1 887	1 847	23.9	1 887	2 770	32.0
Top 0,5%	3 317	1 363	17.6	3 400	2 277	26.3
Top 0,1%	13 581	306	3.9	10 900	1 434	16.6
Summary inequality measures of household net wealth						
Gini coefficient		0.7461			0.7731	
Entropy meas.[a)]						
GE(1)		1.2894			1.8024	
GE(2)		5.5693			302.77	

a) GE(1) is the Theil index, and GE(2) is half of the square of the coefficient of variation.

Table 4.8: The distribution of household net wealth in France

Fractiles household net wealth	Database HFCS			Database HFCS including imputed top wealth distribution		
	Percentile 1000 EUR	Total bill. Euro	%	Percentile 1000 EUR	Total bill. Euro	%
1st - 5th decile	\	359	5.5	\	359	5.3
6th decile	118	411	6.3	118	411	6.1
7h decile	117	578	8.9	177	578	8.5
8th decile	240	781	12.0	240	781	11.5
9th decile	331	1139	17.5	331	1139	16.8
10th decile	517	3235	49.7	517	3499	51.7
Total	\	6503	100.0	\	6767	100.0
Top 7,5%	615	2843	43.7	615	3107	45.9
Top 5%	762	2363	36.3	762	2627	38.8
Top 2,5%	1096	1736	26.7	1096	2000	29.6
Top 1%	1779	1159	17.8	1779	1423	21.0
Top 0,5%	2676	866	13.3	2676	1130	16.7
Top 0,1%	7010	448	6.9	7200	692	10.2
Summary inequality measures of household net wealth						
Gini coefficient		0.6730			0.6857	
Entropy meas.[a)]						
GE(1)		1.0107			1.2694	
GE(2)		5.9386			485.76	

a) GE(1) is the Theil index, and GE(2) is half of the square of the coefficient of variation.

concentration, however somewhat smaller than in Germany. While households below the median hold 5.5 percent in France and 13.1 percent in Spain, the corresponding shares of the top decile are about 50 percent (3,200 billion Euros) and 43 percent (2,100 billion Euros). The richest 1 percent of all households owns about 18 percent in France. Adjusting the French household net wealth distribution for the missing rich increases total wealth only moderately, compared to Germany, by 270 (+4 percent) to 6,770 billion Euros. Accordingly, the share of total net wealth held by the top 1 percent increases by 3 percentage points to 21 percent of total household net wealth. In Spain, the adjustment of the household net wealth distribution for the missing rich is even smaller. Total net wealth increases by 113 (+2 percent) to 5,070 billion Euros, the wealth share of the top 1 percent increases by 2 percentage points. In comparison to Germany, these increases in wealth concentration due to adjusting for the missing rich are substantially smaller. The Gini coefficient for France increases from 0.67 to 0.69 and for Spain from 0.57 to 0.58, reflecting a substantially lower inequality than in Germany.

Finally, we focus on the distribution of Greek household net wealth, shown in Table 4.10. Again, while the left part of the table shows the wealth distribution originating from the HFCS data, the right part contains the adjusted net wealth distribution that consists of the HFCS data, imputed households, and households from the Greek Rich List. When focusing on the left part, it becomes evident that net wealth is less concentrated in the top decile of Greek households, compared to the other countries. While households below the median hold about 12% of total net wealth, the richest 10% of all households hold about 38% of total net wealth. The richest 1 percent (0.1 percent) holds about 8 percent (1.4 percent) of total net wealth. After the imputation of the missing rich households, total wealth increases

Table 4.9: The distribution of household net wealth in Spain

Fractiles household net wealth	Database HFCS			Database HFCS including imputed top wealth distribution		
	Percentile 1000 EUR	Total bill. Euro	%	Percentile 1000 EUR	Total bill. Euro	%
1st - 5th decile	\	647	13.1	\	647	12.8
6th decile	183	350	7.1	183	350	6.9
7h decile	232	440	8.9	232	440	8.7
8th decile	291	574	11.6	291	574	11.3
9th decile	391	808	16.3	391	808	15.9
10th decile	614	2138	43.1	614	2252	44.4
Total	\	4958	100.0	\	5071	100.0
Top 7,5%	717	1856	37.4	717	1969	38.8
Top 5%	867	1516	30.6	867	1629	32.1
Top 2,5%	1152	1096	22.1	1152	1209	23.8
Top 1%	1862	734	14.8	1862	847	16.7
Top 0.5%	2501	556	11.2	2501	669	13.2
Top 0.1%	7374	291	5.9	7000	408	8.0
Summary inequality measures of household net wealth						
Gini coefficient		0.5723			0.5818	
Entropy meas.[a)]						
GE(1)		0.7468			0.9038	
GE(2)		8.0614			161.23	

a) GE(1) is the Theil index, and GE(2) is half of the square of the coefficient of variation.

Table 4.10: The distribution of household net wealth in Greece

Fractiles household net wealth	Database HFCS			Database HFCS including imputed top wealth distribution		
	Percentile 1000 EUR	Total bill. Euro	%	Percentile 1000 EUR	Total bill. Euro	%
1st - 5th decile	\	77	12.6	\	77	12.1
6th decile	103	47	7.8	103	47	7.4
7h decile	130	61	10.1	130	61	9.7
8th decile	168	81	13.3	168	81	12.7
9th decile	222	109	17.9	222	109	17.2
10th decile	333	233	38.3	333	260	40.9
Total	\	608	100.0	\	634	100.0
Top 7,5%	388	196	32.3	388	223	35.1
Top 5%	469	153	25.1	469	179	28.2
Top 2,5%	648	96	15.8	648	123	19.3
Top 1%	875	48	7.9	875	74	11.7
Top 0,5%	1121	30	4.9	1100	55	8.6
Top 0,1%	1510	8	1.4	2800	30	4.7
Summary inequality measures of household net wealth						
Gini coefficient	0.5540			0.5726		
Entropy meas.[a)]						
GE(1)	0.5625			0.7096		
GE(2)	0.7845			23.40		

a) GE(1) is the Theil index, and GE(2) is half of the square of the coefficient of variation.

Table 4.11: The Share of net wealth held by the top when the tail is replaced by the synthetic household and by rich list entries by various w_{min}

	HFCS	Excluding rich list			National rich list			Forbes list		
	Data	>0.5m	>1m	>2m	>0.5m	>1m	>2m	>0.5m	>1m	>2m
Share of net wealth hold by the top 5 %										
Germany	45.4	48.7	47.7	46.2	51.7	51.9	52.1	50.8	50.9	52.4
France	36.3	31.0	31.1	31.5	38.8	39.3	39.8	36.7	37.4	38.7
Spain	30.6	26.0	26.2	26.5	32.1	32.9	33.7	29.9	30.4	32.8
Greece	25.1	22.1	22.1	23.8	28.2	29.5	40.5	36.2	40.1	38.6
Share of net wealth hold by the top 1 %										
Germany	23.9	28.4	27.0	24.9	32.7	32.9	33.2	31.3	31.5	33.6
France	17.8	12.5	12.7	13.2	21.0	21.6	22.3	18.3	19.1	20.9
Spain	14.8	9.6	9.8	10.1	16.7	17.7	18.7	13.9	14.6	17.5
Greece	7.9	6.4	6.3	8.4	11.7	13.3	26.8	21.5	26.3	24.4
Share of net wealth hold by the top 0.1 %										
Germany	3.9	12.8	11.4	9.4	17.3	17.6	17.9	15.8	16.1	18.1
France	6.9	3.8	4.0	4.4	10.2	10.8	11.4	7.3	8.2	9.9
Spain	5.9	2.7	3.0	3.2	8.0	9.0	9.9	5.2	5.8	8.6
Greece	1.4	1.0	1.0	2.3	4.7	6.0	13.9	14.3	18.7	17.0

a) GE(1) is the Theil index, and GE(2) is half of the square of the coefficient of variation.

moderately by 26 (+4 percent) to 634 billion Euros. The imputation increases the share of net wealth that is held by the top 1 percent to almost 12 percent (+3.8 percentage points). Compared to the impact of the imputation on the German household net wealth distribution, this increase is small.

Next, we discuss the robustness of our results. Table 4.11 reports the share of net wealth, which is held by the top, in the four countries when the tail is replaced by synthetic and rich list households for different values of w_{min}. The upper panel reports the share of net wealth, held by the top 5 percent, the middle panel the share held by the top 1 percent and the lower panel the share held by the top 0.1 percent. The data column reports the share that is calculated based on the original HFCS data, when the tail is not replaced. The section "excluding rich

lists" calculates the share when the tail is replaced by the synthetic households that result from the α-estimation that relies only on the HFCS data. The two remaining sections calculate the corresponding shares based on the α-estimations that rely on information from the national rich lists or the Forbes list respectively. The results show that including external information from the national rich lists or the Forbes list increases the shares in all four countries. In Germany, France, and Spain the choice of w_{min} has only a minor impact on the calculated shares. However, for Greece the shares partly change substantially when we increase w_{min}. To some extent this is due to the lower number of very wealthy households in the Greek HFCS data. In sum, the results for Germany, France and Spain are relatively robust to the choice of w_{min}. In contrast, the results for Greece are not robust to the choice of w_{min} and should be interpreted with caution. Further, our results indicate that using the national lists instead of Forbes significantly increase the top wealth shares, in particular for the top 1 percent and for the top 0,1 percent. This impact of national rich lists is higher for France and Spain than in Germany.

Finally, as a check for the corrected wealth distribution we compare our results with macroeconomic wealth data for the household sector from the national and financial accounts statistics (see Table 4.12 - 4.15 in the Appendix). Based on the detailed items provided for Germany we calculate a corrected net wealth aggregate by deducting items that are not recorded in the HFCS database, i.e. the value of occupational pension commitments and claims on private health insurance schemes. The available accounts for France are less detailed, so we roughly correct net wealth by deducting 50 percent of insurance technical reserves. For Spain we use the figures from national and financial accounts without any corrections. For

Greece there is only available households' financial net wealth from the financial accounts.

In the case of Germany, the corrected households' net wealth aggregate reported in national and financial accounts statistics of 8,950 billion Euros (2010) slightly exceeds our estimation for total personal net wealth of 8,755 billion Euros (including imputed top wealth). In contrast, the personal net wealth aggregate for France reported in national and financial accounts is much higher than our estimate (9,470 billion Euros compared to 6,770 billion Euros). However, non-profit institutions serving households (NPISHs) are included in the French accounts, which might explain a minor part of the difference. Likewise, in Spain the households' net wealth aggregate in macroeconomic statistics of 6,650 billion Euros considerably exceeds our estimate of 5,070 billion Euros. For Greece, financial net wealth of households from financial account is reported to only 160 billion Euros. Our estimates for total net wealth result in 630 billion Euros, which mainly stems from real estate. The remarkable underestimation of household net wealth in France and Spain compared to the respective aggregates from national and financial accounts might suggest a remaining under-representation inherent in our estimation of top wealth. However, national and financial accounts of household wealth might be flawed by uncertainty related to the estimation, in particular with respect to non-financial assets, corporate shares in non-quoted firms, and financial assets abroad. This is also true for Germany. The differences between the national and financial accounts statistics and results from household surveys should by analyzed in detail for the different components of household wealth and liabilities.

4.5 Summary and conclusion

In this study we analyze the top tail of the wealth distribution and construct an integrated database for Germany, France, Spain, and Greece that better represents the top wealth concentration. We use the Eurosystem's Household Finance and Consumption Survey (HFCS). Since top wealth is likely to be underrepresented in household surveys we integrate the big fortunes from rich lists provided by business media. We use the Forbes list of billionaires, and national lists, in particular from the German business periodical Manager magazin (2011), from the French magazine Challenges (2010), from the Spanish newspaper Elmundo (2009), and the Greek Rich List 2009/10 (2010).

Following Vermeulen (2014) we combine the household survey data with the rich lists to jointly estimate a Pareto distribution for the top tail of wealth in both countries. After checking different thresholds for the Pareto distribution of 0.5, 1 and 2 million Euros, we set it to 0.5 million Euros. Instead of the Forbes list we mainly rely on national rich lists since they represent a broader base for the big fortunes. Moreover, we check different specifications of the national rich lists for Germany and France and prefer to use the top 200 richest households. The inclusion of the national rich lists instead of the Forbes list substantially affects the estimates for the Pareto coefficient α, resulting in a lower value and thus in a higher top wealth concentration in all subsamples. This is especially the case in France and Spain for which the Forbes list contains only few observations. Generally, Germany shows a higher top wealth concentration than France and Spain. The results for Greece are ambiguous since the data do not show clear concentration patterns.

We impute synthetic household net wealth for the missing rich based on the pre-

ferred Pareto coefficients for each country. The resulting database could be used for detailed distribution or microsimulation analyses. We show the entire distribution of net wealth up to the top 0.1 percent, both for the HFCS alone and including the imputed top wealth. For Germany the results suggest a high impact of the missing rich. The share of the top percentile in household wealth jumps up from 24 percent based on the HFCS alone to 33 percent after top wealth imputation, the share of the top 0.1 percent hikes up from 4 percent to 17 percent, the Gini coefficient for the wealth distribution increases from 0.75 to 0.78. For France and Spain we find smaller effects of the imputation since rich households are better captured in the HFCS survey for these countries. The share of total net wealth held by the top 1 percent in France increases by 3 percentage points to 21 percent, the Gini coefficient increases from 0.67 to 0.69. In Spain, the effect of the adjustment for the missing rich is even smaller. The wealth share of the top 1 percent increases by 2 percentage points, the Gini coefficient rises from 0.57 to 0.58.

It has to be mentioned that the results of our analysis should be interpreted with caution. Uncertainty emerges from the estimation strategy of the top wealth concentration, which relies on the Pareto distribution, and from measurement errors in household wealth, both with the HFCS and the rich lists. With respect to the HFCS, we are dealing with the first wave which might be plagued with some shortcomings to be improved in the subsequent waves. Regarding the rich lists, the reliability is contentious and often debated in the public. We suppose that the listings rather underreport the very top wealth concentration with respect to some selectivity in favor of corporate wealth and against private wealth, such as real estate properties and financial portfolios. It is hard to evaluate the self-assessed property valuations of the survey respondents or the valuations of the properties

collected in the rich lists. We have no evidence of systematic biases in this respect. Actually, these issues indicate substantial need for research. Tax files from wealth taxation or disclosed financial statements of large family-owned corporations might be better utilized for top wealth research. Sampling design, survey strategy and field work of voluntary household surveys might be improved to better collect data from the wealthy strata of the population.

The database of our analysis refers to the period between 2008 and 2011. Since then the substantial changes in macroeconomic performance should have altered both wealth aggregates and distribution. The sharp recession in Spain and Greece could have markedly reduced the value of real estate and business properties in these countries. In Germany, the opposite is true. Historically low interest rates discriminate fixed-income securities such as bank deposits or pension plans, and favor investments in real assets such as real estate, businesses, or corporate shares. As the latter dominate top wealth strata, the wealth distribution might have concentrated further, at least in Germany and France. Counterfactual microsimulation analyses could shed light on the distributional impact involved. Moreover, our integrated database could be used for the analyses of redistribution policies, for instance wealth taxation or programs to promote housing ownership and capital formation.

4.6 Appendix

Table 4.12: Asset and liabilities of households in Germany according to national and financial accounts, 2010 (End-of-year level)

Assets	bill. Euro	%	Liabilities	bill. Euro	%
Non-financial assetss	5,844	51.8	Loan and other liabilities[b]	1,519	13.5
Dwellings	3,584	31.7	Consumer loans	211	1.9
Land underlying buildings	1,673	14.8	Mortgage loans	1,040	9.2
Other buildings	393	3.5	Entrepreneurial loans	256	2.3
Land underlying other buildings	50	0.4	Other liabilities	12	0.1
Other non-financial assets[a]	143	1.3			
Financial assets[b]	4,541	40.2			
Currency and deposits	1,809	16.0			
Mutual funds shares	405	3.6			
Claims on insurance corporations[c]	1,397	12.4			
Short-term claims	71	0.6			
Longer-term claims	1,326	11.7			
with life insurance companies	788	7.0			
with health insurance schemes	167	1.5			
with pension funds	371	3.3			
Company pension commitments	284	2.5			
Securities	645	5.7	Net wealth	9,771	86.5
Bonds, money market papers	229	2.0			
Shares	234	2.1	*Net wealth less company*		
Other equity	182	1.6	*pension commitments, claims*		
			with health insurance schemes	*8,948*	*79.3*
Consumer durables of households	906	8.0			
Total	11,291	100.0	Total	11,291	100.0

a) Machinery and equipment, cultivated assets, and intangible fixed assets.
b) Excluding non-profit institutions serving households.
c) Including private pension funds as well as occupational pension schemes and supplementary pension funds, including accumulated interest-bearing surplus shares with insurance corporations.
Sources: Federal Statistical Office, national accounts; Deutsche Bundesbank, financial accounts.

Table 4.13: Asset and liabilities of households[a] in France according to national and financial accounts, 2010 (End-of-year level)

Assets	bill. Euro	%	Liabilities	bill. Euro	%
Non-financial assets	7,462	65.1	Financial liabilities[c]	1,255	11.0
Buildings and land	7,003	61.1	Loans	1,066	9.3
Housing	3,262	28.5	Equity liabilities	7	0.1
Other buildings and civil engineering	176	1.5	Other financial liabilities	182	1.6
Developed land	3,565	31.1			
Other non-financial assets[b]	459	4.0			
Financial assets[c]	3,994	34.9			
Currency and deposits	1,159	10.1			
Securities other than shares excluding financial derivatives	62	0.5	Net wealth	10,201	89.0
Loans	27	0.2			
Equities and mutual fund shares	1,026	9.0	*Net wealth less 50*		
Insurance technical reserves	1,469	12.8	*percent of insurance*		
Other financial assets	251	2.2	*technical reserves*	*9,467*	*82.6*
Total	11,456	100.0	Total	11,456	100.0

a) Including non-profit serving households.
b) Machinery and equipment, cultivated assets, and intangible fixed assets.
c)Including private pension funds as well as occupational pension schemes and supplementary pension funds, including accumulated interest-bearing surplus shares with insurance corporations.
Sources: INSEE, national accounts; Banque de France, financial accounts.

Table 4.14: Asset and liabilities of households[a] in Spain according to national and financial accounts, 2009 (End-of-year level)

Assets	bill. Euro	%	Liabilities	bill. Euro	%
Non-financial assets[b]	5,881	77.4	Financial liabilities[c]	948	12.5
			Loans	906	11.9
Financial assets	1,716	22.6	Other liabilities	42	0.6
Currency and deposits	815	10.7			
Debt securities	43	0.6			
Equity and investment funds	537	7.1			
Insurance, pensions and standardized guarantees	277	3.6	Net wealth	6,649	87.5
Other financial assets[c]	44	0.6			
Total	7,597	100.0	Total	7,597	100.0

a)Including non-profit institutions serving households.
b) Based on real-estate property.
c) Including financial derivatives, trade credits and advances and other accounts receivable, excluding trade credits.
Sources: Banco de España, financial accounts, housing market indicators.

Table 4.15: Asset and liabilities of households[a] in Greece according to national and financial accounts, 2009 (End-of-year level)

Assets	bill. Euro	%	Liabilities	bill. Euro	%
Financial assets	297.4	100.0	Financial liabilities	136.6	45.9
Currency and deposits	211.5	63.0	Loans		
Debt securities			Short-term	19.4	6.5
Short-term	0.8	0.3	Long-term	103.8	34.9
Long-term	15.2	4.5	Other accounts payable[b]	13.4	4.5
Equity and investment funds					
Listed Shares	21.9	6.5			
Unlisted Shares and other equity	11.1	3.3			
Investment fund shares	5.5	1.6			
Insurance, pension and standardized guarantees					
Total	7,597	100.0	Total	7,597	100.0

a)Including non-profit institutions serving households.
b) Other accounts include trade credits and advances and other accounts that exclude trade credits and advances.
Sources: Bank of Greece, financial accounts.

Summary

In the first three chapters of my dissertation, I investigate how maternal pension wealth affects the behavior of mothers in Germany. In particular, I investigate how mothers respond to the provision of child care pension benefits (*Kindererziehungszeiten*) in terms of employment, old-age savings and retirement.

Public pension wealth is part of total private wealth. However, since measuring pension wealth is often difficult, many surveys on private wealth do not provide information on individual pension wealth. This is also the case in the last chapter, which sheds light on the top tail of the total wealth distribution, based on survey data.

Child care pension benefits are granted to mothers in the German public pension system to compensate them for periods of child care that preclude employment. While child care pension benefits increase pension entitlements of mothers, they also provide economic incentives for employment, old-age savings and retirement. Hence, in order to assess the extend to which they improve individual maternal old-age income, it is essential to investigate potential behavioral responses that in turn could lower their old-age income. That is the aim of the first three chapters of my dissertation.

In chapter 1, I use administrative data, namely BASiD (Biographical Data of

Social Insurance Agencies in Germany (*Biographiedaten ausgewählter Sozialversicherungsträger in Deutschland (BASiD)*) to investigate how a change in pension wealth affects a mother's employment decision after child birth. I exploit the extension of the child care pension benefit in 1992 as a natural experiment, based on the regression discontinuity design to estimate short- and medium-run employment effects. In comparison to most family benefits, the child care pension benefit is accumulated upon child birth but becomes effective on the verge of retirement. Hence, the employment response depends on how a mother discounts future pension benefits. I find that mothers do not respond to child care pension benefits by adjusting their employment in years that follow child birth.

Chapter 2 examines how families adjust old-age savings in response to a change in maternal pension wealth through two expansions of the child care pension benefit, in 1992 and 1999, treating the reforms as natural experiments. Similar to the previous chapter, I rely on the regression discontinuity design, based on three waves of the Survey of Income and Expenditure (EVS): 1998, 2003 and 2008. Overall, the results show that the increase in maternal pension wealth does not crowd-out private old-age savings among couples. Furthermore, the analysis of subgroups along the family net wealth or income quartiles confirms these findings. Moreover, among single mothers, whose relative increase in pension wealth is stronger compared to couple families, the findings are in line with those of couple families: Higher maternal pension wealth does not crowd-out old-age savings of single mothers.

In chapter 3, we investigate how pension wealth affects the retirement decision of mothers based on BASiD. We rely on the peak value model, which captures the forward looking incentives that are inherent in the German public pension

system. To identify the impact of the incentives of the public pension system on maternal retirement, we exploit additional exogenous variation in pension wealth trough two pension reforms, in 1992 and in 1996. Then, we simulate the impact of a moderate expansion of child care pension benefits on maternal retirement and the distribution of annual maternal pension payments. The findings show that mothers retire only slightly earlier, by about two and a half months. Further, the simulated expansions of child care pension benefits also affect the distribution of maternal pension payments. The average annual pension payments increase from €8,560 to €9,630. However, compared to childless women, pension payments of mothers are still considerably lower.

In contrast to the previous three chapters, we focus in the last one not on pension wealth but on the distribution of total wealth. We analyze the top tail of the wealth distribution in Germany, France, Spain, and Greece based on the Household Finance and Consumption Survey (HFCS). Since top wealth is likely to be underrepresented in household surveys we integrate the big fortunes from rich lists, estimate a Pareto distribution, and impute the missing rich. Instead of the Forbes list we mainly rely on national rich lists since they represent a broader base for the big fortunes. As a result, the top percentile share of household wealth in Germany jumps up from 24 percent in the HFCS alone to 33 percent after top wealth imputation. For France and Spain we find only a small effect of the imputation since rich households are better captured in the survey. The results for Greece are ambiguous since the data do not show clear concentration patterns.

German summary

In den ersten drei Kapiteln meiner Dissertation untersuche ich, wie sich das Rentenvermögen von Müttern in Deutschland auf ihr Verhalten auswirkt. Insbesondere betrachte ich Verhaltensanpassungen in der Erwerbsentscheidung, dem Alterssparens und der Renteneintrittsentscheidung als Reaktion auf gestiegene Rentenansprüche durch Kindererziehungszeiten in der Gesetzlichen Rentenversicherung (GRV).

Rentenvermögen ist ein Teil des gesamten individuellen Vermögens. Da es jedoch schwer zu messen ist, bieten viele Umfragedaten keine Auskunft über Rentenvermögen. Das trifft auch auf das letzte Kapitel der Dissertation zu, welches auf Basis von Umfragedaten den oberen Schwanz der Vermögensverteilung in Deutschland, Frankreich, Spanien und Griechenland beleuchtet.

Kindererziehungszeiten in der GRV sollen Erwerbsunterbrechungen auf Grund von Kindererziehung kompensieren, indem sie Rentenansprüche von Müttern für diese Erziehungsphasen erhöhen. Zugleich gehen von ihnen ökonomische Anreize aus, welche die Erwerbs-, Ersparnis- und Renteneintrittsentscheidung von Müttern beeinflussen können. Um die Gesamtwirkung von Kindererziehungszeiten auf das Alterseinkommen abschließend beurteilen zu können, müssen daher mögliche Anpassungsreaktionen von Müttern berücksichtigt werden. Eine deutliche Verhal-

tensreaktion seitens der Mütter könnte ihr Alterseinkommen wiederum vermindern.

In Kapitel 1, nutze ich die administrativen Biographiedaten ausgewählter Sozialversicherungsträger in Deutschland (BASiD), um zu untersuchen wie sich eine Änderung des Rentenvermögens von Müttern auf ihre Erwerbsentscheidung nach der Geburt eines Kindes auswirkt. Um kurz- und mittelfristige Erwerbseffekte zu identifizieren, betrachte ich eine Erhöhung der Kindererziehungszeiten in 1992 als ein natürlich Experiment. Im Gegensatz zu den meisten Familienleistungen, entfalten Kinderziehungszeiten in der GRV nicht zum Zeitpunkt des Erwerbs, sondern erst an der Schwelle zum Renteneintritt ihre Wirkung. Daher hängt die jeweilige Verhaltensanpassung davon ab, in welchem Maße Mütter künftige Rentenzahlungen in ihrer gegenwärtigen Entscheidung berücksichtigen. Die Befunde zeigen, dass Kindererziehungszeiten in der GRV keinen Einfluß auf die Erwerbsentscheidung in den Jahren nach Kindesgeburt haben.

In Kapitel 2 erforsche ich, ob Familien ihr Alterssparen anpassen, wenn das Rentenvermögen von Müttern durch Kindererziehungszeiten ansteigt, wobei ich zwei Reformen, in 1992 und 1999, als natürliche Experimente ausnutze. Wie im zweiten Kapitel, identifiziere ich Ersparnisanpassungen mittels des 'Regression Discontinuity Design', basierend auf drei Wellen der Einkommens- und Verbrauchsstichprobe (EVS): 1998, 2003 und 2008. Die Schätzergebnisse zeigen, dass das gestiegene Rentenvermögen von Müttern privates Alterssparen von Paarfamilien nicht verdrängt. Differenziert nach Vermögens- bzw. Einkommensquartilen zeigt sich der gleiche Befund. Auch alleinstehende Mütter, die einen größeren relativen Anstieg ihres Rentenvermögens erfahren, ändern ihr Sparverhalten nicht.

In Kapitel 3 analysieren wir auf Basis von BASiD in welchem Maße die Rentenein-

trittsentscheidung von Müttern von der Höhe ihres Rentenvermögens abhängt. Um den ökonomischen Vorteil in der GRV, den ein verzögerter Renteneintritt mit sich bringt, abzubilden, nutzen wir das sogenannte 'Peak Value' Modell. In der Modellierung der ökonomischen Anreize der GRV verwenden wir zudem exogene Variation des Rentenvermögens, die durch zwei Rentenreformen in 1992 und 1996 gegeben ist. Nach Schätzung des strukturellen Modells, simulieren wir die Auswirkung einer Erhöhung der Kindererziehungszeiten in der GRV auf die Verteilung der Renten von Müttern. Die empirischen Ergebnisse zeigen, dass Mütter ihren Renteneintritt in Folge der gestiegenen Rentenansprüche nur schwach vorziehen, um rund zweieinhalb Monate. Allerdings wirkt sich die simulierte Reform auf die Verteilung der Rentenzahlungen aus: Die jährlichen Rentenzahlungen an Mütter steigen im Schnitt von €8,560 auf €9,630. Im Vergleich zu den Rentenansprüchen von kinderlosen Frauen liegen sie jedoch immer noch deutlich niedriger.

Im Gegensatz zu den vorherigen Kapiteln, widmen wir uns im letzten Kapitel nicht der Untersuchung des Rentenvermögens, sondern beleuchten die Verteilung von privatem Vermögen insgesamt. Wir analysieren den oberen Schwanz der Vermögensverteilung in Deutschland, Frankreich, Spanien und Griechenland auf Basis des Household Finance and Consumption Survey (HFCS). Da das Topvermögen in den meisten Umfragedaten untererfasst ist, integrieren wir hohe Vermögen aus Reichenlisten, schätzen eine Pareto-verteilung und imputieren die 'fehlenden Reichen'. Statt der *Forbes* Liste, nutzen wir überwiegend nationale Reichenlisten, da diese umfassendere Informationen über die jeweiligen Topvermögen bieten. Im Ergebnis, springt der Anteil des Vermögens, der dem reichsten Perzentil aller Haushalte in Deutschland gehört, von 24 Prozent (basierend auf dem HFCS) auf

33 Prozent, nach der Imputation des Topvermögens. Für Frankreich und Spanien finden wir lediglich geringe Effekte der Imputation, da vermögende Haushalte in den jeweiligen Befragungen besser repräsentiert sind. Die Befunde für Griechenland sind nicht eindeutig.

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Declaration

Erklärung gem. §4 Abs. 2 der Promotionsordnung

Hiermit erkläre ich, dass ich mich noch keinem Promotionsverfahren unterzogen oder um Zulassung zu einem solchen beworben habe, und die Dissertation in der gleichen oder einer anderen Fassung bzw. Überarbeitung einer anderen Fakultät, einem Prüfungsausschuss oder einem Fachvertreter an einer anderen Hochschule nicht bereits zur Überprüfung vorgelegen hat.

Ich erkläre außerdem, dass ich meine Dissertation selbstständig verfasst habe.

Berlin
April 1, 2016

Andreas Thiemann

Erklärung gem. §10 Abs. 3 der Promotionsordnung

Hiermit erkläre ich, dass ich für die Dissertation folgende Hilfsmittel und Hilfen verwendet habe:

Das Statistikprogramm Stata und MS Excel.

Auf dieser Grundlage habe ich die Arbeit selbstständig verfasst.

Berlin
April 1, 2016

Andreas Thiemann