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The Causal Effect of Maternal Leave Duration on Old-Age Pension Income - A European Analysis Using SHARE Data

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Abstract

This study presents findings on the understudied long-term effect of childcare-related leave interruptions on mothers' retirement income. Women's employment trajectories often include career breaks for childbirth and childcare-related leave, which can lower maternal wages and labor force participation. Since pension entitlements largely depend on employment history, this study hypothesizes a negative causal effect of individual leave duration (ILD) on retirement income. Using Ordinary Least Squares (OLS) estimation and a 2-Stage-Least-Squares Instrumental Variable (IV) approach that relies on variation in country- and time-specific statutory maternity leave policies (SLD), the study aims to identify a causal effect of ILD on old-age pension income. While the OLS estimation suggests a significant negative correlation between ILD and retirement income, the main IV estimation finds no significant effect. This implies that the OLS estimates are biased by endogeneity. It also suggests that pension systems, as moderators of the link between employment history and pension income, effectively mitigate disadvantages arising in working life and cushion the effect of maternal leave duration on retirement income. However, heterogeneity analyses indicate that this may not be the case for all income groups: ILD significantly reduces retirement income among mothers with middle to high income, suggesting that their entitlements are more closely tied to employment history than those of low- or very high-income mothers.

Kurzfassung

Diese Studie präsentiert Ergebnisse zu den bislang wenig untersuchten langfristigen Auswirkungen von Mutterschaftsurlaub und Elternzeit auf das Renteneinkommen von Müttern. Die Erwerbsbiografie von Frauen ist häufig geprägt von Karriereunterbrechungen aufgrund von Geburt und Kinderbetreuung, was zu niedrigeren Löhnen und einer geringeren Erwerbsbeteiligung führen kann. Da Rentenansprüche weitgehend von der Erwerbsbiografie abhängen, stellt diese Studie die Hypothese auf, dass die individuelle Dauer des Mutterschaftsurlaubs und anschließender Elternzeit, kurz ILD, einen negativen kausalen Effekt auf das Renteneinkommen von Müttern hat. Die Studie verwendet die Methode der Ordinary Least Squares (OLS) und eine zweistufige Instrumentenvariablenschätzung (IV), um einen kausalen Effekt von ILD auf das Altersrenteneinkommen zu identifizieren. Als Instrument dienen hierbei länderspezifische und jahresbezogene gesetzliche Mutterschaftsurlaubsregelungen (SLD). Während die OLS-Schätzung eine signifikante negative Korrelation zwischen ILD und Ruhestandseinkommen aufzeigt, findet die IV-Schätzung keinen signifikanten Effekt. Dies deutet darauf hin, dass die OLS-Schätzungen durch Endogenität verzerrt sind. Es legt auch nahe, dass Rentensysteme als Moderatoren der Verbindung zwischen Beschäftigungsgeschichte und Renteneinkommen die im Arbeitsleben entstandenen Nachteile wirksam abmildern und Auswirkungen von ILD auf das Renteneinkommen abfedern. Eine Heterogenitätsanalyse deutet jedoch darauf hin, dass dies möglicherweise nicht für alle Einkommensgruppen gilt: ILD verringert das Renteneinkommen von Müttern mit mittlerem bis hohem Einkommen signifikant, was darauf hindeutet, dass ihre Rentenansprüche stärker an ihre Beschäftigungsgeschichte gebunden sind als die von Müttern mit niedrigem oder sehr hohem Einkommen.

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List of Abbreviations

GGP	Gender Gap in Pensions
OLS	Ordinary Least Squares
2SLS IV/IV	Two-Stage-Least-Squares Instrumental Variable/Instrumental Variable
ILD	Individual Maternal Leave Duration
SLD	Statutory Maternity Leave Duration
SHARE	Survey of Health, Ageing and Retirement in Europe
OECD	Organization for Economic Co-operation and Development
DB	Defined Benefit
DC	Defined Contribution
NDC	Notional Defined Contribution
FDC	Funded Defined Contribution
PRR	Pension Replacement Rate
RC	Robustness Check

1. Introduction

In all EU member states, women receive lower average old-age pension income than men. In 2022, women aged 65 to 79 received pensions that were, on average, 26.1 percent lower than those of men in the EU (European Commission, 2024). Because retirement income mirrors past labor market trajectories, the gender gap in pensions (GGP) reflects systematic differences in employment histories of men and women (Dessimirova & Bustamante, 2019; European Commission, 2013). On average, women work fewer hours per week, receive lower wages, and spend fewer years in paid employment than men. These disparities can be largely attributed to motherhood and the unequal division of childcare-related leave around childbirth, which continues to fall disproportionately on mothers. As a result, mothers interrupt their careers more frequently and for longer periods than fathers (Bonnet et al., 2022; Hammerschmid & Rowold, 2019b; Jędrzychowska et al., 2024; Jefferson, 2009; Lis & Bonthuis, 2019; OECD Family Database, 2022).

While intended to grant parents time away from work to prepare for and recover from childbirth, leave periods also affect mothers' position in the labor market (Rossin-Slater, 2018). A large body of research shows that leave breaks influence mothers' post-leave labor force participation rates and earnings, although the size and persistence of these effects vary based on the length of leave. Maternal labor force participation is found to increase with short periods of leave, while longer breaks are negatively associated with mothers' employment rates, especially if mothers drop out of the labor market completely (Cukrowska-Torzewska, 2017; Olivetti & Petrongolo, 2017; Schönberg & Ludsteck, 2014; Thévenon & Solaz, 2012). Similarly, prolonged maternal leave negatively affects wages, however mostly only in the short term as the observed reduction disappears in the long run (Kleven et al., 2020; Lalive & Zweimüller, 2009; Ruhm, 1998). Nevertheless, maternal leave is consistently identified as an impediment to career progression and wage growth of mothers, particularly for extended periods of leave (McIntosh et al., 2012; Thévenon & Solaz, 2012; Torres et al., 2024).

According to the theory that disadvantages accumulate over the life course, – a concept in life course research – economic inequalities that arise during working life can persist and even intensify in retirement (Bernardi et al., 2019; Dannefer, 2003; Elder et al., 2003). This is particularly evident in the case of old-age pensions because pension income is, to some extent, the product of past labor force participation and wages (Kuitto et al., 2021; Möhring, 2018; Möhring et al., 2025). Previous employment trajectories can shape retirement income in two ways: First, lower labor force participation results in lack of pension coverage in countries that require a minimum number of years of employment to qualify for a pension (Jefferson, 2009). Hence, leave duration may negatively affect pension income at the extensive margin. Second, most pension systems calculate retirement income based on total lifetime earnings (OECD, 2019b). Therefore, even short-term reductions in wages due to extended leave interruptions may have a negative effect on pension income at the intensive margin. Based on this rationale, this study analyzes the long-term economic impact of childcare-related career interruptions and hypothesizes that maternal leave duration has a negative causal effect on mothers' old-age retirement income.

So far, previous literature has primarily focused on the relationship between maternal leave duration and mothers' economic outcomes during their working lives. Studies that take a longer-term perspective and investigate the link between the length of maternal leave and income in retirement are limited. Existing research generally finds a negative association between leave duration and mothers' pension income that is significantly moderated by countries' pension systems (Dotti Sani & Luppi, 2021; Frommert et al., 2013; Möhring, 2015, 2018; Möhring & Weiland, 2018). However, these studies do not allow for any causal interpretation of the findings. Evidence on the causal effect of the length of childcare-related leave on pension income remains even more scarce. A cross-country causal analysis by Brugiavini et al. (2011) on the impact of statutory maternity leave duration on mothers' retirement income finds no significant effect. However, the statutory length of leave likely underestimates mothers' actual career interruptions, as parental leave – a leave period that follows maternity leave – is primarily taken by mothers, extending their time away from work beyond statutory maternity leave (OECD

Family Database, 2022). In contrast to Brugiavini et al. (2011), this study makes use of the actual length of maternal leave that is retrospectively reported by mothers.

Understanding the precise mechanisms that link different employment trajectories to mothers' retirement income is particularly relevant in the context of the ongoing process of population aging in Europe, and the increasing need for old-age poverty alleviation and prevention among elderly women. While this study analyzes the effect of maternal leave duration on pension income for past and current generations of retirees, the findings have important implications for the design of labor markets, childcare-related leave policies, and pension systems for future generations.

Understanding how childcare-related career interruptions affect maternal retirement income is crucial for developing effective measures to mitigate old-age poverty among women. Pensions are the primary source of income for retirees, which makes pension adequacy a decisive factor for economic well-being in old age (Corsi et al., 2011; European Commission, 2024a). Yet, elderly women face a higher poverty risk in old age than men, mainly due to women's higher life expectancy and difficulties accumulating sufficient pension income from their own employment (Barigozzi et al., 2023; European Commission, 2013; European Commission, 2024a). With the ongoing process of population aging in Europe and women's higher longevity, the number of elderly women living in financial insecurity will continue to rise (European Commission, 2024a; Lis & Bonthuis, 2019). From a life-course perspective, this has important policy implications: if maternal leave duration is found to significantly reduce pension income, strategies are needed to prevent disadvantages that arise in working life to persist until retirement (Dotti Sani & Luppi, 2021).

In response to an aging population and a resulting decline in the working-age population, European pension reforms are gradually tightening the link between wages and retirement income to improve the financial sustainability of pension systems (Ebbinghaus, 2012; European Commission, 2013; OECD, 2019b). At the same time, standard, uninterrupted work paths are becoming less common as careers become more discontinuous (Hinrichs, 2021; Hinrichs & Jessoula, 2012; Kuitto et al., 2021). These

developments foreshadow an aggravation of pension income inequality and an increase in the number of individuals at risk of old-age poverty, particularly among retirees with lower lifetime earnings (Ebbinghaus, 2012; Hinrichs, 2021). A negative effect of maternal leave duration on retirement income would highlight the need to strengthen poverty-alleviating elements of pension systems to protect mothers from the consequences of career breaks.

The objective of this study is to analyze the causal effect of mothers' leave duration on their old-age pension income across 15 European countries, namely Austria, Germany, Sweden, the Netherlands, Spain, Italy, France, Denmark, Greece, Switzerland, Belgium, Ireland, Luxembourg, Portugal, and Finland. The empirical strategy is comprised of two steps: first, two multiple linear regression models, estimated using ordinary least squares (OLS), assess the correlation between mothers' individual leave duration (ILD) and their retirement income. Throughout this study, ILD and maternal leave duration are used interchangeably. Both refer to the time that mothers are away from work due to childbirth and subsequent childcare-related obligations. Hence, ILD includes maternity leave before and after childbirth, as well as parental leave taken by the mother, which usually follows maternity leave. ILD also includes any additional time that mothers spend away from work due to childcare responsibilities that exceeds the statutory maternity and parental leave period. Therefore, ILD also covers periods during which mothers drop out of employment due to childcare. The necessary individual-level data on retrospective maternal leave trajectories and employment histories, as well as contemporary information on individual-level old-age pension income comes from the Survey of Health, Ageing, and Retirement in Europe, short SHARE. SHARE provides a rich dataset that allows this study to link contemporary data on mothers' pension income with retrospectively collected information on the length of their maternal leave for each child.

The second step of the empirical strategy employs a 2-Stage-Least-Squares Instrumental Variable (2SLS IV or IV) approach to isolate the causal effect of ILD on pension income. Country- and time-specific policies on statutory maternity leave duration (SLD) in 15 European countries from 1960 to 2010 provide the necessary instrument in the IV estimation. SLD refers to the legal framework that establishes the maximum length of

maternity leave available to mothers in each observed country and year. The country-level information on SLD comes from the Comparative Family Policy Database that provides harmonized data on maternity, parental, and childcare leave policies in OECD countries for the years from 1960 to 2010 (Gauthier, 2011b).

The remainder of this study is structured as follows: first, a literature review provides comprehensive information on the institutional framework underlying the subsequent analysis. Next, an overview of existing research on the short-, medium-, and long-term impact of maternal leave duration on mothers' economic outcomes is provided. The estimation strategy and data are described in more detail. Descriptive findings for the main variables are presented, followed by the main analysis. Several robustness checks address concerns about the validity of the IV estimation results. Additionally, heterogeneity analyses indicate a potential group of compliers in the IV estimation and explore whether the results vary for different subgroups. The results are discussed in the light of current literature and possible explanations for the findings are provided. A conclusion summarizes the study.

2. Literature Review

2.1 Institutional Context

2.1.1 Childcare-Related Leave Policies in the European Context

Childcare-related leave policies are designed to grant parents time away from work to prepare for and recover from childbirth, while also protecting the health of both mother and child during the period after the birth (Rossin-Slater, 2018). Several studies document the positive impact of parental leave on the well-being of mothers and newborns: Extensions of leave are associated with higher breastfeeding rates, lower incidence of low birth weight, and reduced infant mortality (Rossin-Slater, 2018; Ruhm, 2000; Tanaka, 2005). In addition to improving the health of mothers and their children, leave policies aim to support parents in balancing care responsibilities and career continuity (Rossin-Slater, 2018).

To achieve these objectives, most European countries have developed four types of leave policies: maternity leave, paternity leave, parental leave and childcare leave. Maternity leave is a period of job-protected time away from work for previously employed women. It usually includes weeks before and after childbirth and is compulsory in some countries. During this time, mothers are typically financially supported by income-related leave benefits, which sometimes provide full income replacement. Paternity leave refers to the same concept for employed fathers, though usually at a shorter length (OECD Family Database, 2024a).

Parental leave often follows maternity leave and is intended to provide additional leave for both parents. The details and peculiarities of parental leave vary significantly from country to country. Several countries reserve a portion of parental leave exclusively for the mother or father, making it non-transferable. In some countries, paternity leave is integrated into parental leave entitlements. To encourage fathers to make use of their parental leave, few countries offer extra paid weeks if both parents take a certain amount of parental leave (OECD Family Database, 2024a). Nevertheless, the greater share of parental leave users are still mothers (OECD Family Database, 2022).

Childcare leave, also known as homecare leave, is a type of job-protected leave that grants parents time away from work during their child's early years, usually until the child starts formal childcare. Childcare leave follows parental leave and allows at least one parent to stay home with the child. While parental leave supports parents in caring for their newborn during the first months and years, childcare leave provides support during a later phase, usually until the child is two or three years old. Only a few countries offer this type of leave, which is usually unpaid or paid at a very low rate (OECD Family Database, 2024a).

Historically, maternity leave has been a core policy of social welfare states and dates back to the 19th century (Daly & Ferragina, 2018). Germany was the first country worldwide to introduce paid maternity leave in 1883 under the Bismarckian government (Son, 2024). It granted women six weeks of leave with leave benefits paying 50 percent of their earnings. Most European countries followed suit and established maternity leave

policies in the early to mid-20th century. Paid leave durations varied widely, from just two weeks in Denmark to twelve weeks in the Netherlands, while most European countries granted around four weeks. By the mid-20th century, most European countries had introduced some form of paid maternity leave. From the 1970s to the 1980s, family policy was determined by extensive expansion in both maternity and parental leave duration. Today, almost all European countries offer longer leave earmarked for mothers than they did in 1970. In 2024, the average length of paid maternity leave among EU countries was 21.5 weeks and the average length of paid parental and home care leave available to mothers stood at 45.2 weeks (OECD Family Database, 2024a, 2024b).

It is only in recent decades that paternity and parental leave schemes earmarked for fathers have emerged. In the second half of the 20th century, paternity leave or parental leave exclusively reserved for fathers was still the exception: in 1970, only three European countries had introduced paternity leave, notably Belgium, Luxembourg and Spain. By 2024, all European OECD countries had reserved some period of paid leave exclusively for fathers (OECD Family Database, 2024b). However, the take-up of parental leave by fathers differs substantially among countries. In the Nordic countries, – e.g. Sweden, Iceland, and Denmark – nearly half of those who take parental leave are men. In contrast, fewer than ten percent of parental leave users are men in countries like Austria and France. In most countries, it is still mothers who use the greater share of parental leave entitlements (Daly & Ferragina, 2018; Gauthier, 2011a; OECD Family Database, 2022, 2024a, 2024b).

An important factor in the uptake of parental leave, particularly among fathers, is the amount of benefits paid during leave. High leave benefits are an important incentive for fathers to use and extend their leave entitlements (Karu & Tremblay, 2018; O'Brien, 2009). Parental leave benefits are generally lower than maternity leave benefits and typically replace one to two-thirds of previous earnings (Kern & Lecerf, 2023; OECD Family Database, 2022, 2024a). Leave benefits during maternity leave are more generous: Most European countries grant benefits of over 50 percent of previous income; some even replace full pre-leave earnings (OECD Family Database, 2024a).

2.1.2 Old-Age Pension Systems in the European Context

The Three Tiers of European Pension Systems

Old-age pension systems are a key institution of modern welfare states and the main moderator of the relationship between maternal leave duration and retirement income (Möhring, 2015). In the European context, pensions serve two main purposes: They intend to maintain a certain standard of living in old age that is proportional to one's living standard during employment, and to reduce poverty among retirees. Most European pension systems aim to achieve these objectives through the interplay of pension contributions, pension entitlements, and redistribution of benefits, and a combination of three pension tiers (Lannoo et al., 2014b; OECD, 2015, 2019b). All these components are defined in more detail below.

Individual pension contributions form the basis for calculating most of an individual's pension income and are usually mandatory for all workers. The total amount of contributions is based on a percentage of the employee's earnings and is typically shared between employees and employers (Lannoo et al., 2014; OECD, 2023a). Upon retirement, the accumulated contributions are converted into pension entitlements, either based on a formula that considers the number of contribution years, accrual rates, and the amount of pensionable earnings, or a notional rate of return is applied to all contributions made during employment. Thus, pension entitlements are largely determined by contribution history and earnings level (OECD, 2019b).

Most European pension systems include redistributive mechanisms to safeguard retirees against old-age poverty caused by otherwise inadequate pension entitlements (OECD, 2019b). In the context of pension policies, redistribution refers to adjusting pension entitlements in favor of low earners and retirees with interrupted careers. More precisely, beneficiaries receive a pension benefit that is higher than the actuarial value of their own contributions (European Commission, 2024a; OECD, 2019b). Therefore, the degree of redistribution in pension schemes significantly affects how career interruptions and low wages impact retirement income (Möhring, 2015).

Almost all European pension systems share a common three-tier structure, with each tier serving a specific purpose. The first two tiers are usually mandatory, while the third tier consists of private, voluntary savings. First-tier pensions are typically public, state-managed pension plans that aim to guarantee retirees a minimum income in old age, unrelated to labor earnings, to protect them against old-age poverty. Therefore, first-tier pensions are generally considered a redistributive element within the three-tier system. The second tier is intended to mirror previous living standards and to maintain a pension income that is proportional to previous earnings from employment. The third tier consists of voluntary, private, or employer-based pension plans that provide an additional option for private retirement savings. Due to their voluntary nature, third-tier pensions play a minor role in determining pension income adequacy in most European countries and usually only act as supplemental savings (Lannoo et al., 2014; OECD, 2019b, 2023a). This study analyzes pension income from first and second pension tiers only, thus, the third tier will not be discussed further.

First-tier pensions can be classified into three types that are all unrelated to previous earning levels but differ in their degree of redistribution and coverage of the retired population: basic, targeted, and minimum pensions. Basic pensions can be either contribution-based or residence-based. This means that eligibility requires a minimum number of contribution or residency years, and the benefit level is usually proportional to the number of years. If the requirements are met, every retiree receives the basic pension, independent of pension income from other sources. Targeted pensions are residence-based, means-tested programs aimed specifically at low-income pensioners. Unlike for basic pensions, eligibility for and the amount of benefits received from targeted pensions depend on current income from other pension sources, assets, and the need for state support. Minimum pensions are intended to supplement the retirement income of retirees whose benefits would otherwise fall below a certain threshold. However, eligibility usually requires a sufficient number of contribution years (OECD, 2019b). Although all first-tier pensions are redistributive, minimum pensions provide supplements only to those with sufficient contributions, making them the least redistributive pension type. In contrast, eligibility for targeted and residence-based basic

pensions does not depend on contribution history, making these pension schemes more redistributive than minimum pensions (Möhring, 2015).

Second-tier pension systems follow one of the three schemes: Point systems, defined benefit (DB) or defined contribution (DC) schemes. Point schemes calculate pension entitlements based on pension points that depend on labor earnings. The sum of points is then multiplied with a fixed value to convert it into monthly pension income. A DB pension plan pays retirees a pension based on previous income, years of contribution and accrual rates. DC schemes can be either funded (FDC) or notional (NDC). In both types, contributions flow into individual accounts. While FDC plans convert individual contributions, together with investment returns, into a monthly pension, NDC plans calculate entitlements based on contributions and a notional rate of return (OECD, 2023a). All three schemes – point systems, DC and DB plans – base pension entitlements on contribution history and earnings and have little to no redistributive power.

A relevant feature of pension systems that shapes the link between maternal leave breaks and pension entitlements are compensating mechanisms that credit childcare-related leave periods in pension calculations. Most European pension systems aim to compensate mothers — and sometimes fathers — implicitly or explicitly for interrupting their careers to give birth and subsequent care to their children (D'Addio, 2012). Implicit mechanisms include considering leave as contributory periods or treating leave benefits as pensionable earnings, while explicit recognition occurs through care credits, which grant pension contributions based on leave duration or the number of children. Most countries impose time limits on the period these measures cover, often until the child reaches a certain age (D'Addio, 2012; OECD, 2015, 2019b).

Country-Specific Pension Systems:

Earnings-Related versus Redistributive Schemes

National pension systems play a key role in moderating the relationship between a mother's employment history and her retirement income. The design of pension systems has a greater impact on women's pension entitlements than men's, as women are more likely to face interrupted careers, particularly due to periods of maternal leave

(Jędrzychowska et al., 2020; Möhring, 2015). Retirees with career breaks and low earnings benefit from redistributive pension schemes, whereas earnings-related systems penalize low life-time earnings and periods away from work. Whether a pension scheme is redistributive or earnings-related is determined by the type of first-tier pension, the balance between first and second tiers, and the crediting of leave periods in the pension calculation (Möhring, 2015). In this cross-country study, outlining the pension system of each country is essential to comprehend pension systems as channels between maternal leave duration and retirement income.

Based on the pension taxonomy used by the OECD in its reports *Pensions at a Glance* and *Pensions at a Glance – Country Notes*, the following section reviews pension schemes and country-specific peculiarities of the 15 observed countries, namely: Austria, Germany, Sweden, the Netherlands, Spain, Italy, France, Denmark, Greece, Switzerland, Belgium, Ireland, Luxembourg, Portugal, and Finland. The outline of each country's pension system is mainly based on the OECD report *Pensions at a Glance* from 2019 (OECD, 2019b); however, information from the reports from 2023, 2021, 2017, and 2015 and from the reports *Pensions at a Glance – Country Notes* and *OECD Reviews of Pension Systems* is also considered (OECD, 2014, 2015, 2017, 2019a, 2021, 2023a, 2023b). Systems may have been altered or adjusted during this analysis's observation period, most likely by raising the statutory retirement age or by reducing pension benefits. However, significant changes to the core design of pension systems are often politically controversial and time-consuming to implement; therefore, the pension types in place in each tier rarely undergo complete changes (Van Vliet et al., 2012). In the following, a general description of each country's first- and second-tier scheme and of its crediting mechanisms for leave periods is provided. In addition, countries are grouped based on the extent to which their systems redistribute or are earnings-related.

Italy, Portugal, Greece, and Spain all depend on a primarily earnings-related pension scheme. Italy, Portugal, and Spain rely on a contribution-based minimum pension in their first tier to which, as of 2019, individuals must have contributed for 22, 30, or 34 years, respectively, to receive its full amount. Portugal and Spain complement this with earnings-related DB plans, where pension contributions during parental leave accrue on

pre-leave wages (Portugal) or leave benefits (Spain). Italy's NDC plan in its second tier further strengthens the link between earnings and pension entitlements in the Italian scheme. In the Italian system, leave benefits are treated as pensionable income. Greece differs slightly from the other three countries as it has implemented a residence-based basic pension in its first tier. However, its main component is an earnings-related DB/FDC mix, where leave benefits count as pensionable income. Given their limited redistribution and dominant earnings-related second tiers, the systems of Italy, Portugal, Greece, and Spain penalize short careers and low wages in the calculation of pension entitlements (OECD, 2015, 2017, 2019b, 2019a).

Austria, Belgium, France, Luxembourg, and Switzerland rely on mainly earnings-related pension systems with moderately redistributive elements. Their first tiers consist of a contribution-based minimum pension: Austria, Belgium, and Luxembourg require 15, 30, and 35 years of contributions, while France and Switzerland grant universal minimum pensions scaled by contribution years. The second tier in Austria, Belgium, France, Luxembourg, and Switzerland is an earnings-related DB plan, with France combining it with a point system. Parental leave is credited differently in the five countries: Austria, France, and Switzerland provide explicit care credits, while Belgium and Luxembourg implicitly count leave as contributory periods and benefits as pensionable income. Overall, these systems combine earnings- and contribution-based structures with limited redistributive elements (OECD, 2015, 2017, 2019b).

Sweden combines a targeted first-tier pension with earnings-related FDC and NDC second-tier plans that calculate benefits over the full working life. Parental leave benefits count as pensionable earnings in the Swedish pension system. Like for Austria, France, Belgium, Luxembourg, and Switzerland, Sweden's mix of earnings-related and redistributive elements makes its pension system moderately earnings-related (OECD, 2015, 2017, 2019b).

Germany has no stand-alone, first-tier pension dedicated to social protection and poverty prevention. Instead, low-income retirees rely on general, means-tested social assistance which is not part of the pension system. Since social assistance is a means-

tested benefit for low-income retirees, it is sometimes referred to as a targeted first-tier pension in the literature; however, it is not a separate pillar in the German pension system (Bundesministerium für Arbeit und Soziales, 2023). In 2021, Germany introduced a supplemental pension for low-income retirees that requires 33 contribution years to become eligible. While it resembles a contribution-based minimum scheme, the supplemental pension is not a separate tier in Germany's pension design (Bundesministerium für Arbeit und Soziales, 2023). Germany's second-tier system is earnings- and contributions-based, using a point scheme similar to France's. Childcare interruptions are credited with one pension point for each child. The number of points is based on the number of children and not on the actual length of leave periods. Overall, Germany's pension system remains largely earnings- and contributions-based, with limited redistributive elements (OECD, 2015, 2017, 2019b, 2023b).

Finland combines a redistributive targeted pension – covering nearly one-third of retirees – with its core scheme, a primarily earnings-related DB system based on lifetime earnings. Pension contributions accrue for 11 months of maternal leave based on pre-leave wages. After 11 months, contributions during leave periods continue to accrue at only one-fifth of average earnings. While the targeted pension offers additional income for low-income retirees independent of contribution history, Finland's core pension scheme remains earnings-related (OECD, 2015, 2017, 2019b).

The Netherlands combines a redistributive, residence-based basic pension in the first tier with an earnings-related DB scheme in the second, calculated on lifetime earnings. While maternal leave is not credited in the second tier, the first tier remains unaffected as it calculates entitlements based on residency rather than earnings. Overall, the Dutch system balances a redistributive basic pension with an earnings-related second tier, making it moderately redistributive (Beetsma et al., 2015; European Commission, 2024a, 2024b; OECD, 2017, 2019b).

In Denmark and Ireland, pension entitlements remain virtually unaffected by previous employment trajectories. Denmark relies on a residence-based basic and a targeted pension in its first tier that are both mostly independent of contribution history and cover

nearly 75 percent of retirees. Denmark combines its first tier with an earnings-related FDC second tier, which functions mainly as a supplement (Andersen, 2015). Pension contributions during maternal leave continue to accrue in the FDC plan based on leave benefits. Ireland has a contribution-based basic pension that requires just ten years of contributions to become eligible. Ireland has no mandatory second tier, though voluntary private plans exist. Leave periods count as contributory periods in the contribution-based basic pension. Denmark's and Ireland's pension systems are the most redistributive among all 15 observed countries (OECD, 2014, 2015, 2017, 2019b; Whitehouse, 2006).

Based on the country-specific descriptions and grouping of pension systems, the observed countries can be broadly ranked by how strongly entitlements depend on pre-retirement labor market trajectories. Retirement income in Italy, Portugal, Greece, and Spain is mainly earnings-related, and the pension system has limited redistributive capability. In Austria, Germany, France, Belgium, the Netherlands, Switzerland, Luxembourg, Sweden, and Finland, an earnings-based pension scheme forms the core system, but is combined with redistributive elements. Ireland and Denmark are the only countries where pension income is largely unrelated to contribution history and earnings due to their core redistributive systems. In summary, the following groups emerge:

Table 1: Countries grouped by their pension systems, based on the degree of redistribution and earnings-relatedness

(1) Highly earnings- and contributions-related, limited redistribution: Italy, Portugal, Greece, Spain
(2) Mainly earnings- and contributions-related, moderate redistribution: Austria, Germany, France, Belgium, the Netherlands, Switzerland, Luxembourg, Sweden, Finland
(3) Unrelated to earnings and contribution history, high redistribution: Denmark, Ireland

Notes: This table shows all observed countries grouped by their pension systems, based on whether their systems are earnings-related or redistributive. The grouping is mostly based on pension system taxonomy from the OECD report *Pensions at a Glance* from 2019.

The degree of redistribution in pension schemes is also reflected in variation of pension replacement rates (PRR) across different pre-retirement earnings levels. The PRR is defined as the percentage of pre-retirement income that is replaced by pension income and is typically calculated using average lifetime earnings (OECD, 2019b). It indicates how well a pension system maintains an individual's income level in retirement. In many European OECD countries, low-income retirees have a higher PRR than those with average or high earnings. Yet, variation by countries exists: redistributive pension schemes provide much higher PRRs for low-earners than for average- and high-earners, while earnings-related systems have similar rates for all income groups, which offers comparatively less protection for individuals with lower lifetime earnings (OECD, 2015, 2017, 2019b).

This pattern is consistent with the country groups in Table 1. In Italy and Spain, low- and average-income retirees face identical PRRs, which highlights the lack of redistributive measures. In most countries in group (2) in Table 1, retirees with prior below-average earnings receive PRRs that are three to 20 percentage points higher than the PRRs for those with average earnings. The difference in the PRR is particularly pronounced in Denmark and Ireland, where low earners have a PRR that is around 43 (Denmark) and 26 (Ireland) percentage points higher than the PRR for average earners (OECD, 2019b). These differences illustrate not only variation in the PRR by country but also disparities between income groups within countries, as low-income retirees are usually better protected by redistributive pension schemes than their higher-earning counterparts (OECD, 2023a).

2.2 Maternal Leave Duration and Economic Outcomes

2.2.1 Maternal Leave Duration and Economic Outcomes During Working Life

The previous section shows that most European pension systems base pension entitlements on previous career earnings. Hence, mothers' labor market trajectories are a key pathway in the link between maternal leave and pension income. Mothers may lose income during leave, but more importantly, prolonged leave influences labor force participation and earnings after reentering the labor market. Lower labor market participation may lead to mothers not being covered by pension schemes at all – hence, affecting the extensive margin of pension income – and a reduction in earnings may impact the intensive margin of retirement income. The following section reviews existing literature on the relationship between maternal leave duration and mothers' short- to medium-term labor market outcomes to contextualize the very long-term effect of leave duration on pension income.

While research on long-run consequences of maternal leave on pension income is limited, there are numerous studies on childcare-related career breaks and economic outcomes during working life. Most studies focus on two outcomes: the development of mothers' labor force participation and of mothers' wages after childbirth. Findings from previous literature show a rather ambiguous picture for both and are presented below.

The relationship between leave duration and maternal labor force participation appears to be country specific. Still, mothers' post-leave employment rates generally tend to decline with extended leave in the short term, while long term effects are only minimal or nonexistent. Numerous policy changes and expansions of statutory leave in late 20th-century Europe have been widely used as natural experiments to study these country-specific effects. Kluve and Schmitz (2018) use the introduction of more generous leave benefits in Germany to estimate the causal effect of the policy change on mothers' labor market outcomes. They find that, up to five years after childbirth, labor market participation among mothers has risen, but mostly due to a greater share of women working in part-time employment. The authors also find significant heterogeneities by

income terciles: while the reform causes a significant increase in the labor force participation of high-income mothers, low-income mothers' employment rates remain almost unaffected. In contrast, Froderman et al. (2023) investigate the same German policy change and identify negative effects on female labor market participation. However, the reduction persists only in the first year after childbirth and maternal employment rates converged to pre-reform levels over time. Other studies confirm immediate post-leave effects that disappear years after giving birth (Bergemann & Riphahn, 2023; Lalive & Zweimüller, 2009; Schönberg & Ludsteck, 2014; Stearns, 2016).

Cross-country studies generally indicate that the impact of maternal leave on mothers' employment depends on the length of leave. An early cross-country study by Winegarden and Bracy (1995) finds that prolonging paid leave entitlements has a positive causal effect on female labor market participation during mothers' childbearing ages. In a causal analysis of nine European countries, Ruhm (1998) confirms an increasing effect on female labor supply as well, but a slight decrease in mothers' wages. Several other studies document a positive impact on maternal employment rates, yet only for short- to medium-long periods of paid leave. Above a certain threshold, any further extension of maternal leave is negatively correlated with mothers' employment rates, leading to the assumption of a non-linear relationship between the length of career breaks and mothers' labor force participation (Cukrowska-Torzewska, 2017; Joseph et al., 2013; Misra et al., 2011; Schönberg & Ludsteck, 2014; Thévenon & Solaz, 2012). Olivetti and Petrongolo (2017) corroborate these findings in a literature review. They conclude that, across countries, shorter lengths of leave have positive causal effects on maternal employment, while longer leave breaks appear to harm mothers' post-leave labor market participation. They also point out heterogeneous effects by education, where leave duration has less detrimental impacts for lower skilled mothers (Olivetti & Petrongolo, 2017). The critical threshold after which an extension of leave has a negative effect on mothers' employment seems to be around one year (Canaan et al., 2022; OECD, 2011; Rossin-Slater, 2018), however, others suggest the turning point to be at around two years of leave (Thévenon & Solaz, 2012).

The effect of maternal leave duration on post-leave earnings appears to be similarly country- and policy-specific, though most research indicates increasingly negative returns with longer leave breaks. Particularly, the adverse impact of longer leave interruptions on mothers' earnings in Germany, a country with long statutory parental leave provisions, is well documented. Each additional month of leave significantly reduces the wages of German mothers in both the short and long term, thereby contributing to the existing motherhood wage penalty in Germany (Ejrnœs et al., 2013; Ondrich et al., 2002; Schönberg & Ludsteck, 2014).

However, Frodermann et al. (2023) show that the German parental leave reform from 2007 only had short-term impacts on mothers' earnings that disappear in the long-run. Likewise, several other country-specific studies find that leave extensions decrease mothers' earnings after re-entering the labor market, but had little long-term impact on wages (Dahl et al., 2016; Girsberger et al., 2021; Lalive & Zweimüller, 2009; Stearns, 2016). Kleven et al.'s (2020) analysis of multiple leave reforms in Austria is in line with the finding of immediate decreases in post-leave earnings: negative effects on earnings are limited to short-term effects that vanish in the long term. In addition, they point to non-linearities, as the marginal effect of leave duration on earnings is greater for shorter leave lengths (Kleven et al., 2020). Reviews of cross-national and country-specific studies also conclude that the impact of maternal leave duration on earnings appears to be non-linear, although policy features such as leave benefits seem to be influential (Canaan et al., 2022; Cukrowska-Torzewska, 2017; Olivetti & Petrongolo, 2017).

Contrary to the findings of non-linearities in the relationship between leave duration and earnings, Evertsson (2016) finds a significant reduction of Swedish mothers' wages that increases linearly with the length of leave. The study also identifies an educational gradient, finding that higher-educated mothers experienced greater wage losses. Similarly, a French reform of maternal leave coverage is estimated to linearly lower wages up to ten years later – each additional year of leave is estimated to reduce earnings by seven to 17 percent (Lequien, 2012).

Although there is no consensus on the exact magnitude and persistence of the impact of leave interruptions, compelling evidence shows that longer interruptions have more adverse effects on mothers' labor force participation and earnings than shorter ones. Thus, the impact of leave on labor market outcomes during working life depends on its length. However, the effects appear to persist only in the short and medium term.

Still, it is plausible that these disparities accumulate over the life course and introduce a similar relation between maternal leave duration and pension income. Most countries in this study base eligibility for pension plans on the premise of uninterrupted employment to achieve full pension coverage. Therefore, gaps in contributions, even for a few years, can result in not being covered by a pension scheme. Similarly, even short-term reductions in wages can result in reduced retirement income because most countries calculate entitlements based on life-time earnings (OECD, 2019b).

2.2.2 Maternal Leave Duration and Economic Outcomes in Retirement

Women receive lower average retirement income than men, a disparity measured by the gender gap in pensions (European Commission, 2013; Lis & Bonthuis, 2019). Factors that determine the GGP can be partially attributed to women's greater share of childcare responsibilities: women have shorter careers and receive lower wages (Frericks & Maier, 2008; Hammerschmid & Rowold, 2019b; Lis & Bonthuis, 2019; Mavrikiou & Angelovska, 2020; Niessen-Ruenzi & Schneider, 2022). Within the broader GGP, research increasingly investigates the motherhood pension gap, which measures the additional reduction of pension income mothers face compared to childless women (Jędrzychowska et al., 2020; Möhring, 2018; Möhring et al., 2025). Several studies find that mothers' retirement income decreases with each additional child, supporting the existence of a motherhood penalty in pensions (European Commission, 2013; Haan et al., 2025; Jędrzychowska et al., 2020; Möhring, 2018). This suggests a direct link between children, childcare, and women's pension entitlements, however, the exact impact of maternal leave on the GGP and on the motherhood penalty in pensions has yet to be quantified.

While there is an extensive body of literature that examines the link between maternal leave duration and economic outcomes during working life, much less is known about

the very long-term economic impact of leave duration in retirement. The limited literature investigating the association between leave length and pension income generally finds a negative relationship, which is elaborated on in more detail below. Studies that investigate a causal link between maternal leave duration and pension income are even more limited. A causal cross-country study by Brugiavini et al. (2011) explores the effect of statutory maternity leave duration on pension income and finds no significant effect. However, the length of statutory maternity leave likely underestimates the actual length of mothers' leave interruptions, as parental leave after maternity leave is predominantly taken by mothers (OECD Family Database, 2022). Hence, the actual duration of maternal leave is often longer than statutory maternity leave alone. Unlike Brugiavini et al. (2011), this study uses self-reported maternal leave duration from the SHARE survey, providing a more accurate measure of the actual length of mothers' leave interruptions.

Existing literature on the association between individual employment trajectories and pension income across different countries reinforces the findings in Section 2.1.2: national pension systems are decisive moderators of the link between employment history and pension income. In a cross-national analysis of 13 European countries, Möhring (2015) shows how pension schemes can either penalize or cushion career interruptions in the calculation of pension entitlements. The study finds that women's non-linear employment histories negatively affect their retirement income in strongly earnings-related pension systems. However, this relationship appears weaker when earnings-related schemes are combined with redistributive elements. Particularly basic and targeted pensions can mitigate the potential adverse impact of career interruptions on retirement income. The study also shows that higher labor market participation is associated with higher pension income in later life across all countries – a correlation that is stronger for women than for men (Möhring, 2015, 2018).

Similarly, Dotti Sani and Luppi (2021) investigate the correlation between leave duration and mothers' pension income and find that retirement income decreases with longer lengths of maternal leave, particularly in Southern European countries. By contrast, in Denmark, mothers' pension income is not significantly associated with leave duration. This pattern aligns with the pension system typologies outlined in Section 2.1.2 that

categorize Southern European pension schemes as largely earnings-related, while Denmark's system is among the most redistributive.

Country-specific studies suggest that not only institutional factors, but also individual decisions about maternal leave and mothers' return to the labor market influence income in retirement. An analysis of administrative data from the German statutory pension insurance finds evidence that shorter leave breaks and a faster return to the labor market have a positive effect on mothers' pension income (Möhring & Weiland, 2018). This is in line with Frommert et al. (2013) who conclude that women who choose to re-enter the labor market faster and start to work full-time right after – in contrast to part-time employment – can expect to reach their highest possible retirement income.

These findings indicate that mothers' leave behavior is shaped by individual characteristics that also affect pension income. Women who return to work quickly after childbirth may be more career oriented and highly attached to the labor market, which also positively affects women's wages and ultimately their pension income (Weisshaar & Cabello-Hutt, 2020). This suggests potential endogeneity of leave duration because women may choose different lengths of leave based on their individual characteristics, which may also affect their retirement income. Section 3.1.2 outlines concerns about endogeneity bias in more detail and stresses the need for an IV approach that can overcome endogeneity bias, unlike the simple OLS estimates.

Previously presented literature on the long-term consequences of maternal leave duration indicates that prolonged leave is rather harmful for pension income, though the extent depends on a country's pension system and its degree of redistribution. Evidence from studies on labor market outcomes during working life shows that longer leave negatively affects mothers' labor force participation and earnings (see Section 2.2.1). Since pension entitlements are closely tied to contribution history (see Section 2.1.2), these short- and medium-term losses likely accumulate over the life course and ultimately lead to lower retirement income. On this basis, this study hypothesizes that maternal leave duration has a negative causal effect on old-age pension income in retirement.

So far, most research focuses on the short- and medium-term consequences of maternal leave length, while only few studies have examined its impact on retirement income – and even fewer have addressed a causal link between leave duration and pensions. This study contributes to the literature by filling this gap: it investigates the causal effect of maternal leave duration on retirement income, using self-reported information on the length of leave for each child and exploiting variation in statutory maternity leave duration across 15 countries and over time.

3. Estimation Strategy and Data

3.1 Main Estimation Strategy

The main estimation strategy is comprised of two steps to examine the effect of maternal leave duration on pension income. First, two multiple linear regressions, estimated with OLS, are used to assess the correlation between individual leave duration and pension income. However, these estimates may be biased due to endogeneity resulting from reverse causality, omitted variables, selection bias, and measurement error, a concern that is further discussed in Section 3.1.2. Thus, the simple OLS estimates may not be reliably interpretable as the causal effect of ILD on pension income. To address endogeneity issues in the simple OLS estimation, the second step uses a 2SLS instrumental variable approach that allows to overcome endogeneity bias and to identify the causal effect of ILD on pension income.

3.1.1 Simple OLS Estimation

The measurement of ILD is based on two specifications of the explanatory variable: leave duration in weeks as a continuous variable and leave duration as a categorical variable with nine categories. Each specification is used as an explanator in the simple OLS estimations, resulting in two separate linear regressions, one with ILD as a continuous variable and one with ILD in categorical format. The two simple OLS estimates provide an initial benchmark estimation and serve as a useful reference point for later comparison with the IV result. This comparison will help determine if endogeneity is indeed biasing

the simple OLS estimates. The multiple linear regression model using OLS estimation looks as follows:

$$\text{Individual pension income}_m = \beta_0 + \beta_1 \text{ILD}_{m,c} + \beta_2 M_m + C_{m,c} + \varepsilon_{m,c} \quad (1)$$

The outcome variable individual pension income $_m$ is the net old-age pension income per year of mother m. The explanatory variable $\text{ILD}_{m,c}$ refers to the individual leave duration of mother m around the birth of child c, measured in weeks and nine categories. The exact construction of the outcome and explanatory variables is further explained in Section 4.1.1 and Section 4.1.2.

M_m and $C_{m,c}$ are vectors that include several control variables, specific to each mother m and her child c. Vector M_m includes the following variables: mothers' educational attainment, number of children, year of birth, country of residence, and self-reported health status at the time of the interview. $C_{m,c}$ is a vector of control variables related to mother m and child c. It includes two additional variables: the industry in which the mother worked during the birth of each child and the cash benefits she received during each period of maternal leave, expressed as a percentage of female wages in manufacturing. The inclusion of each covariate in the model is justified below.

Educational attainment may influence both ILD and pension income, making it a potential confounding factor. Education is a well-known determinant of labor earnings, with higher-educated individuals receiving higher wages (Cohn & Addison, 1998; Psacharopoulos & Patrinos, 2018). Since pension income largely depends on earnings, it is likely that highly educated retirees receive higher pension income. At the same time, mothers with higher education and higher income face a greater motherhood penalty in wages and are thus more likely to take shorter leaves than those with lower education (Bister et al., 2024). Therefore, educational attainment is an important covariate; failing to account for it could overstate the expected negative correlation between ILD and pension income.

Similarly, the number of children a mother has likely affects both her ILD and her pension income. A Spanish study finds that the presence of existing children under the age of five in the household increases the length of maternal leave around the birth of an additional child (Lapuerta et al., 2011). Additionally, the motherhood penalty in earnings varies by parity (Kahn et al., 2014), which persists until retirement as the motherhood penalty in pensions increases with the number of children (Jędrzychowska et al., 2020; Möhring, 2018). Therefore, omitting parity as a covariate may not account for the confounding impact of the number of children on the correlation between ILD and retirement income.

Further, health limitations potentially confound the relationship between maternal leave duration and retirement income. Poor health and chronic conditions reduce labor force participation and lifetime earnings (García-Gómez et al., 2013; Luft, 1975; Polanco et al., 2024), which may ultimately result in lower retirement income for individuals in poor health. If health issues already persisted in earlier life, they induce mothers to stay on leave for longer than healthy mothers, potentially to have more time to recover from the double burden of sickness and childbirth (Bister et al., 2025; Guertzgen & Hank, 2018). To properly account for this confounding channel, a covariate is included that measures the number of activities of daily living that the respondent has difficulties to carry out. Examples for activities of daily living include getting dressed, managing money, or preparing and eating own food.

The duration of maternal leave potentially varies by industry, while the job sector also affects pension income. Respondents working in typical white-collar jobs may be able to take longer leaves than those in blue-collar jobs due to better working conditions and fewer economic pressures. Studies suggest that working in white-collar industries such as education and the public sector increases the likelihood that mothers will use parental leave, which overall prolongs their length of maternal leave (Lapuerta et al., 2011; Valentova et al., 2024). The type of industry likely impacts pension income as well, since the constructed pension variable includes employer-based occupational pensions that vary by job sector. Entitlements tend to be higher in white-collar industries, such as the public sector, and lower in blue-collar sectors, such as the construction and hospitality

industry (Wiß, 2015). Thus, the vector $C_{m,c}$ includes the type of industry mothers were employed in during childbirth to account for this confounding factor.

Lastly, more generous cash benefits during leave encourage longer career interruptions (Lalive et al., 2014) and directly impact pension entitlements, as cash benefits are considered pensionable earnings in many of the countries examined (see Section 2.1.2). Thus, cash benefits may confound the relationship between ILD and pension income and are included in vector $C_{m,c}$ in Equation (1).

3.1.2 Potential Endogeneity of Maternal Leave Duration

In linear regressions using OLS estimation, it is challenging to isolate the sole effect of ILD on pension income due to concerns about maternal leave duration being endogenous. A key assumption of OLS estimation is that the independent variable must be uncorrelated with the error term; otherwise, estimates are biased by endogeneity. Endogeneity bias occurs due to reverse causality, omitted variable bias, selection bias or faulty measurement of variables (Angrist & Pischke, 2009). While reverse causality is unlikely to be an issue in the simple OLS estimation due to the chronology of maternal leave that happens years before receiving pension income, omitted variables, selection bias and measurement error remain probable.

Section 2.2.2 presents evidence that mothers select into specific lengths of leave due to individual characteristics that also influence their pension income (Frommert et al., 2013; Möhring & Weiland, 2018; Weisshaar & Cabello-Hutt, 2020). Studies on German and Australian mothers show that mothers with higher labor market attachment, higher education and higher income are more likely to take shorter leaves, all factors that significantly determine pension income as well (Bister et al., 2024; European Commission, 2024a; Kuhlenkasper & Kauermann, 2010; Ulker & Guven, 2011). This suggests that mothers select into different lengths of leave, based on their socioeconomic status and career orientation and – based on these characteristics – also receive different pension incomes. While Equation (1) includes educational attainment as a covariate, individual career commitment is difficult to account for. Thus, selection

bias and relatedly the omission of maternal variables regarding mothers' socioeconomic status and career attachment likely distort the simple OLS estimates.

Another source of endogeneity may be measurement error of the retrospectively reported variable ILD. The SHARE survey itself acknowledges the possibility of measurement error and even systematic recall bias in retrospective employment data, such as reported length of maternal leave (Alcser et al., 2011). Mothers may have difficulties remembering the exact period they were on leave for each child, introducing measurement error. If specific groups of mothers have difficulties to recall ILD, then recall bias may be a concern. This may specifically be the case for mothers with multiple children as they may have problems to remember the exact beginning and end of each period of maternal leave.

Previous arguments show that maternal leave duration is likely endogenous. The simple OLS estimates are potentially biased due to selection bias, specifically due to mothers choosing different lengths of leave depending on their socioeconomic status and career attachment, which also affects their pension income. Additionally, measurement error of the ILD variable or recall bias are potential concerns. Consequently, the simple OLS estimates are unreliable for identifying the causal effect of individual leave duration on pension income. This underscores the necessity of an IV approach to overcome endogeneity issues.

3.1.3 Instrumental Variable Framework

To address the problem of endogeneity, ideally the treatment – in this case leave duration – would be randomly distributed among mothers. In an ideal experiment, mothers would be randomly assigned to different lengths of leave, independent of their individual characteristics. However, as the previous section shows, this is likely not the case. Instead, the analysis relies on an exogenous source of variation in the form of statutory policies on maternity leave duration. Country- and time-specific policies on the duration of statutory maternity leave act as natural experiments: whether mothers are affected by a particular maternity leave policy depends on their country of residence and the year of childbirth. Mothers in different countries and at different times are subject to varying

maternity leave policies and plausibly adjust their leave duration based on the legal framework, rather than maternal characteristics. Thus, SLD generates variation in ILD that is plausibly exogenous to mothers' traits, enabling the IV approach to isolate the causal effect of ILD on pension income.

For SLD to be a valid instrument, it must satisfy two requirements. First, it must be relevant, i.e. significantly correlated with the endogenous explanatory variable ILD. This is likely the case as maternity leave legislation sets an artificial limit on the maximum length of paid maternity leave. This creates strong incentives for mothers to adjust the duration of maternal leave and either start using parental leave entitlements or return to work. Several studies reinforce that variation in parental leave policies across countries and over time induces changes in leave taking of mothers and offers an ideal instrument (Baker & Milligan, 2008, 2010; Lalive & Zweimüller, 2009; Renner et al., 2025). The relation between SLD and ILD is also formerly tested in the first stage of the IV approach in Section 4.2.2. The result shows that SLD is indeed relevant.

To meet the second requirement, the instrument must be exogenous to maternal characteristics and fulfill the exclusion restriction, i.e. SLD must affect pension income only through ILD. Since this requirement cannot be tested, plausible arguments are needed to justify the exogeneity of SLD. As previously explained, country- and time-specific statutory leave policies are essentially randomly assigned to mothers because they are a product of governments' social welfare policy and unrelated to individual maternal traits. Mothers are subject to different maternity leave policies, depending on the year of childbirth and their country of residence, which affects their pension income only through the length of actual maternal leave taken.

One possible concern that threatens the fulfillment of the exclusion restriction are cash benefits received during leave. Instead of SLD, the anticipation of such benefits may drive mothers' decision to take certain lengths of leave, which may violate the exclusion restriction. This threat is addressed by controlling for cash benefits in all IV models.

Using linear OLS estimation, the first stage of the IV model regresses the reported ILD of mother m with child c on the country-specific statutory leave duration SLD, that was in place in the year mother m gave birth to child c. Therefore, the first stage looks as follows:

$$ILD_{m,c} = \alpha_0 + \alpha_1 SLD_{m,c} + \alpha_2 M_m + C_{m,c} + \varepsilon_{m,c} \quad (2)$$

ILD and SLD are both continuous variables measured in weeks. Equation (2) includes the same vectors M_m and $C_{m,c}$ like Equation (1), with the same covariates.

In the second stage, predicted ILD values from the first stage are used as the explanator in Equation (3) to estimate individual pension income of mother m. Including the same vectors M_m and $C_{m,c}$ as in Equations (1) and (2) and using simple OLS estimation, the second stage looks as follows:

$$\text{Individual pension income}_m = \gamma_0 + \gamma_1 \widehat{ILD}_{m,c} + \gamma_2 M_m + C_{m,c} + \varepsilon_{m,c} \quad (3)$$

Mothers can enter the regressions multiple times as the analysis operates on the child's level. Every leave interruption of mothers around each child's birth is used in the estimation. This makes their observations not independent and violates a key assumption of OLS estimation, which requires that the error terms be uncorrelated across observations. To address this, standard errors are clustered at the mothers' level in all models to account for the within-mother correlation of residuals.

However, the standard first stage F-statistic fails to reliably evaluate instrument strength for IV estimations with clustered standard errors. Therefore, in addition to the standard first-stage F-statistic, the Wald test indicator for the first stage is provided to assess instrument strength as it accounts for clustered standard errors. For cluster-robust standard errors, the Wald test is an equivalent to the Kleibergen-Paap F-statistic (Berge et al., 2024).

Due to comparatively high rates of non-response for questions on pension income amounts and for the sake of simplicity (SHARE-ERIC, 2024), this study uses imputed

values for pension income provided by SHARE. SHARE creates five imputations per variable for each respondent to reduce uncertainty that comes with the use of imputed data. Hence, Rubin's Rule for multiple imputation is applied to all simple OLS and IV estimations to correctly handle the imputed pension values. This comprises running all models five times, with one imputation set used for each run and all other variables kept unchanged. This yields five different coefficients and variances for the predictor variable ILD. Following Rubin's Rule, the coefficients and variances are then pooled to consider variability in the estimates and variances. Thus, each pooled point estimate is the average of the five coefficients. The pooled variance is a combination of the within- and between-imputation variances that considers not only the variance of each coefficient, but also the variability between all five imputed datasets (Rubin, 1987; Van Buuren, 2018).

3.2 Data and Sample Construction

3.2.1 SHARE and SHARELIFE Survey Data

The micro data used in this analysis comes from an extensive dataset of the Survey of Health, Ageing and Retirement in Europe, short SHARE. SHARE is a large panel survey based on more than 150,000 interviews with more than 86,000 individuals from 28 European countries and Israel. Individuals in the survey are noninstitutionalized, aged 50 and older or are younger partners of an interviewed person. Almost all data was ex-ante harmonized, which makes cross-country analyses possible across all waves. Respondents are asked contemporaneous questions about their health, employment, well-being, and socioeconomic situation. Waves 3 and 7 additionally include retrospective modules called SHARELIFE that cover participants' life histories. SHARELIFE asks questions on the respondents' childhood, partners, fertility history, children, past employment, health and more (Bergmann et al., 2019; Börsch-Supan et al., 2013). The unique combination of information on people's life histories and their present-day situation allows to analyze linkages between past life trajectories and current living conditions. This analysis utilizes this quality of SHARE and SHARELIFE data and uses retrospective information on maternal leave duration and contemporary old-age pension income. Control variables come from both, retrospective and contemporary modules.

All waves but wave 1 are included in the analysis. In wave 1, monetary values are given in original currencies and gross amounts, which makes comparison across waves more difficult. Monetary values in waves 2 to 9 are given in euros and net values and can hence be used for comparative analyses across countries and waves (SHARE-ERIC, 2024)[1].

Outcome Variable: Individual Pension Income

Data on the outcome of interest, individual old-age net pension income per year, come from SHARE's contemporaneous waves 2 through 9, which cover the years 2006 to 2019, with the exception of wave 3 which is an exclusively retrospective module. Imputed values for pension income are used, which are provided by SHARE for all waves. The rate of non-response for monetary values, like pension income, is typically comparatively high and shows some country variation in SHARE (SHARE-ERIC, 2024). Additionally, pension types across Europe are diverse and complex. Not all pensions can easily be assigned to a specific pension scheme because, e.g. they have features from various types of pensions or are a combination of them. While the SHARE questionnaire aims to accurately represent each pension type, the notation of different pension variables is inconsistent across some waves and countries. SHARE accounts for these differences in the construction of each imputation variable, which makes a comparison across countries and waves easier. The use of SHARE's imputed pension values is common practice in econometric analyses, as previous studies made use of imputations instead of reported pension income values as well (Dotti Sani & Luppi, 2021; Möhring, 2015, 2018).

[1] This paper uses data from SHARE Waves 2, 3, 4, 5, 6, 7, 8 and 9 (DOIs: 10.6103/SHARE.w2.900, 10.6103/SHARE.w3.900, 10.6103/SHARE.w4.900, 10.6103/SHARE.w5.900, 10.6103/SHARE.w6.900, 10.6103/SHARE.w6.DBS.100, 10.6103/SHARE.w7.900, 10.6103/SHARE.w8.900, 10.6103/SHARE.w8ca.900, 10.6103/SHARE.w9.900, 10.6103/SHARE.w9ca900). The SHARE data collection has been funded by the European Commission, DG RTD through FP5 (QLK6-CT-2001-00360), FP6 (SHARE-I3: RII-CT-2006-062193, COMPARE: CIT5-CT-2005-028857, SHARELIFE: CIT4-CT-2006-028812), FP7 (SHARE-PREP: GA N°211909, SHARE-LEAP: GA N°227822, SHARE M4: GA N°261982, DASISH: GA N°283646) and Horizon 2020 (SHARE-DEV3: GA N°676536, SHARE-COHESION: GA N°870628, SERISS: GA N°654221, SSHOC: GA N°823782, SHARE-COVID19: GA N°101015924) and by DG Employment, Social Affairs & Inclusion through VS 2015/0195, VS 2016/0135, VS 2018/0285, VS 2019/0332, VS 2020/0313, SHARE-EUCOV: GA N°101052589 and EUCOVII: GA N°101102412. Additional funding from the German Federal Ministry of Education and Research (01UW1301, 01UW1801, 01UW2202), the Max Planck Society for the Advancement of Science, the U.S. National Institute on Aging (U01_AG09740-13S2, P01_AG005842, P01_AG08291, P30_AG12815, R21_AG025169, Y1-AG-4553-01, IAG_BSR06-11, OGHA_04-064, BSR12-04, R01_AG052527-02, R01_AG056329-02, R01_AG063944, HHSN271201300071C, RAG052527A) and from various national funding sources is gratefully acknowledged (see www.share-eric.eu).

Monetary values in all SHARE waves are imputed with the Fully Conditional Specification (FCS) method by van Buuren et al (1999). The FCS method imputes variables iteratively with a sequence of regression models that include the newest imputed values and other relevant reported variables to estimate pension income (for more information see van Buuren et al., 1999). Before the imputation process, all monetary values are converted to euros and net values. During the process, the highest and lowest two percent of the data is cut, and a logarithmic or inverse hyperbolic sine transformation was applied to reduce skewness. The final imputed data is given on the original scale (SHARE-ERIC, 2024).

The outcome variable individual pension income is constructed using two pension variables from the imputations module: *ypen1* and *ypen2*, where *ypen1* includes public pension schemes and *ypen2* includes private occupational pensions. *Ypen1* is based on the reported monetary values of six different public pension types, in the SHARE questionnaire denoted as: *public old age pension, public old age supplementary pension/public old age second pension, public early retirement/pre-retirement pension, main public survivor pension from spouse/partner, secondary public survivor pension from spouse/partner, public war pension*. *Ypen2* is derived from reported values of private occupational pension types, namely: *occupational old age pension from last job, occupational old age pension from a second job, occupational old age pension from a third job, occupational early retirement pension, occupational disability or invalidity insurance, occupational survivor pension from spouse/partner's job* (SHARE-ERIC, 2024). The variable pension income is computed as the sum of *ypen1* and *ypen2*. This is comparable to similar studies that utilize a combination of these two imputed variables as well (Möhring, 2015, 2018). This variable is denoted as either pension income or retirement income in the following sections. Detailed descriptive statistics of the pension income variable are presented in Section 4.1.1.

In the SHARE questionnaire, questions on pension income are only asked to respondents who are self-reportedly retired. To determine whether someone is retired or not, SHARE asks respondents for their employment status with the question: *In general, which of the following best describes your current employment situation?* One possible response is *retired*, which refers to people who are retired from their own work, semi-retired or pre-

retired and are entitled to some kind of pension from their own work. Thus, respondents who exclusively receive pension income from their spouses' pensions, e.g. receive only survivor pensions, are not coded as retired.

Independent Variables: Contemporary and Retrospective Data

The explanatory variable, individual leave duration, is based on retrospective questions about employment history and maternal leave behavior. ILD refers to the length of leave reported by the mother for each child. This period therefore covers maternity leave before and after birth, parental leave, and the sum of both, as well as leave interruptions that exceed the statutory leave length. Therefore, ILD also includes periods when mothers drop out of employment.

In the analysis, ILD is specified in nine categories and as a continuous variable measured in weeks. Both distinctions are used in the linear regression models. In the IV estimation, only the continuous specification is used as an explanatory variable. While the continuous variable captures a linear relationship between ILD and pension income, the categorical distinction is able to display potential non-linearities in the linear regression.

The construction of the categorical ILD variable is based on two questions: *Did you temporarily or permanently stop working when your child was born?*. If respondents reply that they temporarily stopped working when their child was born, they receive the second question *How long did you stop working for?*. This question can be answered using the six following categories: *1 month or less, More than 1 month but 3 months at most, More than 3 months but 6 months at most, More than 6 months but 1 year at most, More than 1 year but 3 years at most, More than 3 years, but worked at some point later*. If respondents report leave breaks longer than one year, they additionally get asked the year they returned to work. The categorical specification of ILD is based on the first four of these categories and a category of mothers who report no leave interruption at all. Four more categories are constructed for leave periods longer than one year based on the difference between the child's year of birth and the year the mother returned to work. This creates finer categories for leave breaks exceeding one year. Hence, this results in the following nine categories: *No interruption, 1 month or less, More than 1 month but less than 3*

months, More than 3 months but less than 6 months, More than 6 months but less than 1 year, More than 1 year but less than 2 years, More than 2 years but less than 3 years, More than 3 years but less than 4 years, More than 4 years but worked at some point later.

The continuous specification of ILD is based on the same questions. To transform the categorical ILD variable, the period between the lower bound of the category and its midpoint is converted into weeks[2]. For instance, the category *More than 1 month but less than 3 months* is transformed into 8.6 weeks. For periods longer than one year, the difference between the year of childbirth and the year of mothers' return to the workforce was converted into weeks[3].

Additional covariates included in equations (1), (2) and (3) come from both, contemporary and retrospective modules.

3.2.2 Policy Data on Statutory Maternity Leave Policies

To identify the causal effect of ILD on pension income, the IV estimation utilizes the exogenous variation of statutory leave policies across countries and over time. Specifically, it uses the statutory maximum duration of country-specific job-protected maternity leave measured in weeks, which was granted to employed mothers around the time of birth, including a period before and after the birth. The policy data on statutory maternity leave duration and cash benefits paid during leave, which serve as covariates in all models, comes from the Comparative Family Policy Database. The Comparative Family Policy Database offers a detailed dataset on leave policies in OECD countries from the years 1960 to 2010. The Comparative Family Policy Database contains extensive, harmonized data on the maximum length of statutory maternity, parental and childcare leave, as well as cash benefits paid during leave (Gauthier, 2011b).

Figure 1 depicts the variation in maternity leave duration across countries and over time. It shows how the length of statutory maternity leave changed in all 15 observed countries between 1960 and 2010, using policy data from the Comparative Family Policy Database.

[2] It is assumed that each month has 4.3 weeks.
[3] It is assumed that each year has 52.2 weeks.

Countries are grouped in four panels based on the classification of pension schemes in Table 1 in Section 2.1.2. The largest group of countries, group (2), is divided into two panels, (1) and (2), for better visibility.

In panel (1), the length of maternity leave stayed comparatively constant in Austria, Germany, France and the Netherlands. In Finland, maternity leave duration substantially increased and decreased over the observation period. In 1960, Austria, Germany, France and the Netherlands all offered between 12 and 14 weeks of paid maternity leave, while Finland introduced a maternity leave period of nine weeks four years later. Finland gradually increased maternity leave duration to 43 weeks and replaced some weeks of maternity leave with a parental leave scheme in 1985. In 2010, Finland had one of the longest statutory maternity leave periods of all countries analyzed, with 25.8 weeks of maternity leave available for mothers (Gauthier, 2011b).

While the length of maternity leave did not substantially change in Belgium, Switzerland, and Luxembourg, Sweden replaced maternity leave entirely with a parental leave scheme in 1974 that allows parental leave to be shared between both parents (see (2)) (OECD Family Database, 2024a).

Panel (3) shows that maternity leave duration moderately increased in Spain, Greece, Italy and Portugal in the years of 1960 to 2010. Portugal gradually increased its length of maternity leave from around four weeks to 17 weeks. Greece and Spain extended maternity leave by five and four weeks respectively, and Italy granted around 20 weeks of maternity leave throughout the whole observation period (Gauthier, 2011b).

Between 1960 and 2010, Ireland and Denmark both gradually increased the length of their maternity leave schemes (see (4)). At the end of the observation period, Denmark offered 18 weeks of maternity leave, while Ireland granted 26 weeks, the longest period of maternity leave among the countries analyzed (Gauthier, 2011b).

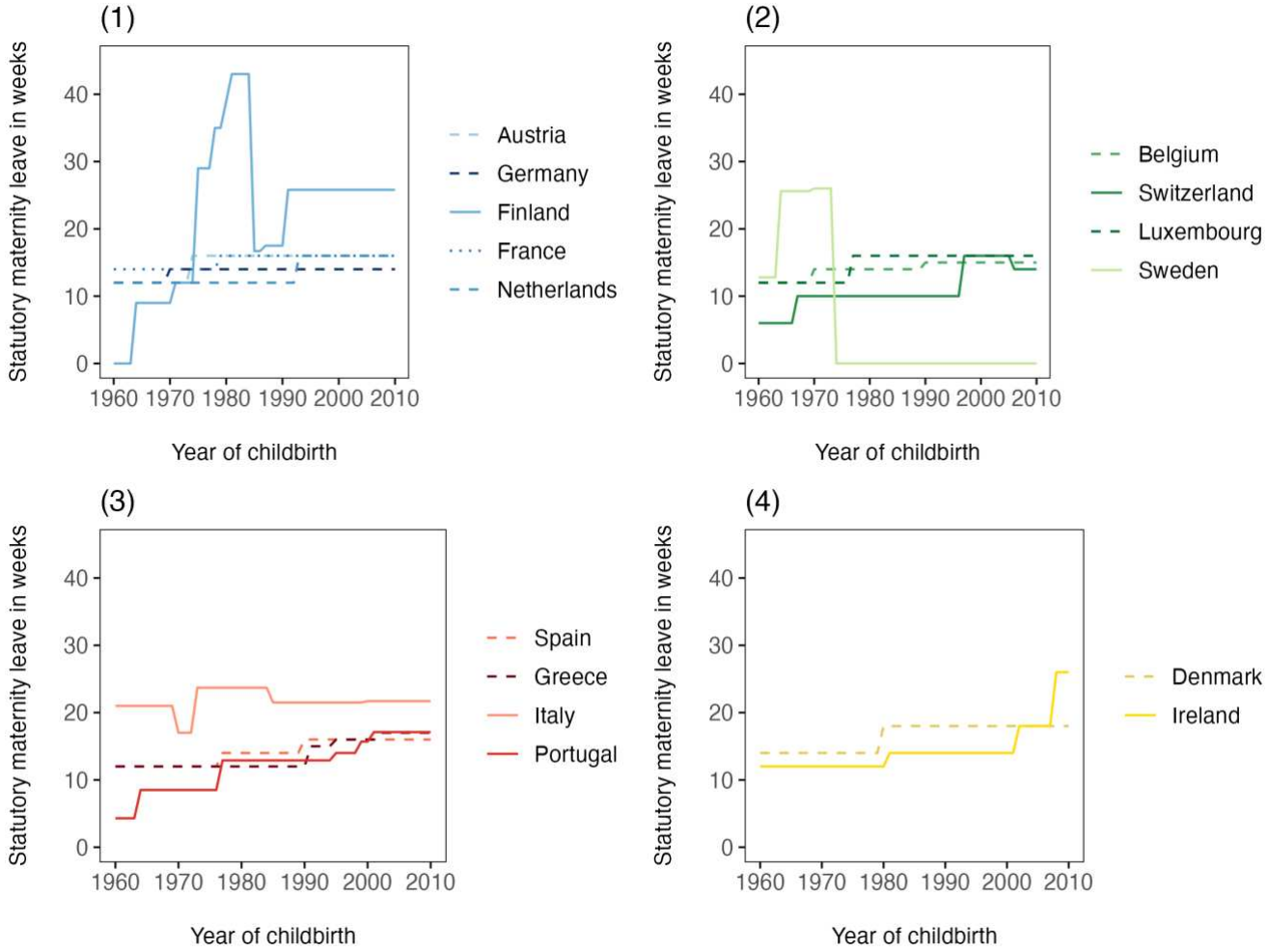
In general, the length of maternity leave moderately increased across all countries during the observation period. In 1960, the average length of maternity leave among the

observed countries was around 11 weeks. By 2010, it had increased to nearly 17 weeks. While statutory maternity leave duration moderately increased, parental leave was greatly extended in all analyzed countries: Austria was the only country to provide parental leave in 1960, but by 2010, all observed countries except Switzerland offered some form of parental leave (Gauthier, 2011b).

Throughout most of the observation period, maternity leave was generously paid in all analyzed countries. In 1960, only Finland and Switzerland did not grant cash benefits during maternity leave. All other countries granted leave benefits in 1960 that equaled on average 54 percent of wages[4]. By 2010, most countries were providing full wage replacement for maternity leave (Gauthier, 2011b).

[4] Leave benefits given as a percentage of female wages in manufacturing.

Figure 1: Statutory maternity leave duration in weeks by country and year



Notes: Statutory maternity leave duration refers to the period of job-protected maternity leave granted to mothers around the time of childbirth. The statutory maternity leave duration depicted in this figure includes periods of statutory maternity leave prior and after childbirth in weeks. The data for Germany before 1990 includes West German policies only. More details on the country-specific maternity leave policies used in this figure can be found in Gauthier (2011a). The countries shown in this figure are depicted in four different panels and grouped based on the classification of the countries' pension systems in Section 2.1.2.

3.2.3 Sample Construction

The main sample consists of 16,838 children and 9,059 mothers for whom complete information is available for all variables included in the analysis. Mothers gave birth between 1960 and 2010, between the ages eleven to 56, and come from Austria, Germany, Sweden, Netherlands, Spain, Italy, France, Denmark, Greece, Switzerland, Belgium, Ireland, Luxembourg, Portugal, and Finland. The observed years and countries result from joint availability in both, the SHARE dataset and the Comparative Family Policy Database.

The main sample only includes mothers who were self-reportedly retired at the time of the interview. Additionally, the analysis is limited to mothers who were employed around the time of birth, making them eligible for statutory leave, and who returned to work at some point, but no later than seven years after giving birth. In the observed countries, children usually start going to school by the age of seven at the latest. Thus, in this study leave interruptions longer than seven years are not defined as childcare-related leave after childbirth. When mothers were interviewed in more than one wave, the newest available response for each question entered the dataset to avoid duplicates.

The following analyses are conducted on the child's level, meaning mothers can appear in the sample multiple times to capture the specific leave period associated with each child.

3.3 Robustness Checks

There are multiple concerns about the robustness and sensitivity of the findings with respect to certain sample and model specifications. Therefore, five robustness checks are conducted to test whether the results remain consistent under different assumptions.

The imputation process for pension income in SHARE leads to some methodological uncertainty about whether pension amounts are imputed for all respondents, retired or not, or only for those eligible for a pension. This ambiguity is addressed in robustness

check (RC) (I). The presence of € 0 imputed pensions among non-retired respondents fuels the assumption that pension income is imputed for all respondents in SHARE, with eligible individuals receiving non-zero values. This then raises the question why € 0 pension values also exist for retired mothers. Section 4.1.5 devotes a separate analysis to this group to further characterize retired mothers with € 0 pensions. The findings reveal that it is especially the country of residence that determines whether mothers have any pension entitlements or not.

Filtering for self-reportedly retired respondents remains the most precise and most reasonable option to make sure that only people in retirement are in the main sample. To ensure that the ambiguity of the € 0 pension values or distinct characteristics of retired mothers with € 0 pensions do not alter the results, all respondents with a € 0 pension are excluded from the main sample in robustness check (RC) (I). Aside from testing the robustness of the results, this allows to explore the effect of ILD on the intensive margins of retirement income.

The second robustness check (RC (II)) further addresses the ambiguity of € 0 pension income values. Pension income may be imputed for all respondents, regardless of reported employment status, with only those receiving a positive amount being actually retired and entitled to a pension. Related to this, some respondents may misreport their employment status, for example, by continuing to work past the statutory retirement age while already claiming a pension. These respondents would have an imputed pension greater than zero even though they state not to be retired. RC (II) excludes all mothers with an imputed pension of € 0 from the initial sample, i.e. the sample that is not filtered for self-reportedly retired respondents, to test whether this affects the main results. Thus, the RC (II) sample includes only mothers with a positive imputed pension income, regardless of their employment status.

The main sample includes mothers who report no leave interruption after childbirth. To test whether the inclusion of this subgroup alters the results, robustness check (III) (RC (III)) excludes all mothers who report no maternal leave after childbirth. These mothers may systematically differ from mothers who had a leave break in ways that impact their

pension income. For example, mothers who had no leave interruption may work in industries that pay low wages and have poor workers' protection, preventing mothers to take any leave and granting low pension entitlements in retirement due to low wages. Mothers with no leave break are further characterized in Section 4.1.4, which reveals that indeed mothers' occupation during childbirth significantly determines whether they take any leave or not.

The fourth robustness check (RC (IV)) addresses the skewness of the distribution of pension income values in the main sample. Income distributions are typically right skewed, with most values concentrated on the left side of the distribution and a few high values creating a long tail to the right. To reduce this skewness and create a more symmetrical distribution of pension income data, it is common practice to transform the income variable (Dotti Sani & Luppi, 2021; Frodermann et al., 2023; Möhring, 2015). Therefore, RC (IV) tests whether the results also hold under a scale transformation of pension income values. Since logarithmic transformations cannot handle values of zero, a cube root transformation is applied to the pension income variable (Schwartz, 1985).

It is plausible that the marginal effects of ILD on pension income differ between shorter and longer leave lengths, similar to the non-linear effects of leave duration on mothers' earnings described in Section 2.2.1. While the main model assumes a linear relationship between ILD and pension income, robustness check V (RC (V)) tests for any non-linear effects of ILD on pension income. To do this, a squared term for ILD is included in Equation (3) in the second stage. The squared term requires a second instrument in the first stage to obtain the predicted values of both, the linear and the squared term. To simplify, a quadratic term for the instrument SLD is included in the first stage (Equation 2), which provides a general estimate of any non-linear effect. This approach is rather simplistic compared to a more complex method proposed by Løken et al. (2012), which is, however, outside the scope of this study.

In summary, the following robustness checks are conducted to test the sensitivity and robustness of the main result with respect to certain sample and model specifications. The results of all robustness checks are presented in Section 4.3.

RC (I): Main sample and excluding all with € 0 pension values

RC (II): Unfiltered sample and excluding all with € 0 pension values

RC (III): Main sample and excluding all with no leave interruption (ILD > 0)

RC (IV): Main sample and cube root transformation of pension income values

RC (V): Main sample and squared terms for ILD and SLD

3.4 Heterogeneity Analyses

The effect of ILD on pension income may not be consistent among all complying mothers in the sample. To test for heterogenous effects, analyses of different subgroups are conducted. First-stage heterogeneities indicate potential compliers in the sample, and heterogeneous second-stage effects show whether the main result is driven by a specific subgroup of mothers.

Socioeconomic status is a key factor that may shape how maternal leave duration affects pension income among mothers. The motherhood penalty after childbirth varies by educational attainment and labor market income, where higher educated mothers with higher earnings face a greater penalty (Anderson et al., 2002; Cukrowska-Torzewska & Matysiak, 2020). This may translate into a similar education and income gradient in pension income. Therefore, heterogenous effects of ILD are examined across pension income quartiles and educational groups. Leave breaks may also influence post-leave labor market trajectories differently in blue- versus white-collar jobs, with long-term consequences for pensions. Additionally, the pension variable in SHARE includes employer-based occupational pensions whose coverage, benefit calculation, and treatment of childcare breaks in occupational pensions likely vary by job sector. Thus, heterogeneous effects of ILD on pension income by blue- versus white-collar jobs are explored.

The relationship between leave duration and pension income may also vary by the number of children a mother has. The motherhood penalty in wages is found to intensify with each additional child (Budig & England, 2001), which may translate into a motherhood pension penalty that increases with each child as well. Hence, effects for mothers with one child, two children, three children and four or more children are analyzed.

Further, there may be cohort effects in the effect of leave duration on pension income as both parental leave policies and pension systems have evolved over time. Older cohorts generally faced shorter and less generous parental leave entitlements, lower statutory retirement ages and higher pension replacement rates. By contrast, younger cohorts experienced longer leaves and more generous benefits, yet retired at older ages and with lower replacement rates (Gauthier, 2011b; OECD, 2015, 2019b). As discussed in Section 2.1.1, many European countries extended statutory maternity leave, introduced parental leave schemes and raised leave benefit levels during the 1970s and 1980s and (Gauthier, 2011b). Birth cohorts born from 1955 onwards were likely the first to experience these reforms as they reached childbearing age in the 1970s to 1990s, while earlier cohorts had children under less generous regimes. Hence, to capture potential cohort effects, the sample is divided into mothers born before 1955 and mothers born in 1955 or later.

Pension systems greatly moderate the impact of employment trajectories on retirement income (Möhring, 2015). The effect of ILD may be weaker in redistributive systems, which cushion career breaks and low earnings, than in earnings-related schemes, where entitlements are closer tied to contribution histories. Hence, leave duration may have little impact in highly redistributive systems but a stronger effect in earnings-based ones. To capture this heterogeneity, separate IV estimations are conducted for the three pension scheme typologies outlined in Section 2.1.2: highly earnings-related, moderately earnings-related, and highly redistributive.

4. Results

4.1 Descriptive Findings

Table 2 provides descriptive statistics for selected variables in the main sample. These summary statistics are calculated at the child's level, meaning that mothers are counted several times if they have more than one child. Descriptives calculated at the mothers' level do not substantially differ and are presented in Table A. 1 in the Appendix. The two main variables, pension income and individual leave duration, are thoroughly described in the following sections.

4.1.1 Pension Income

The annual pension income of mothers is significantly right skewed, with a small number of individuals receiving substantially higher pensions than most, and a notable proportion receiving no pension income at all. Approximately 15 percent of mothers in the main sample receive a pension income of € 0. The outcome variable pension income ranges from € 0 to € 274,200 with a mean of € 14,584, equivalent to a monthly[5] € 1,215 (see Table 2).

[5] Monthly as in annual values divided by 12 months.

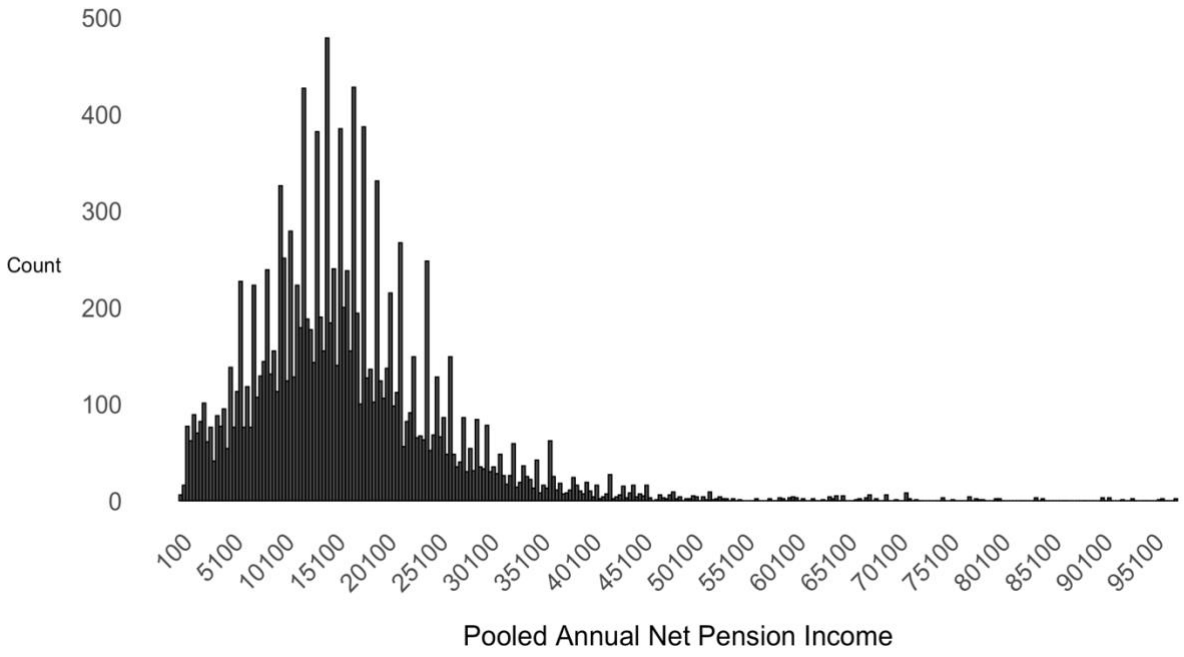
Table 2: Summary statistics for the main sample – children's level

Variable	N	Mean	Median	St. Dev.	Min	Max
Individual Leave Duration (weeks)	16,838	40.462	8.600	70.855	0.000	313.200
Annual Pension Income	16,838	14,583.840	13,225.450	16,298.79	0.000	274,200.000
Monthly Pension Income	16,838	1,215.320	1,102.121	1,358.23	0.000	22,850.000
Number of Children	16,838	2.563	2	1.192	1	13
Year of Birth of Child	16,838	1974	1974	8.216	1960	2005
Year of Birth of Mother	16,838	1946	1947	7.323	1918	1973
ADLs	16,838	0.761	0	1.984	0	13
Cash Benefits during Maternity Leave (% of female wages in manufacturing)	16,838	69.319	79.500	31.365	0.000	100.000
Low Education	16,838	0.350	0	0.477	0	1
Medium Education	16,838	0.339	0	0.473	0	1
High Education	16,838	0.312	0	0.463	0	1
1st Child	16,838	0.456	0	0.498	0	1
2nd Child	16,838	0.345	0	0.476	0	1
3rd Child	16,838	0.137	0	0.344	0	1
4+ Child	16,838	0.061	0	0.240	0	1

Notes: The table shows summary statistics of the main variables in the main sample. The sample size is 16,838 observations and numbers are on the child's level, i.e. mothers are counted as often as they have children. A table with summary statistics on the mothers' level is provided in the Appendix (see Table A.1). Monetary values are net values in euros and pooled according to Rubin's Rule. I.e. point values are the average value of all five imputations.

Figure *2* shows the distribution of yearly non-zero pension income values and illustrates its skewness. For the sake of visibility, incomes of € 0 and outliers above € 100,000 are excluded in this illustration. The majority of pension income values falls between € 10,000 and € 20,000, while relatively few high values form a long right-hand tail. The presence of various peaks is likely due to the fact that most values are imputed in full, even amounts.

Figure 2: Pooled annual net pension income in euros, excluding € 0, capped at € 100,000



Notes: This histogram illustrates the distribution of imputed annual net pension income values in euros. The x-axis depicts the pooled annual net pension income values, and the y-axis depicts the number of observations at each value. The figure shows values for the main sample, excluding observations with a pension income value of € 0 and values above € 100,000 for better visibility. Numbers are on the child's level, i.e. mothers are counted as often as they have children. Numbers on the mothers' level follow a similar distribution. The sample size is 14,124. The imputed pension income values are pooled according to Rubin's Rule.

Pension income varies by level of education. Table 3 displays annual pension income by educational attainment and shows that highly educated mothers receive the highest mean annual pension income of € 18,586. Thus, they receive around € 3,672 more per year than those with a medium level of education. Similarly, the difference in pension

income between mothers with medium education and those with low education is roughly of the same amount. When mothers with € 0 pension income are excluded, like in RC (I), the numbers look similar (see Table 3, second row). This relationship is comparable to, and possibly a consequence of, the well-known educational gradient in earnings (Cohn & Addison, 1998; Psacharopoulos & Patrinos, 2018).

Table 3: Mean annual pension income by educational attainment – main sample and RC (I) sample

Educational Attainment	N	Mean annual pension income
Main Sample:		
Low Education	3,182	11,180.82
Medium Education	3,189	14,913.68
High Education	2,688	18,585.63
RC (I) Sample (excluding € 0 pension income):		
Low Education	2,533.6	14,018.76
Medium Education	2,734.2	17,344.64
High Education	2,330.0	21,346.69

Notes: This table shows the mean of the imputed annual net pension income in euros by mothers' reported educational attainment, for the main sample and the RC (I) sample that excludes all mothers with € 0 pension income. Numbers are on the mothers' level, i.e. each mother is only counted once. Counts of € 0 income values slightly differ for each of the five sets of imputations. Thus, when excluding € 0 incomes in RC (I), the sample size slightly differs for each imputation dataset. The N for the RC (I) sample is therefore the average across the five imputation datasets. Monetary values are annual net values in euros and pooled according to Rubin's Rule.

4.1.2 Individual Leave Duration

As shown in Table 2, the distribution of the explanatory variable, maternal leave duration, is highly dispersed. While mothers in the main sample take an average of 40.5 weeks of

leave, the much lower median of 8.6 weeks indicates a skewness to the right. This dispersion is further intensified by the fact that 39 percent of mothers in the main sample did not take any leave. Among mothers who took at least some leave, the distribution of leave duration remains heterogeneous: the mean is at 66.4 weeks and the median at 38.7 weeks.

Table 4 shows that, similar to pension income, leave duration varies by educational attainment. Medium educated mothers take the longest leave with 48.3 weeks on average, followed by high educated with an average of 37.2 weeks. Low educated mothers take the shortest leave with a mean of 35.7 weeks. The subgroup of mothers with no leave break is particularly large among those with a low level of education. 45.8 percent of mothers with a low level of education did not interrupt their careers, compared to 35.7 percent and 35 percent of those with a medium and high level of education, respectively. This suggests that education is a determinant for the take-up of leave, an assumption that is not confirmed by the analysis of mothers with no leave break in Section 4.1.4.

Among mothers with a leave interruption, the highly educated returned to work sooner than those with a medium or low level of education. When those who report no leave after childbirth are excluded from the main sample, as in RC (IV), highly educated mothers have the shortest mean leave duration, at just over a year. Mothers with a medium level of education still take the longest average leave, followed by those with a low level of education (see Table *4*, second row).

Table 4: Mean individual leave duration by educational attainment - main sample and RC(IV) sample

Educational Attainment	N	Mean Individual Leave Duration in weeks	Share of mothers with no leave interruption
Main Sample:			
Low Education	5,886	35.72	0.458
Medium Education	5,705	48.33	0.357
High Education	5,247	37.22	0.35
RC (IV) Sample (excluding ILD = 0):			
Low Education	3,188	65.95	
Medium Education	3,668	75.17	
High Education	3,410	57.28	

Notes: This table shows the mean of mothers' reported individual maternal leave duration in weeks by their reported educational attainment, for the main sample and the RC (IV) sample that excludes all mothers with no leave interruption. Additionally, the share of mothers with no leave interruption by educational attainment is shown. Numbers are on the child's level, i.e. mothers are counted as often as they have children.

4.1.3 Cohort Effects in the Main Sample

The average length of maternal leave increased across cohorts. This is likely a consequence of the significant expansion of paid parental leave provisions in most European countries, as described briefly in Section 2.1.1 (Gauthier, 2011b; OECD Family Database, 2024b). To capture potential cohort effects in leave behavior, the sample is divided into cohorts born before 1955 and born from 1955 onwards. A corresponding heterogeneity analysis in Section 4.4 examines whether the effect of ILD on pension income differs between these groups. As shown in Table A. 2, the average leave duration across all mothers increased by around five weeks, rising from 39.8 weeks for older mothers to 44.8 weeks for younger cohorts. Among respondents who took any leave,

there is a visible trend toward longer leave durations: 72.1 percent of mothers born before 1955 were out of the work force for longer than six months compared to 75.3 percent in more recent cohorts. These findings align with the expansion of statutory leave policies in the 20th century that established more generous leave regulations in length and cash benefits (Gauthier, 2011b).

The share of mothers with no leave break also declined slightly over time, potentially due to the gradual introduction of more generous cash benefits during leave, which eased financial pressure to return to work immediately (Gauthier, 2011b). The proportion of mothers who report no leave interruption decreased by 2.7 percentage points when comparing older and younger cohorts.

While leave behavior changed over time, there are no substantial changes in pension income across cohorts. The mean of monthly pension income is only € 10 higher for older mothers than for younger cohorts. However, the share of respondents without pension entitlements is slightly lower among the older cohort: 15.2 percent (15.1 percent on the mother level) receive no pension income compared to 18.8 percent (19.3 percent on the mother level) of those born in or after 1955. These findings indicate that the proportion of mothers without pension income is relatively evenly distributed across cohorts.

4.1.4 Who are the Mothers with No Maternal Leave Interruption?

Of the 16,838 observations in the main sample, 6,572 mothers – 39 percent – did not take any leave after giving birth. The substantial size of this subgroup prompts further analysis to determine whether these mothers differ systematically from those who take leave. Descriptive findings and a simple logistic regression model with taking any leave as the outcome reveal that a mother's occupation during childbirth and her country of residence are important influences on leave-taking. Above all, pension income does not significantly predict whether someone takes any leave or not.

Table A. 3 displays the full output table of the simple logistic regression and shows significant differences in the likelihood of taking leave based on the industry mothers

worked in. Compared to the reference category *Agriculture, hunting, forestry, fishing*, having worked in all other industries significantly increases the likelihood of having a leave break. In other words, compared to mothers from all other industries, mothers who worked in the agriculture sector are more likely to not interrupt their career after giving birth. Relatedly, 60 percent of mothers who were employed in the agriculture sector during childbirth report no leave interruption.

Country differences play a significant role in the likelihood of taking any leave as well. In the main sample 62 percent of Spanish respondents say they did not take a leave break after childbirth. Additionally, mothers from almost all other countries are more likely to take any leave than mothers from Spain.

Apart from a mother's occupation and country of residence, both her birth cohort and the number of children are significant predictors of whether she takes any leave or not. The logistic regression results show that mothers with more children are less likely to take maternal leave. Furthermore, mothers who take leave tend to be born in more recent cohorts. This finding is consistent with that in Section 4.1.2, which finds that having no leave break is less prevalent among younger mothers and may be a consequence of the gradual expansion of statutory leave duration and more generous cash benefits paid during leave (Gauthier, 2011b).

The simple logistic regression gives plausible explanations for the rather high share of mothers with no leave break and shows that pension income is not a significant predictor of leave uptake. Instead, whether mothers take leave is significantly determined by their occupation and their country of residence. Specifically, mothers who worked in the agricultural industry and mothers from Spain are significantly less likely to report a leave interruption after childbirth than mothers from all other industries or countries. To further ensure that the inclusion of the subgroup of mothers with no leave interruption does not affect the validity of the main result, a robustness check in Section 4.3 tests whether excluding these mothers alters the main result.

4.1.5 Who are the Mothers with Zero Pension Income?

As described in Section 4.1.1, 15.7 percent[6] in the main sample – 1,429 out of 9,059 individual mothers – receive € 0 pension income despite being self-reportedly retired. This creates some uncertainty surrounding the persistence of these € 0 pension values in the main sample that is filtered for retired mothers. A simple logistic regression explores the factors that determine whether someone receives a pension to find explanations for why some mothers have no pension income.

The results show that, along with educational attainment, a mother's country of residence significantly determines whether she receives any pension income or not. The full results are displayed in Table A. 4. Particularly, being from Spain significantly increases the likelihood of having no pension entitlements. Similar to the probability of taking leave, Spanish mothers are less likely to receive pension earnings than mothers from all other countries. Likewise, 41 percent[7] of Spanish mothers in the main sample report having no pension income. In contrast, only 2.7 percent[7] of Dutch respondents have a pension income of € 0. The categorization of pension systems in Section 2.1.2 helps explain this finding: earnings-related schemes, such as the Spanish system, lack the necessary redistributive measures to protect retirees with interrupted careers and low earnings from being unable to claim any pension entitlements. Additionally, the Spanish first-tier minimum pension requires 34 years of contributions, making eligibility very restrictive. In contrast, the Dutch system is highly redistributive and relies on residence-based basic and targeted pension schemes that are unrelated to contribution history and cover virtually all retirees (OECD, 2019b). This shows that countries' pension systems likely play a decisive role in determining not only the intensive margins but also the extensive margins of retirement income.

Beyond country of residence, higher educational attainment is associated with a higher likelihood of having any pension income. Compared to mothers with low educational attainment, mothers with medium and high education are significantly more likely to

[6] Calculated for the first set of imputed pension income values for each respondent. Results do not significantly change when using the second, third, fourth or fifth set of imputed values.
[7] Calculated on the mothers' level; percentages calculated on the child's level are 40.5% for Spain & 2.7% for Denmark

receive pension income. This indicates that the positive impact of education on earnings during working life may persist until retirement (Heckman et al., 2018).

The simple logistic regression provides a plausible explanation for the presence of retired mothers with € 0 pension income: many with no pension income are likely Spanish mothers who are not covered by the Spanish pension system. This alleviates concerns on the existence of € 0 income values in the sample. Additionally, a robustness check in Section 4.3 excludes the subgroup of mothers with no retirement income to test the robustness of the main result towards this group.

4.2 Main Analysis

The main analysis framework consists of two steps: first, two multiple linear regression models using ordinary least squares estimations are employed, with: (I) ILD as a continuous explanatory variable, and (II) ILD as a categorical explanatory variable. Second, a 2SLS instrumental variable estimation is conducted to overcome endogeneity bias in the simple OLS estimates and to investigate a causal effect of ILD on pension income. The results are presented in the following sections.

4.2.1 The Correlation between Individual Leave Duration and Pension Income

The results for both simple OLS estimations with a continuous ILD in weeks (I) and ILD in nine categories (II) are shown in Table 5. Table A. 5 in the appendix provides a complete corresponding output table.

Table 5: Multiple Linear Regressions using OLS – main sample

	Annual net pension income		
	(I)	(II)	
Individual leave duration in weeks	-5.886***		
	(1.927)		
Individual leave duration in categories			
No interruption		-666.855	(513.837)
1 month or less		-1547.619**	(773.016)
(ref. = More than 1 month but less than 3 months)			
More than 3 months but less than 6 months		-945.165*	(503.571)
More than 6 months but less than 1 year		-723.143	(490.129)
More than 1 year but less than 2 years		-909.285	(923.586)
More than 2 years but less than 3 years		-750.527	(692.397)
More than 3 years but less than 4 years		-1418.053**	(712.347)
More than 4 years but worked at some point later		-2273.447***	(552.969)
Observations	16,838	16,814	
Adj. R2	0.1324	0.1324	

Notes: The table shows results from two simple OLS estimations (see Equation (1)). One simple OLS estimation uses the explanatory variable ILD as a continuous variable in weeks, the other one uses ILD as a categorical variable. The main sample is used, and sample sizes are 16,838 for the continuous ILD specification and 16,814 for the categorical specification. Information is missing for 24 observations for the categorical leave duration variable. Control variables include mothers' educational attainment, their number of children, year of birth, country of residence, health status, the industry the mother worked in during childbirth of each child and the cash benefits she received during each maternity and parental leave as a percentage of female wages in manufacturing. The outcome variable is imputed annual net pension income in euros. Coefficients and variances are pooled according to Rubin's Rule. Standard errors are clustered at the mothers' level and given in parentheses.
Asterisk notation: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Leave duration is statistically significant in both specifications, continuous and categorical, though not all of the nine categories of ILD yield significant estimates. For (I), the results disclose a negative association between ILD and pension income that is statistically significant at the 1 percent level. For each additional week of leave taken, the annual pension income decreases by € 5.89, ceteris paribus. This amounts to on average € 306,28 less in yearly retirement income for each year of longer leave. Given an average

yearly pension income of € 14,583.8 in the main sample, this results in a decrease of 2.1 percent in annual pension income for each additional year of leave, all other factors being equal.

The categorical version of the explanator ILD in (II) reveals a more nuanced relationship. While all categories show negative coefficients, only four out of nine categories of ILD are significantly negatively correlated with pension income at the one, five and ten percent level. Notably, it is lengths of leave at both ends – very short and very long durations – which have a significant negative association with pension income. Despite the lack of significance across all categories, the pattern of coefficients suggests a U-shaped relationship between length of leave and retirement income. For very short and very long interruptions, pension earnings decrease the most, ceteris paribus. The largest pension loss is observed for mothers with the longest leave durations of *More than 4 years but worked at some point later,* with an average of € 2,273.45 less in pensions followed by the shortest lengths of leave of *1 month or less* with € 1,547.62 less income compared to the reference category and holding all other factors equal. Interestingly, having no leave interruption after childbirth does not show a significantly different association with pension income than the reference category that is *More than 1 month but less than 3 months* of leave.

For all leave durations of moderate length – between six months and three years – ILD is not significantly associated with pension income. While their coefficients suggest a negative correlation with pensions, the standard errors are too large to infer any true relationship. Possible explanations for this finding are discussed in the *Discussion of the Main Results* in Section 5.1.

However, as shown in Section 3.1.2, it is likely that the previously presented findings are biased by endogeneity, potentially due to unobserved maternal characteristics. The 2SLS IV model allows to overcome endogeneity issues and identifies the causal effect of ILD on pension income by exploiting exogenous variation in the instrument SLD. The results of the IV estimation, along with several robustness checks and heterogeneity analyses of the main findings, are presented in the following sections.

4.2.2 The Causal Effect of Individual Leave Duration on Pension Income

In the first stage of the IV estimation, individual leave duration is regressed on statutory maternity leave duration to obtain the predicted values of ILD. The predicted values are then used as an explanatory variable to estimate the causal effect on pension income in the second stage.

First Stage Results: Statutory Leave Duration and Individual Leave Duration

The first stage results of the IV estimation are shown in Table 6. The instrument SLD is positively correlated with ILD at the one percent level. First stage results show that a one-unit increase of SLD, meaning one additional week of statutory leave duration, results in an increase of 0.61 weeks of ILD taken by mothers, ceteris paribus. This implies that changes in SLD over time and across countries influence mothers' individual leave duration. This confirms one of the requirements for an instrument in IV estimation: SLD is a relevant instrument and yields reliable results in the second stage of the analysis.

The instrument SLD is not only relevant but also sufficiently strong to explain the variation in ILD. The first-stage F statistic and the first-stage Wald test are both well above the conventional threshold of ten. Hence, SLD proves to be an appropriate instrument as it is significantly correlated with ILD and the high first stage F statistic, evaluated by the Wald test, rules out any concern about instrument weakness.

The first-stage estimates show that, on average, mothers adjust the length of their maternal leave in response to a change in the length of statutory leave. However, this may not apply to all mothers because the first stage of a 2SLS IV model only estimates the treatment effect for compliers, i.e., mothers who prolong their leave in response to an increase in the length of statutory leave. Accordingly, the results of the IV estimation must be interpreted as the local average treatment effect (LATE), which refers to the average causal effect of the treatment ILD on the population of compliers. A heterogeneity analysis in Section 4.4 explores heterogeneous effects in the first stage and identifies potential compliers in the sample.

Second Stage Results: Effect of ILD on Pension Income

The second stage results of the main IV model, as described in Equation (3), are presented in the second row of Table 6. The negative coefficient of the predicted ILD values indicates a negative effect of ILD on pension income. It suggests a reduction of € 35.03 in annual pension income for each additional week of leave. However, unlike in the simple OLS estimation, the effect is not statistically significant with large standard errors. Hence, the null hypothesis cannot be confidently rejected, and an effect for the compliers cannot be inferred. Consequently, there is no statistically significant evidence in the specified IV estimation that ILD has a causal effect on pension income.

Table 6: Two-Stage-Least-Squares Instrumental Variable model – main sample: The effect of ILD on pension income

First stage: SLD and ILD		
Statutory maternity leave duration in weeks	0.611***	(0.128)
	Annual pension income	
Second stage: Effect of ILD on pension income		
Individual maternal leave duration in weeks	-35.033	(37.06)
First-stage F-Statistic	28.1	
First-stage Wald test	22.7	
Observations	16,838	

Notes: The table shows first and second stage results for the 2SLS IV estimation (see Equations (2) and (3)). The first row displays results from the first stage that estimates the correlation between SLD and ILD using simple OLS estimation. Statutory maternity leave duration (SLD) is measured in weeks and refers to the statutory length of the maximum available maternity leave that was in place at the child's year of birth and in the child's country of birth. SLD is used as an instrument for mothers' individual maternal leave duration (ILD) to introduce exogenous variation that is needed to identify a causal effect of ILD on pension income. The variable ILD is a continuous variable that measures mothers' reported maternal leave duration in weeks. The second row illustrates results from the second stage of the IV estimation and shows the estimated effect of ILD on the outcome variable annual pension income. Annual pension income is the imputed annual net pension income in euros. The third row provides the general first stage F-statistic, the first-stage Wald test and the number of observations. The main sample was used, thus the sample size is 16,838. Control variables in both stages include mothers' educational attainment, number of children, year of birth, country of residence, health status, the industry the mother worked in during childbirth of each child and the cash benefits she received during each maternity and parental leave as a percentage of

female wages in manufacturing. All coefficients and variances are pooled according to Rubin's Rule. Standard errors are clustered at the mothers' level and given in parentheses.
Asterisk notation: * p < 0.10, ** p < 0.05, *** p < 0.01.

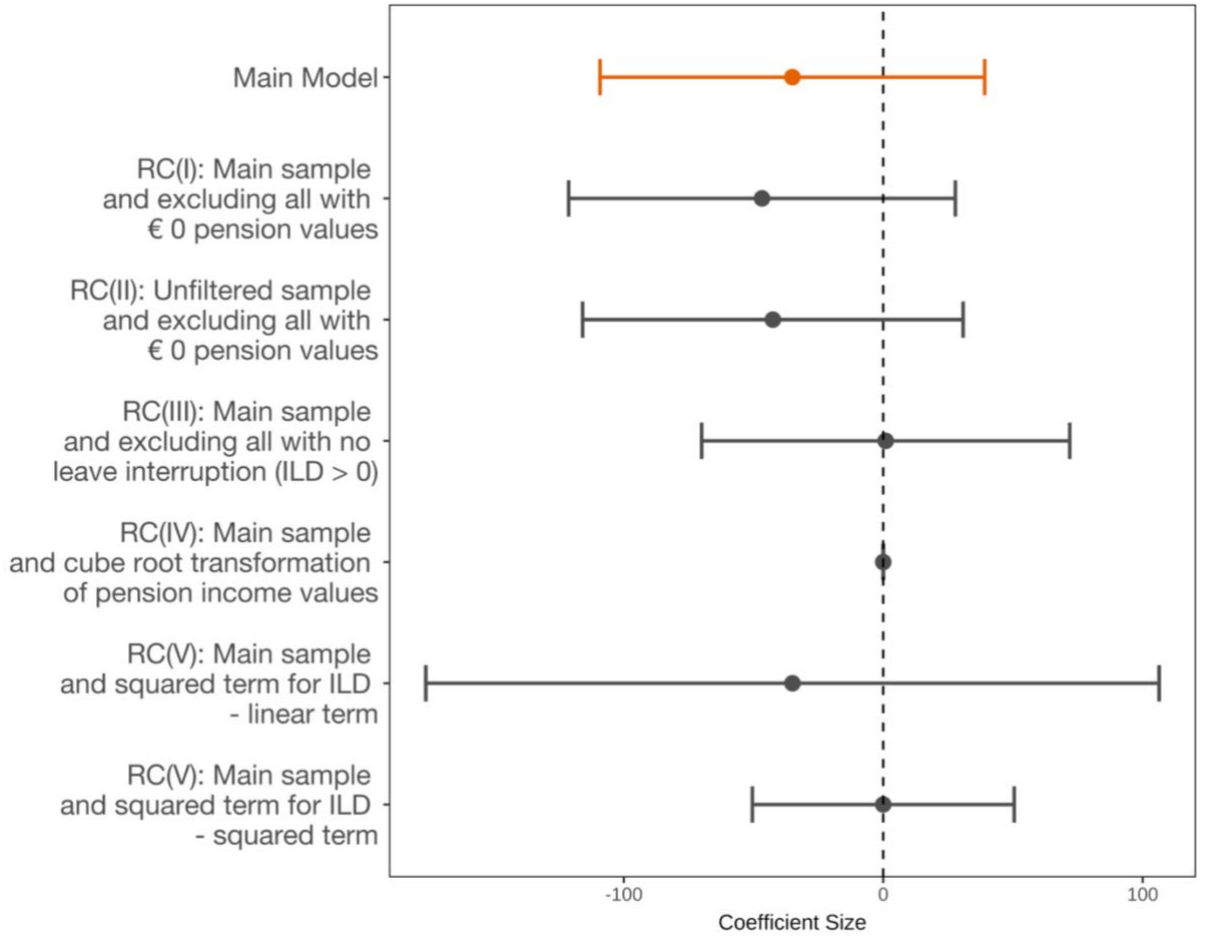
It is worth noting that ILD is statistically significant in one of the five sets of imputations for pension income (see Table A. 6). The predicted values of ILD are significant at a ten percent level for the second imputed dataset. The effect indicates that an additional week of ILD reduces yearly pension income by € 57.50, i.e. any additional month of maternal leave lowers pension income by € 230 per year. Hence, compared to a mother who takes leave for six months, a mother who stays home for one year after childbirth could expect to receive approximately € 125 less in monthly pension income due to her longer leave. Given the average monthly pension income of € 1,215.3 in the main sample, this results in a reduction of 10.3 percent for every additional six months of leave.

However, when applying Rubin's Rule und pooling the coefficients and variances, the final pooled estimate loses its statistical significance. The pooled variance accounts for both within- and between-imputation variance which reduces precision and leads to larger standard errors. While there is a causal effect for this specific set of imputed values, the uncertainty introduced by using imputations adds some variability and the evidence for a causal relationship is insufficient across all imputations. In other words, once imputation uncertainty is properly accounted for, a consistent causal effect cannot be detected.

4.3 Robustness of the Main Result

Figure 3 shows that the main findings are robust to the five robustness and sensitivity analyses described in Section 3.3 (see also Table A. 7 for an output table depicting the results of all five robustness checks). The coefficient of ILD is consistently insignificant, and there is no evidence of a causal effect of ILD on pension income across different samples and model specifications.

Figure 3: Results for the causal effect of ILD on pension income: coefficient plot for the main IV model and all five robustness checks RC (I) to RC (V)



Notes: This figure illustrates the coefficient sizes and their confidence intervals for the explanatory variable ILD from the main model and all robustness checks that are specified in Section 3.3. The variable ILD is a continuous variable measuring mothers' reported duration of maternal leave in weeks. Table A. 7 in the Appendix provides an output table with the coefficients for the main model and all robustness checks, the first stage F-statistic and first-stage Wald test, and the number of observations for each model.

Excluding all € 0 pension values in RC (I) shows that the main finding is robust to this sample restriction: Leave duration has no causal effect on pension income, also not for mothers who are entitled to some pension income. The result from RC (I) also reveals that the duration of leave has no causal impact on the intensive margins of retirement income. Among mothers who have pension entitlements – as opposed to those with a pension income of € 0 – the length of leave does not affect the amount of pension income mothers receive.

RC (II) excludes all mothers without pension entitlements and is not filtered for retired respondents. Hence, the sample only includes mothers with pension income greater than zero. This specification does not affect the main result, which rules out the concerns regarding the validity of € 0 pension income values. The coefficient for ILD is not significant and nearly identical to the one in the main estimation and in RC (I). The instrument is slightly weaker in RC (II) than in the main model but still well above the threshold of ten. As with the main model, the point estimate of ILD is significant at the five percent level in the second imputed dataset and additionally significant at the ten percent level in the fifth imputed dataset. Ultimately, Rubin's pooling process increases the standard errors and weakens the significance of the estimate, rendering it impossible to draw conclusions about a true effect for the pooled estimate.

The main finding also holds for mothers who take some maternal leave. While the main sample includes mothers who did not take leave after childbirth, this group is excluded in RC (III). The result shows that the point estimate remains insignificant with large standard errors, which supports the main result. Even though the instrument is weaker for the subsample in RC (III), it is still reliably strong. Consequently, the main results are not significantly altered by mothers who take no leave.

RC (IV) also confirms the main outcome and shows that it is robust to scale transformations and is not driven by extreme values in the data. As shown in Section 4.1.1, the outcome variable, pension income, is right skewed, with few high values and values of zero. To make the distribution more symmetrical and to test whether the results are distorted by the skewness of pension income, the pension income variable is cube root transformed in RC (IV). In Figure *3*, the point estimate and the confidence intervals of the coefficient appear very close to zero because they are presented as the cube roots of the original values and are not back-transformed to the original pension income scale. The estimate suggests that each additional week of leave results in a slight reduction of 0.001235 in the cube root of retirement income, though this effect is not statistically significant. This further strengthens the robustness of the main findings.

There is no evidence for a non-linear effect of ILD on pension income. The main IV estimation assumes a linear relationship, however the coefficients of the categorical ILD specification suggest a non-linear correlation in the simple OLS estimation. The simple OLS estimates reveal that shorter and longer breaks are significantly negatively correlated with retirement income, while moderate leave lengths are not (see Section 4.2.1). However, RC (V) indicates that there are no nonlinearities in the causal effect of ILD on pension income that the main IV model fails to capture.

4.4 Heterogenous Effects

To test for potential heterogeneous effects, this section analyzes whether the effect of ILD on retirement income varies by: pension income quartiles, education, the industry the mother worked in during childbirth, parity, cohorts, and the degree of redistribution in countries' pension schemes. The findings are displayed in the Appendix from Table A. 8 to Table A.14.

As previously explained, socio-economic status may be an important determinant in the link between leave duration and pension income. However, the effect of leave duration does not differ for pension income quartiles in the main sample (see Table A. 8). What becomes evident though is that the instrument SLD is considerably stronger for mothers with pension incomes in the upper half of the income distribution. While the instrument is too weak for the first and second quartiles to allow for reliable conclusions, it exceeds the threshold of ten and is statistically significant in the first stage for the third quartile. For mothers with a mean pension income of € 16,101.5, one additional week of statutory leave duration is associated with, on average, additional 0.765 weeks of leave mothers take, holding all other factors equal. This effect is even greater than for the whole main sample. This suggests that mothers with middle to high retirement income are potential compliers as they are more responsive to variation in the instrument than mothers in the lower pension income quartiles. The main results likely estimate the LATE for mothers with medium to high pension income while they may be less representative for mothers from lower pension income quartiles. One possible explanation for this finding could be that mothers with higher pension incomes were generally in a better economic situation throughout their lives. They reacted to expansions in statutory leave duration with

extending their own leave because they had to worry less about forgone labor income than mothers with lower pension incomes, who were in more precarious economic positions.

The previous heterogeneity analysis is done on the main sample and includes mothers with zero pension income. Examining only mothers entitled to a pension – so excluding all observations with € 0 retirement income – yields a statistically significant estimate for the third pension income quartile in the second stage of the IV model (see Table A.9). One additional week of ILD causes a reduction of yearly pension income of € 21.30, which is significant at the five percent level. ILD is significant for this subgroup of mothers only and remains insignificant for the remaining three retirement income quartiles. Thus, there is a causal effect for a particular group of respondents with a specific range of middle to high pension incomes and mothers from the other pension income quartiles dilute the significant effect for the full sample. Possible reasons for and implications of this finding are further discussed in Section 5.2.

Even though educational attainment proves to be a highly significant predictor of pension income in the main model, there are no significant heterogeneous effects by education. Table A.10 provides results for three education levels, which reveals no notable effects in the second IV stage. However, there are differences in instrument strength and mothers' responsiveness towards changes in the instrument SLD. The ILD of low educated respondents has a much weaker and smaller reaction to variation in SLD, whereas the ILD of medium educated mothers is associated with an extension of 0.604 weeks for each additional week of SLD. This suggests that the main results are more relevant for respondents with a medium level of education – as they are likely to be compliers – than for those with a high level, and even less relevant for the low educated. However, the first stage F-statistic is below ten for all education levels, which makes an interpretation of the LATE in the second stage impossible.

Considering socio-economic status as a possible factor in the relationship between leave duration and pension income, potential heterogenous effects by the mother's type of work during childbirth are examined. The results reveal no notable heterogeneities in the

effect of ILD on pension income by blue versus white collar jobs (see Table A.11). The instrument is not strong enough to explain the variation in ILD for both groups, but the first stage indicates that mothers in white collar jobs are more responsive to changes in SLD than mothers in blue collar jobs. Again, this suggests that respondents who have worked in white-collar jobs are more likely to be compliers than those who have worked in blue-collar jobs.

The previous analyses of heterogeneous effects by socio-economic status reveal no significant impact of ILD on the retirement income of mothers with different levels of education or in different industries. However, ILD is found to significantly cause a reduction in pension income of mothers with medium-to-high incomes. Additionally, the heterogeneous first-stage results for pension income quartiles, education and industry suggest that socio-economic status is a determinant in mothers' compliance with changes in the instrument SLD. Mothers who worked in white collar jobs during childbirth, have medium to high pension income and medium to high educational attainment are more responsive to variation in statutory leave duration than mothers with lower socio-economic status, i.e. mothers with low education, lower pension income and mothers who worked in blue collar jobs.

Next, possible heterogeneous effects by parity are examined. The second stage for each subgroup shows no statistically significant effects and quite large standard errors, possibly due to small sample sizes (see Table A. 12). The first stages show that mothers with two and three children react more strongly to variation in the instrument than mothers with one child or four or more children, possibly because an extension of statutory leave allows them more time to care for additional children. The first stage F-statistics are never above ten for all parity groups and the coefficients in the second stage are insignificant. Hence, there are no relevant heterogeneous effects of ILD on pension income by the number of children of the mother.

Because there is a noticeable cohort effect in individual leave duration, whereby younger mothers tend to take longer leaves, heterogeneities by cohorts are plausible. For this analysis, the main sample is divided into two groups – those born before 1955 and those

born in or after 1955. No significant heterogeneous effects can be found between the two subsamples in the second stage. However, the instrument SLD is stronger for mothers born before 1955 (see Table A. 13). The Wald test shows that the first stage F-statistic is well above ten, and SLD is significant at the one percent level. However, the sample size of younger mothers is much smaller than that of older mothers, making comparisons between the two groups difficult.

The heterogeneity analysis by groups of pension systems reveals no significant heterogenous effects of ILD on pension income across different pension scheme regimes (see Table A. 14). The second stage of the IV estimation yields no significant estimates, and the first stage F-statistics are too low to for any reliable interpretations of the point estimates for the highly earnings-related and the highly redistributive countries, probably due to the small number of observations in the subgroups. However, mothers from countries with moderately earnings-based pension schemes with moderate redistribution are much more responsive to variation in SLD. The first stage shows that a one-week expansion of statutory leave induces mothers to increase their individual leave by 0.47 weeks, ceteris paribus and the first stage F-statistic is above ten. This is potentially due to the higher number of countries in this group that introduce more cross-country variation and thus improve instrument strength.

5. Discussion of the Results

This study investigates the relationship between individual maternal leave duration and pension income in later life, using a two-step estimation strategy. First, two simple OLS estimations examine the correlation between the length of maternal leave and pension income. Second, a 2SLS IV estimation is conducted to address a possible bias in the simple OLS estimates due to potential endogeneity of maternal leave duration. This analysis is one of the first to explore a causal link between the length of maternal leave and pension income using an IV approach. Country- and time-specific statutory leave duration policies serve as a strong and relevant instrument that allows to isolate the causal effect of ILD on retirement income of mothers by exploiting the exogeneous variation of SLD.

5.1 Discussion of the Main Results: Simple OLS and IV Estimates

This study hypothesizes that maternal leave duration has a negative effect on old-age pension income and tests this hypothesis using simple OLS estimations and a 2SLS IV approach. While simple OLS estimates reveal a negative correlation between ILD and pension income, the IV estimation finds no evidence of a negative causal effect of ILD on pension income. Five robustness checks reinforce this finding, which contradicts the expected outcome and refutes the hypothesis. The findings also reinforce the initial concern about potential endogeneity of leave duration due to unobserved maternal characteristics that influence both leave behavior and pension income in retirement. These main results are discussed in more detail below.

The simple OLS regressions disclose a negative correlation between ILD and pension income and find that yearly pension income decreases by € 5.89 for each additional week of leave, holding all other factors equal. This corresponds to a 2.1 percent reduction in annual retirement income for each additional year of leave. Previous studies support this result, as they also find a negative correlation between leave length and pension income (Brugiavini et al., 2011; Dotti Sani & Luppi, 2021; Sefton et al., 2011). The study by Dotti Sani and Luppi (2021) is the most comparable to this analysis as it uses data on the reported length of maternal leave interruptions from the SHARE survey as well. Their simple OLS estimation yields a strikingly similar result: it also finds a 2 percent decrease in annual retirement income for each additional year of leave, strengthening the validity of the finding in this study.

Additionally, the categorical specification of ILD finds a U-shaped relationship between leave duration and pension income: very short and very long maternal leave significantly reduces pension income, while leave of medium length has no significant impact, ceteris paribus. Similarly, Misra et al. (2011) identify a U-shaped pattern between leave duration and mothers' labor force participation and argue that moderate lengths of leave keep mothers attached to the labor market, while both short and very long leave decrease labor force participation. Budig et al. (2012) discover a U-shaped relationship between parental leave length and mothers' wages that is nearly identical to the correlation found between the categorical ILD specification and pension income. Earnings decrease with

very short and very long leave, while moderate leave up to around two years does not negatively affect maternal earnings. This turning point is very similar to the one found in the simple OLS estimation in this study. This suggests that the negative impact of very short and very long leave on post-birth employment and wages may persist until retirement and may ultimately translate into a similar curvilinear relationship with pension income.

Due to endogeneity concerns, the second step of the main analysis relies on an IV estimation to elicit a possible causal effect of ILD on pension income. The first stage results show that the instrument SLD is significantly correlated with ILD, and changes in statutory leave policies induce mothers to change their individual leave duration. However, ILD is not statistically significant in the second stage. This contradicts the initial expectation of a negative effect of ILD on pension income, which is based on evidence that longer leave durations harm mothers' labor market outcomes (see Section 2.2.1), and the negative correlation found between ILD and pension income in the simple OLS estimations.

Comparing the IV and the simple OLS estimates indeed fortifies the assumption that the latter are biased by endogeneity, probably due to selection bias and unobserved maternal characteristics. While the simple OLS estimations find a negative correlation between leave duration and pension income, the IV estimate, free from endogeneity, shows no significant effect of ILD on retirement income. A selection of mothers into different leave lengths based on their socio-economic status is probable as women with a higher labor market attachment and higher wages take shorter maternal leave, likely because they experience a greater motherhood penalty and risk higher opportunity costs (Bister et al., 2024; Kuhlenkasper & Kauermann, 2010). At the same time, mothers with higher income and labor force participation likely have higher pension entitlements due to the close link between wages and retirement income. Other studies on the effect of leave duration on mothers' labor market outcomes also address the problem of endogenous maternal leave and use causal empirical methods to overcome this issue as well (Lequien, 2012).

A possible explanation for the null result is that the observed countries effectively ensure that mothers do not forgo contributions in pension accruals during and after periods of maternal leave. Almost all of the analyzed countries – except for Ireland with its already highly redistributive pension scheme – have specific compensation mechanisms that acknowledge leave periods in the pension calculation, either explicitly with pension credit points or implicitly with continued accrual of contributions during leave (see Section 2.1.2). An extensive cross-country study by D'Addio (2012) analyzes the impact of these measures on mothers' pension entitlements and shows: in most countries, mothers' pension replacement rates would be lower without these measures, whether they acknowledge leave periods implicitly or explicitly with pension credit points. This evidence highlights the role of compensation mechanisms in mitigating the effect of leave breaks on pension entitlements across different countries' pension systems.

When looking at countries individually, it becomes evident that the size of the gap in pension income with and without compensating mechanisms varies by country. In Austria, Belgium, Finland, France, Germany, Italy, Luxembourg, Sweden, and Switzerland, – all of which have moderately to highly earnings-related pension schemes – the pension replacement rate would be considerably lower without mechanisms that acknowledge periods of leave (D'Addio, 2012). D'Addio (2012) concludes that compensating mechanisms are an important measure for mitigating the impact of career breaks, particularly in moderately and highly earnings-related pension schemes. Other studies equally emphasize the importance of crediting methods to cushion the effect of leave interruptions in systems that lack fully redistributive pension designs (Blank & Blum, 2017; Möhring, 2018). Hence, compensating mechanisms contribute to explain the absence of an effect of ILD on retirement income in countries with moderately and highly earnings-related pension systems.

Similarly, country-specific studies on the German and French pension credit point systems confirm that they increase mothers' pension income, particularly for those with low pre-retirement wages (Bach et al., 2014, 2018; Blesch et al., 2024; Geyer et al., 2020; Thiemann, 2015). More importantly, since credit points in Germany and France are granted per child rather than by leave duration, they may offset disparities in pension

entitlements regardless of leave length. In France, this applies even if the number of children is different (Bonnet & Rapoport, 2020). This is an important finding that further supports the main result and demonstrates that particularly pension credit points in the German and French systems render individual maternal leave trajectories irrelevant to mothers' pension accruals.

In Denmark and Ireland, the difference in replacement rates for mothers with and without crediting mechanisms is negligible and replacement rates remain between 100 and 90 percent, even for leave breaks of five years (D'Addio, 2012). This reflects the high degree of redistribution in the pension systems of both countries due to basic and targeted first-tier pensions, which make compensating measures redundant. Basic and targeted schemes are both found to be highly effective at offsetting the impact of maternal leave on retirement income because they guarantee minimum pension income, regardless of contribution history (Möhring, 2014, 2015). The heterogeneity analysis of the effect of ILD on pension income of Danish and Irish mothers cannot provide any empirical evidence that aligns with these previous findings due to very low first stage F-statistics. Still, previous research suggests that the redistributive designs of the Danish and Irish pension systems likely offset the impact of different leave lengths on maternal pension entitlements in this study.

In summary, the implicit and explicit acknowledgement of leave periods in the pension calculation as well as generally redistributive basic and targeted pensions are conducive in cushioning the impact of leave interruptions and subsequently lower earnings. While compensating mechanisms can increase mothers' pension entitlements and can reduce the impact of earnings-based pensions (D'Addio, 2012), basic and targeted pensions guarantee a minimum pension income, unrelated to contribution history. In fully redistributive systems, this renders any compensating measures unnecessary. Thus, Möhring (2018) argues that basic and targeted first-tier pensions are the most effective in offsetting possible adverse effects of leave interruptions on retirement income.

Another possible explanation for the non-existent effect is the importance of survivor pensions for women's pension income in some countries. As explained in Section 3.2.1,

the imputed pension values in SHARE are aggregates of different pension types. The imputed variable *ypen1* includes not only public old-age pensions but also survivor and war pensions from one's spouse or partner. These are payments to a surviving partner derived from a deceased spouse's pension and are usually not conditional on the widow's own pension entitlements. Due to the gender disparity in life expectancy, women make up the majority of survivor pensions recipients (European Commission, 2024a). Especially in countries with earnings-related pension schemes, survivor pensions are an important source of income for widowed women during retirement and notably increase widows' pension entitlements, particularly in Spain, Greece, Italy, Portugal, Germany, and Austria (Ahn, 2004; Arza, 2015; European Commission, 2024a; European Commission, 2020). Since survivor pensions reflect spousal earnings rather than mothers' own history of earnings and contributions, they may introduce additional noise in the measurement of pension income and reduce precision of the estimated effect of leave duration in the IV estimation.

Moreover, survivor pensions may bias the effect of maternal leave on retirement income and pull the IV estimate towards zero if mothers who stay on leave for longer also receive higher income from survivor pensions. This may be the case for women in partnerships that follow more traditional gender roles, where the man is the main earner and childcare is viewed mainly as the responsibility of the woman. In such couples, mothers typically take longer leaves than mothers in more egalitarian partnerships (Mensinger & Zimpelmann, 2024; Stertz et al., 2017; Stertz & Wiese, 2024), especially if overall higher household income allows them to prolong their maternal leave (Ulker & Guven, 2011). Women in these traditional households likely benefit from higher survivor pensions if their partners accumulated higher pension entitlements due to their role as the household's main earner. As a result, mothers in a couple that follows more traditional gender roles generally take longer leave and may have higher retirement income, however not from their own employment-related entitlements but from their deceased partners' survivor pensions. Given the observed cohorts, it is likely that many mothers in this study follow more traditional gender roles. Hence, additional income from survivor pensions possibly dilutes the effect of leave duration on overall pension income, especially in earnings-related pension schemes.

The previous discussion suggests that pension systems and additional income through survivor pensions can offset the effects of labor market disparities in retirement income, at least between different lengths of leave. However, gaps in pension income between men and women and mothers and childless women undoubtedly remain and thus the question of what is driving them (OECD, 2019b). Numerous studies find that the prevailing differences in pension income between men and women are largely related to the fact that mothers more often work part-time than men to balance childcare and careers. Individuals working part-time will never be able to reach the same level of lifetime earnings as those following a standard career of uninterrupted full-time employment, leading to substantially lower retirement income (Hammerschmid & Rowold, 2019b; Möhring, 2015; Niessen-Ruenzi & Schneider, 2022). These fundamental differences in employment trajectories cannot be levelled out by pension systems (Möhring, 2015; Niessen-Ruenzi & Schneider, 2022).

5.2 Heterogeneity in the Main Results: Responsiveness to Variation in the Instrument and Vulnerability of Middle- to High-Income Retirees

The heterogeneity analyses in Section 4.4 uncover significant heterogeneities in instrument strength for different subgroups: mothers with higher education, medium to high pension income, and who worked in typical white-collar jobs are more responsive to changes in SLD. These results suggest that mothers with a higher socioeconomic status may be compliers in the IV analysis. This means that the LATE may primarily reflect the findings for this subgroup, making the results more representative of women with higher socioeconomic status. This is in line with previous studies that also find a higher responsiveness to changes in leave policies among mothers with higher educational attainment and higher income (Bergemann & Riphahn, 2023; Bister et al., 2024; Renner et al., 2025). A possible reason for this is that mothers with higher education and income levels are more informed about their rights to maternal leave and about parental leave systems in general, and are thus more likely to adapt their leave behavior accordingly (Grossmann et al., 2024). In line with previous research, the findings of this study support

the assumption that socioeconomic status is a significant determinant of mothers' compliance with changes in statutory leave.

While the heterogeneity analyses find no significant heterogeneous effects of ILD on pension income by education, industry, parity, cohorts, and pension systems, there is a significant negative effect of ILD among mothers with a pension greater than zero and who receive pension income in the third quartile. The effect is of moderate size: Any additional month of maternal leave reduces annual pension income by around € 85. This indicates that the impact of leave duration is not uniform across all income levels. Leave duration has a harmful effect for a specific group of mothers with middle- to high pension income while it has no impact on pension income in lower and higher quartiles.

This finding can be explained by the variation in pension replacement rates for different earnings levels, as discussed in Section 2.1.2. In most of the countries analyzed, low-income individuals have a higher share of their wages replaced by pension income than workers with average or above-average incomes. In all observed countries, pension entitlements of eligible lower-income earners are supplemented by first-tier basic, targeted, or minimum pensions that effectively raise the PRR of low earners (OECD, 2019b). In contrast, replacement rates are notably lower for individuals with medium and higher wages, whereof retirees with higher income are likely to rely on generally higher household pension income and private savings that increase their monthly available income in retirement. Additionally, most countries have ceilings for pensionable earnings above which any additional income does not count towards pension contributions. Hence, the marginal impact of additional maternal leave may be small or zero for high-income workers as any reduction in earnings does not affect their pension entitlements once they have reached the ceiling (OECD, 2019b). Pensioners in the middle-income range are "in the middle" of both: they likely do not benefit from safety nets in pension systems or high household income and mostly rely on second-tier earnings-related pension types, as is reflected in the significant negative effect in the third pension income quartile.

Further, upper-middle income groups face the steepest decline in income when entering retirement, which contributes to explaining the negative effect for retirees in this retirement income quartile. They are less able to uphold their pre-retirement living standard compared to other income groups since they receive less support from social security systems and first-tier pension schemes (Mitchell et al., 2022). This indicates that the pension income of individuals in middle to high income groups is more proportional to their contribution history. Thus, their retirement income is more sensitive to career interruptions and wage reductions than the pensions of individuals at the low and high ends of the income distribution.

In summary, most European countries support low-income workers in retirement with means-tested, targeted pensions – schemes for which workers with middle- and high-incomes are often ineligible. This suggests that in retirement, pensioners with middle- to high-income levels primarily rely on earnings-related pensions. Hence, their retirement income is more susceptible to reductions in earnings and interruptions in pension contributions, which explains the significant negative impact of ILD on pension income in the third quartile. Future research may further analyze this effect for different pension regimes, like the ones identified in this study, to explore the magnitude of the effect in redistributive and earnings-related schemes.

5.3 Discussion of Descriptive Results

Nearly 40 percent of mothers report no maternal leave interruption after childbirth and 15 percent of mothers have a pension income of € 0. These peculiarities in the main sample prompt a further investigation of those subgroups using simple logistic regressions in Sections 4.1.4 and 4.1.5. The results reveal that a mother's country of residence and the industry she worked in during childbirth are significant determinants of whether she takes maternal leave and receives any pension income.

More specifically, being from Spain significantly increases the likelihood of having no pension entitlements in retirement. Data from Eurostat and previous studies show that these findings are reasonable, as the proportion of women with no pension entitlements is particularly high in Spain: Between 24 to 27 percent of retired women in Spain cannot

claim any pension from their own employment (European Commission, 2024). Coverage is especially low in Spain's first-tier minimum contributory pension, as eligibility requires almost 35 years of contributions (European Commission, 2020, 2024; Lannoo et al., 2014; OECD, 2019b; Vara, 2013). Since maternal leave periods count as contributory periods in the Spanish pension calculation, the comparatively low coverage of women may not be a consequence of maternal leave interruptions, but is rather associated with relatively few years of employment and a generally low labor force participation of Spanish women (Arza, 2015; Hammerschmid & Rowold, 2019a; OECD, 2019b).

Another peculiarity in the main sample is the surprisingly high share of mothers who take no maternal leave after childbirth. Almost 40 percent of mothers report no interruption from work, which is mostly due to mothers who were working in the agricultural industry during childbirth. This finding is plausible as the agricultural industry is characterized by generally more precarious working conditions, high economic pressure and higher rates of informal work and self-employment, making it more difficult to take leave (Padel et al., 2022; Popescu et al., 2021). A study on German women working in agriculture describes the challenges mothers face when they want to take leave after giving birth. Specifically loss of workforce during leave and lack of regulations on maternity protection in the agricultural sector create obstacles for mothers working in agriculture to interrupt their work (Padel et al., 2022; Popescu et al., 2021). These findings offer a plausible explanation for why a substantial share of mothers in this study did not take maternal leave after childbirth.

5.4 Study Limitations

A main limitation of this study is the reliance on imputed pension income variables instead of using reported values. In addition to entitlements from mothers' own employment, the aggregation of different retirement income types in the imputed pension income variable includes survivor pensions. This is a shortcoming as it hinders the sole analysis of pension income derived from mothers' own work and may dilute the effect of ILD on retirement income.

This study assumes that the instrument SLD fulfills the exclusion restriction and impacts pension income solely through ILD. However, this assumption may be threatened by the fact that leave policies and pension systems are both part of a country's overarching welfare system. Changes in a country's statutory leave policy may be accompanied by other policy changes affecting labor market structures or pension benefit rules. For example, adjustments in statutory maternity leave duration could coincide with reforms in pension contribution requirements or eligibility criteria, thereby influencing pension income directly through channels other than individual leave duration. Such correlated policy shifts pose a risk of violating the exclusion restriction, as SLD may affect pension income through pathways other than ILD.

Further, as Möhring (2015) notes in a similar analysis using SHARE data, the rather small number of countries in this study does not allow for an analysis of more divergent pension systems. The inclusion of more countries would contribute to a more robust and meaningful analysis of the effect of ILD in different pension regime clusters.

6. Conclusion

Based on previous research on the impact of maternal leave duration on short- to long-term economic outcomes of mothers, this study hypothesizes that the length of individual maternal leave has a negative causal effect on mothers' old-age pension income. While there is extensive literature on the relationship between maternal leave duration and short- to medium-term labor market outcomes, research on the long-term economic impact of leave is limited. This study aims to fill that gap by examining the long-term effects of leave duration on retirement income, offering a causal perspective that has been lacking in previous studies on leave duration and pension income.

Simple OLS estimations and 2SLS IV estimation are used to examine the relationship between individual maternal leave duration and pension income and to test the hypothesis that there is – beyond correlation – a negative causal effect of ILD on retirement income. To do this, the IV model uses exogenous variation in statutory leave policies across 15 countries from 1960 to 2010 as an instrument. SLD proves to be a

strong and relevant instrument as women adapt their individual leave behavior in response to changes in statutory leave policies.

After presenting an extensive literature review, performing two simple OLS estimations and an IV estimation, testing the results in five robustness checks, exploring heterogenous effects, and discussing the findings in depth, three conclusions can be drawn from this study.

First, the length of maternal leave appears irrelevant for mothers' pension income. Although individual leave duration is negatively correlated with pension income, the IV estimation finds no evidence of a causal effect of maternal leave duration on pension income, thus disproving the initial hypothesis.

In relation to this, mothers with a higher socio-economic status likely select into shorter lengths of leave and higher pension income. Therefore, the negative correlation between leave duration and pension income in the simple OLS estimates is likely a product of endogeneity bias, which is supported by the fact that the endogeneity-free IV estimate finds no significant effect.

Second, the design of countries' pension systems plays a crucial role in moderating how and to what extent career interruptions and subsequent lower earnings are cushioned in pension entitlements. Existing literature highlights that compensating mechanisms and pension credit points can notably raise mothers' retirement income in earnings-related pension schemes. In redistributive systems with first-tier basic and targeted pensions, such measures are redundant as the system itself already guarantees universal pension income, independent of contribution history and former earnings. Coming from this, leave interruptions have no effect on pensions in the highly redistributive pension schemes in Denmark and Ireland, irrespective of the length of the leave period, because both systems mainly rely on basic and targeted pensions.

The moderately redistributive pension systems in Austria, Germany, France, Belgium, the Netherlands, Switzerland, Luxembourg, Sweden, and Finland, feature compensating

mechanisms, pension care credits, and some redistributive elements, including basic and targeted pensions. All of these mitigate the impact of different lengths of leave on retirement income insofar that there is no universal cross-country effect.

Spain, Italy, Greece, and Portugal have mostly earnings-related pension systems that rely almost exclusively on minimum contributory pensions in their first tier, but periods of leave are acknowledged in the calculation of pension entitlements. It appears that these measures are sufficiently effective in mitigating the effect of different leave durations on pension income.

Third, while redistributive measures effectively support mothers with low pension entitlements, they do not sufficiently protect mothers with middle- to high earnings from the adverse effects of prolonged leave on retirement income. ILD significantly reduces pension income for mothers in the third pension income quartile, whose pension income is more proportional to their contribution and earnings history. Thus, career breaks due to childcare-related leave and subsequent lower earnings do translate into lower pension income in retirement for this subgroup of mothers.

These findings show that pension policies significantly moderate if and how inequalities that arise during working life due to maternal leave translate into economic disadvantages in retirement. Therefore, this study has important policy implications for designing pension systems that effectively protect individuals with interrupted careers and lower incomes from adverse economic outcomes in retirement – most frequently mothers. Highly redistributive pension schemes are most effective in mitigating effects of prolonged leave because they detach pension entitlements from contribution history. Hence, redistributive systems benefit mothers the most. However, primarily earnings-related schemes do not necessarily reinforce employment inequalities among mothers if they integrate some redistributive elements and compensate for periods of leave, at least for leave periods up to seven years. These schemes likely lack the redistributive capacity to offset the effects of longer childcare breaks or of cases in which mothers leave the workforce entirely. The analysis also suggests that these measures are not effective enough to protect retirees with middle to high income from the adverse effect of maternal

leave duration on their retirement income. Further analyses are needed to determine whether fully redistributive pension schemes are able to mitigate the impact of prolonged leave on pension income for this group.

On the background of a persisting gender gap and a motherhood penalty in pensions, this study has even greater implications. Since the duration of maternal leave has no effect on pension income, the disparities in retirement income between women and men, as well as between mothers and childless women, must be due to other reasons, such as part-time employment and discrimination in the workforce. As long as the inherent differences in labor market trajectories between men and women do not change, the GGP is unlikely to close because, as Frericks and Maier (2008) put it, since “labour markets are gendered, [...] pensions are, per se, gendered.”

References

Ahn, N. (2004). *Economic Consequences of Widowhood in Europe: Cross-country and Gender Differences* (Documento de Trabajo 2004-27). Fundación de Estudios de Economía Aplicada. Retrieved 20 August 2025, from https://documentos.fedea.net/pubs/dt/2004/dt-2004-27.pdf

Alcser, K. H., Grant, B., Blom, A., & Börsch-Supan, A. (2011). *Retrospective Data Collection in the Survey of Health, Ageing and Retirement in Europe. SHARELIFE Methodology*. Mannheim Research Institute for the Economics of Ageing (MEA).

Andersen, T. (2015, June). *Robustness of the Danish Pension system*. CESifo DICE Report, *13*(2), 25-30. Retrieved 12 August 2025, from https://www.ifo.de/DocDL/dice-report-2015-2-andersen-pension-june.pdf

Anderson, D. J., Binder, M., & Krause, K. (2002). The Motherhood Wage Penalty: Which Mothers Pay It and Why? *American Economic Review*, *92*(2), 354–358. https://doi.org/10.1257/000282802320191606

Angrist, J. D., & Pischke, J.-S. (2009). *Mostly harmless econometrics: An empiricist's companion*. Princeton University Press.

Arza, C. (2015). *The gender dimensions of pension systems: Policies and constraints for the protection of older women*. UN Women Discussion Papers. https://doi.org/10.18356/31959a6d-en

Bach, S., Buslei, H., Coppola, M., Haan, P., & Rausch, J. (2014). Die Verteilungswirkungen der Mütterrente. *DIW Wochenbericht*, *81*(20), Deutsches Institut für Wirtschaftforschung, 447–456. Retrieved 8 June 2025, from https://www.econstor.eu/handle/10419/97192

Bach, S., Buslei, H., & Harnisch, M. (2018). Die Mütterrente II kommt vor allem Rentnerinnen mit geringen und mittleren Einkommen zugute. *DIW Wochenbericht*, *85*(28), 613–622. https://doi.org/10.18723/diw_wb:2018-28-1

Baker, M., & Milligan, K. (2008). How Does Job-Protected Maternity Leave Affect Mothers' Employment? *Journal of Labor Economics*, *26*(4), 655–691. https://doi.org/10.1086/591955

Baker, M., & Milligan, K. (2010). Evidence from Maternity Leave Expansions of the Impact of Maternal Care on Early Child Development. *The Journal of Human Resources*, *45*(1), 1–32. JSTOR.

Barigozzi, F., Cremer, H., & Lozachmeur, J.-M. (2023). Gender wage and longevity gaps and the design of retirement systems. *Journal of Economic Behavior & Organization*, *209*, 263–287. https://doi.org/10.1016/j.jebo.2023.03.007

Beetsma, R., Constandse, M., Cordewener, F., Romp, W., & Vos, S. (2015). The Dutch Pension System and the Financial Crisis. *CESifo DICE Report*, *13*(2), 14–19. Retrieved 12 August 2025, from https://www.ifo.de/DocDL/dice-report-2015-2-beetsma_etal-pension-june.pdf

Berge, L., Krantz, S., McDermott, G., & Lenth, R. (2024). *Fast Fixed-Effects Estimations* (Version 0.13.2) [Software manual]. CRAN. Retrieved 24 May 2024, from

https://cran.r-project.org/web/packages/fixest/fixest.pdf

Bergemann, A., & Riphahn, R. T. (2023). Maternal employment effects of paid parental leave. *Journal of Population Economics*, *36*(1), 139–178. https://doi.org/10.1007/s00148-021-00878-7

Bergmann, M., Kneip, T., De Luca, G., & Scherpenzeel, A. (2019). *Survey participation in the Survey of Health, Ageing and Retirement in Europe (SHARE), Wave 1-7. Based on Release 7.0.0. SHARE Working Paper Series: 41-2019*. Munich: MEA, Max Planck Institute for Social Law and Social Policy.

Bernardi, L., Huinink, J., & Settersten, R. A. (2019). The life course cube: A tool for studying lives. *Advances in Life Course Research*, *41*, 100258. https://doi.org/10.1016/j.alcr.2018.11.004

Bister, L., Eibich, P., & Rutigliano, R. (2024). Who is affected by parental leave reforms? Women's selection into different parental leave lengths across recent policy reforms in Germany. *Genus*, *80*(1), 15. https://doi.org/10.1186/s41118-024-00221-4

Bister, L., Eibich, P., Rutigliano, R., Kühn, M., & Van Hedel, K. (2025). Selection into maternity leave length and long-run maternal health in Germany. *Journal of Social Policy*, *54*(2), 528–547. https://doi.org/10.1017/S0047279423000429

Blank, F., & Blum, S. (2017). *Kindererziehungszeiten in der Alterssicherung: Ein Vergleich sechs europäischer Länder* (WSI Working Paper 209). Hans-Böckler-Stiftung, Wirtschafts- und Sozialwissenschaftliches Institut (WSI). Retrieved 3 April 2025, from https://hdl.handle.net/10419/155680

Blesch, M., Gehlen, A., Geyer, J., Haan, P., & Klotz, S. (2024). Abschaffung der Mütterrente würde Altersarmut erhöhen. *DIW Wochenbericht*, *91*(31/32), 495–502. https://doi.org/10.18723/diw_wb:2024-31-1

Bonnet, C., Meurs, D., & Rapoport, B. (2022). Gender pension gaps along the distribution: An application to the French case. *Journal of Pension Economics and Finance*, *21*(1), 76–98. https://doi.org/10.1017/S1474747220000177

Bonnet, C., & Rapoport, B. (2020). Is There a Child Penalty in Pensions? The Role of Caregiver Credits in the French Retirement System. *European Journal of Population*, *36*(1), 27–52. https://doi.org/10.1007/s10680-019-09517-0

Börsch-Supan, A., Brandt, M., Hunkler, C., Kneip, T., Korbmacher, J., Malter, F., Schaan, B., Stuck, S., Zuber, S., & on behalf of the SHARE Central Coordination Team. (2013). Data Resource Profile: The Survey of Health, Ageing and Retirement in Europe (SHARE). *International Journal of Epidemiology*, *42*(4), 992–1001. https://doi.org/10.1093/ije/dyt088

Brugiavini, A., Pasini, G., & Trevisan, E. (2011). Maternity and Labour Market Outcome: Short and Long Term Effects. In A. Börsch-Supan, M. Brandt, K. Hank, & M. Schröder (Eds.), *The Individual and the Welfare State: Life Histories in Europe* (pp. 151–159). Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-642-17472-8_13

Budig, M. J., & England, P. (2001). The Wage Penalty for Motherhood. *American Sociological Review*, *66*(2), 204–225. https://doi.org/10.1177/000312240106600203

Budig, M. J., Misra, J., & Boeckmann, I. (2012). The Motherhood Penalty in Cross-National Perspective: The Importance of Work-Family Policies and Cultural Attitudes. *Social*

Politics: International Studies in Gender, State & Society, *19*(2), 163–193. https://doi.org/10.1093/sp/jxs006

Bundesministerium für Arbeit und Soziales. Economic Policy Committee—Ageing Working Group. (2023). *2024 Ageing Report. Germany—Country Fiche*. Retrieved 29 June 2025, from https://economy-finance.ec.europa.eu/document/download/e8f41d38-6d27-45b4-8919-c9348720fcfc_en?filename=2024-ageing-report-country-fiche-Germany.pdf

Canaan, S., Lassen, A., Rosenbaum, P., & Steingrimsdottir, H. (2022). Maternity Leave and Paternity Leave: Evidence on the Economic Impact of Legislative Changes in High Income Countries. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.4114688

Cohn, E., & Addison, J. T. (1998). The Economic Returns to Lifelong Learning in OECD Countries. *Education Economics*, *6*(3), 253–307. https://doi.org/10.1080/09645299800000021

Corsi, M., Crepaldi, C., & Samek Lodovici, M. (2011). *The socio-economic impact of pension systems on the respective situations of women and men and the effects of recent trends in pension reforms: Synthesis Report; Final version*. Europäische Kommission/Expertengruppe Geschlechtergleichstellung, Soziale Integration und Beschäftigung. Retrieved 30 July 2025, from https://iris.uniroma1.it/handle/11573/956996

Cukrowska-Torzewska, E. (2017). Cross-Country Evidence on Motherhood Employment and Wage Gaps: The Role of Work–Family Policies and Their Interaction. *Social Politics: International Studies in Gender, State & Society*, *24*(2), 178–220. https://doi.org/10.1093/sp/jxx004

Cukrowska-Torzewska, E., & Matysiak, A. (2020). The motherhood wage penalty: A meta-analysis. *Social Science Research*, *88–89*, 102416. https://doi.org/10.1016/j.ssresearch.2020.102416

D'Addio, A. (2012). Pension entitlements of women with children: The role of credits within Pension systems in OECD and EU countries. In D. Robalino, Palmer, Edward, & Holzmann, Robert (Eds.), *Nonfinancial Defined Contribution Pension Schemes in a Changing Pension World: Volume 2 Gender, Politics, and Financial Stability*. The World Bank.

Dahl, G. B., Løken, K. V., Mogstad, M., & Salvanes, K. V. (2016). What Is the Case for Paid Maternity Leave? *Review of Economics and Statistics*, *98*(4), 655–670. https://doi.org/10.1162/REST_a_00602

Daly, M., & Ferragina, E. (2018). Family policy in high-income countries: Five decades of development. *Journal of European Social Policy*, *28*(3), 255–270. https://doi.org/10.1177/0958928717735060

Dannefer, D. (2003). Cumulative Advantage/Disadvantage and the Life Course: Cross-Fertilizing Age and Social Science Theory. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, *58*(6), S327–S337. https://doi.org/10.1093/geronb/58.6.S327

Dessimirova, D., & Bustamante, M. A. (2019, July). *The gender gap in pensions in the EU*. Policy Department for Economic, Scientific and Quality of Life Policies Directorate-

General for Internal Policies. Retrieved 8 April 2025, from https://www.europarl.europa.eu/RegData/etudes/BRIE/2019/631033/IPOL_BRI(2019)631033_EN.pdf

Dotti Sani, G. M., & Luppi, M. (2021). Absence from Work after the Birth of the First Child and Mothers' Retirement Incomes: A Comparative Analysis of 10 European Countries. *Work, Employment and Society*, *35*(3), 470–489. https://doi.org/10.1177/0950017020937935

Ebbinghaus, B. (2012). Europe's Transformations Towards a Renewed Pension System. In G. Bonoli & D. Natali (Eds.), *The Politics of the New Welfare State* (pp. 182–205). Oxford University Press. https://doi.org/10.1093/acprof:oso/9780199645244.003.0009

Ejrnœs, M., Ejrnæs, M., & Kunze, A. (2013). Work and Wage Dynamics around Childbirth. *The Scandinavian Journal of Economics*, *115*(3), 856–877. JSTOR.

Elder, G. H., Johnson, M. K., & Crosnoe, R. (2003). The Emergence and Development of Life Course Theory. In J. T. Mortimer & M. J. Shanahan (Eds.), *Handbook of the Life Course* (pp. 3–19). Springer US. https://doi.org/10.1007/978-0-306-48247-2_1

European Commission (2024a). *The 2024 pension adequacy report: Current and future income adequacy in old age in the EU. Volume I*. Publications Office. Retrieved 15 July 2025, from https://data.europa.eu/doi/10.2767/909323

European Commission (2024b). *The 2024 pension adequacy report: Current and future income adequacy in old age in the EU. Volume II*. Publications Office. Retrieved 15 July 2025, from https://data.europa.eu/doi/10.2767/550848

European Commission, Eurostat (2020). *Ageing Europe—Statistics on pensions, income and expenditure*. Eurostat. Retrieved 26 May 2025, from https://ec.europa.eu/eurostat/statistics-explained/index.php?_income_and_expenditure&oldid=500271

European Commission, Eurostat (2024). *Taux de couverture des pensions entre hommes et femmes par groupe d'âge* [Dataset]. Eurostat. Retrieved 2 June 2025, from https://doi.org/10.2908/ILC_PNP14

European Commission, Istituto per la Ricerca Sociale (IRS)., Fondazione Giacomo Brodolini (FGB)., & Directorate General for Justice. (2013). *The gender gap in pensions in the EU*. Publications Office. Retrieved 2 July 2025, from https://data.europa.eu/doi/10.2838/43810

Evertsson, M. (2016). Parental leave and careers: Women's and men's wages after parental leave in Sweden. *Advances in Life Course Research*, *29*, 26–40. https://doi.org/10.1016/j.alcr.2016.02.002

Frericks, P. R. H., & Maier, R. M. (2008). Pension norms and pension reforms in Europe – the effects on gender pension gaps. *Community, Work & Family*, *11*(3), 253–271. https://doi.org/10.1080/13668800802133651

Frodermann, C., Wrohlich, K., & Zucco, A. (2023). Parental Leave Policy and Long-run Earnings of Mothers. *Labour Economics*, *80*, 102296. https://doi.org/10.1016/j.labeco.2022.102296

Frommert, D., Heien, T., & Loose, B. L. (2013). Auswirkungen von Kindererziehung auf

Erwerbsbiografien und Alterseinkommen von Frauen. *WSI-Mitteilungen*, *66*(5), 338–349. https://doi.org/10.5771/0342-300X-2013-5-338

García-Gómez, P., Van Kippersluis, H., O'Donnell, O., & Van Doorslaer, E. (2013). Long-Term and Spillover Effects of Health Shocks on Employment and Income. *Journal of Human Resources*, *48*(4), 873–909. https://doi.org/10.3368/jhr.48.4.873

Gauthier, A. (2011a). *A brief history of maternity, parental, and childcare leave schemes in selected OECD countries*. Netherlands Interdisciplinary Demographic Institute and Max Planck Institute for Demographic Research (distributors). Retrieved 9 June 2024, from: www.demogr.mpg.de

Gauthier, A. (2011b). *Comparative Family Policy Database, Version 3* [computer file]. Netherlands Interdisciplinary Demographic Institute and Max Planck Institute for Demographic Research (distributors). Retrieved 4 April 2024, from: www.demogr.mpg.de

Geyer, J., Haan, P., & Harnisch, M. (2020). *Zur Wirkung der Grundrente und der Mütterrente auf die Altersarmut* (Arbeitspapier 07/2020). Sachverständigenrat zur Begutachtung der Gesamtwirtschaftlichen Entwicklung. https://hdl.handle.net/10419/226021

Girsberger, E. M., Hassani Nezhad, L., Karunanethy, K., & Lalive, R. (2021). Mothers at Work: How Mandating Paid Maternity Leave Affects Employment, Earnings and Fertility. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.3900867

Grossmann, J., Pertold, F., & Šoltés, M. (2024). Parental allowance increase and labor supply: Evidence from a Czech reform. *Labour Economics*, *89*, 102589. https://doi.org/10.1016/j.labeco.2024.102589

Guertzgen, N., & Hank, K. (2018). Maternity Leave and Mothers' Long-Term Sickness Absence: Evidence From West Germany. *Demography*, *55*(2), 587–615. https://doi.org/10.1007/s13524-018-0654-y

Haan, P., Kreyenfeld, M., Schmauk, S., & Mika, T. (2025). The Gender Pension Gap Grows the More Children a Woman Has. *DIW Weekly Report*, *15*, 79-85. https://doi.org/10.18723/DIW_DWR:2025-12-1

Hammerschmid, A., & Rowold, C. (2019a). Gender Pension Gaps in Europa hängen eindeutiger mit Arbeitsmärkten als mit Rentensystemen zusammen. *DIW Wochenbericht*, *86*, 439-447. https://doi.org/10.18723/DIW_WB:2019-25-1

Hammerschmid, A., & Rowold, C. (2019b). Gender Pension Gaps in Europe Are More Explicitly Associated with Labor Markets than with Pension Systems. *DIW Weekly Report*, *9*, 203-211. https://doi.org/10.18723/DIW_DWR:2019-25-1

Heckman, J. J., Humphries, J. E., & Veramendi, G. (2018). Returns to Education: The Causal Effects of Education on Earnings, Health, and Smoking. *Journal of Political Economy*, *126*(S1), 197–246. https://doi.org/10.1086/698760

Hinrichs, K. (2021). Recent pension reforms in Europe: More challenges, new directions. An overview. *Social Policy & Administration*, *55*(3), 409–422. https://doi.org/10.1111/spol.12712

Hinrichs, K., & Jessoula, M. (2012). Labour Market Flexibility and Pension Reforms: What Prospects for Security in Old Age? In K. Hinrichs & M. Jessoula (Eds.), *Labour Market*

Flexibility and Pension Reforms, 1–25. Palgrave Macmillan UK. https://doi.org/10.1057/9780230307605_1

Jędrzychowska, A., Kwiecień, I., & Poprawska, E. (2020). The Motherhood Pension Gap in a Defined Contribution Pension Scheme—The Case of Poland. *Sustainability*, *12*(11). https://doi.org/10.3390/su12114425

Jędrzychowska, A., Kwiecień, I., Poprawska, E., Cichowicz, E., & Gałecka-Burdziak, E. (2024). How do lifecycle, employment and childcare support contribute to the gender pension gap in Europe? The clustering methods analysis. *Technological and Economic Development of Economy*, *30*(6), 1862–1889. https://doi.org/10.3846/tede.2024.21887

Jefferson, T. (2009). Women and Retirement Pensions: A Research Review. *Feminist Economics*, *15*(4), 115–145. https://doi.org/10.1080/13545700903153963

Joseph, O., Pailhé, A., Recotillet, I., & Solaz, A. (2013). The economic impact of taking short parental leave: Evaluation of a French reform. *European Association of Labour Economists 24th Annual Conference, Bonn, Germany, 25,* 63–75. https://doi.org/10.1016/j.labeco.2013.04.012

Kahn, J. R., García-Manglano, J., & Bianchi, S. M. (2014). The Motherhood Penalty at Midlife: Long-Term Effects of Children on Women's Careers. *Journal of Marriage and Family*, *76*(1), 56–72. https://doi.org/10.1111/jomf.12086

Karu, M., & Tremblay, D.-G. (2018). Fathers on parental leave: An analysis of rights and take-up in 29 countries. *Community, Work & Family*, *21*(3), 344–362. https://doi.org/10.1080/13668803.2017.1346586

Kern, V., & Lecerf, M. (2023). *At a Glance Infographic: Maternity and paternity leave in the EU*. Retrieved 19 August 2024, from https://www.europarl.europa.eu/RegData/etudes/ATAG/2023/739346/EPRS_ATA(2023)739346_EN.pdf

Kleven, H., Landais, C., Posch, J., Steinhauer, A., & Zweimüller, J. (2020). *Do Family Policies Reduce Gender Inequality? Evidence from 60 Years of Policy Experimentation* (w28082; p. w28082). National Bureau of Economic Research. https://doi.org/10.3386/w28082

Kluve, J., & Schmitz, S. (2018). Back to Work: Parental Benefits and Mothers' Labor Market Outcomes in the Medium Run. *ILR Review*, *71*(1), 143–173. https://doi.org/10.1177/0019793917710933

Kuhlenkasper, T., & Kauermann, G. (2010). Duration of maternity leave in Germany: A case study of nonparametric hazard models and penalized splines. *Labour Economics*, *17*(3), 466–473. https://doi.org/10.1016/j.labeco.2009.12.001

Kuitto, K., Kuivalainen, S., & Möhring, K. (2021). Inequalities in pensions and retirement from a life course perspective: An introduction. *Social Policy & Administration*, *55*(3), 403–408. https://doi.org/10.1111/spol.12663

Lalive, R., Schlosser, A., Steinhauer, A., & Zweimuller, J. (2014). Parental Leave and Mothers' Careers: The Relative Importance of Job Protection and Cash Benefits. *The Review of Economic Studies*, *81*(1), 219–265. https://doi.org/10.1093/restud/rdt028

Lalive, R., & Zweimüller, J. (2009). How does Parental Leave Affect Fertility and Return to

Work? Evidence from Two Natural Experiments. *Quarterly Journal of Economics*, *124*(3), 1363–1402. https://doi.org/10.1162/qjec.2009.124.3.1363

Lannoo, K., Barslund, M., Chmelar, A., & von Werder, M. (2014). *Employment and Social Affairs. Pension Schemes. Study for the EMPL Committee*. European Parliament. Directorate General for Internal Policies. Retrieved 8 May 2025, from https://www.europarl.europa.eu/RegData/etudes/STUD/2014/536281/IPOL_STU(2014)536281_EN.pdf

Lapuerta, I., Baizán, P., & González, M. J. (2011). Individual and Institutional Constraints: An Analysis of Parental Leave Use and Duration in Spain. *Population Research and Policy Review*, *30*(2), 185–210. https://doi.org/10.1007/s11113-010-9185-y

Lequien, L. (2012). The Impact of Parental Leave Duration on Later Wages. *Annals of Economics and Statistics*, *107/108*, 267. https://doi.org/10.2307/23646579

Lis, M., & Bonthuis, B. (2019). Drivers of the Gender Gap in Pensions: Evidence from EU-SILC and the OECD Pension Models. In R. Holzmann, et al. (Eds.), *Progress and Challenges of Nonfinancial Defined Contribution Pension Schemes*. World Bank Publications.

Løken, K. V., Mogstad, M., & Wiswall, M. (2012). What Linear Estimators Miss: The Effects of Family Income on Child Outcomes. *American Economic Journal: Applied Economics*, *4*(2), 1–35. https://doi.org/10.1257/app.4.2.1

Luft, H. S. (1975). The Impact of Poor Health on Earnings. *The Review of Economics and Statistics*, *57*(1), 43. https://doi.org/10.2307/1937862

Mavrikiou, P. M., & Angelovska, J. (2020). Factors determining gender pension gap in Europe: A cross national study. *UTMS Journal of Economics*, *11*(2), 151–160.

McIntosh, B., McQuaid, R., Munro, A., & Dabir-Alai, P. (2012). Motherhood and its impact on career progression. *Gender in Management: An International Journal*, *27*(5), 346–364. https://doi.org/10.1108/17542411211252651

Mensinger, T., & Zimpelmann, C. (2024). *How Gender Role Attitudes Shape Maternal Labor Supply*, Beiträge zur Jahrestagung des Vereins für Sozialpolitik 2025: Revival of Industrial Policy. ZBW. https://hdl.handle.net/10419/325373

Misra, J., Budig, M., & Boeckmann, I. (2011). Work-family policies and the effects of children on women's employment hours and wages. *Community, Work & Family*, *14*(2), 139–157. https://doi.org/10.1080/13668803.2011.571396

Mitchell, O. S., Clark, R. L., & Lusardi, A. (2022). Income trajectories in later life: Longitudinal evidence from the Health and Retirement Study. *The Journal of the Economics of Ageing*, *22*, 100371. https://doi.org/10.1016/j.jeoa.2022.100371

Möhring, K. (2014). Der Einfluss von Kindererziehungszeiten und Mütterrenten auf das Alterseinkommen von Müttern in Europa. *Vierteljahrshefte Zur Wirtschaftsforschung*, *83*(2), 139–155. https://doi.org/10.3790/vjh.83.2.139

Möhring, K. (2015). Employment Histories and Pension Incomes in Europe: A multilevel analysis of the role of institutional factors. *European Societies*, *17*(1), 3–26. https://doi.org/10.1080/14616696.2014.934874

Möhring, K. (2018). Is there a motherhood penalty in retirement income in Europe? The role of lifecourse and institutional characteristics. *Ageing and Society*, *38*(12), 2560–

2589. https://doi.org/10.1017/S0144686X17000812

Möhring, K., Overweg, C., & Weiland, A. P. (2025). The Motherhood Penalty in Financial Resources for Retirement: A Life Course Perspective on the Accumulation of Public Pension Wealth and Personal Wealth in East and West Germany. *Jahrbücher Für Nationalökonomie Und Statistik*. https://doi.org/10.1515/jbnst-2024-0064

Möhring, K., & Weiland, A. (2018). Ausgleich oder Verschärfung von Einkommensrisiken? Lebensläufe und Alterseinkommen in Deutschland aus der Paarperspektive. *Zeitschrift für Sozialreform*, *64*(4), 463–493. DACH Information. https://doi.org/10.1515/zsr-2018-0023

Niessen-Ruenzi, A., & Schneider, C. (2022). The Gender Pension Gap in Germany – Reasons and Remedies. *CESifo Forum*, *23*(02), 20–24. Retrieved 10 June 2025, from https://www.ifo.de/DocDL/CESifo-Forum-2022-2-niessen-schneider-gender-employment-and-pay-gap-march.pdf

O'Brien, M. (2009). Fathers, Parental Leave Policies, and Infant Quality of Life: International Perspectives and Policy Impact. *The ANNALS of the American Academy of Political and Social Science*, *624*(1), 190–213. https://doi.org/10.1177/0002716209334349

OECD. (2011). *Doing Better for Families*. OECD Publishing. https://doi.org/10.1787/9789264098732-en

OECD. (2014). *OECD Reviews of Pension Systems: Ireland*. OECD. https://doi.org/10.1787/9789264208834-en

OECD. (2015). *Pensions at a Glance 2015: OECD and G20 indicators*. OECD. https://doi.org/10.1787/pension_glance-2015-en

OECD. (2017). *Pensions at a Glance 2017: OECD and G20 Indicators*. OECD. https://doi.org/10.1787/pension_glance-2017-en

OECD. (2019a). *OECD Reviews of Pension Systems: Portugal*. OECD. https://doi.org/10.1787/9789264313736-en

OECD. (2019b). *Pensions at a Glance 2019: OECD and G20 Indicators*. OECD. https://doi.org/10.1787/b6d3dcfc-en

OECD. (2021). *Pensions at a Glance 2021: OECD and G20 Indicators*. OECD. https://doi.org/10.1787/ca401ebd-en

OECD. (2023a). *Pensions at a Glance 2023: OECD and G20 Indicators*. OECD. https://doi.org/10.1787/678055dd-en

OECD. (2023b). *Pensions at a Glance 2023—Country notes: Germany*. Retrieved 23 June 2025, from https://www.oecd.org/en/publications/pensions-at-a-glance-2023-country-notes_080dc9b1-en/germany_5c33989b-en.html

OECD Family Database. (2022). *PF2.2: Parents' use of childbirth-related leave*. Retrieved 23 June 2025, from https://www.oecd.org/content/dam/oecd/en/data/datasets/family-database/pf2-2-use-childbirth-leave.pdf

OECD Family Database. (2024a). *PF2.1. Parental leave systems*. Retrieved 8 June 2025, from https://webfs.oecd.org/Els-

com/Family_Database/PF2_1_Parental_leave_systems.pdf

OECD Family Database. (2024b). *PF2.5. Trends in parental leave policies since 1970*. Retrieved 4 April 2025, from https://webfs.oecd.org/Els-com/Family_Database/PF2_5_Trends_in_leave_entitlements_around_childbirth.pdf

Olivetti, C., & Petrongolo, B. (2017). The Economic Consequences of Family Policies: Lessons from a Century of Legislation in High-Income Countries. *Journal of Economic Perspectives*, *31*(1), 205–230. https://doi.org/10.1257/jep.31.1.205

Ondrich, J. I., Spieß, C. K., & Yang, Q. (2002). *The Effect of Maternity Leave on Women's Pay in Germany 1984-1994* (DIW Discussion Papers 289). Deutsches Institut für Wirtschaftsforschung (DIW). https://hdl.handle.net/10419/18273

Padel, S., Pieper, J. L., Edebohls, I., & von Davier, Z. (2022). *Policy Brief. Women on agricultural holdings in Germany: Findings and recommendations of the nationwide study "women.life.agriculture."* Retrieved 25 May 2025, from https://www.bmel.de/SharedDocs/Downloads/EN/_Rural-Regions/women-life-agriculture-policy-brief.pdf?__blob=publicationFile&v=5

Polanco, B., Oña, A., Sabariego, C., & Pacheco Barzallo, D. (2024). Chronic health conditions and their impact on the labor market. A cross-country comparison in Europe. *SSM - Population Health*, *26*, 101666. https://doi.org/10.1016/j.ssmph.2024.101666

Popescu, A., Tindeche, C., & Marcuta, A. (2021). Labor Force in the European Union Agriculture—Traits and Tendencies. *Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development*. Retrieved 8 May 2025, from https://managementjournal.usamv.ro/pdf/vol.21_2/Art55.pdf

Psacharopoulos, G., & Patrinos, H. A. (2018). Returns to investment in education: A decennial review of the global literature. *Education Economics*, *26*(5), 445–458. https://doi.org/10.1080/09645292.2018.1484426

Renner, A.-T., Shaikh, M., & Spitzer, S. (2025). Absence from work and lifetime smoking behavior: Evidence from European maternal leave policies. *Journal of Health Economics*, *102*, 103004. https://doi.org/10.1016/j.jhealeco.2025.103004

Rossin-Slater, M. (2018). Maternity and Family Leave Policy. In S. L. Averett, L. M. Argys, & S. D. Hoffman (Eds.), *The Oxford Handbook of Women and the Economy* (pp. 322–342). Oxford University Press. https://doi.org/10.1093/oxfordhb/9780190628963.013.23

Rowold, C. (2024). *Differences in gender pension gaps in public and private pensions in West Germany: What role do work-family life courses play?* (WP-2024-015; 0 ed., p. WP-2024-015). Max Planck Institute for Demographic Research. https://doi.org/10.4054/MPIDR-WP-2024-015

Rubin, D. B. (1987). *Multiple Imputation for Nonresponse in Surveys* (1st ed.). Wiley. https://doi.org/10.1002/9780470316696

Ruhm, C. J. (1998). The Economic Consequences of Parental Leave Mandates: Lessons from Europe. *The Quarterly Journal of Economics*, *113*(1), 285–317. https://doi.org/10.1162/003355398555586

Ruhm, C. J. (2000). Parental leave and child health. *Journal of Health Economics*, *19*(6), 931–960. https://doi.org/10.1016/S0167-6296(00)00047-3

Schönberg, U., & Ludsteck, J. (2014). Expansions in Maternity Leave Coverage and Mothers' Labor Market Outcomes after Childbirth. *Journal of Labor Economics*, *32*(3), 469–505. https://doi.org/10.1086/675078

Schwartz, J. E. (1985). The Utility of the Cube Root of Income. *Journal of Official Statistics*, *1*(1), 5. Publicly Available Content Database; Social Science Premium Collection.

Sefton, T., Evandrou, M., Falkingham, J., & Vlachantoni, A. (2011). The relationship between women's work histories and incomes in later life in the UK, US and West Germany. *Journal of European Social Policy*, *21*(1), 20–36. https://doi.org/10.1177/0958928710380475

SHARE-ERIC. (2024). *SHARE Release Guide (Release Version 9.0.0)*. Survey of Health, Ageing and Retirement in Europe. Retrieved 4 April 2024, from https://share-eric.eu/fileadmin/user_upload/Release_Guides/SHARE_release_guide_9-0-0.pdf

Stearns, J. (2016). The Long-Run Effects of Wage Replacement and Job Protection: Evidence from Two Maternity Leave Reforms in Great Britain. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.3030808

Stertz, A. M., Grether, T., & Wiese, B. S. (2017). Gender-role attitudes and parental work decisions after childbirth: A longitudinal dyadic perspective with dual-earner couples. *Journal of Vocational Behavior*, *101*, 104–118. https://doi.org/10.1016/j.jvb.2017.05.005

Stertz, A. M., & Wiese, B. S. (2024). Dual-Earner Couples' Gender Role Attitudes and Their Parental Leave Decisions: A Longitudinal Study of Partner Influences. *Sex Roles*, *90*(8), 1018–1039. https://doi.org/10.1007/s11199-024-01474-1

Tanaka, S. (2005). Parental Leave and Child Health Across OECD Countries. *The Economic Journal*, *115*(501), F7–F28. https://doi.org/10.1111/j.0013-0133.2005.00970.x

Thévenon, O., & Solaz, A. (2012). Labour Market Effects of Parental Leave Policies in OECD Countries. *OECD Social, Employment, and Migration Working Papers*, ProQuest One Business.

Thiemann, A. (2015). *Pension wealth and maternal employment: Evidence from a reform of the German child care pension benefit* (DIW Discussion Papers 1499). Deutsches Institut für Wirtschaftsforschung (DIW). https://hdl.handle.net/10419/114565

Torres, A. J. C., Barbosa-Silva, L., Oliveira-Silva, L. C., Miziara, O. P. P., Guahy, U. C. R., Fisher, A. N., & Ryan, M. K. (2024). The Impact of Motherhood on Women's Career Progression: A Scoping Review of Evidence-Based Interventions. *Behavioral Sciences*, *14*(4), 275. https://doi.org/10.3390/bs14040275

Ulker, A., & Guven, C. (2011). Determinants of Maternity Leave Duration in Australia: Evidence from the HILDA Survey. *Economic Record*, *87*(278), 399–413. https://doi.org/10.1111/j.1475-4932.2011.00729.x

Valentova, M., Amjahad, A., & Genevois, A.-S. (2024). Parental Leave Take-up and its Intensity. Do Partners' Workplace Characteristics Matter? *Journal of Social Policy*, *53*(4), 1164–1186. https://doi.org/10.1017/S0047279422000885

Van Buuren, S. (2018). *Flexible Imputation of Missing Data, Second Edition* (2nd ed.). Chapman and Hall/CRC. https://doi.org/10.1201/9780429492259

Van Buuren, S., Boshuizen, H. C., & Knook, D. L. (1999). Multiple imputation of missing blood pressure covariates in survival analysis. *Statistics in Medicine*, *18*(6), 681–694. https://doi.org/10.1002/(SICI)1097-0258(19990330)18:6<681::AID-SIM71>3.0.CO;2-R

Van Vliet, O., Been, J., Caminada, K., & Goudswaard, K. (2012). Pension reform and income inequality among older people in 15 European countries. *International Journal of Social Welfare*, *21*(s1). https://doi.org/10.1111/j.1468-2397.2012.00873.x

Vara, M. J. (2013). Gender Inequality in the Spanish Public Pension System. *Feminist Economics*, *19*(4), 136–159. https://doi.org/10.1080/13545701.2013.822525

Weisshaar, K., & Cabello-Hutt, T. (2020). Labor Force Participation Over the Life Course: The Long-Term Effects of Employment Trajectories on Wages and the Gendered Payoff to Employment. *Demography*, *57*(1), 33–60. https://doi.org/10.1007/s13524-019-00845-8

Whitehouse, E. (2006). New indicators of 30 OECD countries' pension systems. *Journal of Pension Economics and Finance*, *5*(3), 275–298. https://doi.org/10.1017/S1474747206002642

Winegarden, C. R., & Bracy, P. M. (1995). Demographic Consequences of Maternal-Leave Programs in Industrial Countries: Evidence from Fixed-Effects Models. *Southern Economic Journal*, *61*(4), 1020. https://doi.org/10.2307/1060738

Wiß, T. (2015). From welfare states to welfare sectors: Explaining sectoral differences in occupational pensions with economic and political power of employees. *Journal of European Social Policy*, *25*(5), 489–504. https://doi.org/10.1177/0958928715611006

Appendix

Table A. 1.: Summary Statistics for the main sample – mothers' level

Variables	N	Mean	Median	St. Dev.	Min	Max
Individual Leave Duration (weeks)	9,059	43.305	8.600	77.163	0.000	313.200
Annual Pension Income	9,059	14,692.050	13,200.000	16,945.25	0.000	274,200.000
Monthly Pension Income	9,059	1,224.337	1,100.000	1,412.10	0.000	22,850.000
Number of Children	9,059	2.220	2	1.059	1	13
Year of Birth of Mother	9,059	1946	1947	7.493	1918	1973
ADLs	9,059	0.772	0	1.992	0	13
Cash Benefits during Maternity Leave (% of female wages in manufacturing)	9,059	69.292	79.500	30.630	0.000	100.000
Low Education	9,059	0.351	0	0.477	0	1
Medium Education	9,059	0.352	0	0.478	0	1
High Education	9,059	0.297	0	0.457	0	1
1st Child	9,059	0.841	1	0.365	0	1
2nd Child	9,059	0.096	0	0.294	0	1
3rd Child	9,059	0.043	0	0.202	0	1
4+ Child	9,059	0.020	0	0.141	0	1

Notes: This table shows summary statistics for the main variables in the main sample. Numbers are on the mothers' level, i.e. mothers are only counted once. The sample size is 9,059 observations. Monetary values are net values in euros and pooled according to Rubin's Rule, i.e. point values are the average value of all five imputations.

Table A. 2: Summary statistics for cohorts born before 1955 and cohorts born from 1955 onwards – main sample

	Cohort < 1955				Cohort >= 1955			
Variable	N	Mean	Min	Max	N	Mean	Min	Max
Individual Leave Duration (weeks)	14,371	39.787	.000	313.20	2,443	44.830	.000	313.20
Annual Pension Income	14,371	14,604.70	.000	274,200.0	2,443	14,499.010	.000	252,000.0
Monthly Pension Income	14,371	1,217.058	.000	22,850.0	2,443	1,208.251	.000	21,000.0
Number of Children	14,371	2.593	1	13	2,443	2.381	1	8
Year of Birth of Mother	14,371	1944	1918	1954	2,443	1957	1955	1973
ADLs	14,371	.840	0	13	2,443	.289	0	10
Low Education	14,371	.370	0	1	2,443	.228	0	1
Medium Education	14,371	.330	0	1	2,443	.390	0	1
High Education	14,371	.300	0	1	2,443	.381	0	1
No interruption	14,371	.393	0	1	2,443	.366	0	1
Leave longer than 6 months	10,382	.721	0	1	1,841	.753	0	1

Notes: The table shows summary statistics of the main variables for cohorts born before 1955 and cohorts born from 1955 onwards for the main sample. The sample size is 16,814 observations and numbers are on the child's level, i.e. mothers are counted as often as they have children. N does not sum up to 16,838 (the sample size of the main sample) because information is missing for some mothers for the categorical leave duration variable. Monetary values are net values in euros and pooled according to Rubin's Rule, i.e. point values are the average value of all five imputations.

Table A. 3: Simple Logistic Regression Results for taking any leave versus taking no leave

	Mother took any leave (ILD > 0)	
Medium education (ref. = Low education)	0.097	(0.067)
High education (ref. = Low education)	0.100	(0.078)
Year of Birth of Mother	0.025***	(0.004)
Number of Children	-0.105***	(0.030)
ADLs	0.012	(0.014)
Yearly old-age pension income	-0.000	(0.000)
Industry (ref. = Agriculture, hunting, forestry,		
Health and social work	0.665***	(0.127)
Mining and quarrying	0.530*	(0.314)
Manufacturing	0.671***	(0.116)
Electricity, gas and water supply	0.725**	(0.299)
Construction	0.460**	(0.204)
Wholesale and retail trade	0.527***	(0.119)
Hotels and restaurants	0.636***	(0.171)
Transport, storage and communication	0.699***	(0.218)
Financial intermediation	0.781***	(0.172)
Real estate, renting and business activities	0.828***	(0.264)
Public administration and defence	0.619***	(0.142)
Education	0.572***	(0.130)
Other community	0.682***	(0.121)
Country (ref. = Spain)		
Austria	1.248***	(0.136)
Germany	0.868***	(0.136)
Sweden	3.098***	(0.163)
Netherlands	1.146***	(0.186)
Italy	0.755***	(0.139)
France	-0.180	(0.129)
Denmark	1.572***	(0.144)
Greece	1.288***	(0.177)
Switzerland	0.474***	(0.154)
Belgium	-0.238*	(0.131)

Ireland	1.309**	(0.518)
Luxembourg	-0.015	(0.187)
Portugal	0.511***	(0.172)
Finland	1.590***	(0.162)
Constant	-48.334***	(7.073)
Observations	16,838	

Notes: This table shows results from a simple logistic regression with taking any maternal leave (ILD > 0) as the outcome, using the main sample (N = 16,838). Numbers are on the child's level, i.e. mothers are counted as often as they have children. Standard errors are clustered at the mothers' level and given in parentheses. Monetary values are net values in euros and pooled according to Rubin's Rule.
Asterisk notation: * p < 0.10, ** p < 0.05, *** p < 0.01.

Table A. 4: Simple Logistic Regression Results for receiving any pension income versus receiving € 0 pension income

	Pension income is not € 0 (PI > 0)	
Medium education (ref. = Low education)	0.196**	(0.086)
High education (ref. = Low education)	0.270***	(0.105)
Year of Birth of Mother	-0.009*	(0.005)
Number of Children	0.059*	(0.035)
ADLs	-0.026	(0.017)
Industry (ref. = Agriculture, hunting, forestry,		
Health and social work	0.008	(0.167)
Mining and quarrying	-0.295	(0.415)
Manufacturing	0.009	(0.149)
Electricity, gas and water supply	1.123**	(0.525)
Construction	0.159	(0.290)
Wholesale and retail trade	0.063	(0.154)
Hotels and restaurants	-0.206	(0.200)
Transport, storage and communication	-0.154	(0.266)
Financial intermediation	0.286	(0.239)
Real estate, renting and business activities	-0.142	(0.324)
Public administration and defence	0.213	(0.190)
Education	0.039	(0.173)
Other community	0.099	(0.121)
Country (ref. = Spain)		
Austria	1.145***	(0.146)
Germany	1.426***	(0.164)
Sweden	1.560***	(0.154)
Netherlands	3.146***	(0.446)
Italy	0.970***	(0.150)
France	1.579***	(0.155)
Denmark	1.947***	(0.182)
Greece	1.549***	(0.205)
Switzerland	1.485***	(0.204)
Belgium	1.555***	(0.151)

Ireland	0.550	(0.477)
Luxembourg	1.125***	(0.230)
Portugal	0.312*	(0.184)
Finland	0.651***	(0.163)
Observations	16,838	

Notes: This table shows results from a Logistic Regression model with receiving any annual pension income (pension income > € 0) as the outcome and using the main sample (N = 16,838). Numbers are on the child's level, i.e. mothers are counted as often as they have children. The analysis is done using the first set of imputed pension income values. Standard errors are clustered at the mothers' level and given in parentheses. Asterisk notation: * p < 0.10, ** p < 0.05, *** p < 0.01.

Table A. 5: Full output table of results from simple OLS estimations

	Annual net pension income			
	ILD continuous in weeks (I)		ILD in categories (II)	
Individual leave duration in weeks	-5.886***	(1.927)		
No interruption			-666.855	(513.837)
ILD (ref. = More than 1 month but less than 3 months)				
1 month or less			-1547.619**	(773.016)
More than 3 months but less than 6 months			-945.165*	(503.571)
More than 6 months but less than 1 year			-723.143	(490.129)
More than 1 year but less than 2 years			-909.285	(923.586)
More than 2 years but less than 3 years			-750.527	(692.397)
More than 3 years but less than 4 years			-1418.053**	(712.347)
More than 4 years but worked at some point later			-2273.447***	(552.969)
Number of Children	-438.559***	(125.210)	-428.989***	(125.684)
Year of Birth of Mother	-45.702*	(24.851)	-46.739*	(25.187)
ADLs	-62.515	(92.163)	-63.585	(92.482)
Cash Benefits during Maternity Leave (% of female wages in manufacturing)	0.376	(6.935)	0.422	(7.168)
Medium education (ref. = Low education)	1610.868***	(423.892)	1585.103***	(424.132)
High education (ref. = Low education)	4639.221***	(585.386)	4612.592***	(586.450)

Industry (ref. = Health and social work)				
Agriculture, hunting, forestry, fishing	-1342.675*	(716.889)	-1309.608*	(714.862)
Mining and quarrying	-2512.737*	(1352.975)	-2485.333*	(1347.246)
Manufacturing	42.795	(689.187)	51.341	(689.128)
Electricity, gas and water supply	2275.320*	(1309.300)	2296.995*	(1316.482)
Construction	-59.483	(1072.464)	-37.635	(1068.077)
Wholesale and retail trade	1.683	(639.990)	22.101	(638.841)
Hotels and restaurants	-1244.711	(822.848)	-1227.001	(823.300)
Transport, storage and communication	3110.084	(2414.236)	3115.439	(2414.306)
Financial intermediation	2900.321**	(1340.535)	2900.515**	(1341.459)
Real estate, renting and business activities	2015.057	(2816.601)	2012.072	(2820.966)
Public administration and defence	2846.969***	(1030.646)	2870.649***	(1030.380)
Education	2729.372***	(707.658)	2747.520***	(707.323)
Other community	16.009	(564.778)	26.178	(563.587)
Country (ref. = Austria)				
Germany	-1060.058**	(473.316)	-1066.776**	(475.923)
Sweden	805.340	(655.455)	814.354	(681.585)
Netherlands	5791.473***	(2019.596)	5864.497***	(2032.749)
Spain	-6168.713***	(574.942)	-6163.656***	(596.608)
Italy	-3131.358***	(478.689)	-3126.158***	(491.933)
France	2145.801***	(518.627)	2175.741***	(544.519)
Denmark	763.449	(535.645)	714.990	(561.612)
Greece	-6253.897***	(588.415)	-6279.347***	(619.331)
Switzerland	14922.770***	(1558.417)	14975.788***	(1562.155)
Belgium	6494.592***	(1062.703)	6508.604***	(1088.782)
Ireland	-993.213	(2649.138)	-1074.061	(2629.962)
Luxembourg	11618.407***	(2578.112)	11663.558***	(2586.756)
Portugal	-7401.679***	(547.649)	-7329.540***	(557.494)
Finland	-1998.442***	(656.225)	-2026.755***	(667.136)

Observations	16,838	16,814
Adj. R2	0.1324	0.1324

Notes: This table shows the full output table from a simple OLS estimation, using a continuous specification of ILD as the explanator (I), and using a categorical specification of ILD as the explanator (II). The main sample is used, and sample sizes are 16,838 for the continuous ILD specification and 16,814 for the categorical specification. Information is missing for 24 observations for the categorical leave duration variable. Control variables include mothers' educational attainment, their number of children, year of birth, country of residence, health status, the industry the mother worked in during childbirth of each child and the cash benefits she received during each maternity and parental leave as a percentage of female wages in manufacturing. The outcome variable is imputed annual net pension income in euros. Coefficients and variances are pooled according to Rubin's Rule. Standard errors are clustered at the mothers' level and given in parentheses.
Asterisk notation: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A. 6: The effect of individual maternal leave duration on pension income – main sample, second set of imputed pension income values

First stage: SLD and ILD		
SLD	0.611***	(0.128)
	Annual pension income	
Second stage: Effect of ILD on second set of imputed pension income		
ILD	-57.50*	(32.88)
First-stage F-Statistic	28.1	
First-stage Wald test	22.7	
Observations	16,838	

Notes: The table shows first and second stage results for the 2SLS IV estimation (see Equations (2) and (3)) using pension income values from the second set of imputations only. The first row displays results from the first stage that estimates the correlation between SLD and ILD using simple OLS estimation. Statutory maternity leave duration (SLD) is measured in weeks and refers to the statutory length of the maximum available maternity leave that was in place at the child's year of birth and in the child's country of birth. SLD is used as an instrument for mothers' individual maternal leave duration (ILD). The variable ILD is a continuous variable that measures mothers' reported maternal leave duration in weeks. The second row illustrates results from the second stage of the IV estimation and shows the estimated effect of ILD on the outcome variable annual pension income from the second set of imputations. Annual pension income is the imputed annual net pension income in euros. The third row provides the general first stage F-statistic, the first-stage Wald test and the number of observations. The main sample is used, thus the sample size is 16,838. Control variables in both stages include mothers' educational attainment, number of children, year of birth, country of residence, health status, the industry the mother worked in during childbirth of each child and the cash benefits she received during each maternity and parental leave as a percentage of female wages in manufacturing. Coefficients and variances are pooled according to Rubin's Rule. Standard errors are clustered at the mothers' level and given in parentheses.
Asterisk notation: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A. 7: The effect of individual maternal leave duration on pension income – main model and robustness checks

	Main Model	RC (I)	RC (II)	RC (III)	RC (IV)	RC (V)	
Second stage: Effect of ILD on pension income							ILD^2
ILD	-35.03	-46.74	-42.55	0.948	-0.00123	-35.00	-0.00014
	(37.06)	(36.72)	(36.36)	(35.92)	(0.033)	(71.85)	(25.75)
(Pooled) first-stage F-Statistic	28.1	*25.4*	*24.8*	17.5	28.1	15.7	20.6
(Pooled) first-stage Wald test	22.7	*20.7*	*20.4*	15.2	22.7	12.1	16.0
(Pooled) N of observations	16,838	*14,191*	*15,387*	10,266	16,838	16,838	

Notes: This table shows the estimated effects for the second stage of the 2SLS IV estimations (see Equation (3)) using the main model and the robustness checks (I), (II), (III), (IV), and (V) (see Section 3.3). The IV estimation estimates the effect of the explanatory variable individual leave duration (ILD) on annual pension income by using statutory maternity leave duration (SLD) as an instrument. ILD is a continuous variable measured in weeks and refers to mothers' reported maternal leave duration in weeks. SLD is the statutory length of the maximum available maternity leave that was in place at the child's year of birth and in the child's country of birth. Annual pension income is the imputed annual net pension income in euros. Control variables in all models include mothers' educational attainment, number of children, year of birth, country of residence, health status, the industry the mother worked in during childbirth of each child and the cash benefits she received during each maternity and parental leave as a percentage of female wages in manufacturing. All coefficients and variances are pooled according to Rubin's Rule. Further, first stage F-statistics and first-stage Wald tests as well as the number of observations are provided for all models. Some of them are *pooled* because the number of € 0 slightly differs across the five sets of imputations. Hence, the sample sizes and first-stage F statistics and Wald tests slightly differ for each set of imputations. They are pooled, i.e. the average across all five sets of imputations is taken. Standard errors are clustered at the mothers' level and given in parentheses.
Asterisk notation: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A. 8: The effect of individual maternal leave duration on pension income by pension income quartiles – main sample, split by pension income quartiles

	Pension income quartiles			
	Quartile 1 (lowest)	Quartile 2	Quartile 3	Quartile 4 (highest)
First stage: SLD and ILD				
SLD	0.415	0.456	0.765**	0.734**
	(0.252)	(0.300)	(0.231)	(0.283)
Second stage:				
Effect of ILD on pension income				
ILD	8.179	20.812	0.455	62.000
	(18.711)	(30.908)	(8.152)	(84.231)
(Pooled) first-stage F-Statistic	*3.5*	*3.2*	*13.9*	*8.6*
(Pooled) first-stage Wald test	*2.7*	*2.4*	*11.4*	*7.5*
(Pooled) mean of annual pension income	*1,290.6*	*10,008.5*	*16,101.5*	*30,939.0*
Observations	4,210	4,210	4,209	4,209

Notes: This table depicts results from the heterogeneity analysis by pension income quartiles using the main sample. It shows first and second stage results for the 2SLS IV estimation (see Equations (2) and (3)), where statutory maternity leave duration (SLD) provides the necessary instrument. SLD is measured in weeks and refers to the statutory length of the maximum available maternity leave that was in place at the child's year of birth and in the child's country of birth. SLD is used as an instrument for mothers' individual maternal leave duration (ILD). The variable ILD is a continuous variable that measures mothers' reported maternal leave duration in weeks. The outcome variable is imputed annual net pension income in euros split by quartiles. Control variables in all models include mothers' educational attainment, number of children, year of birth, country of residence, health status, the industry the mother worked in during childbirth of each child and the cash benefits she received during

each maternity and parental leave as a percentage of female wages in manufacturing. All coefficients and variances are pooled according to Rubin's Rule. Further, first stage F-statistics and first-stage Wald tests, the mean of annual pension income for all pension income quartiles as well as the number of observations are provided for all models. Some of them are *pooled* because the cut-off between pension income quartiles is slightly different for each of the five sets of imputations. Hence, the sample sizes and first-stage F statistics, Wald tests and the means slightly differ for each set of imputations. They are pooled, i.e. the average across all five sets of imputations is taken. The main sample is split by pension income quartiles; thus the complete sample size is 16,838. Coefficients and variances are pooled according to Rubin's Rule. Standard errors are clustered at the mothers' level and given in parentheses.
Asterisk notation: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A. 9: The effect of individual maternal leave duration on pension income by pension income quartiles – RC (I) sample, split by pension income quartiles

	Pension income quartiles - excluding € 0			
	Quartile 1 (lowest)	Quartile 2	Quartile 3	Quartile 4 (highest)
First stage: SLD and ILD				
SLD	0.337	0.509	0.926***	0.780**
	(0.343)	(0.289)	(0.254)	(0.308)
Second stage:				
Effect of ILD on pension income				
ILD	43.896	-11.504	-21.300**	37.816
	(79.770)	(12.866)	(9.099)	(82.702)
(Pooled) first-stage F-Statistic	*1.3*	*4.4*	*16.7*	*8.2*
(Pooled) first-stage Wald test	*1.2*	*3.5*	*14.0*	*7.1*
(Pooled) mean of annual pension income	*6,080.9*	*12,595.2*	*17,550.0*	*32,981.1*
Observations	3,548	3,548	3,548	3,547

Notes: This table depicts results from the heterogeneity analysis by pension income quartiles using the RC (I) sample, e.g. excluding all pension income values of € 0. It shows first and second stage results for the 2SLS IV estimation (see Equations (2) and (3)), where statutory maternity leave duration (SLD) provides the necessary instrument. SLD is measured in weeks and refers to the statutory length of the maximum available maternity leave that was in place at the child's year of birth and in the child's country of birth. SLD is used as an instrument for mothers' individual maternal leave duration (ILD). The variable ILD is a continuous variable that measures mothers' reported maternal leave duration in weeks. The outcome variable is imputed annual net pension income in euros split by quartiles. Control variables in all models include mothers' educational attainment, number of children, year of birth, country of residence, health status, the industry the mother worked in during

childbirth of each child and the cash benefits she received during each maternity and parental leave as a percentage of female wages in manufacturing. All coefficients and variances are pooled according to Rubin's Rule. Further, first stage F-statistics and first-stage Wald tests, the mean of annual pension income for all pension income quartiles as well as the number of observations are provided for all models. Some of them are *pooled* because the cut-off between pension income quartiles is slightly different for each of the five sets of imputations. Hence, the sample sizes and first-stage F statistics, Wald tests and the means slightly differ for each set of imputations. They are pooled, i.e. the average across all five sets of imputations is taken. The RC (I) sample is split by pension income quartiles; thus the complete sample size is 14,191. Coefficients and variances are pooled according to Rubin's Rule. Standard errors are clustered at the mothers' level and given in parentheses.
Asterisk notation: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A. 10: The effect of individual leave duration on pension income by educational attainment – main sample, split by education

	Educational attainment		
	Low education	Medium education	High education
First stage: SLD and ILD			
SLD	0.396*	0.604***	0.488**
	(0.239)	(0.228)	(0.215)
Second stage: **Effect of ILD on pension income**			
ILD	-126.277	-52.157	2.319
	(112.007)	(59.209)	(82.345)
First-stage F-Statistic	3.7	7.2	7.6
First-stage Wald test	2.8	7.0	5.2
Observations	5,886	5,705	5,247

Notes: This table depicts results from the heterogeneity analysis by educational attainment. It shows first and second stage results for the 2SLS IV estimation (see Equations (2) and (3)), where statutory maternity leave duration (SLD) provides the necessary instrument. SLD is measured in weeks and refers to the statutory length of the maximum available maternity leave that was in place at the child's year of birth and in the child's country of birth. SLD is used as an instrument for mothers' individual maternal leave duration (ILD). The variable ILD is a continuous variable that measures mothers' reported maternal leave duration in weeks. The outcome variable is imputed annual net pension income in euros. Control variables in all models include mothers' number of children, year of birth, country of residence, health status, the industry the mother worked in during childbirth of each child and the cash benefits she received during each maternity and parental leave as a percentage of female wages in manufacturing. All coefficients and variances are pooled according to Rubin's Rule. Further, first stage F-statistics and first-stage Wald tests, as well as the number of observations are provided for all models. The main sample is split by educational attainment; thus the complete sample size is 16,838. Coefficients and variances are pooled according to Rubin's Rule. Standard errors are clustered at the mothers' level and given in parentheses. Asterisk notation: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A. 11: The effect of individual leave duration on pension income by industry – main sample, split by industry: blue collar versus white collar jobs

	Type of industry during childbirth	
	Blue collar	White collar
First stage: SLD and ILD		
SLD	0.186	0.400**
	(0.193)	(0.178)
Second stage:		
Effect of ILD on pension income		
ILD	-51.429	-21.710
	(54.441)	(53.068)
First-stage F-Statistic	0.8	7.2
First-stage Wald test	0.8	5.0
Observations	4,727	9,567

Notes: This table depicts results from the heterogeneity analysis by mothers' type of industry during childbirth. It shows first and second stage results for the 2SLS IV estimation (see Equations (2) and (3)), where statutory maternity leave duration (SLD) provides the necessary instrument. SLD is measured in weeks and refers to the statutory length of the maximum available maternity leave that was in place at the child's year of birth and in the child's country of birth. SLD is used as an instrument for mothers' individual maternal leave duration (ILD). The variable ILD is a continuous variable that measures mothers' reported maternal leave duration in weeks. The outcome variable is imputed annual net pension income in euros. Control variables in all models include mothers' education, number of children, year of birth, country of residence, health status, the industry the mother worked in during childbirth of each child and the cash benefits she received during each maternity and parental leave as a percentage of female wages in manufacturing. All coefficients and variances are pooled according to Rubin's Rule. Further, first stage F-statistics and first-stage Wald tests, as well as the number of observations are provided for all models. The main sample is split by typical blue-collar and typical white-collar jobs. The complete sample size is 14,294 (some industries were excluded because they could not be classified as typical blue- or white-collar jobs). Coefficients and variances are pooled according to Rubin's Rule. Standard errors are clustered at the mothers' level and given in parentheses. Asterisk notation: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A. 12: The effect of individual leave duration on pension income by parity – main sample, split by parity

	Parity			
	1 child	2 children	3 children	4+ children
First stage: SLD and ILD				
SLD	0.134	0.602***	0.779***	0.531*
	(0.285)	(0.198)	(0.259)	(0.312)
Second stage: Effect of ILD on pension income				
ILD	-732.027	22.963	-6.973	-181.373
	(1,603.6)	(54.976)	(51.051)	(136.795)
First-stage F-Statistic	0.2	11.7	12.8	3.4
First-stage Wald test	0.2	9.3	9.0	2.9
Observations	2,152	7,378	4,708	2,600

Notes: This table depicts results from the heterogeneity analysis by parity. It shows first and second stage results for the 2SLS IV estimation (see Equations (2) and (3)), where statutory maternity leave duration (SLD) provides the necessary instrument. SLD is measured in weeks and refers to the statutory length of the maximum available maternity leave that was in place at the child's year of birth and in the child's country of birth. SLD is used as an instrument for mothers' individual maternal leave duration (ILD). The variable ILD is a continuous variable that measures mothers' reported maternal leave duration in weeks. The outcome variable is imputed annual net pension income in euros. Control variables in all models include mothers' education, year of birth, country of residence, health status, the industry the mother worked in during childbirth of each child and the cash benefits she received during each maternity and parental leave as a percentage of female wages in manufacturing. All coefficients and variances are pooled according to Rubin's Rule. Further, first stage F-statistics and first-stage Wald tests, as well as the number of observations are provided for all models. The main sample is split by parity; thus the complete sample size is 16,838. Coefficients and variances are pooled according to Rubin's Rule. Standard errors are clustered at the mothers' level and given in parentheses. Asterisk notation: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A. 13: The effect of individual leave duration on pension income by birth cohort of mother – main sample, split by birth cohorts

	Birth cohort of the mother	
	Cohort < 1955	Cohort >= 1955
First stage: SLD and ILD		
SLD	0.575***	0.402
	(0.133)	(0.553)
Second stage:		
Effect of ILD on pension income		
ILD	-48.082	-64.944
	(40.590)	(222.259)
First-stage F-Statistic	22.3	0.6
First-stage Wald test	18.7	0.5
Observations	14,392	2,446

Notes: This table depicts results from the heterogeneity analysis by mothers' birth cohort. It shows first and second stage results for the 2SLS IV estimation (see Equations (2) and (3)), where statutory maternity leave duration (SLD) provides the necessary instrument. SLD is measured in weeks and refers to the statutory length of the maximum available maternity leave that was in place at the child's year of birth and in the child's country of birth. SLD is used as an instrument for mothers' individual maternal leave duration (ILD). The variable ILD is a continuous variable that measures mothers' reported maternal leave duration in weeks. The outcome variable is imputed annual net pension income in euros. Control variables in all models include mothers' education, number of children, year of birth, country of residence, health status, the industry the mother worked in during childbirth of each child and the cash benefits she received during each maternity and parental leave as a percentage of female wages in manufacturing. All coefficients and variances are pooled according to Rubin's Rule. Further, first stage F-statistics and first-stage Wald tests, as well as the number of observations are provided for all models. The main sample is split by cohorts born before 1955 and cohorts born onwards. The complete sample size is 16,838. Coefficients and variances are pooled according to Rubin's Rule. Standard errors are clustered at the mothers' level and given in parentheses. Asterisk notation: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A. 14: The effect of individual leave duration on pension income by degree of redistribution – main sample, split by countries according to pension system typology

	Highly earnings-related, low redistribution	Moderately earnings-related, moderate redistribution	Earnings-unrelated, highly redistributive
First stage: SLD and ILD			
SLD	0.154	0.467**	0.107
	(0.461)	(0.147)	(0.793)
Second stage:			
Effect of ILD on pension income			
ILD	717.261	5.627	-907.515
	(2,175.17)	(51.630)	(6,876.11)
First-stage F-Statistic	1.1	10.8	0.018
First-stage Wald test	0.7	10.1	0.012
Observations	3,280	11,907	1,651

Notes: This table depicts results from the heterogeneity analysis by pension systems. It shows first and second stage results for the 2SLS IV estimation (see Equations (2) and (3)), where statutory maternity leave duration (SLD) provides the necessary instrument. SLD is measured in weeks and refers to the statutory length of the maximum available maternity leave that was in place at the child's year of birth and in the child's country of birth. SLD is used as an instrument for mothers' individual maternal leave duration (ILD). The variable ILD is a continuous variable that measures mothers' reported maternal leave duration in weeks. The outcome variable is imputed annual net pension income in euros. Control variables in all models include mothers' education, number of children, year of birth, country of residence, health status, the industry the mother worked in during childbirth of each child and the cash benefits she received during each maternity and parental leave as a percentage of female wages in manufacturing. All coefficients and variances are pooled according to Rubin's Rule. Further, first stage F-statistics and first-stage Wald tests, as well as the number of observations are provided for all models. The main sample is split by pension systems based on the categorization in Section 2.1.2. The complete sample size is 16,838. Coefficients and variances are pooled according to Rubin's Rule. Standard errors are clustered at the mothers' level and given in parentheses. Asterisk notation: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.