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The Pension Gap in the European Union

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Abstrakt

Diese Arbeit untersucht die geschlechtsspezifische Rentenlücke in zehn europäischen Ländern und konzentriert sich dabei auf den Zusammenhang zwischen Lebenszyklusfaktoren, institutionellen Strukturen und den Unterschieden im Ruhestandseinkommen von Männern und Frauen. Anhand von retrospektiven Mikrodaten aus SHARELIFE Wave 3 analysiere ich, wie sich bestimmte Faktoren (z. B. Bildung, Anzahl der Kinder, Familienstand, Teilzeitarbeit und Beschäftigungsbranche) auf die Rentenhöhe von Männern und Frauen auswirken. Die empirische Analyse basiert auf Regressionsmodellen mit länderspezifischen Effekten und einer dreiteiligen Oaxaca-Blinder-Zerlegung, mit der sich die Ausstattungseffekte, Koeffizienteneffekte und deren Interaktion bei der Erklärung der geschlechtsspezifischen Rentenlücke bestimmen lassen.

Die Ergebnisse zeigen, dass Teilzeitarbeit und Familienstand besonders starke Einflussfaktoren für ein geringeres Renteneinkommen bei Frauen sind, während Bildung für Frauen trotz gleicher oder höherer Bildungsabschlüsse im Vergleich zu Männern nur begrenzte Erträge bringt. Die Zerlegungsanalyse bestätigt zudem, dass Frauen am Ende ihrer Erwerbslaufbahn weniger Renteneinkommen ansammeln und gleichzeitig geringere institutionelle Erträge für dieselben Merkmale erhalten – insbesondere, wenn sie in männerdominierten oder niedrig entlohnten Branchen tätig sind. Die Unterschiede zwischen den Ländern verdeutlichen die Rolle der nationalen Rentenpolitik und Arbeitsmarktinstitutionen, die diese Ungleichheiten entweder verstärken oder abmildern können – oft mit Nachteilen für Frauen.

Die Ergebnisse zeigen, dass Rentenreformen notwendig sind, die geschlechtsspezifische Lebensverläufe stärker berücksichtigen und Männern und Frauen gleiche Chancen beim Zugang zum Arbeitsmarkt und zu Rentenansprüchen ermöglichen.

Abstract

This thesis explores the gender pension gap across ten European countries, focusing on how life-cycle factors and institutional structures relate to differences in retirement income for men and women. Using retrospective micro-data from SHARELIFE Wave 3, I examine how specific factors (e.g. education, number of children, marital status, part-time work, and industry of employment) affect pension outcomes for men and women. The empirical strategy employs country-fixed effects regression models using a three-part Oaxaca–Blinder decomposition to understand the total, compositional (endowment) and structural (coefficient) sources of the gender pension gap.

The findings indicate that part-time work and marital status are particularly strong predictors of reduced pension income for women, whereas education yields small returns for women despite showing equal or higher levels of attainment compared to men. The decomposition analysis further confirmed that women accumulate lower pension income at the end of their careers but also receive lower institutional rewards for these same characteristics, especially if they work in male-dominated or low-paid occupations. Differences between countries highlight the importance of the country-level pension policies and labour market institutions that act to allow or limit these differences-more or less punitive for women. The results indicate the need for pension reforms that more fully accommodate gendered life-course trajectories, allowing men and women to have equal access to labour market participation and pension entitlements.

Acknowledgments

The process of writing this thesis was both difficult and enlightening. I would like to express my gratitude to Professor Christine Zulehner, my supervisor, for her guidance and insightful feedback.

This thesis is dedicated to all women who are subjected to systematic injustices every day, and who make selfless sacrifices for their families that are often overlooked. I dedicate this thesis to my mother and sister, from whom I draw strength and resilience, as well as to my late father, your persevering spirit constantly inspires me.

Lastly, I would like to especially thank my friends, my chosen family, for your encouragement and support during this endeavour. Without you, I would not be able to say I have accomplished this, thank you.

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1.Introduction

Pension incomes, account for a substantial share of monetary assets in old age. Moreover, they are a crucial element of financial independence of older people. The poverty or social exclusion rates of the older population have been climbing slowly since 2015 and the absolute population of older people who are at risk of poverty or social exclusion has also been growing, despite that the overall percentage may be stable. Although the old-age AROPE rate (at-risk-of-poverty or social exclusion indicator) fell from 2008 to 2015, the AROPE rates increased (except in 2021) from 2015 to 2022 The risk of poverty or social exclusion among older people has again increased in the EU-27 since 2015. In 2022, the risk affected 22.9 % of women and 16.7 % of men, which corresponds to about 18.5 million people aged 65+,and is increasing from 14.8 million in 2015 (European Commission et al., 2024). This increase reflected both the increasing number of people of pensionable age from 84.5 million in 2015 to 94.3 million in 2022, as well as the increased poverty rates. Besides that, the increasing life expectancies press an additional financial burden on governments to ensure adequate and fair pension systems that protect individuals against poverty and sufficiently replace prior incomes from employment and meet both conditions (European Commission et al., 2024).

The poverty risk is even more alarming for women as they are the main recipients of minimum income benefits. In most countries, the disparity is staggering. For instance,38% of women in Bulgaria receive minimum income benefits while the figure stands at 8.3% for men. This is also the case for many countries in the EU including Malta, Austria, Sweden and Luxembourg (European Commission et al., 2024).

Despite the considerable research that has been conducted on the gender pension gap lately, the implementation of mitigating measures in labour and employment policies are still set back. This is particularly important as most pension incomes in the European Union are based on PAYG (Pay as You Go) systems in which contributions from employment are used to fund pension incomes. Hence, gender

differences in the labour market and income are reflected on pension outcomes. Therefore, understanding the reasons behind variations in employment histories and the factors contributing to it, is essential in formulating effective policies and appropriate intervention. (European Commission et al., 2024).

In this thesis, I aim to study the motherhood penalty in ten countries in the European Union and the potential factors that might contribute to it. In my analysis, I focus on the marital status of individuals, the number of children they have, the number of education years they have attained and their employment history translated into their job industry and the share of part-time work throughout their careers.Through an empirical analysis, my goal is to comprehend the interplay of individual life course trajectories and institutional determinants that drive pension disparities among individuals .Given that, I intend to answer the following research question:

To what extent do country-level differences and individual-level factors (Education, part-time work, family size, job industry) explain the gender pension gap among retirees in the EU?

To answer the question, I used the Survey of Health, Ageing and Retirement in Europe (SHARELIFE, Wave 3) for individuals aged 50 and older in 2008/2009.In line with these objectives I employed fixed country-effects regression models and an Oaxaca Decomposition model approach to apprehend the repercussions of the investigated variables.

2. Pension Systems in the EU:

Pension systems in the European Union vary widely across several dimensions including the length of statutory social insurance, level of contributions, funding sources, the range of entitled beneficiaries and the level of benefits. In many pension systems, there are publicly and privately financed schemes that are categorized in three pillars. The first consists of public statutory pensions (mandatory), the second consists of occupational pensions (quasi-statutory, earnings-related) and third is an example of supplementary personal pensions (voluntary, earnings-related). Most systems also have a minimum guaranteed pension for people who are not in an earnings-related scheme or have limited accrued pension rights. In the European Union, the state has dominant power over pension provision and can stipulate minimum and maximum pensions.

Public pension systems can be divided according to a wide range of criteria. In terms of funding source, there can be contributory (earnings-related) or non-contributory (tax-sourced or other sources). In some countries, public pensions can have an earnings-related component, while in others, they consist of flat level pensions (which can be supplemented by occupational schemes). The formula used to derive the concrete pension benefits varies by country. The formula normally combines some merit (i.e., years worked, contributions made to the system) with the revenue level enjoyed with a basic pension component (equal for all individuals). Publicly provided, earnings-related pensions schemes can be broadly classified into three arrangements. Depending on the basis on which the pension benefit is determined, they can be defined-benefit, defined-contribution, on a notional defined contribution, or on a points systems basis (European Parliamentary Research Service, 2023):

1. Defined-benefit (DB): A constant accrual rate paid for each completed year of service. Earnings related benefits are based on lifetime average revalued earnings.

2. Notional defined contribution (NDC): Wages multiplied by the contribution rate represents the annual inflow to notional accounts. The national interest rate raises the notional capital annually. The total notional capital is divided by the notional annuity factor at retirement
3. Points systems (PS): Contributions collected throughout individuals' careers are converted to points and are accumulated in notional accounts. The pension benefit would depend on the value of a point as determined upon retirement (European Parliamentary Research Service, 2023).

Table 1:Main types of publicly provided pension schemes in the EU (Adapted from The 2021 Ageing Report, European Commission, 2021)

Pension-scheme type	Countries
Defined Benefit (DB)	Austria, Belgium, Bulgaria, Czechia, Finland, Hungary, Luxembourg, Portugal, Slovenia, Spain
Notional defined contribution (NDC)	Italy, Latvia, Poland, Sweden
Point systems (PS)	Croatia, Cyprus, Estonia, Germany, Lithuania, Romania, Slovakia
Flat rate + DB	Denmark, Ireland, Malta, The Netherlands
Other combination	Greece: Flat rate + DB + NDC (auxiliary mandatory pension scheme) France: DB + PS (complementary schemes AGIRC and ARRCO)

Source: The 2021 Ageing Report, European Commission, 2021

The classification system for pensions employed comprises two obligatory "tiers". The first tier entails retirement income irrespective of the individual's previous earnings level. This scheme aims to ensure a minimum standard of living during retirement, while the second-tier addresses components related to earnings to smooth out consumption, and consequently, the standards of living between working life and retirement. The third tier consists of voluntary provision, whether it is personal or employer-provided (OECD, 2023).

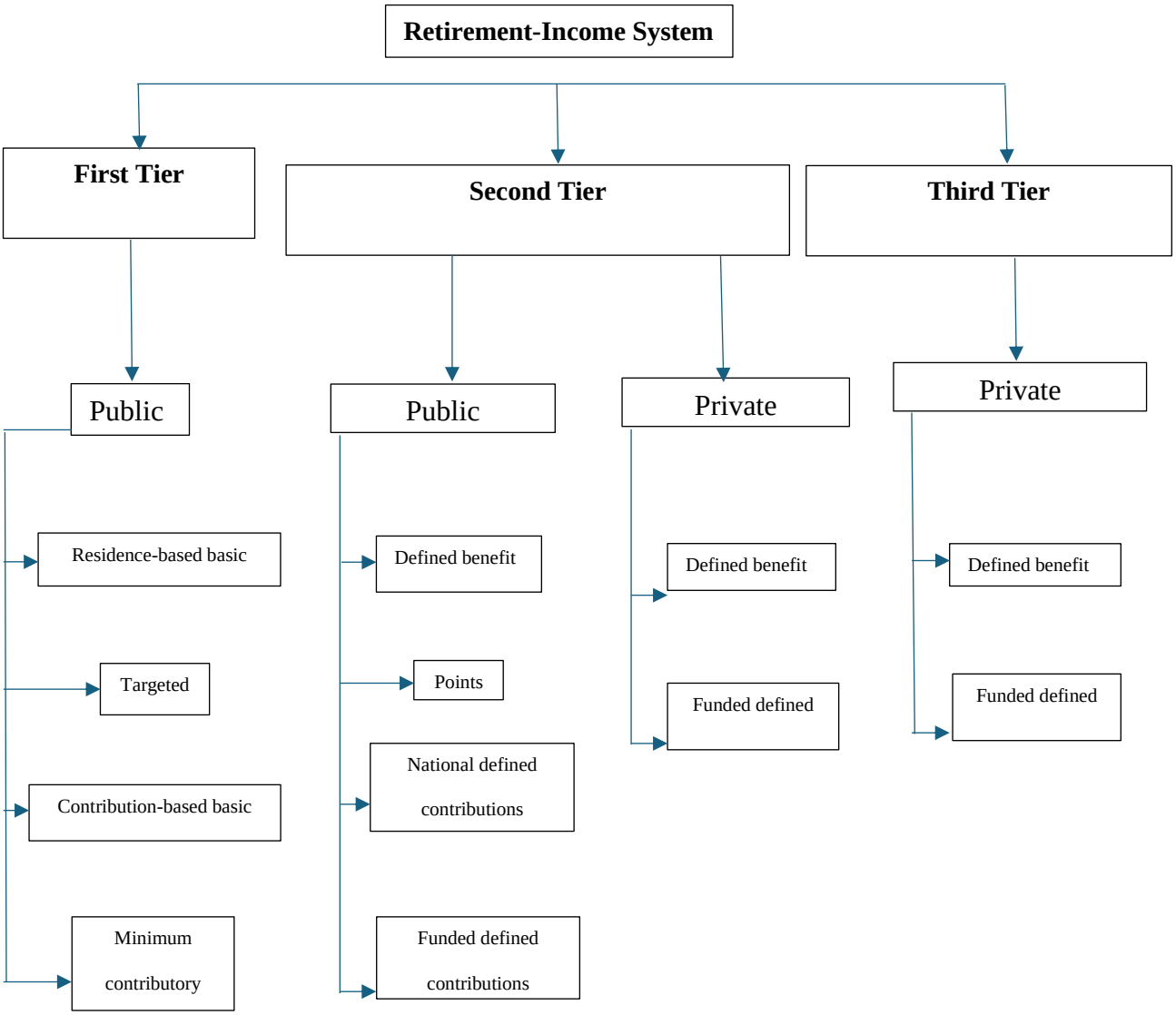

Figure 1:Taxonomy: Different types of retirement-income provision. Adapted from *Pensions at a Glance, OECD and G20 Indicators 2023*

Source: Pensions at a Glance, OECD and G20 Indicators 2023

3.The Gender Pension Gap

The gender pension gap is the percentage difference between the average pension income of men and women (age 65+). In formal terms, it can be represented as a percentage of the mean male pension less the mean female pension, divided by the male mean (OECD, 2021, Chapter 1.1),

$$\Delta PG = \frac{\overline{PI^M} - \overline{PI^F}}{\overline{PI^M}} \times 100$$

Where ΔPG denotes the gender pension gap, $\overline{PI^M}$ denotes the average male pension and $\overline{PI^F}$ denotes the average female pension.

A predominant factor that is greatly reflected in pension disparities is the differences in lifelong earnings between women and men throughout their employment. The gap is not only observed in the wages of individuals, but also in the number of hours worked by women and men. Numerous literatures have highlighted that women tend to choose more flexible and marginal jobs that are often part-time roles that align with their caregiving and family obligations. These restrictions result in reduced accumulated earnings of women.

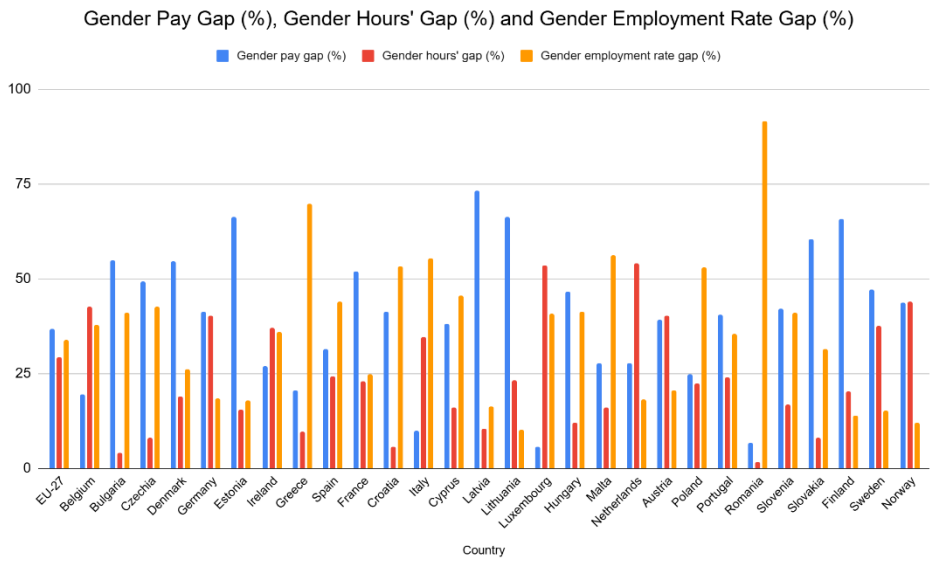

Figure 2: Overview of the Labour Gender Gaps in the EU (Adapted from European Commission et al., 2024).)

Source: European Commission et al., 2024

This graph depicts how the issue of gender inequality manifests in different European countries by measuring three gender inequality indicators: the gender pay gap, the gender gap in hours worked, and the gender gap in the employment rate. On average across the EU-27, women earn 36.7% less, work 29.3% fewer hours, and are less employed than men (at the rate of 34%). From this data, some of the largest pay gaps can be observed. The pay gaps for Latvia (73.2%), Lithuania (66.4%), and Estonia (66.4%) are among the largest pay gaps, alongside no pay gaps for any hours or employment, implying that women are working similar amounts of hours as men, but making significantly less money. By contrast, in Romania, which has one of the lowest pay gaps (6.7%), small hours' gap (1.7%), but an exceptionally large employment rate gap (91.6%); which reflects that not many women are economically active. For women who are active, conditions seem more equal. While countries like the Netherlands (54.1%), and Luxembourg (53.6%) have the largest gaps for working hours to females, and fewer men because the majority of those women work engaged in part-time work. Germany (40.2%), and Austria (40.3%) have similar trends. These trends are often related to child caring responsibilities or lack of full-time support for mothers (from European Commission et al., 2024).

Meanwhile, Nordic countries like Sweden (47.2% pay gap, 37.5% hours gap), and Norway (43.8% pay gap, 43.9%) generally show better performance in the employment gap and working hours but have not managed to close the pay gap either. In summary, the chart points to a clear conclusion: addressing the gender pay gap alone is insufficient. Equality requires a more holistic approach that includes improving access to full-time work and reducing barriers in gendered employment activity.

To moderate the effects of career breaks related to childcare, almost all Member States provide pension breaks that are restricted to the age of the child and eligibility to childcare benefits.

Table 2: Career Break Credits – Childcare and Unemployment (Adapted from European Commission et al., 2024)

Reason for break	Formula	Countries
Childcare	Credited if allowance granted	BE, EE, IE, EL, FR, IT, LV, LT, LU[1], HU, MT, PT, RO, SE, FI
Childcare	Credited	DK[2], NL[3]
Childcare	Credited up to maximum age	(6 months) HR; (1 yr) SI; (1.5 yrs) LV; (3 yrs) BG, DE, ES, CY; (4 yrs) CZ, NO, AT; (6 yrs) SK[4]
Childcare	Credited up to maximum time	PL (12 months)
Childcare	Not credited	None

"Notes: (1) Maximum two years while child is aged six or under. During a childcare break in LU: (a) replacement income (maternity leave, paid parental leave, etc.) is subject to pension contributions; (b) pension contributions for up to two years may be granted without paid allowance (baby years); and (c) credited non-contributory periods up to age 6 may be granted. (2) Residence-based pensions; career breaks treated the same as other residence periods. (3) Residence-based pensions. (4) Extended to 18 years in the case of child disability."
Source: European Commission et al., 2024

Besides that, the marital status of women is an important determinant of pensions. Being a widow acts as a safety net for women as they have higher life expectancies than men and are most likely to be in marriages where age differences exist. Therefore, they benefit from survivor pensions. In most countries, the widow is entitled to the acquired pension of her partner, which can sometimes be added to her own pension. This structure sustains the financial adequacy of women since it may no longer be possible to compensate for the loss of their partner's income through employment.

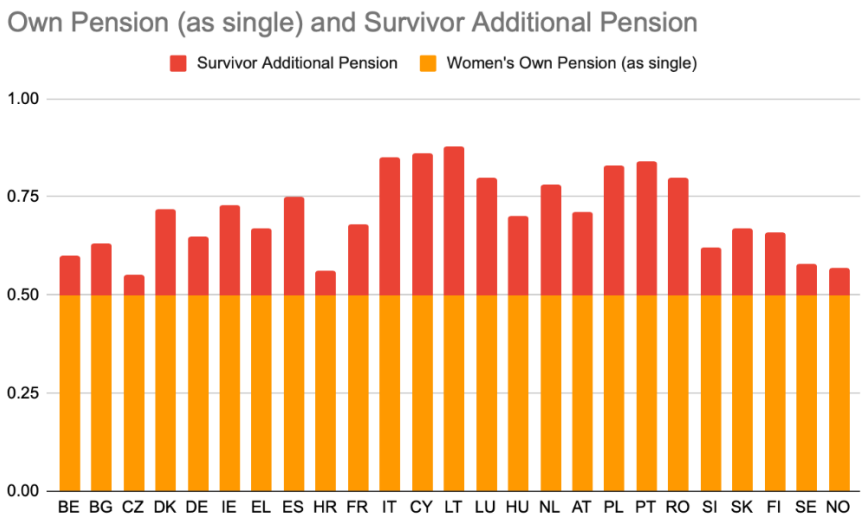

Figure 3: Survivor Ratio: Widow's Pension Comparison (Adapted from European Commission et al., 2024).

Source: 2024 Pension Adequacy Report: Current and future income adequacy in old age in the EU

Lastly, women's educational attainment has improved substantially over the past few decades. In the European Union and Norway, it is clear that the educational attainment of young women now compares favourably with that of young men. In 2022, women (55-64) had less educational attainment possibly than men (55-64) in the EU. Therefore, the educational attainment of young women has only become this high only recently. In fact, the widening of the impact on the gender pension gap provides not only a clear educational difference for women across generations but also relative homogeneity for men.

The gender pay gap appears to operate early on in one's career, despite the educational attainment of young women that is comparable with young men. This is related to the financial costs of career breaks for childcare and gender-specific differences in sectors. Despite observing small improvements, there remains a significant gap (European Commission et al., 2024).

4.Literature Review

Several factors ranging from individual characteristics and circumstances to institutional and pension design systems interplay to determine the pension income of individuals. For instance, employment history is a powerful predictor of pension income, with each additional year of regular work leading to a higher retirement income as contributions accumulate. Similarly, non-standard work patterns (part-time work, self-employment,marginal jobs) results in lower incomes and lower pension entitlement. This is important when we consider that women engage in non-standard work opportunities almost exclusively to balance caregiving responsibilities to children or elderly family members, leading to fewer pension credits. A variety of institutional design aspects exacerbate the situation; while men's pension income remains broadly stable across different pension system characteristics, women's retirement income is much more responsive to the ways pension systems credit years and reward different work patterns (Möhring, 2014).

Marital Status and Spousal Buffers

The strongest predictor of poverty risk for women is their current marital status: Belgian women aged 65–71 who are single or divorced had an incidence of poverty of 16–25 percent, while widows and those who were remarried were essentially risk-free (Peeters & De Tavernier, 2015). The crediting of unemployment and maternity leave to further reduce the poverty risk. However, only women with partners are primarily eligible to receive these benefits (Peeters & De Tavernier, 2015). Given the lack of comprehensive data on private transfers, wealth holdings, or education, the authors were unable to separate the question of whether childbearing creates disruptions in the labour market or is merely a result of pre-existing disruptions. They conclude that married women's low poverty outcomes are probably due to their joint asset accumulation with their partners, particularly housing (Peeters & De Tavernier, 2015).

On the other hand, marital duration, creates a pension penalty; every additional year of being married decreased German women's pension income by approximately €15 compared to €5 in Britain. Germany’s conservative-corporatist regime has its costs reflected in longer marriages. Marriage length

directly correlates with the length of time employed in multiple forms of part-time public-sector work as they yield at least €11 of extra entitlement for public-sector work. Additionally, if we look at Britain, fragmented private sector plans drive down pension income for each year of part-time service worked to around €3 (Fasang et al, 2012).A similar limitation is however observed in both studies; that only one partner is considered and that complex policy bundles are uniform across are assumed across both genders, which leaves us without clarity as to what factors are responsible for the observed marital effects.

Educational Attainment:

Women in China receive an average pension of ¥411 per month, which represents less than half of men's ¥833. It is estimated that there is a 6.3 percentage points less likelihood of women's participation in public schemes. Lower levels of education account for 41.7 percent of this coverage gap, under-representation in state owned firms accounts for 53.1 percent, and even for women covered, 6.8 percent of the benefits shortfall is accounted for by education level.However, the CHARLS data utilized does not collect or under-represents private occupational pensions, wealth parameters, informal transfers and can only retrospectively report individual characteristics/tasks and anecdotal accounts. Therefore, the overall design may under report informal or rural activities.(Zhao & Zhao, 2018).

In terms of education's apparent influence on the actual labour-market, Möhring (2018) shows that if we control for actual participation in the labour-market, or total years employed or mean ISEI, education does not predict retirement income in thirteen European nations. (Möhring, 2018).

Motherhood and Accumulating Occupational-Status Losses

Motherhood comes with both immediate losses and changes in occupational status with cumulative disadvantages as a mother. Each first child is correlated with a drop of 0.39 ISEI points and subsequently a drop of 0.12 ISEI points per child year, such that mothers capture slightly under half the occupational status compared to their childless peers (Abendroth, Huffman, & Treas, 2014). Each child incurs a motherhood wage penalty between 9–18 percent associated with the mother's shift to either a lower-

prestige job or part-time position; both of these work status changes explained the motherhood wage penalty in the UK and US (Gangl & Ziefle, 2009).

Goldin (2014) argues that while much of the evidence of barriers to women's engagement in the labour market in terms of access to schooling, legal restrictions on labour etc. has been eliminated or greatly diminished, there still remains a residual gender earnings gap in sectors that still reward long, inflexible hours. This workplace structure penalises workers, specifically women, who need flexible hours to accommodate their family responsibilities, and thus contributes to the unequal distribution of pension. The pension gap discussed in this paper is a consequence of the accumulation of these mid-career penalties for women. In addition to clustering in lower-paid and caregiving-oriented sectors of the economy, it is noted that women earn weaker returns to their investments on education and labour market experience with respect to pensions. Consequentially, the gender pension gap is the retirement-age outcome of what Goldin calls the "last chapter of convergence" between the genders Goldin (2014).

The empirical analysis in this thesis is carried out in two related ways. First, I estimate gender-specific regressions and pooled fixed-effects regressions to estimate how the explanatory variables of education, marital status, number of children, part-time work and industry are related to the pension income of each gender. I then pool the fixed-effects models with country-by-gender interaction terms to examine how institutional context affects the relationship between gender, and the explanatory variables, and how this relationship varies among different welfare states. In the second part of the analysis, I apply Oaxaca–Blinder three-fold decompositions, using alternative versions of the models with country, industry, and marital status dummy variables. This decomposed approach produces estimates of the extent to which characteristics (endowments), differences in returns to these characteristics (coefficients), and the effects when endowments and coefficients are treated together by country (counterfactual). Importantly, these regression and decomposition procedures provide estimates of the determinants of pension income and a structural explanation regarding how the unequal valuation of life-course pathways creates systemic disadvantage for women.

5.Hypotheses

Overview of proposed hypotheses:

H1 *Differences in education years may contribute to the gender pension gap.*

H2 *Differences in the number of the children may contribute to the gender pension gap.*

H3 *Differences in job industry may contribute to the gender pension gap.*

H4 *Differences in part-time share may contribute to the gender pension gap.*

H5 *Marital status may contribute to the gender pension gap.*

H6 *The design of pension systems contributes to the gender pension gap*

6.Data Description

6.1Data Description

SHARELIFE represents the third phase of data collection for SHARE, with a focus on individuals' life histories. The survey was conducted across 13 European countries, with a total of almost 30,000 male and female participants. The respondents are representative of the European population aged 50 and over in Scandinavia (Denmark and Sweden), Central Europe (Austria, France, Germany, Switzerland, Belgium, and the Netherlands), and the Mediterranean (Spain, Italy, and Greece), as well as two other countries (the Czech Republic and Poland).

SHARELIFE establishes a linkage between individual micro data and institutional macro data on the welfare state, extending over the entire life course of the respondents. This approach enables a comprehensive evaluation of the impact of welfare state interventions on the quality of life of the individual.

The SHARELIFE questionnaire encompasses all domains of the respondents' lives, including their partners and children, housing, employment history, and detailed inquiries into their health and healthcare. It is evident that, due to the variety inherent in this dataset, SHARELIFE constitutes an ideal

interdisciplinary resource for research in a range of fields, including sociology, economics, gerontology, and demography.

The data collection for SHARELIFE took place between autumn 2008 and summer 2009. The SHARELIFE data can be linked to the existing data of the Survey of Health, Ageing and Retirement in Europe (SHARE).

6.2 Variable Description

To obtain the variables in question, I merged the following modules to create an extensive dataset that provides an informative overview of the individuals' life histories:

Table 3: Data Sources

Module	Content of Questionnaire Modules
CVR (Wave 3)	Coverscreen on individual level
DN (Wave 2)	Demographics and Networks
RE (Wave 3)	Retrospective Employment
RC (Wave 3)	Retrospective Children History

Initially, I started with a sample of 25,299 individuals and 1330 variables that I further filtered and sorted to eventually end up with my final dataset that I worked with. I explain below how I obtained each variable:

a. Gender:

I took gender from the CVR module where females are coded as '2' and males as '1'.

b. Part-time Share variable:

I derived each person's share of part-time jobs by using the merged dataset that includes the total number of jobs for each individual has held throughout their career (sl_re046_) and whether these jobs were full-time or part -time (for each of up to 20 consecutive jobs, indicated by sl_re016_1 to sl_re016_20).

Next, I determine how many of these positions were part-time jobs by looping through sl_re016.I include all jobs that were:

(i) Always part-time

(ii) Changed once from full-time to part-time

(iii) Changed multiple times

I excluded the values related to permanent full-time jobs or jobs that changed from part-time to full-time. By summing these ratios, I obtained the number of part-time jobs. I finalize the calculation by calculating the part-time share through the following equation:

$$Part-time\ Share\ = \frac{Part-time\ Jobs\ Number}{Total\ Jobs\ Number}$$

c. The Number of Children variable:

Here, I simply created a column for the total number of children for each individual by counting the number of their named biological children (indicated by 'sl_childid_biological') and adding to it 'other children' indicated in a separate column (sl_rc022_).

d. Total Pension:

To calculate the total pension received by individuals I took the first pension received at retirement (indicated by re_036_) and converted all individuals' entries with negative values to NA values as these are ''Refuse to answer'' or ''I do not know'' responses. Next, I filtered out rows where values remain missing. This ensures that every observation in my sample has a value. As the new total pension column values were right-skewed and has very extreme values, I calculated the 25^{th} and 75^{th} percentile (Q1 and Q3) and computed the IQR.

$$IQR = Q3 - Q1$$

I then determined any observation that was below 1.5×IQR below Q1 or 1.5×IQR above Q3. Rather than removing or filtering out these outlier observations completely, I replaced each extreme value of the total pension column with the overall median of the distribution. By doing this I was able to retain the same sample size while minimizing the influence of extreme pensions. Following the median-

adjusted pension, I next aimed to achieve normality and stabilize the variance for the conducting a regression analysis by transforming the median-adjusted pension to logarithmic form.

e. Education Years:

I used the education years variable (dn041_) included in the Demographics and Network module.

f. Marital Status:

When extracting the marital status for each respondent. I used the variable “sl_rp009_1” (living with a partner or not). In case of the response in sl_rp009_1 being 1, the individual is to be labelled 'Living with Partner' and being 5 as no longer cohabiting.

g. Job Industry:

The dataset includes all industries reported by respondents across up to twenty positions (sl_re014_1 through sl_re014_20). I identified the mode for these industries. Hence, the variable industry represents the most often reported industry for that respondent.

6.3 Sample Description

After obtaining the required variables, I applied age filters to only include respondents that are 50 years and older. Besides that, I excluded countries where the sample size is small. The final dataset comprises 5768 respondents.

Table 4: Data and Country Representation

Country	Male Count	Female Count
Austria	155	134
Germany	351	228
Sweden	280	270
Italy	491	215
France	378	313
Denmark	259	254
Switzerland	175	96
Belgium	503	272
Czech Republic	299	515
Poland	263	317
Total	**3154**	**2614**

6.4 Descriptive Statistics

Across European states, lies a persistent pattern: men retire with a greater average amount of pension wealth than women, however, the actual values and amount of the gender gap differ across countries. In Denmark and Sweden, both men and women experience the highest average pensions, though there is still a full one-point difference in log-pension in these countries. The Czech Republic and Germany are in the middle: men have approximately 8.5 log-points of pension compared to about 8.1 log-points for women in the Czech Republic, while the amounts are about 7.5 log-points versus 6.9 log-points respectively in Germany. By contrast, Poland is notable for the smallest gap approximately 0.3 log-points albeit from the lowest pension amount starting from just over seven log-points for men and less

than 6.8 for women. Italy, France, Switzerland, Belgium, and Austria are all within the gap range of about 0.3-0.6 log-points.

Figure 4: Average Pensions Received by Country

The age-distribution curves show that, on average, women in the pension sample are slightly younger than men; the peak density for women (orange line) is 66-68 years old, while the peak for men (red line) is 69-71 years old. The orange curve continuously stands above the red, and women are slightly over-represented between the ages of 60 and 75. However, the density of women decreases more dramatically after the age of seventy-five, whereas men continue to occupy the oldest brackets into their 80s and 90s.

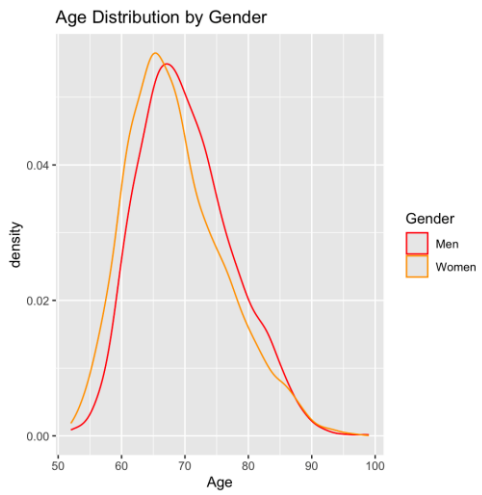

Figure 5: Age Distribution by Gender

The distributions of education for men and women are similar, each showing two strong peaks: one near 8-10 years of schooling (lower-secondary or vocational completion) and another at 12-14 years (upper-secondary or initial tertiary qualifications). Women's density (orange) is slightly higher in that middle range, indicating that there is slightly higher density of female pensioners with mid-range formal education, while men (red) have a slightly thicker tail past 15 years, representing a few more men with advanced degrees from university education. At the other end (0-5 years), men also slightly edge women, representing a small group of people with little or no formal schooling. It can be ascertained that the female distribution is a bit more compressed. That is, there are fewer women at both extremes, and a stronger peak in the middle, while men's distribution extends further into both remarkably high and exceptionally low formal education levels. Overall, the distributions tell us that, in this cohort of pensioners, women are at least as well-educated as men in total, particularly at the secondary-to-early tertiary change points, despite there being a higher representation of men at the highest and lowest ends of formal education.

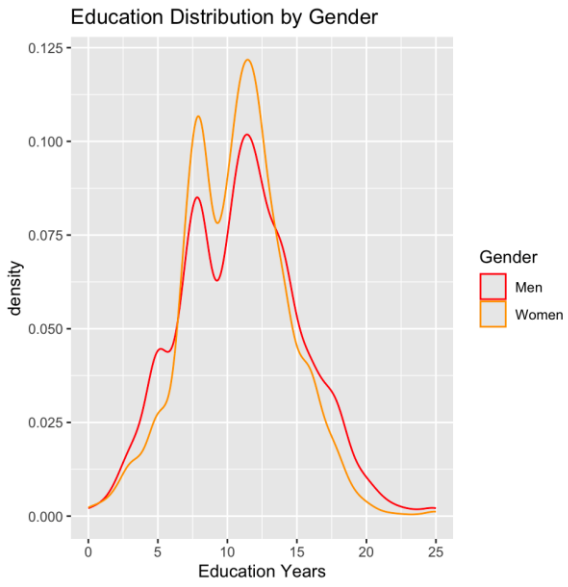

Figure 6: Education Distribution by Gender

The graph shows a strong presence of men compared to a limited number of women in industries typically dominated by men like manufacturing, construction, mining and quarrying, electricity and gas and water Supply. Conversely, fields such as women predominantly occupy health and social work and education, with over 300 females working in health-related roles and nearly 200 in education, a figure far more than that of their male counterparts. Wholesale and retail trade, hotels and restaurants, and transport and communication demonstrate a more balanced distribution of gender representation. However, a slight advantage is observed for females within the retail and hospitality sectors. In the fields of public administration and defense and financial intermediation, while the male population continues to outnumber their female counterparts, the gender disparity is marginal.

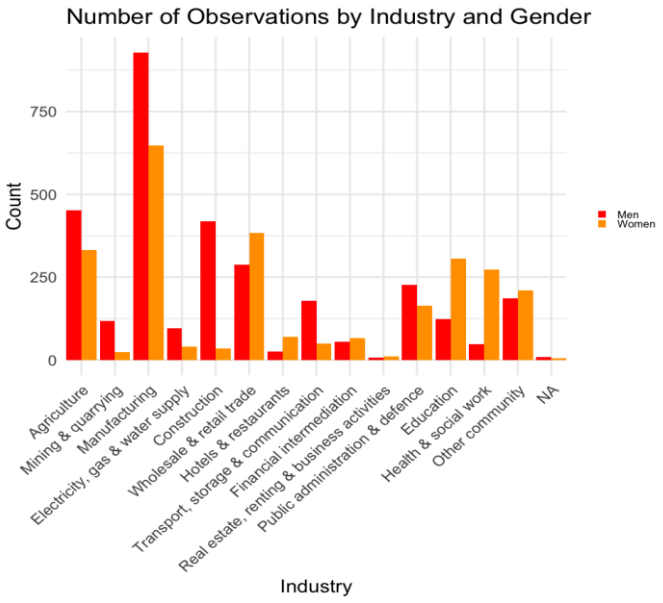

Figure 7: Number of Observations by Industry and Gender

The dot-plot depicting the average log pension by industry clearly illustrates the difference that the gender gaps vary across sectors. In most of the sectors from agriculture & forestry through manufacturing to hotels and restaurants men (red dots) have higher mean pensions than women (orange dots) with the widest gap in mining & quarrying, manufacturing, and construction where men have log-pensions of approximately 0.15-0.20 points above their female counterparts (between 16%-22% in levels). The gaps narrow in financial intermediation and real estate and business activities but are still

in favor of men. Women slightly out-earn men within health and social work and education sectors. In public administration and defense and transport, storage and communication sectors, the dots are on top of each other suggesting significant parity. Overall, this industry-level picture shows that whilst a male pension premium persists in male-dominated sectors, women are in a stronger position in the health and social work and education sectors, working towards bridging gender differences in relation to the pension.

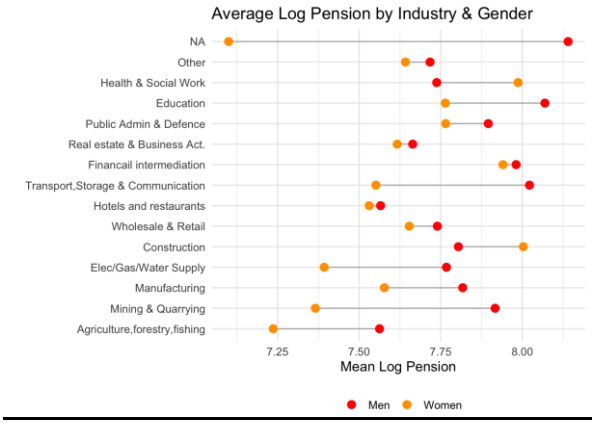

Figure 8: Average Log Pension by Industry & Gender

The education-by-gender pension diagram reveals two patterns. First, as educational attainment increases moving from low through medium to high, the average pensions for men and women increase steadily at the low education level, men's mean log pension (≈7.25) is above women's (≈7.15), indicating a 10% or higher pensions for less-educated men. At the medium education level, the two lines almost overlap at about 7.55 log-points in mean log pensions, suggesting almost equivalent pension outcomes for people with secondary school or vocational qualifications. However, at the high education level, men reassert their lead: highly educated men have mean log pensions of around 7.80 and highly educated women have mean log pensions of around 7.72, a remaining gap of approximately 8 % even for the most highly educated. In summary, higher education creates a benefit for both genders; however, a small male advantage exists at the low and high extremes of the education continuum, with some gender differences likely in terms of the variation of people's contribution histories, employment interruptions varied by gender, or retirement-age credits granted that disproportionately affect women at the lowest or highest ends of education level.

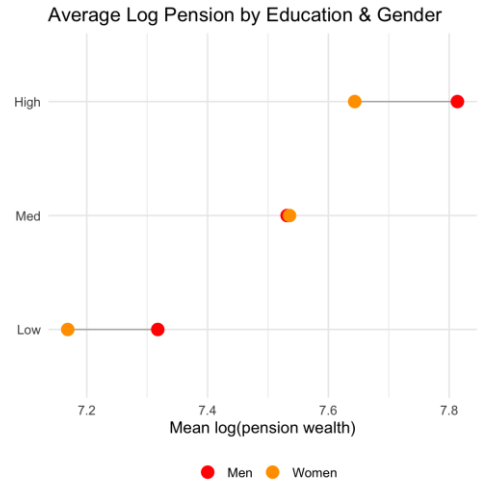

Figure 9: Average Log Pension by Education & Gender

The data shows that part-time employment is more common among women compared to men. Although both men and women have a peak at zero part-time work percentage the curve for men (shown in red) sharply rises at 0, suggesting that most men, in the sample were employed full time. Alternatively, the curve for women (orange) still achieves fullness at zero but very noticeably approaches and exceed 100% for women working part-time; significant numbers of women undertake part-time employment from a reported 10% to 50% and very often higher. This contrast in distributions indicates patterns in labor market participation, that women may take on caregiving roles, with varying degrees of choice due to large part-time roles.

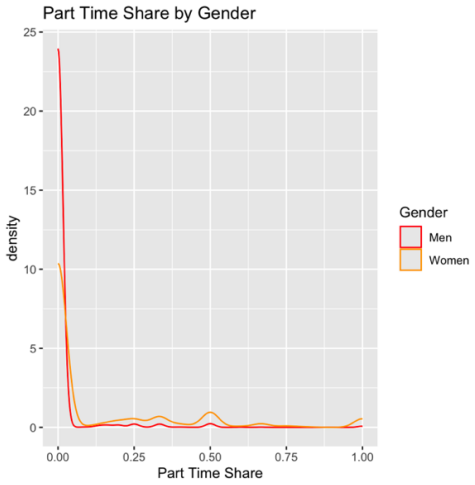

Figure 10: Part-time Share by Gender

7.Regression Analysis

7.1 Research Methodology

Conventionally, researchers adopt a multi-level regression methodology when addressing social science research questions that include individual-level effects (education, income, employment) and country-level effects (economic and political factors).Despite this method being quite common, it could be yet cumbersome when the upper-level sample (number of countries) is small due to three main reasons:

i. The low-level degrees of freedom at the country level makes it only possible to include a few number of macro predictors to maintain statistical power.
ii. The random-slope and cross-level interaction terms digest the degrees of freedom, making reliable estimation difficult.
iii. The omitted variable bias leads to difficulties in controlling for every macro predictor, making country-level coefficients inaccurate.

To overcome these complications, an alternative fixed country-fixed effects method in which it is possible to include a dummy for each country (minus one), that absorbs all time-invariant country-level heterogeneity is applied. In a paper, (Möhring, Katja,2021) suggests that a country's moderator role can be assessed by interacting it with individual-level variables.

The empirical analysis was conducted in two parts. First, gender specific OLS and fixed effects regression models (Table 5) were estimated for males and females separately. The OLS models provide the basic associations between life-course variables and pension income, but they are not country-specific. Subsequently, I introduced country fixed effects to account for unobserved, time-invariant differences across countries. This is crucial because it recognizes that the pension outcomes of individuals are influenced as much by national policy designs, welfare state configurations and labour market arrangements as by the level of individual characteristics.

Secondly, I conducted a pooled fixed-effects regression with the inclusion of country-by-gender interaction terms (Table 6). This allowed to control for country differences while permitting the gender pension gap to vary across national contexts. The interaction of gender with each country dummy would indicate how institutional arrangements mediate the dimensions of the gender gap.

The inclusion of fixed effects models is methodologically warranted, because it controls for unobserved heterogeneity that may bias estimates from a simple OLS model. While controlling for country fixed effects may provide less nuance about the source of observed differences, the coefficients may reflect individual level characteristics and structural components at the country level, which is difficult to unpack. By absorbing all time-invariant characteristics of each country, we are better able to provide an interpretation of our coefficients as being a measure of within-country variation.

.**The country-fixed effects model:**

$$y_{ij} = \gamma_{00} + \sum_{k=1}^{K} \beta_k \, x_{kij} \; + \; \sum_{c=1}^{N-1} \alpha_c u_{cj} + \; \varepsilon_{ij}$$

- y_{ij} is the outcome for person i in country j.
- $\gamma_{00}$is the overall intercept.
- x_{kij} are the K individual-level predictors.
- β_k are the slopes (effects) of those individual predictors on the outcome.
- u_{cj} are dummy-variable indicators for each country c ($N-1$ are included to avoid perfect collinearity).
- α_c are the "fixed-effect" coefficients that absorb all time-invariant, unobserved characteristics of country c.
- ε_{ij} is the individual specific residual error.

7.2 Model

$$Log\ Pension\ Income_{ij} = \beta_0 + \beta_1 Age_{ij} + \; \beta_2 Education\ Years_{ij} + \; \beta_3 Marital\ Status_{ij} +$$

$$\beta_4 Industry_{ij} + \beta_5 The\ number\ of\ children_{ij} + \; \beta_6\, Part-time\ share_{ij} + \; \alpha_j + \; \varepsilon_{ij}$$

7.3 Results

Table 5: Regression Models

	Females				Males			
	Without Fixed Effects		With Fixed Effects		Without Fixed Effects		With Fixed Effects	
	Estimate	Standard Errors	Estimate	Standard Errors	Estimate	Standard Errors	Estimate	Standard Errors
(Intercept)	9.165 (0.000)***	0.487			7.676 (0.000)***	0.455		
Age	-0.026 (0.000)***	0.003	-0.026 (0.212)	0.019	-0.001 (0.634)	0.003	-0.001 (0.941)	0.016
Education Years	0.012 (0.057).	0.007	0.012 (0.408)	0.014	0.021 (0.000)***	0.005	0.021 (0.141)	0.013
Marital Status: Married	-0.091 (0.025)*	0.041	-0.091 (0.023)*	0.033	0.048 (0.359)	0.052	0.048 (0.422)	0.057
Number of Children	-0.041 (0.011)*	0.016	-0.041 (0.094).	0.022	-0.003 (0.845)	0.015	-0.003 (0.802)	0.012
Part-time Share	-0.332 (0.001)**	0.097	-0.332 (0.005)**	0.091	-0.507 (0.043)*	0.251	-0.507 (0.285)	0.447
Country: Germany	-0.611 (0.009)**	0.233	-	-	-0.656 (0.000)***	0.162	-	-
Country: Sweden	1.525 (0.000)***	0.236	-	-	1.143 (0.000)***	0.175	-	-
Country: Italy	-0.110 (0.631)	0.230	-	-	-0.397 (0.011)*	0.156	-	-
Country: France	-0.423 (0.006)**	0.230	-	-	-0.239 (0.137)	0.161	-	-
Country: Denmark	1.397 (0.000)***	0.227	-	-	1.081 (0.000)***	0.161	-	-
Country: Switzerland	0.291 (0.227)	0.240	-	-	0.189 (0.249)	0.164	-	-
Country: Belgium	0.255 (0.322)	0.258	-	-	-0.635 (0.001)***	0.187	-	-
Country: Czech Republic	0.875 (0.000)***	0.220	-	-	0.635 (0.000)***	0.153	-	-
Country: Poland	-0.843 (0.000)***	0.220	-	-	-0.908 (0.000)***	0.154	-	-
Industry Dummies	No		No		No		No	
Num.Obs.	1298		1298		1292		1292	
R2	0.658		0.139		0.588		0.079	
R2 Adj.	0.651		0.651		0.579		0.579	
AIC	2570.9		-		2608.4		-	
BIC	2725.9		-		2763.3		-	
Log.Lik.	-1255.433		-		-1274.193		-	
RMSE	0.637		0.637		0.649		0.649	
p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001								

The most significant finding from the analysis shown in table 5,is the negative relationship between part-time employment and pension income. Specifically, a 10% increase in the number of years spent in part-time employment is associated with a 3.3% decrease on a woman's pension income (-0.332, $p < 0.01$), demonstrating the financial costs of part-time work over for women.

With respect to marital status, it is evident that being married is associated with a 9.1% lower pension income, compared to unmarried women (-0.091, $p = 0.023$). This is likely an indication of cumulative gendered disadvantages that persist from the traditional role of family in which married women may have accumulated through their partnerships, career interruptions due to taking time-off for childcare or limited working hours when caring for dependent family members.

Although not statistically significant at conventional levels, the number of children (-0.041, $p \approx 0.094$) has a negative effect on pension income in this sample. This suggests that being a mother may worsen the impact on a woman's pension income prospectively and retrospectively (by either limiting attachment to the labor market, or by having lower earnings over a lifetime), although with marginal significance.

Ultimately, and contrary to expectation, the number of years of education has no statistically significant effect on women's pension income in this model (0.012, $p=0.41$) despite the positive coefficient. This might suggest that the return on education increased due to barriers of the structure or institution of labor market women are faced with, even with higher education.

Age is also statistically insignificant (-0.026, $p=0.21$), despite the negative direction of the relationship, it suggests minimal effects of age when the sample is limited to a population already past retirement age and adjusting for career history.

With respect to industry, none of the industry dummies are statistically significant. This could be explained as the sector of employment does not self-predict pension income for women once controlled for other individual-level factors, or that the within-sector variation is greater than between-sector difference in the data.

Overall, the results from the model demonstrate the importance of part-time work and marital status in explaining pension outcomes for women and highlighting the ongoing importance of policies designed to help mitigate the long-lasting and structural financial implications of family obligations and gendered patterns of employment.

Table 6: Pooled Fixed Effects Model

Covariate	**Estimate**	**Std. Error**	**p value**
Country: Austria	1.015	0.017	0.000***
Country: Germany	0.334	0.018	0.000***
Country: Sweden	2.034	0.021	0.000***
Country: Italy	0.487	0.019	0.000***
Country: France	0.717	0.019	0.000***
Country: Denmark	2.063	0.019	0.000***
Country: Switzerland	1.077	0.022	0.000***
Country: Belgium	0.440	0.020	0.000***
Country: Czech Republic	1.629	0.011	0.000***
Austria: Gender	-0.547	0.013	0.000***
Germany: Gender	-0.700	0.010	0.000***
Sweden: Gender	-0.139	0.019	0.000***
Italy: Gender	-0.253	0.007	0.000***
France: Gender	-0.654	0.015	0.000***
Denmark: Gender	-0.206	0.023	0.000***
Switzerland: Gender	-0.577	0.016	0.000***
Belgium: Gender	-0.084	0.018	0.001***
Czech Republic: Gender	-0.319	0.011	0.000***
Poland: Gender	-0.382	0.014	0.000***

The pension income received by males and females varies by countries in Europe as it does between the two genders as demonstrated in table 6. Taking Austrian males as the reference group, whose average log-pension sits about 1.02 points above the grand intercept, German (+0.33) and Italian (+0.49)

males cluster in the lower-middle tiers, with French (+0.72) and Belgian males (+0.44) slightly above them. Switzerland is generous (+1.08) with Nordic countries standing out: male Swedes are receiving about +2.03 log-points of pension wealth, while male Danes sit at almost equal amounts with +2.06. Across the board however, women retire with less pension income: Austrian women are -0.55 log points below Austrian men; German women -0.70 log points below; French women -0.65 log points below; Swiss women -0.58 log points below; Polish women -0.38 log points below; Czech women -0.32 log points below; Italian women -0.25 log points below; Danish women -0.21 log points below; and Swedish women -0.14 log points below their male counterparts; while female Belgians had the least gap (-0.08). All these gender by country interaction terms is statistically significant at $p<0.001$, confirming that even the most generous pension systems create a systematic disadvantage for women.

8.Oaxaca Decomposition

8.1 Oaxaca Decomposition

A vast amount of social science literature has focused on determining the root causes of racial and gender disparities in health, education, the labor market, and other outcomes. Decomposing inter-group differences in mean levels of an outcome into those resulting from different observable characteristics or "endowments" across groups and those resulting from different effects of characteristics or "coefficients" of groups is the most popular method used in recent decades to identify and quantify these causes. (Fairlie, Robert W.,2006).

8.2 Research Methodology

In this analysis, I follow the three-fold decomposition framework established by Jann (2008), who extended the traditional two-fold framework, by decomposing the total effect into three separate components: endowments, coefficients, and the interaction between them. In this case, I completed the decomposition using the oaxaca package in R, with females coded as a reference group (i.e., males == 0), and used dummy variables for industry, country, and marital status. These three components allowed

me to capture heterogeneous characteristics. The decomposition was bootstrapped (100 replications) to provide robust standard errors for all components. Results are displayed separately for each categorical dimension to help provide clarity on the variation in structural sorting (e.g., by industries or countries) from differentially treated variations within this structure.

OLS regression models were originally estimated with alternative specifications (industry dummies, country dummies, marital status dummies), as well as other life-course covariates. The rationale behind including OLS was two-fold. First, the OLS provides its own baseline model that captures the direct associations between gender, individual characteristics, and pension income. Second, the OLS results provide a base from which to conduct the decomposition analysis, given that Oaxaca–Blinder decompositions are mathematically derived from linear regression coefficients. OLS is therefore useful as both a good means of establishing determinants of pensions, and for maintaining internal consistency with the contents of the decomposition results.

8.3 Models

Based on the models' specifications above, this section includes three-fold decomposition models and a series of regression models that are the foundation of this analysis. In all models, the natural logarithm of total pension income is the dependent variable that is regressed on a set of individual characteristics variables that include age, marital status, the number of children they have, years of education, industry of work ,part-time share of employment and dummy variables that capture institutional and structural variation analysed in a marital status model specification, industry model specification and a country model specification.

The general form of the regression model is:

$$Log\ Pension\ Income = \beta_0 + \beta_1 Age_{ij} + \beta_2 Education\ Years_{ij} + \beta_3 Marital\ Status_{ij} + \beta_4 Industry_{ij} + \beta_5 The\ number\ of\ children_{ij} + \beta_6\ Part-time\ share_{ij} + D_i + \varepsilon_{ij}$$

Where D_i,denotes the set of dummy variables in the country, industry, and marital status models and ε_{ij} denotes the error term.

(A) Linear Regression Models:

1.Industry Model:

$$Log\ Pension\ Income = \beta_0 + \beta_1 Age_{ij} + \beta_2 Education\ Years_{ij} +$$

$$\beta_3 The\ number\ of\ children_{ij} + \beta_4\ Part - time\ share_{ij} + \sum_{k-1}^{K-1} \delta_k\ Industry_{ik} + \varepsilon_{ij}$$

Where, $Industry_{ik}$ denotes K– 1 dummy variables with "Agriculture, forestry and fishing" being the base category.

2.Marital Status Model:

$$Log\ Pension\ Income = \beta_0 + \beta_1 Age_{ij} + \beta_2 Education\ Years_{ij} +$$

$$\beta_3 The\ number\ of\ children_{ij} + \beta_4\ Part - time\ share_{ij} +$$

$$\sum_{m-1}^{M-1} \theta_m\ Marital\ Status_{im} + \varepsilon_{ij}$$

Where $Marital\ Status_{im}$,denotes M - 1 dummy variables with "Not married" being the base category.

3.Country Model:

$$Log\ Pension\ Income = \beta_0 + \beta_1 Age_{ij} + \beta_2 Education\ Years_{ij} +$$

$$\beta_3 The\ number\ of\ children_{ij} + \beta_4\ Part - time\ share_{ij} + \sum_{c-1}^{C-1} \gamma\ Country_{ic} + \varepsilon_{ij}$$

Where $Country_{ic}$,denotes C – 1 country dummies with "Austria" being the base category.

(B) Oaxaca Decomposition Models:

The mean outcome difference ($\Delta\overline{Y}$), the gap, is simply the difference of the mean outcomes for observations between the males' group ($\overline{Y_M}$) and the females' group ($\overline{Y_F}$).

$$\Delta\overline{Y} = \overline{Y_M} - \overline{Y_F}$$

$$\Delta = \left(\overline{X}^M - \overline{X}^F\right)\beta^F + \overline{X}^F(\beta^M - \beta^F) + (\overline{X}^M - \overline{X}^F)(\beta^M - \beta^F)$$

Where,

$\left(\overline{X}^{M} - \overline{X}^{F}\right)\beta^{F}$ captures the part due to differences in characteristics.

$\overline{X}^{F}(\beta^{M} - \beta^{F})$ captures the part due to differences in returns.

$(\overline{X}^{M} - \overline{X}^{F})(\beta^{M} - \beta^{F})$ is the remainder from their differences jointly.

Accordingly, the decomposition model was tested for each model specification to examine the variation in structural dimensions:

1.Industry model: quantifies the impact of sectoral wage disparities.

2.Country model: examines the role of country-specific institutional variation across countries.

3.Marital-status model: captures the role of partnerships and family structures on the pension gap.

8.4 Results

Table 7: Three-Fold Oaxaca Decomposition Model- Industry Dummies

Variable	Coefficient Endowment	SE. Endowment	Coeff. Coefficient	SE. Coefficient	Coefficient Interaction	SE Interaction
(Intercept)	0.0000	0.0000	-0.2960	0.2417	0.0000	0.0000
Age	0.0109	0.0051	0.6094	0.2164	0.0146	0.0055
Education Years	0.0203	0.0071	-0.2408	0.0892	-0.0072	0.0039
Number of Children	-0.0043	0.0028	0.1301	0.0768	0.0021	0.0020
Part-time Share	0.0071	0.0097	-0.0500	0.0303	0.0437	0.0265
Industry: Mining and quarrying	-0.0077	0.0062	0.0037	0.0021	0.0112	0.0067
Industry: Manufacturing	0.0001	0.0025	-0.0014	0.0160	-0.0003	0.0033
Industry: Electricity, gas, and water supply	-0.0039	0.0023	0.0038	0.0027	0.0036	0.0024
Industry: Construction	0.0307	0.0218	-0.0028	0.0026	-0.0252	0.0226
Industry: Wholesale and retail trade	-0.0016	0.0031	-0.0151	0.0127	0.0057	0.0048
Industry: Hotels and Restaurants	0.0008	0.0024	-0.0066	0.0052	0.0045	0.0038
Industry: Transport, storage, and communication	-0.0046	0.0057	0.0069	0.0028	0.0140	0.0066
Industry: Financial intermediation	-0.0023	0.0015	-0.0027	0.0041	0.0008	0.0014
Industry: Real estate, renting and business activities	0.0002	0.0006	0.0006	0.0015	-0.0002	0.0009
Industry: Public administration and defense	0.0010	0.0012	-0.0015	0.0063	-0.0002	0.0011
Industry: Education	0.0018	0.0051	0.0113	0.0123	-0.0075	0.0085
Industry: Health and social work	-0.0262	0.0068	-0.0414	0.0156	0.0355	0.0135

Table Continued						
Industry: Other community	-0.0029	0.0021	-0.0193	0.0091	0.0051	0.0031
(Base)	-0.0043	0.0029	0.0095	0.0113	0.0013	0.0020

Table 7 shows the Oaxaca–Blinder three-fold decomposition results when accounting for industries. The results indicate that differences in characteristics account for a small part of the pension gap. The estimates for age (0.0109, SE =0.0051) and education (0.0203, SE =0.0071) have positive contributions, suggesting that women are disadvantaged because they have lower endowments than men. In contrast, the estimates for the number of children (–0.0043) and our concentration in health and social work (–0.0262) demonstrate how women's family responsibilities and labor market occupational segregation into lower-paying and caring job sectors enhance their disadvantage regarding pensions.

Turning to the coefficients component, this is the largest driver of the pension gap. Education contributes negatively (–0.2408, SE = 0.0892), which means that when women have the same years of schooling as men, their pension returns are much lower. The negative contribution from health and social work (–0.0414, SE = 0.0156) indicates that women not only cluster in this sector but also derive lower pension benefits from it with respect to men. Age contributes positively (0.6094, SE = 0.2164) which signals that returns from accumulated labor market experience in pensions disproportionately favor men.

The interaction effects are smaller but still significant. Positive interactions for age (0.0146, SE = 0.0055) and health and social work (0.0355, SE = 0.0135) show that women's characteristics combined with the rewards for these characteristics worsen their outcomes relative to men. Part-time work is another case where interaction has positive contributions (0.0437), showing that the interaction of more female part-time workers leads to worse women’s pension accumulation collectively, i.e., the same endowments, but much worse rewards.

In summary, the decomposition suggests that the gender pension gap arises more from differences in the structure of how the labor market rewards men and women, rather than differences in observable

characteristics. The gender pension gap as a long-term stratifying phenomenon can be understood as gendered occupational segregation, motherhood penalties, and differential rewards associated with education.

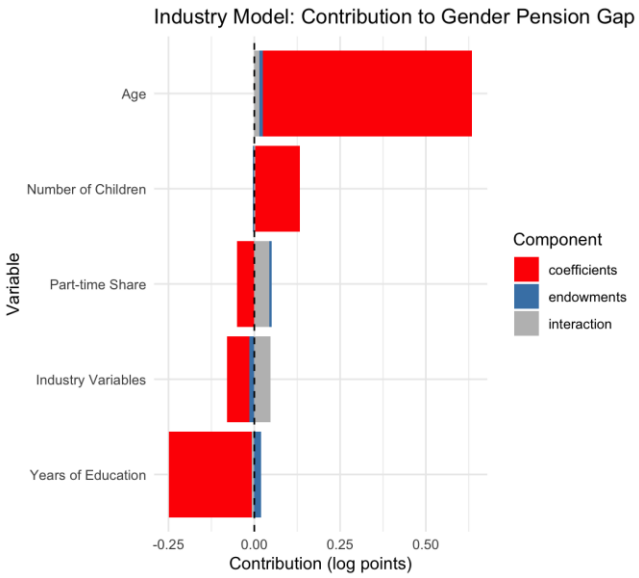

Figure 11: Industry Model

Table 8: Linear Model- Industry Dummies

Variable	Estimate	Std. Error
(Intercept)	(6.5799) *** 0.0000	0.1444
Gender: Female	(-0.1844)*** 0.0000	0.0296
Age	(0.0110)*** 0.0000	0.0018
Years of Education	(0.0482)*** 0.0000	0.0036
Number of Children	(-0.0555)*** 0.0000	0.0109
Part-time Share	(-0.0843) 0.2454	0.0725
Industry: Mining and quarrying	(0.2799)** 0.0022	0.0915
Industry: Manufacturing	(0.2076)*** 0.0000	0.0443
Industry: Electricity, gas, and water supply	(0.1222) 0.1905	0.0933
Industry: Construction	(0.2878)*** 0.0000	0.0598
Industry: Wholesale and retail trade	(0.1965)*** 0.0002	0.0533
Industry: Hotels and Restaurants	(0.0786) 0.4688	0.1085
Industry: Transport, storage, and communication	(0.3896)*** 0.0000	0.0760
Industry: Financial intermediation	(0.4692)*** 0.0000	0.0986
Industry: Real estate, renting and business activities	(0.1359) 0.5780	0.2443
Industry: Public administration and defense	(0.3090)*** 0.0000	0.0634

Table Continued

Industry: Education	(0.2466)*** 0.0001	0.0648
Industry: Health and social work	(0.4546)*** 0.0000	0.0693
Industry: Other community	(0.2255)*** 0.0003	0.0619

In table 8,we observe the results of a linear regression with industry dummies; the results reveal a significant female pension penalty (–0.1844, p<0.001) after accounting for individual and occupational characteristics showing that gender itself remains an independent determinant of lower pensions.

Most covariates have a significant and positive effect on pension income. Age (0.0110, $p < 0.001$) and years of education (0.0482, $p < 0.001$) are strong significant positive effects, given the cumulative elements of human capital. By contrast, the number of children has a large and significant negative effect on pensions (–0.0555, $p < 0.001$), consistent with the motherhood penalties we see with other life-course outcomes. The part-time work dummy is negatively associated with pensions, but it is not statistically significant in the model.

The industry coefficients allowed us to see the significant heterogeneity between sectors. For example, working in financial intermediation (0.4692, $p < 0.001$), social work and health and social work (0.4546, $p < 0.001$), and transport, storage, and communication (0.3896, $p < 0.001$) all have substantially higher pensions than the base industry category with very large positive and significant coefficients; similarly we see positive and significant effects for manufacturing, construction, public administration, education, and other community services. By contrast, there are relatively weaker or statistically insignificant associations for hotels and restaurants, real estate, and electricity, these three had statistically significant but much lower positive coefficients than the higher categories.

In total, the regression results reinforce that the gender, education, the family role, and the sector of employment are extremely important variables for determining pensions. Human capital variables (age, education) are associated with improved pensions, but we still see persistent female penalty, and negative impacts of children which highlight structural disadvantages not observable or measurable with other factors.

Overall, the results presented in Tables 7 and 8 deliver a cohesive explanation around the gender pension gap. The linear regression clearly demonstrates the significant and enduring female disadvantage while also showing the importance of education, motherhood, and sector of employment as contributing factors. The decomposition analysis accounts for the same characteristics but goes one step further in illustrating that the gap is not only explained by women's endowments that are different from those of men but rather the way that women's endowments are rewarded in the labor market of their respective careers. More specifically, lower returns to education and sectoral segregation, in combination with penalties associated with motherhood, are responsible for the pension disadvantage. Therefore, taking both the linear regression and the decomposition analysis together shows that the gender pension gap is structurally embedded: not only are women clustered into lower wage roles, but also for the same characteristics as men, women receive systematically poorer pension rewards.

Table 9: Three-Fold Oaxaca Decomposition Model- Country Dummies

Variable	Coefficient Endowment	SE. Endowment	Coefficient Coefficient	SE. Coefficient	Coefficient Interaction	SE Interaction
(Intercept)	0.0000	0.0000	-0.6869	0.2280	0.0000	0.0000
Age	-0.0117	0.0039	1.1098	0.2058	0.0267	0.0063
Education Years	0.0114	0.0041	-0.0907	0.0536	-0.0027	0.0019
Number of Children	-0.0010	0.0010	-0.0124	0.0575	-0.0002	0.0011
Part-time Share	0.0266	0.0064	-0.0287	0.0224	0.0250	0.0194
Country: Germany	-0.0233	0.0082	0.0215	0.0045	0.0059	0.0026
Country: Sweden	-0.0195	0.0097	-0.0295	0.0055	0.0041	0.0022
Country: Italy	-0.0228	0.0045	-0.0101	0.0042	-0.0090	0.0037
Country: France	-0.0001	0.0044	0.0358	0.0076	0.0000	0.0026
Country: Denmark	-0.0182	0.0093	-0.0186	0.0041	0.0029	0.0016
Country: Switzerland	-0.0004	0.0012	0.0037	0.0029	0.0019	0.0017
Country: Belgium	-0.0131	0.0035	-0.0318	0.0063	-0.0169	0.0045
Country: Czech Republic	-0.0658	0.0070	-0.0090	0.0108	0.0047	0.0055
Country: Poland	0.0384	0.0098	0.0100	0.0070	-0.0031	0.0024
(Base)	0.0002	0.0009	0.0115	0.0065	-0.0005	0.0015

The endowments part displays relatively small, but meaningful contributions in the Oaxaca model in table 9. Age (–0.0117, SE = 0.0039) contributes negatively, indicating that different distributions of age between men and women reduces the pension gap slightly. Education contributes positively (0.0114, SE = 0.0041), suggesting that women's expected benefits are informative of their value-added

disadvantage, with post-secondary education accounting for their disadvantage. Children have almost none (–0.0010), while part-time work contributes positively (0.0266, SE = 0.0064), indicating that women's high degree of part-time work is slightly informative about part of the gap illustrated. At the level of the country, there are strong contributions from Czech Republic (–0.0658) and Poland (0.0384), emphasizing how the difference in the country composition of respondents matter for the pension gap.

The coefficients part illustrates the structural differences in return on endowed characteristics. Age contributes positively and strongly (1.1098, SE = 0.2058) - meaning that over time women accrue pension values from their labor market experience, however these returns benefit men more than women. Contrastingly, education contributes negatively (–0.0907, SE = 0.0536) meaning that for the same years of schooling which both men and women achieve they experience weaker growth in pension. Meaning that, education alone, does not mitigate the pension gap. Part-time work also has a negative contribution (–0.0287, SE = 0.0224), reinforcing the contribution that women's part-time careers seem to be rewarded less well by pension systems. Among the country's dummies, there are also substantial negative contributions for Belgium (–0.0318) and Sweden (–0.0295) with France positively contributing (0.0358). The results demonstrate the importance of institutional arrangements at the country level, which systematically increase or decrease the gender pension gap.

The interaction effects have smaller state-mean comparisons, but stress compounding dynamics. Age (0.0267, SE = 0.0063) and part-time work (0.0250, SE = 0.0194) are informative, indicating that the combination of women's labor market characteristics and how they are rewarded, tend to contribute to their temporal pension disadvantage.

In conclusion, key findings from the decomposition indicate that the gender pension gap has less to do with differences in characteristics and more based on institutional arrangements in that country, which could be in several ways (mandates, policy constructions, etc.). More than informed differences in characteristics, the structural difference in how pensions will be determined in relation to age, education and part-time work explain most of the observed differences, alongside the possible variation from the country of residence.

Figure 12: Country Model

Table 10: Linear Model- Country Dummies

Variable	Estimate	Std.Error
(Intercept)	(7.6410)*** 0.0000	0.1067
Gender: Female	(-0.3083)*** 0.0000	0.0203
Age	(0.0013) 0.3302	0.0013
Years of Education	(0.0314)*** 0.0000	0.0026
Number of Children	(-0.0209)** 0.0073	0.0078
Part-time Share	(-0.2408)*** 0.0000	0.0524
Country: Germany	(-0.8369)*** 0.0000	0.0520
Country: Sweden	(1.1808)*** 0.0000	0.0518

Table Continued

Country: Italy	(-0.4015)*** 0.0000	0.0494
Country: France	(-0.3882)*** 0.0000	0.0500
Country: Denmark	(1.0899)*** 0.0000	0.0533
Country: Switzerland	(0.0287) 0.6343	0.0604
Country: Belgium	(-0.4493)*** 0.0000	0.0495
Country: Czech Republic	(0.6081)*** 0.0000	0.0492
Country: Poland	(-0.9859)*** 0.0000	0.0510

Table 10 shows a substantial pension gap exists between men and women (–0.3083, $p < 0.001$). This effect, which is marginally greater than that of the prior industry model, shows that, even after controlling for individual and country variables, gender continues to have a significant impact on pensions.

In terms of other covariates, years of education is positively and significantly related to pensions (0.0314, $p < 0.001$).The data shows that education serves as the main source for people to earn their retirement income. The number of children shows a negative relationship with pension amounts (–0.0209, $p < 0.01$) which confirms the motherhood penalty exists throughout a woman's life span. The coefficient for part-time work is negative and large (–0.2408, $p < 0.001$). The variable for age is not statistically significant. This suggests that much of the variation correlated with age is absorbed by the cross-country variation.

Regarding country dummy variables, there is significant variation internationally. Sweden (1.1808, $p < 0.001$)) and Denmark (1.0899, $p < 0.001$) followed by the Czech Republic (0.6081, $p < 0.001$).On the contrary, the disadvantage for Germany (–0.8369, $p < 0.001$), Italy (–0.4015, $p < 0.001$), France (–0.3882, $p < 0.001$), Belgium (–0.4493, $p < 0.001$), and especially Poland (–0.9859, $p < 0.001$) are significant. The only country with no significant effect is Switzerland.

The research confirms that gender status along with education level and family background and part-time work and national environment determine the pension income. The results also point to institutional differences between countries are fundamentally essential in explaining the amount of the pension gap, and even the direction of the pension gap.

Taken together, Tables 9 and 10 show how the individual factors and location factor into the gender pension gap across countries. The raw female penalty and the importance of education, the number of children, and part-time employment were highlighted in the regression results while the decomposition results revealed that differences in returns to characteristics were the bulk of the gap while differences in characteristics were much less relevant. Moreover, individual country contributions highlight how institutional pension rules and labour market arrangements exacerbated the gender gap or reduced it; Germany, Belgium, and Poland being the consistently negative contributions; show that there is more to the gender pension gap than an individual concern; it is grounded in the national institutional designs.

Table 11: Three-Fold Oaxaca Decomposition Model- Marital Status Dummies

Variable	Coefficient Endowment	SE. Endowment	Coefficient Coefficient	SE. Coefficient	Coefficient Interaction	SE Interaction
(Intercept)	0.0000	0.0000	-0.6930	0.4613	0.0000	0.0000
Age	-0.0142	0.0070	0.7189	0.3807	0.0199	0.0102
Education Years	0.0372	0.0158	-0.1475	0.1128	-0.0058	0.0057
Number of Children	-0.0080	0.0075	0.3294	0.1091	0.0050	0.0054
Part-time Share	-0.0082	0.0098	-0.1065	0.0327	0.0906	0.0281
Marital status: Married	-0.0134	0.0066	0.0460	0.0313	0.0156	0.0108
(Base)	-0.0134	0.0066	-0.0268	0.0183	0.0156	0.0108

In table 11, marital status dummies are included in the Oaxaca–Blinder decomposition results. The decomposition divides the total gap into contribution from differences in characteristics (endowments), differences in returns (coefficients), and interactions.

The endowments component shows that observable differences in characteristics show a modest contribution to the pension gap. Education provides a positive contribution (0.0372, SE = 0.0158) indicating that the lower education levels of women help account for their disadvantages. By contrast, children (–0.0080, SE = 0.0075) and married (–0.0134, SE = 0.0066) provide a negative contribution suggesting the higher probability of women having children and being married contribute to some of the observed inequality. Age (–0.0142) provides a slight negative contribution to the gap and even part-time work (–0.0082) has a small negative endowment contribution.

The coefficients component emerges as the largest contributor to the pension gap, again. Age provides a strong positive contribution (0.7189, SE = 0.3807) indicating that the returns to collective experience accrued are more beneficial to men than to women. Education provides a negative contribution (–0.1475, SE = 0.1128) since women do not realize the same proportional pension benefits for additional educational years. Children (0.3294, SE = 0.1091), clearly have sizable and positive contributions

reflecting the differential structures of parenthood. Married positively contributes (0.0460, SE = 0.0313) indicating that the benefits of being married provides men a comparative advantage.

The interaction component shows how compounding factors ultimately make a substantial contribution. Part-time work provides a considerable contribution through an interactive channel (0.0906, SE = 0.0281) meaning that women not only have more part-time work incidence, combined with the fact that pensions returns are lower for part-time work, perpetuates their disadvantage. Age (0.0199, SE = 0.0102) and marriage (0.0156; SE = 0.0108) both are positively contributing through interactive effects indicating that life course or family patterns combined with institutional factors contributed to finding patterns of inequality.

Overall, the Oaxaca-Blinder decomposition suggests that while differences in education, family structure and roles, as well as part-time work help explain the gap in pensions, the major source of inequality is related to how the characteristics are compensated. Specifically, structural factors such as parenthood and marriage provide compensation that is typically more favorable for men, thus producing structural theories of gendered disparities in pension plan compensation.

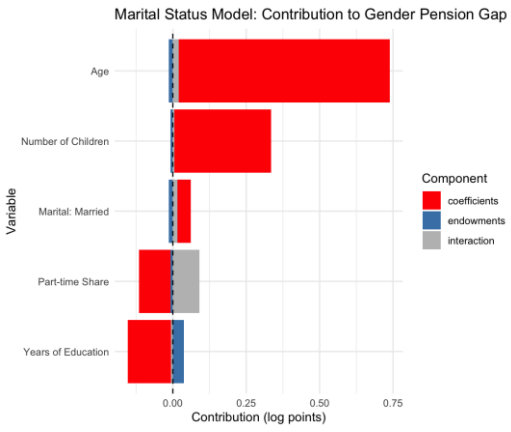

Figure 13: Marital Status Model

Table 12: Linear Model- Marital Status Dummies

Variable	Estimate	Std.Error
(Intercept)	(7.5964)*** 0.0000	0.2242
Gender: Female	(-0.2252)*** 0.0000	0.0421
Age	(-0.0022) 0.3978	0.0026
Education Years	(0.0828)*** 0.0000	0.0052
Number of Children	(-0.1005)*** 0.0000	0.0162
Part- time Share	(-0.0511) 0.6860	0.1265
Marital Status: Married	(-0.0548) 0.2469	0.0474

In addition to that, the linear regression results which included marital status are in table 12. The estimates show a statistically significant female pension penalty (-0.2252, $p < 0.001$), meaning that gender independently predicts lower pensions, even after controlling for marital status and other life-course factors.

Among the covariates, education is also a strong and positive predictor (0.0828, $p < 0.001$), giving it the most important predictor of pension entitlements in this model. In contrast, the number of children is a large and negative predictor (-0.1005, $p < 0.001$) exemplifying the motherhood penalty in pension accumulation. Although age and part-time work were not statistically significant, they have negative coefficients which indicates a potentially negative effect. Marital status (-0.0548) was also not statistically significant, but the direction of its effect suggests that married women have lower pensions after accounting for all the factors discussed.

Overall, these results support the notion that education contributes to enhanced pension outcomes for all genders, however the motherhood penalty remains one of the largest predictors of being disadvantaged, statistically.

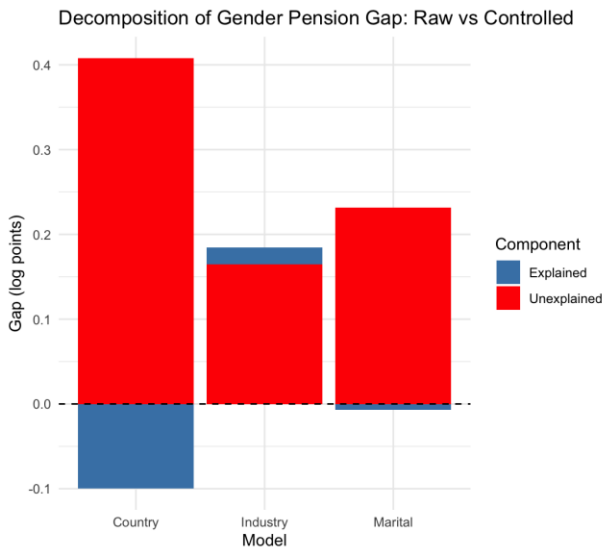

Figure 14: Gender Pension Gap Decomposition

9.Conclusion

The study demonstrates an enduring and notably large gender pension gap, after controlling for various factors such as human capital, family situation, sector of employment and experience across the relevant country-level institutions. The linear regression models (Tables 8, 10, and 12) provide large and statistically significant female penalties, while the Oaxaca–Blinder decompositions (Tables 7, 9, and 11) show that the coefficients component, which captures the differences in the returns to characteristics, accounts for the largest share of the gender pension gap. The existence of a gender pension gap seems to be driven more by systematic differences between men and women in the way these characteristics are rewarded than by differences in the observable characteristics themselves.

Human capital variables are not impactless, but they clearly affect men and women asymmetrically. While years of education are strongly associated with greater pensions in the regression models, the Oaxaca–Blinder decompositions show that women receive substantially lower returns to education with their pensions than men. In the same vein, returns to the number of years of labour market experience

proxied by age are clearly greater for men, which highlights how men's career continuity and tenure are more effectively converted into pension wealth than women's labour market continuity and tenure.

Family-related factors are shown to be the main drivers of inequality. The regression results clearly show the substantial negative effect of the number of children on pensions: a persistent motherhood penalty crossing decades. The decomposition results have also illustrated that both marriage and parenthood contribute to the gender pension gap not only in endowments, but more importantly, in weaker returns and reinforcing interaction effects. Part-time work is also particularly relevant: while its direct effect is sometimes suppressed in the regressions, the decomposition results suggest that women's greater reliance on part-time work, combined with pension accrual rules that are less generous, systematically stack the odds against women later in life.

Sectoral and national contexts also play an important role. The regression results show that certain sectors/broad industries such as financial intermediation, health and social work, and public administration are associated with pensions that are considerably larger, and other sectors are associated with weaker outcomes. The industry-based decomposition demonstrates that sectoral segregation alone does not account for the gap, but rather, the returns within sectors are also systematically weaker for women. From a national perspective, the regressions show that there is extensive cross-country variation where pensions in countries like Sweden, Denmark, and the Czech Republic are found to be higher and lower in others such as Germany, Belgium, and Poland. The decomposition results confirm this is due to country-level coefficients dominating endowments, it also underscores that institutional pension rules and design of the welfare state systematically increase or reduce the gender pension gap.

Taken together, the findings here suggest that the gender pension gap is a structurally embedded phenomenon. Women are not only more likely to be in roles and lives that yield less rewards under pension systems, but they also receive systematically lower returns for the same characteristics than men. This means that, as well as being at a sorting disadvantage, they are also at a rewards disadvantage, and as such, closing the gap is not just a matter of getting women to work more or attain more education. It requires structural reforms that ensure pension systems and labour market institutions reward women's careers on an equal basis. Women ought to be able to maintain career trajectories that include

consideration of their care responsibilities, ability to work part-time and have career breaks and still receive comparable outcomes in their retirement through labour market institutions and retirement systems. In addition, the wider level of inequity by sector and institutional factors (e.g. public/private sector pensions) should be addressed in broader dimensions.

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Appendix:

EU Member States and Norway:	
Code	Country
BE	Belgium
BG	Bulgaria
CZ	Czechia
DK	Denmark
DE	Germany
EE	Estonia
IE	Ireland
EL	Greece
ES	Spain
HR	Croatia
FR	France
IT	Italy
CY	Cyprus
LV	Latvia
LT	Lithuania
LU	Luxemburg
HU	Hungary
MT	Malta
NL	The Netherlands
AT	Austria
PL	Poland
PT	Portugal
RO	Romania
SI	Slovenia
SK	Slovakia
FI	Finland
SE	Sweden
NO	Norway