

Extending Working Lives and Related Social Inequalities in Ageing Welfare States



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Statement of Authorship

Paper 3, *Convergence or Continued Stratification? Late Working Lives and Retirement Trajectories in Germany*, is jointly written by Kun Lee and Bernhard Ebbinghaus. In line with the Examination Regulations, both authors hereby certify that the majority of the work (over 70 per cent) has been done by Kun Lee. The other three papers are solely authored by Kun Lee.

3 June 2024

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Bernhard Ebbinghaus



Thesis Abstract

This doctoral thesis studies the recent dynamics of old-age inequality related to extending working lives from a comparative perspective. It contributes to the understanding of pension systems, labour market institutions, social stratification in late careers and retirement income inequality. *Paper 1* examines how public pension spending is associated with old-age employment rates of population subgroups and whether the associations vary across countries with different institutional designs of public pensions, using time-series cross-section data from 20 European countries and the United States from 1998 to 2019. Findings show that, while the employment rates of female and low-educated groups are more sensitive to pension spending changes, the estimated effects differ between insurance-based pension systems and tax-financed, flat-rate benefit systems. *Paper 2* explores how cross-country variations in ‘new’ policy responses to the COVID-19 crisis and ‘old’ welfare state institutions explain early exit from work in Europe following the pandemic, based on a panel survey of 26 countries. Results reveal that while job retention schemes and expanded unemployment benefits had opposite effects, existing pension institutions moderated exit outcomes especially among lower-educated workers. *Paper 3* analyses the social stratification of retirement processes and their pension income consequences following major institutional and socio-economic transformations in Germany by studying several cohorts until 2019. Using administrative pension insurance records linked with survey data, the study demonstrates persistent social stratification in late working lives by gender and education level, with some convergence between East and West Germans. Inequalities in retirement trajectories also partly explain pension income inequality. *Paper 4* estimates the impact of non-contributory pensions on old-age poverty, based on the recent Basic Pension expansions in South Korea. Using the Korean Household Income and Expenditure Survey and a difference-in-difference design, the study finds that the series of reforms effectively reduced older people’s poverty without undermining their employment outcomes.

Introduction¹

Today, people in ageing societies tend to work longer and retire later. Most European countries with massive early retirement trends until the late 1990s have since significantly raised old-age employment rates and average retirement ages. This reversal has been achieved through major welfare state reforms aimed at closing down financial pathways to early retirement, such as pre-retirement programmes, unemployment benefits and disability pensions (Ebbinghaus, 2006). Moreover, countries have gradually raised statutory pension ages, partially privatised pension systems and introduced flexible retirement schemes to promote later retirement (Eurofound, 2016; Hinrichs, 2021). These reforms have been motivated by concerns from international organisations over fiscal strains in welfare states facing population ageing (OECD, 1994; World Bank, 1994). Beyond Europe, in liberal welfare states and East Asian countries, working lives have also been extended, though not as dramatically due to traditionally high retirement ages.

However, whether extending working lives brings about desirable social outcomes requires closer inspection, as this occurs unequally within societies. Promoting longer working lives has been believed to benefit older adults and society as a whole by reducing

¹ Part of the literature review in this introduction is based on the following co-authored book chapters:

Bernhard Ebbinghaus and **Kun Lee** (2023) 'From early retirement to later exit from work: shifting towards active ageing', in D. Clegg and N. Durazzi (eds.), *Handbook of Labour Market Policy in Advanced Democracies*. Cheltenham: Edward Elgar.

Kati Kuitto and **Kun Lee** (in preparation) 'How to make extending working lives in ageing welfare states socially sustainable', in M. Vaalavuo, K. Nelson & K. Kuitto (eds.), *Social Sustainability in Ageing Welfare States*, Cheltenham: Edward Elgar.

the risk of poverty and social exclusion in old age, as well as by mitigating fiscal pressures on welfare states in an ageing population (OECD, 2006; Eurofound, 2012). Nevertheless, not all older workers are able to work until older ages, as health issues or job loss risks can lead to an involuntary exit from work (Radl, 2013). At the same time, some disadvantaged older workers need to take up low-quality jobs for financial reasons and cannot enjoy sufficient leisure after retirement. Therefore, tensions arise between the goal of active ageing and achieving social equality when policies to extend working lives disproportionately affect older adults with limited financial resources. The same international organisations that recommended extending working lives in the 1990s now raise concerns over rising social inequalities in old age (OECD, 2017).

In this thesis, I investigate the recent dynamics of old-age inequality in high-income countries since the 1990s when most ageing welfare states embarked on pension and labour market reforms to activate the older workforce. My motivation stems from an empirical puzzle from a cross-national perspective: given a common paradigm shift towards activation, why have some countries been successful in balancing the goals of extending working lives and limiting social inequality, while others have not? What institutional arrangements and macro-social conditions determine such divergence across countries? What are the micro-level mechanisms that steer the development of social inequalities in various dimensions? If the policies of activation do not necessarily lead to higher inequalities in old age, what policy implications can be drawn from country-specific experiences in balancing these two seemingly conflicting goals?

The thesis overall adopts a macro-comparative approach to address these questions, as my core perspective is that the consequences of the policy shift vary depending on country-specific institutional structures as well as economic and social conditions. The

thesis is composed of four independent research papers, two of which are based on large-N comparative analysis of over 20 countries, while the other two are single-country studies. The country cases involved throughout these papers are mostly in Europe, but I also include the United States and South Korea (hereafter Korea) to draw out more generalisable implications.

The remainder of this introduction is structured as follows. The subsequent section elaborates on the comparative empirical puzzle by displaying the current state of old-age activation (or active ageing) and social inequalities in high-income countries. I then provide an overview of the relevant literature in two parts. The first part synthesises theoretical approaches to explaining the variations in old-age employment and retirement patterns both at country and individual levels. The second part summarises recent empirical evidence on social inequalities in multiple dimensions related to extending working lives. Finally, the analytical approach and structure of the thesis are presented, with a focus on how it addresses the gaps identified in the existing literature.

Extending Working Lives and Related Social Inequalities: A New Policy Problem

Inequalities in old age have recently been recognised as an emerging concern among policymakers and researchers. A simple and straightforward example consistent with this problem is shown in Figure 1, presenting a cross-national relationship between the effective retirement age – estimated labour market exit age – and the relative poverty rate among individuals aged 65 or above, based on the most recent OECD data (OECD, 2019). The figure demonstrates a strong positive correlation between the two indicators across high-income countries, implying that greater activation of older workers may result in higher social inequality. However, the relationship also contains substantial variation,

especially among countries with retirement ages higher than 65. Poverty rates in these countries range from below five percent (Norway, Iceland) to over 30 percent (Korea, Estonia, Latvia). Such huge variation among countries with long working lives suggests that the inequality consequences of activation are likely to depend on institutional and macro-social contexts, and high inequality is not an inevitable outcome.

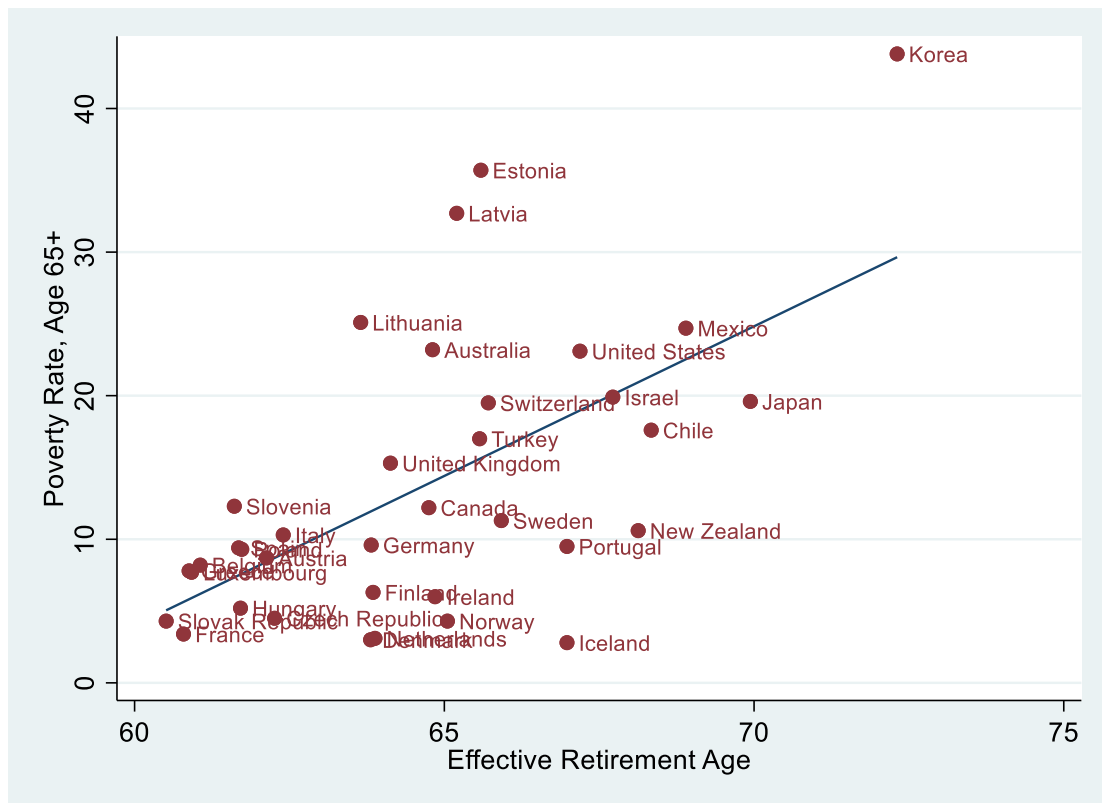


Figure 1. Effective retirement age and poverty rate (age 65+) in OECD countries
Note: Data from OECD Pensions at a Glance 2019. The poverty threshold is defined as 50 percent of median household disposable income.

When looking at the variation closer, Nordic countries are identified as welfare states that have maintained high old-age employment while also containing social inequality,

mainly explained by their commitment to active labour market policies that help integrate low-status older workers into the labour market (Ebbinghaus and Hofäcker, 2013). In contrast, countries with more ‘liberal’ approaches to old-age pensions and labour market policies, including the United States, Japan, Switzerland and Australia, typically show high poverty rates. Korea is an outlier in this respect as its huge pension gap drives both the effective retirement age and poverty at an exceptionally high level. Cross-country variations also exist even when comparing those with similar institutional and cultural backgrounds. For example, Dutch older workers retire at similar ages to those of Germans but are at a lower risk of poverty. Poverty rates in Japan and New Zealand are also much lower than in their neighbours with similar retirement ages: Korea and Australia.

The relationship between activation and social inequality in old age appears to be more complex when considering multiple dimensions of inequality and their longitudinal development altogether. Table 1 presents employment rates of individuals aged 55 to 64, their gender and educational differences, and at-risk-of-poverty rates of those aged 65 or above in 2003 (or 2005) and 2019 among 18 European countries. All countries experienced substantial growth in old-age employment rates between the two years, and that was by over 20 percentage points in most Western and Eastern European countries as well as in Italy. Moreover, gender differences in the employment rate were reduced in all countries but Hungary and Poland, thanks to increases in women’s employment at a higher pace than men’s. On the other hand, the educational gap shows a divergence across countries, as the figure declined in ten countries but increased in the others. Poverty rates display a similar pattern, with six countries showing significant rises in the risk of old-age poverty over the period.

Table 1. Employment rates of the aged 55-64, gender and educational gaps in employment rates, and at-risk-of-poverty rates in European countries, 2003 (2005) and 2019

	Employment Rate			Gender Gap			Education Gap			Poverty, 65+		
	2003	2019	Diff	2003	2019	Diff	2003	2019	Diff	2005	2019	Diff
Western												
Austria	29.1	54.5	25.4	20.1	17.1	-3.0	29.9	36.1	6.2	13.9	13.9	0.0
Belgium	28.1	52.1	24.0	21.0	10.3	-10.7	24.6	38.2	13.6	21.4	15.7	-5.7
France	36.3	53.1	16.8	6.3	4.6	-1.7	23.1	26.2	3.1	16.4	9.7	-6.7
Germany	39.4	72.7	33.3	16.5	8.7	-7.8	31.5	28.8	-2.7	13.4	18.0	4.6
Netherlands	44.5	69.7	25.2	24.9	17.1	-7.8	28.9	24.4	-4.5	5.4	11.8	6.4
Eastern												
Czechia	42.3	66.7	24.4	28.6	15.8	-12.8	50.9	47.4	-3.5	5.3	16.6	11.3
Hungary	28.9	56.7	27.8	17.1	22.8	5.7	44.6	34.0	-10.6	6.5	11.1	4.6
Poland	27.1	49.5	22.4	15.2	22.0	6.8	30.5	42.8	12.3	7.3	17.4	10.1
Northern												
Denmark	60.7	71.3	10.6	14.9	8.9	-6.0	27.5	21.8	-5.7	17.6	9.0	-8.6
Finland	49.6	66.8	17.2	2.1	-3.8	-5.9	23.0	27.3	4.3	18.7	14.4	-4.3
Norway	66.3	72.8	6.5	9.4	8.1	-1.3	30.3	27.6	-2.7	17.9	8.1	-9.8
Sweden	68.6	77.7	9.1	4.7	4.2	-0.5	23.5	21.4	-2.1	10.1	15.2	5.1
Southern												
Italy	30.0	54.3	24.3	24.5	20.0	-4.5	40.2	43.0	2.8	22.7	16.2	-6.5
Portugal	51.8	60.4	8.6	20.0	11.4	-8.6	11.3	23.2	11.9	27.6	17.3	-10.3
Spain	40.9	53.8	12.9	35.5	14.2	-21.3	29.5	26.2	-3.3	28.8	14.5	-14.3
Liberal												
Ireland	49.2	61.8	12.6	31.3	16.0	-15.3	27.5	20.2	-7.3	32.8	18.1	-14.7
Switzerland	65.8	73.0	7.2	23.6	12.8	-10.8	26.7	28.6	1.9	26.1*	27.1	1.0
United Kingdom	55.4	66.3	10.9	18.6	9.0	-9.6	14.3	12.5	-1.8	24.8	20.4 ⁺	-4.4

Note: Diff = Changes in percentage points between 2003 (2005) and 2019. Education gap means the percentage-point difference in employment rates between high-educated and low-educated groups. Education levels are measured based on the International Standard Classification of Education (ISCED): Low-educated = ISCED 0-2 and High-educated = ISCED 5-8.

At-risk-of-poverty is defined as below 60 percent of median household income after tax and transfers.

* 2007 value; ⁺ 2018 value

Source: Eurostat Database.

There seems to be no clear association between changes in the employment rate and the three indicators of social inequality. For example, Germany, the most outstanding case that has transformed from one of the lowest to one of the highest employment rates, shows an increase in the at-risk-of-poverty rate with reductions in the educational and gender gaps. Similarly, among ten countries that show a decline in the educational gap, only five countries have achieved reductions in the poverty risk.

The ambiguity of the cross-national patterns deserves further investigation, given that the causal link between policies to extend working lives and multiple outcomes of social inequality has thus far not been clarified in the literature. Reforming public pensions and labour market institutions is anticipated to alter the dynamics of social stratification in retirement processes, as financial incentives for retiring early (so-called *pull* factors) are influenced differently by welfare state reforms among older workers depending on their socioeconomic positions (Mäcken et al., 2022). Such policy changes could also reshape poverty and income inequality before and after retirement. However, social inequalities in old age are not solely determined by pull factors. Individual and structural labour market constraints (*push* factors), such as differential health conditions, skill levels and access to job training across individuals as well as uneven impacts of macroeconomic conditions (Turek and Henkens, 2023), are expected to create unequal employment opportunities and thereby influence social inequalities at multiple levels.

In the following two sections, I first juxtapose theoretical approaches relevant to explaining old-age employment and retirement patterns both at country and individual levels. I then provide a review of empirical evidence focusing on the link between extending working lives and various aspects of social inequality. As I demonstrate throughout these sections, multiple strands of literature have often been disconnected

from each other when addressing issues that are closely linked.

Theoretical Lenses on Early vs. Late Retirement

The emergence of early retirement and its reversal have been explained from different perspectives that represent distinct disciplinary and analytical approaches in the social sciences. Economists have tended to focus on labour supply factors, in particular rational (individual) choice models of leisure-work trade-offs, known as the “option value” (Stock and Wise, 1990), stressing incentives to draw on pension benefits to maximise leisure over work at the earliest advantageous moment. Less consideration has been given to demand-side factors, such as employers’ interest in mandatory retirement to shed older workers (Lazear, 1979), particularly in seniority wage systems and due to insufficient training. Human resource management strategies to retain older workers are studied in the field of business administration. Industrial relations literature has highlighted the role of workplace representatives and collective bargaining partners in negotiating early retirement deals and the recent shift towards active ageing.

Political economy approaches (Conde-Ruiz and Galasso, 2003; Schmitt and Starke, 2016) have often applied cross-national time-series analysis to study intergenerational inequity, the partisan drive for welfare state expansion, favourable public attitudes towards earlier retirement, and vested interests in coping with deindustrialisation and the alleviation of mass unemployment since the 1970s. Welfare state regime (Esping-Andersen, 1996) and Varieties of Capitalism (Mares, 2003) approaches have been used to explain variations across countries in early retirement but also active ageing policies.

Sociological and gerontological studies concentrate on social class, gender-specific and age-gradient retirement patterns, stressing (dis)advantages accumulated over the life

course and reinforced by social norms. Life-course perspectives (Mayer, 2009) in social demography have been used to link working lives and retirement patterns, using event history and sequence analyses. Gerontological studies explore the age gradient of productivity (Skirbekk, 2008), the causes of deteriorating health and age-related disability, or the needed measures for active ageing, in particular prolonged working lives.

Table 2. Theoretical approaches explaining old-age employment and retirement patterns

Approaches	Analytical focus	Levels of analysis	Discipline
Labour supply models	Financial incentives provided by public pensions (implicit tax on work) and their impact on labour supply	Macro (policy) and micro (retirement decision)	Economics
Comparative political economy	Multiple pathways to retirement provided by welfare system (pull); institutional and structural factors making older workers redundant (push); investment in lifelong learning (retention); role of social partners	Macro (policies) and comparative exit patterns (outcome)	Politics, Sociology, and Social Policy
Culture and social norms	(Early) exit cultures; social norms towards working in old age; changes in preferences and expectations of the retirement timing (push and pull)	Meso (workplace practices) and micro (attitudes)	Sociology and Social Policy
Life course and social demography	Personal health; family/partnership situation (linked life courses); financial and non-financial motivation; impact of early life course on later outcomes	Micro (often longitudinal data)	Gerontology, Demography and Sociology

Four analytical approaches across different disciplines have evolved with the aim to explain changes in old-age employment and retirement patterns: (i) labour-supply models in economics; (ii) the comparative political economy approach to retirement mainly in

politics and sociology; (iii) the role of culture and social norms related to work and welfare but also attitudinal survey analyses (sociology and social policy); and (iv) gerontological and longitudinal studies focusing on life-course patterns and individual-level heterogeneities. The first two strands are primarily concentrated on macro-level structures shaping individual behaviour, while the latter two focus on meso- and micro-level factors (see Table 2 for a summary).

(a) Labour supply models

Labour economics explains labour supply as an outcome of rational retirement decisions (i.e. maximising utility) based on older workers' preferences with respect to work, leisure and consumption. Studies highlight how financial incentives set by social protection systems (mainly public pensions) shape individual retirement decisions and thus labour supply in the aggregate. Favourable pension conditions impose an "implicit tax" on continuing paid work. With diminishing wage prospects allegedly due to declining health and productivity in old age, high implicit tax rates tend to make paid work less attractive for older workers (for detailed accounts, see Blundell, French and Tetlow, 2016: 487-488). A standard model is the option value approach (Stock and Wise, 1990), which assumes that an individual decides to go on retirement by assessing the welfare gains of retirement versus continuing to work (and retiring later).

Economic studies using historical data have investigated the impact of public pensions (and other social benefits) on old-age employment (Blundell and Johnson, 1998), while further international research contends that delaying statutory pension ages and reducing pension benefits would increase elderly employment (Gruber and Wise, 1999, 2004). Overall, these studies demonstrate that such financial incentives account for cross-

national differences and changes in older people's labour supply as well as retirement timing. Recent studies also show that older workers' job search behaviour and their decision to delay retirement beyond pension age are also affected by pension rules, such as regulations on early retirement, actuarial adjustments and employer subsidies (Hairault, Sopraseuth and Langot, 2010; Börsch-Supan et al., 2021).

The economic models of labour supply are often criticised for unrealistic rationality assumptions, for example that workers make a "free" choice independent of their employers and maximise mainly financial gains. Moreover, these economic incentive-oriented approaches have been focusing on the *pull* factors (labour supply) but not as much on the *push* factors (labour demand), for instance why employers stop investing in updating older workers' skills or use labour shedding strategies during economic downturns. Few economists have looked at the labour demand side, the particular policies of employers to mandate retirement and their reversal (Lazear, 1979). With an increased shortage of skilled labour among younger cohorts, interests in active ageing policies and lifelong learning strategies have been developed to enhance older workers' productivity and retain them for a longer career.

(b) Political economy approach

The political economy approach to early retirement, arising mainly from comparative studies on retirement systems, combines pull and push factors and highlights interrelations between the set of policies, institutional configurations, social actors and structural conditions (Guillemard and Rein, 1993). Most studies engage with comparative historical analysis, investigating how different institutions offer analogous functions while seemingly similar policies serve different objectives depending on specific contexts.

Institutional approaches tend to study multiple “pathways” to retirement ranging from public pensions to other welfare institutions (Kohli et al., 1991). For instance, early retirement programmes were administered not only within public pension schemes but also by private occupational pensions to discharge older workers during industrial restructuring. Long-term unemployment benefits and generous disability pensions can also be used as pathways to exit from work and “bridges” until statutory pension begins. Since the 1990s, most European countries with massive early retirement have embarked on reform packages to phase out these pathways, following recommendations from international organisations (World Bank, 1994; OECD, 2006).

The pull factors associated with social protection systems often coincide with push factors that negatively affect the demand for older workers, accelerating early retirement trends. Salient push factors would be economic downturns, mass unemployment and the transition from the industrial to service economy that occurred in the 1970s and 1980s, which made older workers with obsolete skills least attractive to employers. Rising competition, uncertainty and technological changes stimulated by globalisation further raised the risk of older workers being redundant in many industries (Blossfeld, Buchholz and Kurz, 2011). These structural factors stimulating early retirement can be combined with institutional push factors, such as seniority-based wage structures and employment protections (Lazear, 1979). Employers would be reluctant to retain or recruit older workers when their productivity is perceived to decline or labour costs are significantly higher when keeping older workers.

Generous early retirement pathways had been facilitated by implicit negotiations between collective actors, mainly trade unions, employers and the state pursuing their own interests (Guillemard and Rein, 1993). Quite rationally, social partners seek ways to

deal with an economic crisis, and massive early retirement could be seen as an “unintended consequence” of achieving social rights and using them to find a socially acceptable way to downsize a redundant workforce (Ebbinghaus, 2006).

The recent literature identifies *retention* (or *stay*) factors that limit early retirement options and promote active ageing (Ebbinghaus and Hofäcker, 2013; Hofäcker, Hess and König, 2016). Those involve access to lifelong education and training opportunities managed by the state and social partners, and other active labour market policies (ALMPs), which take various forms depending on institutional contexts. Nordic countries and the Netherlands stand out among European welfare states in their spending on ALMPs and the participation rate in lifelong learning (Zaidi et al., 2017). Though many of these policies do not explicitly target older workers, those are needed prior to and during the late-career phase to maintain skills and productivity and thereby improve employment prospects for older workers. In contrast, ALMPs focusing on direct job creation in the public sector or subsidising private firms for hiring older workers, specifically targeting their career extensions, are predominant approaches in East Asian countries including South Korea and Japan (Clark and Ogawa, 1996; Choi, 2016).

Combining push, pull and retention factors, large-N comparative studies on the political economy of retirement often exploit regime-based approaches (Blossfeld, Buchholz and Kurz, 2011). The literature largely builds on the previous work of labour market institutions (Mares, 2003) and social protection-related welfare regimes (Esping-Andersen, 1996). Cross-national studies of OECD countries differentiate high-employment regimes in social democratic Nordic countries, liberal market economies such as the US and UK, and more residual models as in Japan, from early-exit regimes in continental, Southern and Eastern Europe (Ebbinghaus and Hofäcker, 2013). Continental

Germany and the Netherlands stand out as they show a successful reversal of early retirement.

Recently, comparative studies have also analysed cross-national outcomes of policies to reverse early retirement and promote active ageing. While studies often use employment rates of older age groups (Kuitto and Helmdag, 2021) or cohort-specific exit rates (Ebbinghaus, 2006), the active ageing index (AAI) provides a comprehensive overview of how countries differ in achieving multiple goals of active ageing by measuring not only employment but also social and cultural contributions of and enabling environments for older people (Zaidi et al., 2017; Olivera, 2022). The AAI incorporates various indicators of policy outcomes, from older people's employment rates and poverty risks to physical and mental health, access to lifelong learning and social connectedness.

(c) Culture and social norms

Age-related welfare culture in the form of shared values, social norms or common practices is intangible, yet it shapes welfare policies towards older people, working ethos, and retirement expectations (Maltby, Vroom and Øverbye, 2004). Welfare-related values are the basis of social policy, as the former is connected to the latter via ideas and interests of social actors. Pfau-Effinger thus defines “welfare culture” as “values, ideals, stocks of knowledge in relation to welfare state policies” (Pfau-Effinger, 2005: 4-5). The impact of policy changes on the behaviour of social actors is also moderated by culture and social norms when values lag behind an exogenous institutional change.

While there has been a debate on “work ethics” since Weber, the social norms with respect to working in old age and the timing of retirement have been noted as particular “exit cultures” (Maltby, Vroom and Øverbye, 2004). In many continental European

countries, an early exit culture had developed outside agriculture and self-employment, particularly since growing mass unemployment in the 1970s, while Nordic countries, Anglophone market economies and Asian societies promoted longer working lives to a larger degree. Cultural scripts are not inert, as discursive institutionalism claims that ideational changes through political and societal debates evolve, such as the paradigm shift towards active ageing advanced by international organisations (López-López and Sánchez, 2020).

Overall welfare principles and the specific exit culture are societal phenomena, but these values and norms affect individual behaviour and organisational practices. In the case of retirement, age-related norms operate as both push and pull factors. On the one hand, age-discriminatory stereotypes among employers who perceive older people as slower in adapting and less productive restrict opportunities for older workers in the labour market (Walker and Maltby, 2012; Karpinska, Henkens and Schippers, 2013). On the other hand, public pensions confer moral justifications for welfare dependency during retirement in compensation for lifetime dedication to paid work and the social right of a ‘deferred wage’ (Kohli, 1987). These age-related rules are not merely financial incentives but reinforce deep-seated age boundaries within the ‘institutionalised life course’ (Mayer and Schoepflin, 1989).

Empirical survey research has studied cross-national differences and trends in age-related norms and expectations. While European attitudes have been adjusted towards later retirement across countries, there are still socioeconomic differences (Radl, 2012). Higher-educated older workers have increased their preferred retirement age more than their lower-educated peers, presumably due to their better understanding of pension regulations and favourable working conditions with greater autonomy and less physical

demand (Hess, 2017). However, adjustments in preferred and expected retirement ages are not always in sync as expectations tend to follow the direction of institutional changes, but preferences are shaped by personal circumstances and societal norms. In Germany, for example, the increase in expected retirement age was stronger among low-skilled workers, who were most likely to be affected by the phasing-out of early retirement pathways, the implementation of training programmes and subsidised employment for older workers, whereas the preference towards later retirement was greater among high-skilled workers (Hess, 2018).

(d) Life course and social demography

Beyond the macro-economic and institutional analyses, gerontological (Moen, Sweet and Swisher, 2005; Raymo et al., 2011) and micro-sociological studies (Visser et al., 2016) explore retirement decisions under given institutional rules and welfare incentives. They explore individual characteristics including health, personal and household financial situation, gender and marital/partnership status but also work preferences and past work trajectories.

Among various individual characteristics, good health is universally recognised as a precondition for older workers' labour market participation (Blundell et al., 2023), while bad health or disability is a push factor that leads to early exit from work (van Rijn et al., 2014), be it due to the personal needs of individuals, the availability of pathways or discrimination by employers. Similarly, having chronic conditions or disabilities significantly reduces the likelihood of working longer (Oksanen and Virtanen, 2012; Schofield et al., 2017).

From older workers' perspectives, staying in paid work is motivated by both financial

and non-financial reasons (Scherger, 2015). Financial reasons to continue working could be insufficient retirement income or the wish to ensure additional savings for retirement. Qualitative research reveals that marital/partnership status and other social reasons also matter; for instance, maintaining social contact and daily routine and enjoyment of work are important motivations to remain employed (Hokema and Scherger, 2016). Studies also underline the significance of workplace arrangements, such as better time control and less physical demand (Carr et al., 2016; Virtanen et al., 2017).

Sociological research adopting a life-course perspective studies the impact of earlier life events on employment outcomes at older ages and its variation across cohorts and socio-demographic groups. The life-course framework conceptualises human lives from early childhood to old age into several phases and investigates how transitions between different life stages occur and how events in earlier stages affect later outcomes (Elder, 1994). From this viewpoint, age is less of a biological category than a time-specific social structure, and the individual life course is structured in multiple social domains, such as work and family. Individual life courses might also be 'linked' through cohabitation or care responsibilities. Life course researchers study how individual outcomes evolve differently by socio-demographic characteristics, such as gender, marital status, education and family background. They also investigate how life trajectories interact with temporal, institutional and cultural contexts, often studied through a mix of longitudinal, cross-cohort and cross-national research designs (Mayer, 2009).

From this perspective, late careers (above age 50 and even beyond pension ages) could be understood as an outcome of an individual's family context (Bennett and Möhring, 2014; Worts et al., 2016). Work orientations of older adults differ by gender and are influenced by one's family situation and marital/partnership status. For instance,

divorced women are more likely to be in paid work in old age than partnered women, given financial needs or desire to keep social contacts (Hokema and Scherger, 2016). For couples, retirement is often a joint decision induced by eligibility for pension receipt and their preferences to spend leisure together (or to look after grandchildren). Older women who are secondary earners often choose to retire in sync with their partner, while welfare benefits such as spouse's allowances can also affect the labour supply of main earners, though mostly men (Baker, 2002).

Life-course studies also find that gender differences in labour force participation are influenced by earlier life events and work history. For example, older women are less likely to remain employed as a result of volatile careers related to family or care responsibilities (Worts et al., 2016). Personal characteristics and life course trajectories often interact with institutional and cultural contexts, as evident from cross-national research (Möhring, 2016). Different extents of gendered career histories across countries would thus lead to societal differences in early or late retirement.

Social Inequalities in Old Age: Empirical Literature

While earlier studies on welfare states focused on cross-national variations in institutional pull, push and retention factors shaping retirement patterns, they often overlooked individual-level differences associated with policies of extending working lives. More recently, social inequalities in old age have gained sizeable attention across social science disciplines, as the policy transitions raise concerns about their potential consequences on older people in socially disadvantaged positions. The evolution in the literature has been facilitated by wider usage of internationally comparable panel surveys targeting older populations, such as the English Longitudinal Study of Ageing and the

Survey of Health, Ageing and Retirement in Europe.

Understanding social inequalities related to extending working lives is not a simple task as these are multidimensional and influenced by various individual, socio-cultural and institutional factors. In this threefold section, I focus on social gradients in extending working lives as well as their causes and consequences. I first review empirical studies on late working lives to understand how socioeconomic differences in late careers are shaped by multiple individual and societal factors. The second and third parts of this section survey post-retirement inequalities linked with extending working lives, including income, health and subjective well-being.

(a) Socioeconomic differences in late careers and retirement timing

Studies on late-career inequalities are often interested in socioeconomic differences in retirement timing or the risk of premature retirement. These are mainly micro-level studies that partly overlap with gerontological and life-course research focusing on individual-level heterogeneities in extending working lives. Yet, this body of literature puts more emphasis on the social stratification of retirement processes by the level of education, occupational class and gender (Turek and Henkens, 2023). The literature also involves comparative studies exploring the relationship between institutions and social inequalities (Ebbinghaus and Radl, 2015; Mäcken et al., 2022).

In most high-income countries, higher-educated older workers tend to stay longer in employment, though the educational gradient can be reversed under weak welfare states (Floridi, 2023). While old-age employment has universally increased in recent decades, its educational differences have not diminished necessarily and vary substantially across countries (Riekhoff and Kuitto, 2022). Occupational differences also show similar

patterns, where high-skilled workers enjoy better employment prospects, flexibility and autonomy, and hence retire later (Wahrendorf et al., 2017). Low-skilled or manual workers, on the other hand, are at higher risk of early retirement for involuntary reasons like unemployment and disability (Radl, 2013; Visser et al., 2016). Such disparities between social class positions in late careers and retirement processes are explained by differential health (Carr et al., 2018; Schuring et al., 2019), job-related stress and working conditions (Wahrendorf, Dragano and Siegrist, 2013) as well as the risk of unemployment (Heisig and Radl, 2017). However, when looking at individuals who work beyond the normal retirement age, the educational gradient is U-shaped, where high- and low-educated workers are both expected to retire latest (Hofäcker and Naumann, 2015). The low-educated group working until those ages is likely due to financial constraints.

Gender is another crucial dimension of social inequalities in old-age labour markets, as older women tend to be employed less and retire earlier than men in almost all countries (Radl, 2013; Turek, Henkens and Kalmijn, 2024). Educational inequalities are also larger among women than men due to very low and stagnant employment rates among low-educated women (Riekhoff and Kuitto, 2022). The gender gap in late careers is partly explained by lower levels of education among older women on average but is mainly attributed to persistent gender norms and women's weaker attachment to the labour market due to family obligations (Worts et al., 2016).

(b) Poverty and income inequality after retirement

As economic inequality in old age has become an emerging concern in advanced welfare states after pension reforms, many studies with varying approaches have recently explored poverty and income inequality after retirement and their link with rising old-age

employment. Nevertheless, the relationship between extending working lives and later-life inequality is not straightforward, because social policies regulating access to social transfers around normal retirement ages affect both retirement processes and income inequality (Fasang, 2012). All other factors remaining constant, longer careers and higher employment rates in old age among low-educated workers or women would enhance their pension adequacy and reduce poverty risks. However, as the activation has been done through retrenchments in pensions and other social transfers, these policy changes could rather limit financial resources among those conventionally underemployed groups.

Recent studies in labour economics demonstrate that policies solely addressing financial incentives for labour supply would result in unintended (negative) consequences among less privileged older adults. For example, a study by Etgeton (2018) shows that raising the normal retirement age by two years in Germany is expected to increase the actual retirement age by only 0.7 years, while poverty risks among low-educated and blue-collar workers would rise significantly. This is because lower-skilled groups are likely to face involuntary job loss and limited employment opportunities while early access to pension income is restricted. An evaluation of the French pension reform in 2010 by Rabaté and Rochut (2020) reports similar findings.

Findings from macro-comparative studies in social policy are consistent with these results. For instance, reducing the generosity of public pensions is associated with rises in old-age poverty and income inequality across high-income countries (Been et al., 2017; Kuitto, Madia and Podestà, 2023). A case study of the Swedish pension reform in the 1990s also finds that relative poverty and income inequality increased among Swedish pensioners following the reform (Gustafsson, Johansson and Palmer, 2009). Among individual-level longitudinal studies, Riekhoff and Järnefelt, (2018) show that some of

the older workers in Finland working beyond the normal retirement age tend to experience a steeper drop in income after retirement, implying that their long working lives would be due to expectations of insufficient pension income.

Nevertheless, some studies suggest that extending women's careers would in the long run help reduce the gender gap in retirement income. For example, a study by Gornick and Sierminska (2021) shows that the strongest determinant of women's retirement preparedness, measured by their wealth accruals, is previous years of work experience. A longitudinal study by Heisig (2015) also finds that whereas men's income losses after retirement were augmented after public pension cuts, longer careers and higher lifetime earnings among women countervailed the loss and led to their greater retirement income. Contradictory findings by gender reflect the fact that women's pension income has been historically low due to their shorter careers in the past.

(c) Health and well-being effects of longer working lives

While it has already been well-documented that good physical and mental health is a necessary condition for working longer, the impact of extending working lives on health and subjective well-being is less clear-cut. This is not only because the health and well-being effects of later-life working are contextual but also due to endogeneity and selectivity bias in empirical estimation – those who are in good health are more likely to work longer and at the same time show better health outcomes after retirement.

Working at older ages can have both positive and negative impacts on one's health and well-being, and there are reasonable grounds for both arguments. From a psychological perspective, staying in paid work can have intrinsic values and meanings for older adults beyond financial gains (Moen, 1996). Qualitative studies demonstrate that

staying in paid work can be a way of maintaining personal connections and keeping active and healthy lifestyles among pensioners (Hokema and Scherger, 2016; Sewdas et al., 2017). The psychological value of work is now recognised even in economic studies, where work has been conventionally treated as ‘disutility’ or an antonym of leisure (Hussam et al., 2022). On the other hand, negative aspects of extending working lives include a bigger exposure to daily stress and time constraints, which are augmented when the job is physically or mentally demanding.

Empirical studies report mixed findings that underline the significance of social contexts in retirement processes. Studies report that older adults show improvements in health and subjective well-being immediately after making the transition from work to retirement, as they get more leisure time and less job-related stress and thereby develop healthier habits, such as more exercise (Kim and Moen, 2002; Insler, 2014). However, being in retirement gradually deteriorates one’s mental health and life satisfaction since one’s personal identity, social network and cognitive activities are strongly attached to paid work (Mazzonna and Peracchi, 2017). The positive well-being effect of staying in employment is often stronger for men, especially in societies with strong male-breadwinner obligations (Kim and Moen, 2002; Ashwin, Keenan and Kozina, 2021).

The health consequences also involve social gradients based on individuals’ job characteristics. For example, Mazzonna and Peracchi (2017) find that, unlike most other workers, those who were previously in physically demanding jobs enjoyed a positive health effect immediately after retirement. Similarly, poor physical and mental health outcomes among older workers are significantly associated with high physical demands, job strain and low autonomy, which are concentrated in low-skilled sectors (de Breij, Huisman and Deeg, 2020). Therefore, health gains from retirement are often positive

among older workers in low-status occupations (Abeliansky and Strulik, 2023).

Moreover, extending working lives through ‘economic coercion’ also twists the health and well-being consequences of working longer. Many studies show that older people who stayed in paid work due to insufficient retirement income report lower subjective well-being than their retired counterparts (Di Gessa et al., 2018; Ashwin, Keenan and Kozina, 2021). Evidence from Italy also demonstrates that those who experienced longer unemployment spells in old age and were not adequately protected by social transfers show higher post-retirement mortality rates after controlling socio-demographic characteristics and occupational class (Scotti, 2022).

Overall, empirical studies from various disciplines suggest that voluntariness matters. Extending working lives can improve one’s health and well-being when the decision to work longer is voluntary and not driven by financial constraints, though financial and social motivations are not always clear-cut or mutually exclusive. Nevertheless, our takeaway from the existing evidence is that older workers seeking to prolong careers should be provided with better choices rather than facing economic coercion.

Analytical Approaches and the Structure of the Thesis

In summary, the relationship between extending working lives and social inequality in old age is complex to understand, not least due to its context-conditionality but also its multidimensionality. The development of old-age inequality after major welfare state reforms would depend not only on policy designs tackling pull factors but also on push and retention factors shaped by institutional arrangements as well as macroeconomic and social conditions. Different dimensions of inequality do not always evolve in the same direction, for example closing down early retirement routes may reduce socioeconomic

differences in later-life employment but at the same time increase poverty risks among underemployed or disadvantaged groups. Nevertheless, the literature often demonstrates a disconnection between comparative institutional analysis, social stratification in late careers and post-retirement inequality outcomes, which can limit the understanding of complex phenomena, though several studies are exceptions (Fasang, 2010; Blossfeld, Buchholz and Kurz, 2011; Möhring, 2015; Mäcken et al., 2022).

This doctoral thesis lies in the intersection of these distinct but interrelated bodies of literature by investigating the recent dynamics of old-age inequality related to extending working lives. The thesis consists of four independent empirical papers based on diverse analytical approaches using both macro- and micro-level data. The first two of them are comparative quantitative studies analysing country-level panel data (Paper 1) and cross-country harmonised individual-level data (Paper 2), involving 21 and 26 advanced economies, respectively. The large-N comparative design is intended to highlight the significance of institutional contexts across countries under different time frames – from the late 1990s until the pre-2020 era when the impact of common policy shifts had gradually unfolded (Paper 1) and after the recent COVID-19 crisis (Paper 2). The selection of countries is based on the availability and quality of internationally harmonised datasets from various sources.

The third and fourth papers are single-country studies to expand the focus to the micro-level dynamics of retirement processes and policy outcomes. Paper 3 adopts cohort-based longitudinal analysis because the influence of institutional and macro-social changes on individuals' late working lives would vary within societies by individuals' socioeconomic position. Germany is selected as an ideal-typical case that has gone through radical institutional and socio-economic transitions since the late 20th century

that are likely to transform retirement patterns. Paper 4 shifts the focus to poverty after the age of 65 in Korea, the outlier case with the highest retirement age and old-age poverty. The study adopts a quasi-experimental design to estimate the impact of specific pension reforms expanding non-contributory pensions on poverty and employment outcomes.

Table 3 presents an overview of the main research questions, case selection and analytical approaches of each paper.

Table 3. Overview of the thesis

No.	Main Question	Units	Case Selection	Data	Methods
1	Why did social inequalities evolve differently across countries after similar public pension cuts?	Macro	20 European countries & United States	OECD, EU-LFS, US-CPS	Error correction models
2	Despite the COVID-19 crisis, why did old-age employment in Europe show relatively minor disruptions?	Macro & Micro	26 European Union Member States	SHARE Corona Survey	Cross-country multilevel modelling
3	Do social stratification in retirement transitions persist after major early retirement reforms?	Micro	Germany	SHARE-RV	Sequence & cluster analysis
4	Do basic/targeted pension schemes reduce old-age poverty without reducing employment?	Micro	South Korea	KHIES	Difference-in-difference

Paper 1, *Varying Effects of Public Pensions: Pension Spending and Old-age Employment under Different Pension Regimes*, surveys how pension reforms affect old-age employment rates (also poverty rates in supplementary analysis) among different gender/educational groups and how these effects vary across countries with different institutional designs of public pensions. Using time-series cross-section data from 20 European countries and the United States from 1998 to 2019, the study employs error

correction models to estimate the associations between public pension spending and group-specific employment rates under varying institutional structures of public pensions. Findings show that, while the employment rate of low-educated workers and women's poverty risk were disproportionately affected by pension spending changes, the estimated effects vary between insurance-based systems and tax-financed flat-rate systems.

Paper 2, *Old and New Welfare States Retaining Older Workers in the Face of Crisis: The Case of COVID-19 in Europe*, explores how cross-country variations in 'new' social policy responses to the COVID-19 crisis and 'old' welfare state institutions explain early exit from work in Europe during the pandemic. Using multilevel models to analyse the SHARE Corona Survey, a cross-national panel survey targeting older adults, the study examines the association between a set of institutional indicators and older workers' medium-term exit rates after COVID-19, and how the association varies by one's education level. Results show that novel job retention schemes and extended unemployment insurance in 2020 had opposite effects on older workers' retention, whereas existing pension institutions strongly moderated exit outcomes during the crisis, especially among lower-educated workers.

Paper 3, *Convergence or Continued Stratification? Late Working Lives and Retirement Trajectories in Germany*, investigates the dynamics of social stratification in retirement processes and their pension income consequences following major institutional and socio-economic transformations in Germany. The study uses administrative pension insurance records linked with survey data (SHARE-RV data) and combines sequence and cluster analyses to study the late working lives of several cohorts in Germany across three decades until 2019. Results demonstrate a gradual shift from early retirement to standard retirement trajectories, with persistent disparities by

education level. Women's rising later-life employment has been driven more by flexible/part-time trajectories than standard forms, while some convergence was observed between East and West Germans. The social stratification of retirement trajectories also partly explains pension income inequality, net of socio-demographic characteristics and work histories.

Paper 4, *Old-age Poverty in a Pension Latecomer: The Impact of Basic Pension Expansions in South Korea*, examines the impact of implementing means-tested, non-contributory pensions to a latecomer contributory pension system, based on the recent expansions of the Basic Pension scheme in South Korea. Using the Korean Household Income and Expenditure Survey from 2011 to 2019, the study adopts a difference-in-difference design to estimate causal effects of three major benefit increases on older people's poverty, employment and other income sources. The study finds that the series of policy reforms have effectively reduced older people's poverty rate without crowding out their employment outcomes, supporting the significance of the income floor.

Overall, the four empirical studies employ various methodological approaches from macro-comparative analysis to longitudinal and quasi-experimental designs to address respective research questions under the common theme of old-age inequalities. They also build on theoretical frameworks from multidisciplinary fields, including comparative social policy, social stratification, demography and impact evaluation studies. This thesis thereby contributes to the consolidated understanding of pension systems, labour market institutions, social stratification in late careers and retirement income inequality.

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Paper 1

Varying Effects of Public Pensions: Pension Spending and Old-age Employment under Different Pension Regimes

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Abstract

Socioeconomic consequences of pension reforms have often been discussed without careful consideration of institutional contexts, despite the fact that institutional designs of public pensions differ substantially across countries. This study argues that the outcomes of pension reforms vary depending on the institutional structure of public pensions, by showing that the associations between public pension spending and old-age employment rates of different socio-demographic groups vary across different institutional contexts. Using time-series cross-section data from 20 European countries and the United States from 1998 to 2019, the study examines how changes in public pension spending ‘per older person’, a comparable measure for the welfare state effort towards old-age income security, are associated with gender- and education-specific employment rates in old age. The study also explores how these associations differ under different pension regimes, constructed based on the degree to which financing and benefit structures exhibit redistributive orientations. The results reveal complex gender and educational gradients in the relationship between public pension spending and old-age employment. Female employment rates, especially among the low-educated, are more sensitive to changes in pension spending in the ‘Beveridgean’ regime that focuses on basic income security. In the Bismarckian regime characterized by earnings-related pensions, educational differences in the marginal effects on male employment rates are particularly larger. Future pension reforms balancing the goal of activation and social equity should therefore consider the longstanding institutional design of public pensions.

Key words: public pensions, old-age employment, welfare states, social inequality, time-series cross-section analysis

Introduction

Extending working lives and increasing labour force participation among older people have been major policy goals in advanced economies, primarily motivated by fiscal restrictions resulting from ageing populations and economic downturns. Since the 1990s, when international organizations promoted restructuring public pensions and welfare programmes for “averting the old-age crisis” (World Bank, 1994), mature welfare states have reformed public pensions and social policies to reverse the trend of massive early retirement and limit the growth of public spending (Ebbinghaus, 2006).

However, concerns have been raised as retrenchments in public pensions are also associated with rising economic inequality in old age (Been et al., 2017; Kuitto et al., 2023). Studies on the social stratification of retirement processes demonstrate that less-educated or lower-skilled workers are at higher risk of involuntary early exit from work due to unemployment and health-related issues (Radl, 2013; Riekhoff, 2018; Visser et al., 2016). Thus, simply raising the normal retirement age or reducing financial support for early retirement may disproportionately affect older people with low socioeconomic status (SES) and worsen income inequality (Etgeton, 2018). Older women with insufficient work history, especially those divorced or widowed, are also vulnerable to public pension cuts (Möhring, 2015). Without providing better labour market opportunities and working conditions, low-SES older workers may find it unjust to be forced to work longer due to financial hardships.

Therefore, investigating how public pensions shape old-age employment differently across different socio-demographic groups would offer significant policy implications for balancing the goal of activation and social equity. Two important gaps are identified in the existing literature regarding this issue. First, only a few studies explore heterogeneous

outcomes among different SES groups when examining the impact of pension reforms (Etgeton, 2018). Most empirical studies, often in labour economics, focus on the aggregate labour-supply effects of pension reforms but less on their socioeconomic differences (Geyer and Welteke, 2021; Rabaté and Rochut, 2020).

Secondly, the literature has yet to investigate how different institutional structures of public pensions shape the consequences of pension reforms differently. Depending on the longstanding institutional design, for example whether the entitlement and benefit levels are conditional to contributions or whether public schemes crowd out private pension markets, the same reform may have different meanings for individuals with different SES. Even comparative studies that put emphasis on the role of institutions have been less concerned about the varying outcomes of pension reforms under different institutional structures of public pensions (Duval, 2003; Ebbinghaus, 2006; Hofäcker et al., 2016; Kuitto and Helmdag, 2021).

This study addresses these gaps by investigating how old-age employment among different socio-demographic groups responds differently to pension system changes, and how these relationships vary across different institutional contexts. Using time-series cross-section data from 20 European countries and the United States from 1998 to 2019, the study examines how public pension spending ‘per older person’, a comparable measure for the welfare state effort towards old-age income security, is associated with gender- and education-specific employment rates in old age. The study also explores how these associations vary under different pension regimes, constructed based on the degree to which the financing and benefit structures of public pensions aim for poverty alleviation as opposed to income maintenance after retirement.

The results show that female employment rates, especially among the low-educated,

are more sensitive to changes in pension spending in the ‘Beveridgean’ regime that focuses on basic income security. In the ‘Bismarckian’ regime characterized by earnings-related pensions, educational differences in the marginal effects on male employment rates are particularly larger. Overall, our findings reveal complex gender and educational gradients in the relationship between public pension spending and old-age employment, depending on the institutional design of public pensions. In the end, we argue that future pension reforms balancing the goal of activation and social equity should consider the longstanding institutional design of public pensions.

Recent Pension Reforms in the Context of Active Ageing

Recent decades have seen a shift in policy strategies from early retirement to active ageing across Western welfare states, with the aim of increasing economic activity among older adults. To explain cross-national variations in the transition, comparative institutional studies since the 1990s have approached the phenomena from push and pull perspectives (Ebbinghaus, 2006; Guillemard and Rein, 1993). The *push* perspective highlights structural constraints faced by older workers in the labour market. Those include augmented unemployment and health risks in old age, outdated skills due to technological changes and seniority-based labour costs that discourage employers from hiring older workers. On the other hand, the *pull* perspective problematizes public pensions with generous early retirement options and other welfare programmes, mainly unemployment and disability benefits, that impose “implicit taxes” on continued employment (Duval, 2003; Gruber and Wise, 2004). The literature also recognizes the importance of active labour market policies such as lifelong learning and training, public employment services and subsidies for hiring older workers, referred to as *retention*

factors (Ebbinghaus and Hofäcker, 2013; Hofäcker et al., 2016).

Among numerous institutional and structural factors, the focus of this study narrows down to public pensions – cash transfers provided by the state for retirement income security, either through benefits at a minimum level or in proportion to previous earnings and contributions. Public pensions are not only the biggest welfare state institution that accounts for about a third of social expenditures in OECD countries (OECD, 2019), but also represent the main *pull* factor that shapes financial incentives for older workers to stay in paid work. Therefore, extensive pension reforms have been implemented across Western welfare states particularly during the 1990s and 2000s to enhance public pensions' fiscal sustainability and promote older workers' activation amidst rapid demographic ageing,

Most reform measures have involved gradual, parametric changes aimed at reducing the ratio of total benefits to total contributions in public schemes. Nevertheless, some structural reforms have expanded the role of private pension provisions or introduced market mechanisms into public pensions, such as defined-contribution principles (Hinrichs, 2021; Hinrichs and Lynch, 2021). Key adjustments in recent decades included terminating special early retirement programmes and restricting early pension withdrawals through actuarial deductions, primarily in continental Europe but also in Finland. Moreover, statutory retirement ages have been lifted to promote later retirement and limit the ratio of pensioners to workers. Notably, state pension ages for women have undergone significant increases as part of the EU-wide gender-neutral pension policy, as observed in Belgium, Italy, Sweden, Finland, Slovakia, Czechia, the UK and the USA (Carone et al., 2016; Dewitt and Berkowitz, 2014).

Overall benefit generosity has also been reduced by modifying the methods of benefit

calculations. In many public earnings-related schemes, benefit levels are no longer determined based on one's peak earnings but on average lifetime earnings. Contribution periods required for the full benefit entitlement have also been lengthened. Similarly, demographic parameters, such as life expectancy at retirement age or the system dependency ratio, have been incorporated into benefit calculations in Nordic countries as well as Germany, Austria, Spain and Portugal (Hinrichs, 2021). More radical shifts have occurred in Sweden and Italy, where notional accounts combining defined-contribution principles with pay-as-you-go financing have been established. Similar moves were also present in Eastern Europe (e.g., Poland, Hungary and Slovakia), although public schemes were quickly reinstated following the financial market crash of 2008 (Naczyk and Domonkos, 2016).

Heterogeneous Effects of Pension Reforms by Education Level and Gender

Most of these reform measures were oriented towards cutting public expenditures or limiting their growth.² They were also aimed at increasing older adults' labour market participation by altering their financial incentives, which are often labelled as 'implicit taxes' on continuing work at older ages (Gruber and Wise, 2004). It is therefore straightforward to expect that a decline in public pension spending or other indicators of pension generosity would be associated with higher employment rates of older people.

However, the impact of these reforms may be heterogeneous depending on one's SES. This is because low-educated or low-skilled workers are more likely to exit from work

² Some reforms contained expansionary elements to address "new social risks" (Bonoli, 2005), for example introducing or raising minimum pensions, extending pension coverage to non-standard workers and introducing childcare credits. Nonetheless, the predominant trend was geared toward retrenchment.

earlier than high-educated workers and more often rely on public early retirement benefits (Radl, 2013; Visser et al., 2016). Some reform measures, especially in continental Europe, were explicitly aimed at tackling this by terminating pre-retirement programmes or restricting pension withdrawals. Empirical studies confirm that raising the normal retirement age and reducing pension generosity tend to hit low-income groups hardest (Etgeton, 2018) and are associated with higher old-age poverty (Been et al., 2017; Kuitto et al., 2023). The employment effects of public pension reforms would thus be greater among low-educated older adults as they are more likely to experience financial hardships than high-educated groups due to retrenchments in public pension systems (Hypothesis 1).

Likewise, older women's employment rates are anticipated to be more influenced by pension reforms than those of men, primarily due to differences in their reliance on public pension income. Older women in general have shorter employment histories and weaker attachment to the labour market than men, largely due to persistent gender norms and family obligations (Worts et al., 2016). Their frequently interrupted careers are strongly associated with inadequate wealth accumulation in later life (Gornick and Sierminska, 2021), which can be compensated by public pension schemes (Möhring, 2015). Furthermore, reform measures in many countries included raising the normal retirement age only for women to achieve gender-equal retirement age. Therefore, older women's employment rates may show bigger increases following pension reforms and may be more strongly associated with public pension generosity than those of men (Hypothesis 2).

Cross-national Variation in the Structure of Public Pensions

The distributional consequences of public pension reforms and the related employment effects among heterogeneous social groups may also vary across countries with different institutional structures of public pensions. For example, the outcomes of activation and income inequality among older adults after reducing benefit generosity or limiting access to early pension withdrawals would differ between a system that guarantees only a basic level of benefits and a system that offers sufficient retirement income also for middle- and high-class workers. Even comparative studies in the literature have barely taken this aspect into account when evaluating the role of public pensions, often assuming similar effects across countries (Börsch-Supan et al., 2021; Duval, 2003; Kuitto and Helmdag, 2021).

The classic approach to understanding institutional variations in pension systems among Western welfare states is the division between Beveridgean and Bismarckian regimes (Hinrichs and Lynch, 2021). This classification focuses on the redistributive orientations of public pensions reflected in their financing and benefit structures as well as their interactions with state-regulated occupational and private schemes.

The Beveridgean system is known for its explicit goal of poverty alleviation by providing basic income security in old age financed through general taxes. Typical cases include state pensions in the UK and Ireland, where the basic state pension is provided conditional to tax-like contributions. In the Netherlands and Denmark, public expenditures on old-age pensions are concentrated on residence-based universal basic pensions. Since public pensions in Beveridgean systems mostly offer flat-rate benefits regardless of previous earnings, the overall level of public spending is generally not very high. Moreover, private pension markets are well-developed for middle and high earners,

either through (quasi-) mandatory occupational schemes (Denmark, Netherlands) or voluntary schemes (UK, Ireland).

On the other hand, Bismarckian systems feature contribution-based financing and earnings-related benefit structures, primarily aimed at consumption smoothing or status maintenance after retirement. Examples are found in most mature public schemes in continental and Southern Europe, including Germany, Austria, France, Italy and Spain but also Finland, along with East European latecomers. Sweden also joined this group in the late 1990s after introducing notional accounts and restructuring the universal basic pension into a means-tested guarantee pension. The ideal-typical Bismarckian system would offer similar replacement rates for high- and low-wage earners with a low or no income ceiling. Thus, private pension schemes are usually underdeveloped.

However, the dichotomy between Beveridgean and Bismarckian pensions may oversimplify the reality, as contemporary pension systems often exhibit the features of both. Though most parametric reforms have not fundamentally altered the core financing and benefit principles within public schemes, some systems now contain a mixed nature. For example, basic or minimum pensions are supplemented by contributory schemes with low-to-median income ceilings (Norway, Belgium) or by highly redistributive defined-benefit schemes that provide low replacement rates for high earners (Czechia). Similarly in the USA, redistributive defined-benefit pensions are complemented by means-tested benefits. In Switzerland, public pensions offer earnings-related benefits, but its low maximum benefit effectively renders the system highly redistributive.

It is important to note that a high degree of redistributive orientation does not necessarily lead to generous payments for low-income households or equitable societal outcomes. The distinction between Beveridgean and Bismarckian regimes mainly

considers the financing and benefit structures of public pensions, which pertain to the allocation of available budgets (or how given expenditures are distributed), not the size of these budgets. For instance, the Austrian public scheme, one of the most ideal-typical Bismarckian cases, provides significantly higher replacement rates for low-income individuals than Beveridgean state pensions in the UK and Ireland (OECD, 2019).

Varying Outcomes under Different Pension Regimes

Based on the classification of pension regimes, our hypothesis is that the consequences of pension reforms among different socioeconomic groups would vary across pension regimes. This is because varying extents of redistribution achieved by a public system may shape different patterns in labour market outcomes among high- and low-SES older adults.

A related theoretical idea can be traced back to (Korpi and Palme, 1998) seminal work on the “Paradox of Redistribution”, suggesting that a high degree of low-income targeting in social policy tends to shrink the base of political support for overall redistribution, resulting in poorer redistributive outcomes. In the context of public pensions, earnings-related Bismarckian systems that encompass the middle and upper class are likely to crowd out private pension markets. A limited role of private pensions would lead to more redistributive outcomes in countries with Bismarckian pensions than in Beveridgean systems, where a greater reliance on private schemes tends to drive higher income inequality. Following this line of reasoning, educational differences in the impact of pension reforms may be more pronounced in Bismarckian systems than in Beveridgean systems (Hypothesis 3a). Differences in employment outcomes in Beveridgean countries are more likely to be determined instead by inequalities in private pension income.

However, one might argue that (Korpi and Palme, 1998) work did not measure the direct effects of specific policies and was merely comparing the overall societal outcomes of 11 countries cross-sectionally. Their idea has been challenged by empirical studies using more recent data and sophisticated methods, which demonstrate that targeting can be an effective tool for redistribution, especially in countries with high social spending (Brady and Bostic, 2015; Marx et al., 2013). Similarly, evidence on pension institutions using microdata shows that basic or targeted pensions effectively compensate for low pension accruals of older people with non-standard employment histories (Möhring, 2015). Therefore, an alternative hypothesis regarding the regime variation would be that educational differences in the impact of public pension retrenchment are larger in Beveridgean than in Bismarckian systems (Hypothesis 3b). This is because the low-SES group's poverty risk and thereby labour force participation may be more sensitive to the changes in eligibility age or benefit generosity in Beveridgean pension systems that focus on basic income security.

Research Design and Methods

Construction of time-series cross-section data and the dependent variable

To investigate the heterogeneous effects of public pension changes and their variations across pension regimes, this study draws on pooled time-series data of country-level institutional and economic indicators along with group-specific old-age employment rates in 20 European countries and the USA from 1998 to 2019. Pooled time-series cross-section (TSCS) analysis is well-suited for examining the role of institutions by leveraging both cross-national and temporal variations in policy-related variables. The selection of country cases was based on the availability of harmonizable labour force

survey data and macro-level indicators among OECD countries in recent decades. Countries with large numbers of missing values in the OECD data were excluded from the case selection.

The dependent variable is the *group-specific employment rate* estimated using micro-data from the European Union Labour Force Survey (EU-LFS) for European countries and the Current Population Survey (CPS) for the USA (Flood et al., 2022). Disaggregating the dependent variable by population sub-groups enables the examination of the heterogeneous effects of policy variables depending on one's socio-demographic characteristics. Therefore, employment rates were disaggregated by gender and three education levels.³

Two datasets were then created for the age groups of 60 to 64 and 65 to 69, respectively, since pension reforms may have predominantly affected the employment rates of older people in their 60s. Given that normal retirement ages have been around 65 in most countries, the effects of pension system changes may differ between the two age groups. The two age-specific datasets contain six gender-education groups for 21 countries observed over 22 years, yielding 2,772 observations in total when assuming no missing data.⁴

³ The level of education was coded based on the International Standard of Classification of Education (ISCED). ISCED 0-2 is defined as low-educated, ISCED 3-4 as mid-educated and ISCED 5-8 as high-educated.

⁴ In practice, missing values are present in the initial years for some countries, making an unbalanced panel structure. Observations start from 1999 for Germany and Ireland and from 2008 for the UK. In the dataset for the aged 65 to 69, some group-specific employment rates for Belgium (2000, 2003), Slovakia (2001, 2002, 2004) and the UK (2011) were imputed using linear interpolation as original estimates were unreliable due to large missing data in the EU-LFS.

Measuring public pension systems across countries and over time

Developing a comparable measure of public pension systems across countries and over time is the most challenging task in this macro-level TSCS study. Pension policies involve many dimensions, such as benefit generosity, eligibility criteria and coverage, and a single reform package tends to contain multiple measures in those dimensions. Thus, commonly used indicators, such as income replacement rates and normal retirement ages, can only partially capture the nature of pension systems across countries and their over-time changes. Moreover, these partial indicators may overlook complex or hidden details of pension reforms, including changes in benefit calculation formulas or demographic adjustment rules, conditions of early pension withdrawals and contribution requirements.

Therefore, this study instead develops a novel indicator of public pension spending *per older person*, conceptualized as ‘the overall welfare state effort towards old-age income security’. Despite criticisms on its conceptual ambiguity (Kühner, 2015), the comprehensive nature of pension spending has the advantage of encompassing every relevant dimension of pension policies. However, the problem with using public pension spending measured as a percentage of gross domestic product (GDP), a widely used OECD indicator, is that its variation is easily driven by structural factors rather than actual policy changes, such as demographic ageing and business cycles. This problem has already been discussed in the ‘dependent variable problem’ of comparative welfare state analysis (Clasen and Siegel, 2007). Dividing the aggregate spending by the number of older persons instead of GDP would account for varying population structures across countries and over time and are independent of economic cycles.

Public pension spending *per older person*, constructed as the main explanatory variable in this study, captures all public expenditures on old-age and survivors’ cash

benefits as well as special early retirement programmes.⁵ The total nominal spending was divided by the number of older persons aged 65 or over and then adjusted with constant price and purchasing power parity (PPP) using 2015 as the reference year to ensure comparability over time and across countries. The necessary data for the whole process were obtained from the OECD Social Expenditure Database (OECD, 2023). Since the full effects of pension reforms tend to materialize in the spending data with an extended time lag (Hinrichs, 2021), the impacts of major pension reforms implemented in the 1990s and early 2000s are expected to appear in relatively recent data.

Pension regimes and covariates

The *pension regime* is a categorical variable constructed based on the degree of redistributive orientations within public pension schemes. The variable is expected to moderate the relationship between public pension spending and group-specific employment rates. Country cases are classified into Beveridgean, Mixed and Bismarckian regimes, based on the qualitative description of financing and benefit structures in the OECD's Pensions at a Glance (OECD, 2019). The Beveridgean regime includes public pension systems concentrated on basic flat-rate benefits financed by general taxes or tax-like contributions. Pension systems where contributory earnings-related benefits are the main public pillar are assigned to the Bismarckian regime. The Mixed regime consists of countries having both basic and earnings-related public pensions or those with highly redistributive earnings-related schemes.

⁵ Public spending on early retirement programmes is not classified as old-age pensions but as labour market programmes in the OECD Social Expenditure Database. We thus added public expenditures on old-age pensions and early retirement programmes to create a combined indicator.

Table 1.1 displays the classification of pension regimes with average replacement rate ratios (RRRs), the ratio of the net replacement rate for low earners to that for high earners, calculated using the OECD’s net replacement rates by earnings level between 2004 and 2018 (see Table A1 for full data). The RRR levels broadly align with our theoretically constructed regime clusters⁶, with the exception of the Netherlands and Czechia. For the Netherlands, this is because occupational pensions were jointly considered in the OECD’s replacement rate simulation since the target replacement rates of Dutch occupational schemes are fixed by state regulation. The Czech public scheme contains both basic and earnings-related components, but its highly progressive benefit formula effectively generates an RRR similar to the level of the Beveridgean group. A sensitivity analysis is thus provided in Table A3 by re-assigning Czechia to the Beveridgean regime.

Table 1.1. Classification of Countries in Pension Regimes

Bismarckian (RRR<1.2)		Mixed		Beveridgean (RRR>1.7)			
Country	RRR	Country	RRR	Country	RRR		
Austria	1.03	Italy	1.00	Belgium	1.51	Denmark	1.70
Finland	1.09	Poland	1.00	Czechia	1.93	Ireland	2.31
France	1.20	Portugal	1.08	Norway	1.44	Netherlands	1.04
Germany	0.98	Slovakia	0.98	Switzerland	1.64	United Kingdom	2.28
Greece	1.10	Spain	0.98	United States	1.41		
Hungary	0.96	Sweden	0.98				

RRR=Replacement Rate Ratio. Czechia is re-assigned to the Beveridgean regime for a sensitivity analysis.

⁶ We do not use the RRR as one of our explanatory variables because the OECD’s net pension replacement rates are simulated values for this year’s labour market entrants assuming 40 years of contributions under current pension rules, not reflecting pension benefits for current retirees (OECD, 2019). Moreover, the indicator does not capture over-time changes in pension structures since year-by-year changes in the RRR are sensitive to fluctuations in average wages.

Covariates are mainly demographic and macroeconomic indicators, including the *share of the older population*, *gender-specific healthy life expectancy*, *unemployment rates of prime-aged workers*, *OECD's output gap* and *log GDP per capita*. The age structure and population health are important structural factors in most countries that drive old-age employment rates upward over time. The prime-aged unemployment rate and the output gap reflect business cycles that often impose constraints on older workers' labour market opportunities. The GDP per capita controls the level of economic development, which is correlated with country-level employment performances.

Other policy variables controlled are *unemployment benefit spending* and *disability benefit spending* (both as a percentage of GDP), which are identified in the literature as alternative pathways to early retirement. Other pension-related variables, including statutory retirement ages or net pension replacement rates, are not controlled since changes in these parameters are already reflected in public pension spending. Finally, *general government debt* is controlled as a proxy for the state's capacity to spend on other social transfers (see Table A2 for variable definitions and data sources).

Analytical strategy

Unlike in program evaluation strategies based on the potential outcomes framework (Angrist and Pischke, 2008), estimating causal effects of policies in pooled TSCS analysis is inherently challenging due to endogenous variations in explanatory variables, raising concerns about unobserved confounders or reverse causation. Moreover, two time-series indicators often exhibit a spurious correlation without a substantive relationship, especially if they follow nonstationary processes (Box-Steffensmeier et al., 2014). In our case, old-age employment rates may naturally rise driven by structural factors including

better population health, changing educational compositions and rising female labour force participation from younger ages. The upward trend in old-age employment may have simply coincided with or even reversely accelerated declines in public pension spending following pension reforms.

The main analytical strategy exploiting the TSCS structure to address these challenges is using error correction models (ECMs), which are modified specifications of the Engle-Granger method (Engle and Granger, 1987). The equation below is a simple model to display the basic features of ECMs:

$$\Delta Y_{it} = \alpha Y_{i,t-1} + \beta_1 \Delta X_{it} + \beta_2 X_{i,t-1} + \varepsilon_{it}$$

Y_{it} and X_{it} are dependent and independent variables, respectively, of group i at time t , and Δ indicates the first-differencing of a variable (e.g., $\Delta Y_{it} = Y_{it} - Y_{i,t-1}$). The core advantage of this model lies in first-differencing the dependent and independent variables to rule out the possibility of spurious correlations, and then separately estimating the ‘equilibrium’ relationship by including the lagged level of Y and X . In other words, a *permanent* relationship between the two can be estimated by controlling short-term deviations from that relationship. While β_1 indicates the *transient* effect of X , the *permanent* (equilibrium) effect can be estimated by β_2 divided by $-\alpha$. Another noteworthy aspect is that, though ECMs do not provide direct causal effects, their coefficients are highly conservative estimates for policy impacts, perhaps downward biased (Beck and Katz, 2011; Kittel, 1999), since the lagged dependent variable ($Y_{i,t-1}$) is highly correlated with unobserved confounders and accounts for much of the variations in the dependent variable (Y_{it}).

Based on this approach, our empirical models are specified as follows:

$$\begin{aligned} \Delta \text{Emp}_{it} = & \alpha \text{Emp}_{i,t-1} + \beta_{11} \Delta \text{PenSp}_{it} + \beta_{12} \text{PenSp}_{i,t-1} + \beta_{21} \Delta \text{PenSp}_{it} \text{Mid}_i \\ \text{Model 1} \quad & + \beta_{22} \text{PenSp}_{i,t-1} \text{Mid}_i + \beta_{33} \Delta \text{PenSp}_{it} \text{Low}_i + \beta_{32} \text{PenSp}_{i,t-1} \text{Low}_i \\ & + \beta_4 C_{it} + \tau_t + \varepsilon_{it} \end{aligned}$$

$$\begin{aligned} \Delta \text{Emp}_{it} = & \alpha \text{Emp}_{i,t-1} + \beta_{11} \Delta \text{PenSp}_{it} + \beta_{12} \text{PenSp}_{i,t-1} + \beta_{21} \Delta \text{PenSp}_{it} \text{Female}_i \\ \text{Model 2} \quad & + \beta_{22} \text{PenSp}_{i,t-1} \text{Female}_i + \beta_4 C_{it} + \tau_t + \varepsilon_{it} \end{aligned}$$

$$\begin{aligned} \Delta \text{Emp}_{it} = & \alpha \text{Emp}_{i,t-1} + \beta_{111} \Delta \text{PenSp}_{it} + \beta_{112} \text{PenSp}_{i,t-1} \\ & + \beta_{121} \Delta \text{PenSp}_{it} \text{Mid}_i + \beta_{122} \text{PenSp}_{i,t-1} \text{Mid}_i \\ & + \beta_{131} \Delta \text{PenSp}_{it} \text{Low}_i + \beta_{132} \text{PenSp}_{i,t-1} \text{Low}_i \\ & + \beta_{211} \text{Mix}_i \Delta \text{PenSp}_{it} + \beta_{212} \text{Mix}_i \text{PenSp}_{i,t-1} \\ & + \beta_{221} \text{Mix}_i \Delta \text{PenSp}_{it} \text{Mid}_i + \beta_{222} \text{Mix}_i \text{PenSp}_{i,t-1} \text{Mid}_i \\ \text{Model 3} \quad & + \beta_{231} \text{Mix}_i \Delta \text{PenSp}_{it} \text{Low}_i + \beta_{232} \text{Mix}_i \text{PenSp}_{i,t-1} \text{Low}_i \\ & + \beta_{311} \text{Bev}_i \Delta \text{PenSp}_{it} + \beta_{312} \text{Bev}_i \text{PenSp}_{i,t-1} \\ & + \beta_{321} \text{Bev}_i \Delta \text{PenSp}_{it} \text{Mid}_i + \beta_{322} \text{Bev}_i \text{PenSp}_{i,t-1} \text{Mid}_i \\ & + \beta_{331} \text{Bev}_i \Delta \text{PenSp}_{it} \text{Low}_i + \beta_{332} \text{Bev}_i \text{PenSp}_{i,t-1} \text{Low}_i \\ & + \beta_4 C_{it} + \tau_t + \varepsilon_{it} \end{aligned}$$

Emp_{it} denotes the employment rate of group i in year t , where i indicates 126 country-gender-education groups and t ranges from 1998 to 2019, while PenSp_{it} means public pension spending. Female_i , Mid_i and Low_i are dummy variables indicating female, mid- and low-educated groups, respectively, for estimating gender and educational differences

in the effect of pension spending. Similarly, Mix_i and Bev_i indicate the Mixed and Beveridgean regimes for examining whether educational differences in these groups are systematically different from those in the Bismarckian regime. C_{it} represents all time-varying covariates, while β_4 is a vector of coefficients for each covariate. τ_t is a year-fixed effect that controls common temporal shocks across countries and socio-demographic groups, and ε_{it} denotes idiosyncratic errors. Models 1 and 2 are for estimating heterogeneous effects of pension spending on old-age employment rates by education level and gender, respectively. Model 3 is for examining how educational gradients in the effects vary across pension regimes. All models are run for both age groups, while Model 3 is also estimated separately for female and male groups.

Considering the panel structure, standard errors in all models are clustered at the group level with small sample corrections. For a supplementary analysis, the effects of public pension spending on at-risk-of-poverty rates in Europe were also estimated using country-fixed effect models in the Appendix Paper 1.

Empirical Findings

Public pension spending: trends and cross-national variations

Figure 1.1 illustrates changes in public pension spending *per older person* in 20 European countries and the USA from 1998 to 2019. Most countries showed overall flat or mild upward trends until the early 2010s, though the German data show a moderate decrease already from the 2000s. In many countries, the trends flattened or turned downward in the 2010s, but no country showed a steep decline over the period despite the waves of pension retrenchment in the 1990s and early 2000s. These findings reflect the fact that pension reforms were mainly about incremental changes and usually take

decades to materialize their effects.

Looking at cross-national variations, Austria consistently marks the highest level of public pension spending per older person over the two decades, followed by Switzerland, France, Norway, the USA and Denmark. The lowest spenders are mostly in Southern and Eastern Europe but also include the UK and the Netherlands. Overall, higher levels of spending are not necessarily related to the Bismarckian system that covers high-income groups. For example, the highest (Austria) and lowest (Slovakia) spenders are both in the Bismarckian group, while the Beveridgean Denmark shows an above-average level of pension spending. Moreover, they do not correspond to higher or lower old-age employment rates across countries, as illustrated in Figures A1 and A2.

Compared to the same expenditures measured as a percentage of GDP (see Figure A3), notable differences in the trends are found in Greece and Portugal, where substantial GDP contractions following the Great Recession may have inflated the expenditures relative to GDP. Conversely, clear upward trends are present in Ireland and Norway in Figure 1.1 but not in Figure A3, presumably due to their strong GDP growth. Similarly, the rank of spending levels among countries in Figure 1.1 does not match that in Figure A3. Pension expenditures in the USA, Switzerland, Norway, Denmark and Ireland are in higher relative positions when population structures and GDP per capita are adjusted. In contrast, expenditures in Greece, Portugal, Italy and Poland look much lower, reflecting their poor economic performance and relatively aged populations.

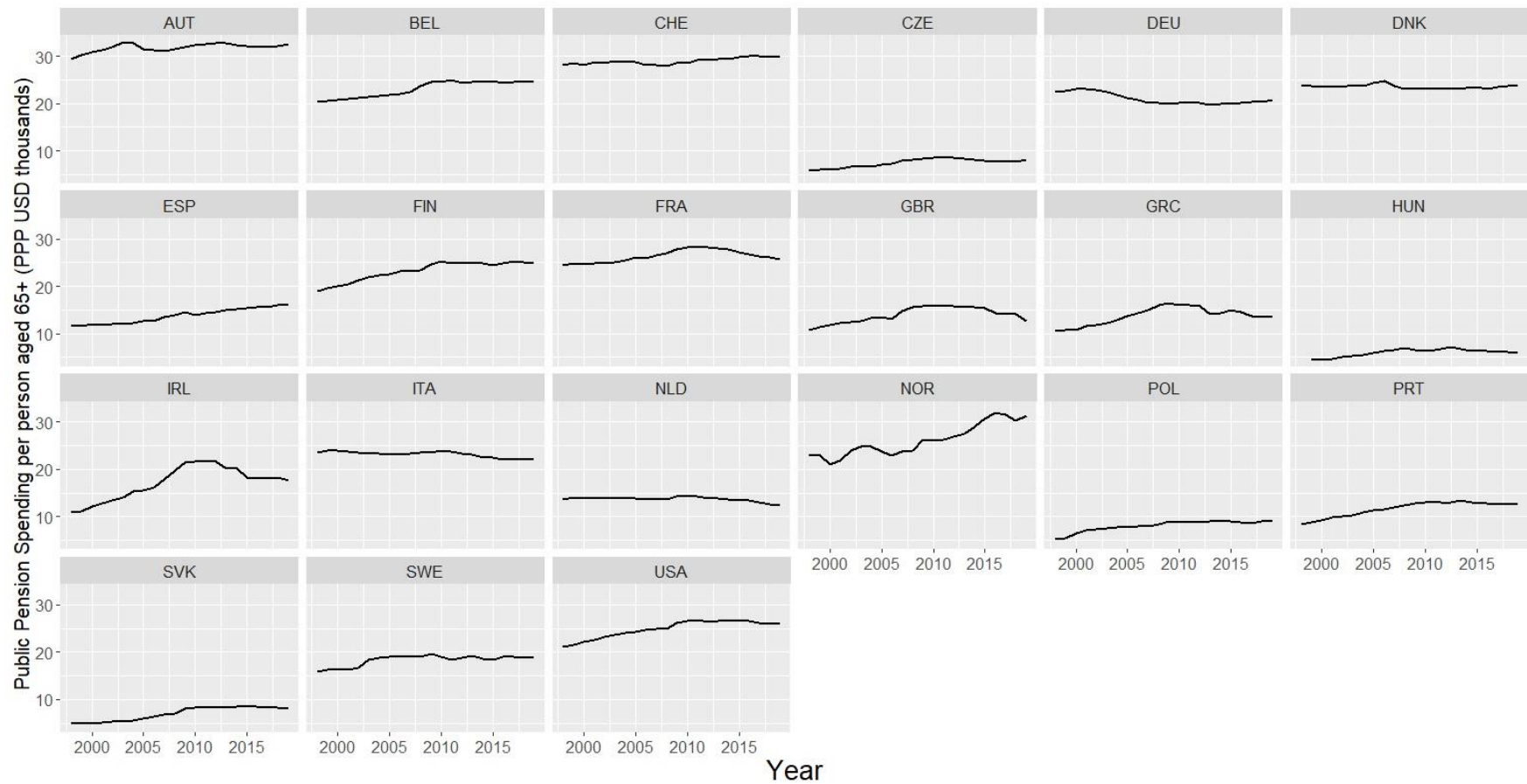


Figure 1.1. Public spending on old-age pensions and early retirement programmes, per person aged 65 or over, 1998-2019

Note: Price and purchasing power parity are fixed at 2015 level as the reference year; *Source:* OECD Social Expenditure Database

Heterogeneous effects of pension spending by education level and gender

Table 1.2 presents the results from Models 1 and 2 showing the marginal effects of public pension spending on employment rates by the level of education and gender, estimated separately by age groups. The table does not include short-term effects estimated with the first-differenced explanatory variable, as our focus is on the equilibrium (permanent) effects.

Consistent with Hypothesis 1, a lower level of education corresponds to a stronger (negative) effect of public pension spending. Educational differences in the effects of pension spending are both statistically significant between the high- and mid-educated and between the high- and low-educated. Holding other demographic, economic and policy-related variables constant, a reduction in pension spending by one unit (PPP USD 1,000 of 2015) is associated with a permanent increase in employment rates by 2.165 percentage points for the low-educated and by 1.102 percentage points for the high-educated group among the aged 60 to 64. The effect sizes are smaller for the age group 65 to 69, with the equivalent effects presenting 0.809 (high-educated) and 0.288 (low-educated), respectively.

Gender gaps in the marginal effects are also statistically significant (Hypothesis 2), more among those aged 65 to 69 than those aged 60 to 64. In the former, the (absolute) equilibrium effects are 0.450 for male groups and 0.753 for female groups. In the latter group, the effect sizes are 1.741 and 2.042, respectively, showing a smaller gender difference in relative terms.

Table 1.2. Marginal effects of public pension spending, by education level and gender

Dependent Variable: ΔEmp_{it}	Age 60-64		Age 65-69	
	Model 1	Model 2	Model 1	Model 2
$\text{Emp}_{i,t-1} (\alpha)$	-0.085 *** (0.009)	-0.054 *** (0.006)	-0.145 *** (0.018)	-0.113 *** (0.015)
$\text{PenSp}_{i,t-1} (\beta_{12})$	-0.094 *** (0.019)	-0.094 *** (0.019)	-0.042 * (0.017)	-0.051 *** (0.018)
$\text{PenSp}_{i,t-1} \times \text{Mid}_i (\beta_{22})$	-0.052 *** (0.009)		-0.052 *** (0.010)	
$\text{PenSp}_{i,t-1} \times \text{Low}_i (\beta_{32})$	-0.091 *** (0.011)		-0.076 *** (0.012)	
$\text{PenSp}_{i,t-1} \times \text{Female}_i (\beta_{22})$		-0.016 + (0.009)		-0.034 ** (0.011)
Equilibrium Effects by Education Level/Gender				
High-Edu ($-\beta_{12}/\alpha$)	-1.102 *** (0.186)		-0.288 ** (0.115)	
Mid-Edu [$-(\beta_{12}+\beta_{22})/\alpha$]	-1.712 *** (0.187)		-0.644 *** (0.106)	
Low-Edu [$-(\beta_{12}+\beta_{32})/\alpha$]	-2.165 *** (0.191)		-0.809 *** (0.109)	
Male ($-\beta_{12}/\alpha$)		-1.741 *** (0.318)		0.450 ** (0.157)
Female [$-(\beta_{12}+\beta_{22})/\alpha$]		-2.042 *** (0.332)		0.753 *** (0.138)
Adjusted R ²	0.090	0.069	0.081	0.062
$N \times T$	2,568	2,568	2,568	2,568

Note: + $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; In parentheses are standard errors. Standard errors for equilibrium effects were simulated using coefficients and variance-covariance estimates from each model. All models include year-fixed effects, first-differenced public pension spending and its interaction terms with education levels/gender, with the full list of control variables. One unit of pension spending equals to PPP USD 1,000 per older person fixed to the price level and PPP of 2015.

Variations in the effects across pension regimes

Table 1.3 presents the results from Model 3 examining the moderating role of pension regimes, categorized as Beveridgean, Mixed and Bismarckian. The table only includes the coefficients of lagged levels and their statistical significance for a simplified presentation. The third and fourth rows, representing educational differences in the Bismarckian regime, the largest cluster, are consistent with the aggregate patterns shown in Table 1.2.

The results in Table 1.3 also demonstrate that the educational differences in the marginal effects significantly vary between different pension regimes, especially among those aged 60 to 64 (Hypothesis 3). Whereas the (negative) effects are augmented among the high-educated in the Mixed and Beveridgean regimes relative to the Bismarckian regime (by -0.068 and -0.071 on average, respectively), the negative educational gradients are significantly countervailed by the positive values of three-way interaction effects. In Beveridgean countries, the positive three-way interaction coefficients are statistically significant only among males but not among females. In the Mixed group, the countervailing effects are significant in the low-educated female group and the mid-educated male group.

The moderating effects of pension regimes are less clear in the 65-to-69 age group. However, the educational gaps between high- and low-educated female groups are greater in the Mixed and Beveridgean regimes (by 0.084 and 0.052, respectively). On the other hand, the educational gradients are significantly narrowed among males by about 0.050 in Beveridgean countries compared to the Bismarckian regime.

Table 1.3. Moderating effects of pension regimes and education levels (Model 3)

Dependent Variable: ΔEmp_{it}	Age 60-64			Age 65-69		
	All Groups	Female	Male	All Groups	Female	Male
$Emp_{i,t-1} (\alpha)$	-0.086*** (0.009)	-0.100*** (0.014)	-0.109*** (0.017)	-0.147*** (0.019)	-0.285*** (0.046)	-0.149*** (0.026)
$PenSp_{i,t-1} (\beta_{112})$	-0.093*** (0.020)	-0.102*** (0.028)	-0.088* (0.034)	-0.040+ (0.020)	-0.079** (0.024)	-0.008 (0.030)
$PenSp_{i,t-1} \times Mid_i (\beta_{122})$	-0.070*** (0.011)	-0.075*** (0.016)	-0.093*** (0.018)	-0.056*** (0.011)	-0.065*** (0.016)	-0.077*** (0.020)
$PenSp_{i,t-1} \times Low_i (\beta_{132})$	-0.107*** (0.011)	-0.124*** (0.017)	-0.124*** (0.019)	-0.069*** (0.013)	-0.084*** (0.021)	-0.090*** (0.024)
$Mix_i \times PenSp_{i,t-1} (\beta_{212})$	-0.068*** (0.014)	-0.091*** (0.020)	-0.023 (0.019)	0.006 (0.020)	0.040 (0.036)	0.016 (0.024)
$Mix_i \times PenSp_{i,t-1} \times Mid_i (\beta_{222})$	0.034* (0.015)	0.039 (0.024)	0.036+ (0.019)	-0.001 (0.018)	-0.022 (0.035)	0.007 (0.025)
$Mix_i \times PenSp_{i,t-1} \times Low_i (\beta_{232})$	0.033* (0.017)	0.041* (0.020)	0.024 (0.024)	-0.030 (0.020)	-0.084* (0.035)	-0.016 (0.026)
$Bev_i \times PenSp_{i,t-1} (\beta_{312})$	-0.071*** (0.018)	-0.089** (0.029)	-0.053+ (0.031)	-0.011 (0.028)	-0.028 (0.028)	0.017 (0.027)
$Bev_i \times PenSp_{i,t-1} \times Mid_i (\beta_{322})$	0.051** (0.019)	0.040 (0.029)	0.073* (0.032)	0.028 (0.029)	0.001 (0.019)	0.047+ (0.028)
$Bev_i \times PenSp_{i,t-1} \times Low_i (\beta_{332})$	0.031 (0.026)	-0.004 (0.033)	0.066+ (0.037)	0.017 (0.033)	-0.052* (0.024)	0.052+ (0.031)
Adjusted R ²	0.097	0.090	0.105	0.080	0.153	0.088
$N \times T$	2,568	1,284	1,284	2,568	1,284	1,284

Note: + $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; In parentheses are standard errors. All models include year-fixed effects, first-differenced public pension spending and its interaction terms with pension regimes and education levels, with the full list of control variables. One unit of pension spending equals to PPP USD 1,000 per older person fixed to the price level and PPP of 2015.

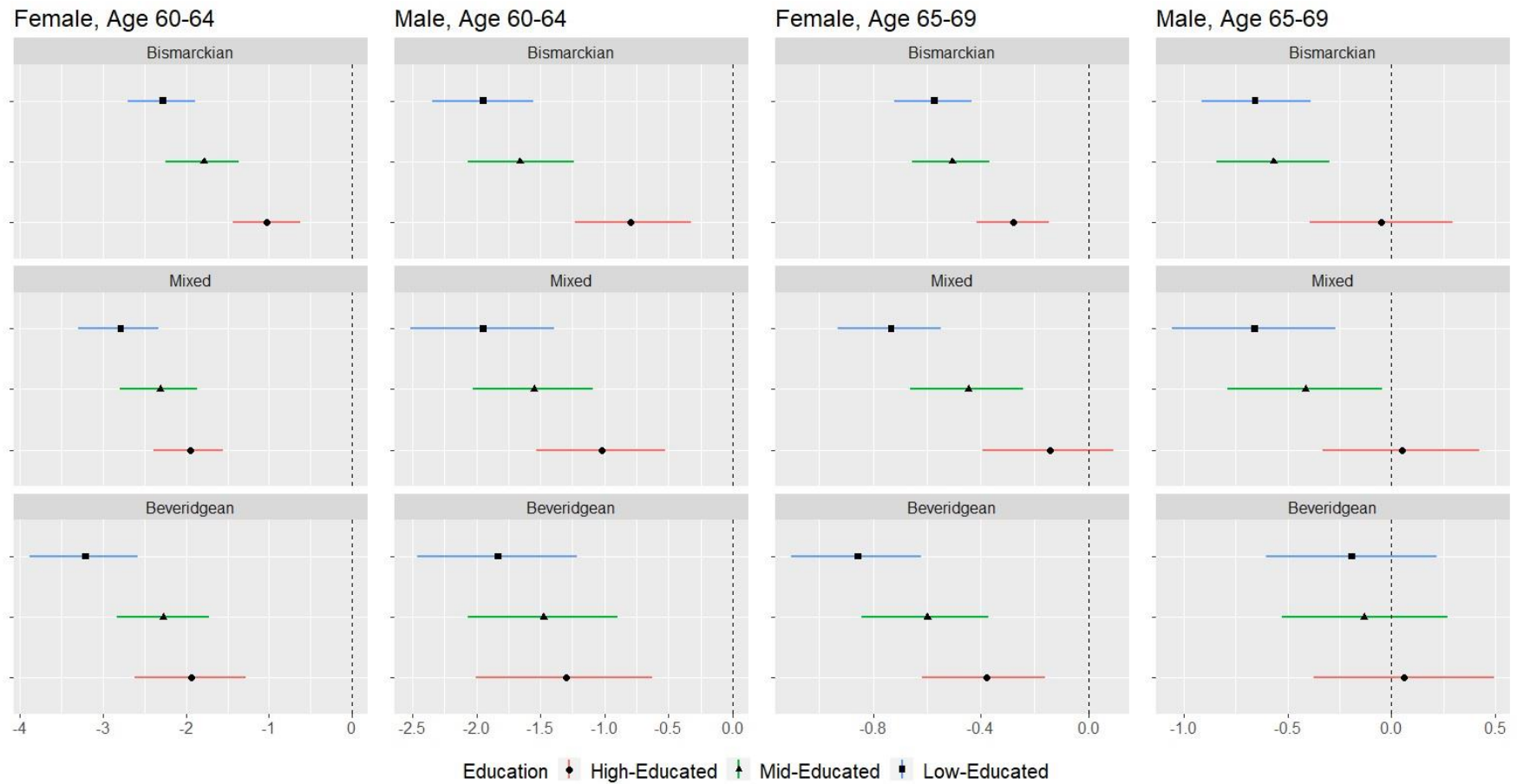


Figure 1.2. Equilibrium effects of pension spending on employment rates by level of education and pension regimes

Note: Confidence intervals are presented at 0.90 level due to small sample sizes in gender-education-regime cells. The intervals were simulated using coefficients and variance-covariance estimates from each model.

Figure 1.2 illustrates the equilibrium (permanent) effects of pension spending by the level of education, also varying between pension regimes, estimated separately for the four gender-age groups. Among females aged 60 to 64, the effect sizes are the largest in the Beveridgean regime, followed by the Mixed and Bismarckian regimes, though their educational gradients do not look significantly different. Among females aged 65 to 69, both the overall effect sizes and their educational differences tend to be larger in the Beveridgean and Mixed groups than in the Bismarckian cluster.

In contrast, among males in both age groups, the educational gaps tend to be wider in the Bismarckian and Mixed groups than in the Beveridgean systems. Among those aged 60 to 64, the large educational difference in the Bismarckian group is attributed to a particularly small employment effect of pension spending among high-educated males. Among the aged 65 to 69, null effects are observed across all education groups in Beveridgean countries. However, the effects on mid- and high-educated males' employment are still substantial in the Mixed and Bismarckian regimes.

Discussion and Conclusion

This study examined gender- and education-specific effects of public pension spending on employment rates of age groups 60 to 64 and 65 to 69, and how these effects vary across countries with different institutional structures of public pensions. The results showed significant educational and gender differences in the marginal effects of public pensions, confirming Hypotheses 1 and 2. Across all gender-age groups, the negative associations between public pension spending and employment rates were more pronounced among the low-educated compared to the high-educated. Similarly, pension spending was, on average, more strongly associated with female employment than male

employment rates in both age groups. These findings imply that public pension cuts may disproportionately affect low-educated older adults and women in their financial situation and, thereby, their employment rates.

Unexpected but noteworthy patterns were also found regarding the moderating role of pension regimes. Overall, female employment rates were significantly more sensitive to changes in public pension spending in the Beveridgean system than in the Bismarckian regime, related to particularly large effects on the low-educated group in the former. Among males, educational differences in the marginal effects of pension spending tend to be smaller in the Beveridgean than in the other regimes. Particularly among males aged 65 to 69, the estimates were not statistically significant in all education groups in the Beveridgean regime, whereas the effects were still clear among low- and mid-educated groups under the Bismarckian systems.

Our findings offer substantive implications that public pensions in different institutional contexts may play distinct roles for women and men. Older women's unstable work histories could be better compensated by non-contributory pensions (Möhring, 2015), which explains why female employment seems more strongly affected by public pensions in the Beveridgean system, especially among the low-educated. This idea is in line with our supplementary analysis of the poverty-reducing effects of public pensions. Beveridgean systems offer greater protection against older women's poverty risk than other systems but not particularly against older men's poverty (see Table A4 and Figure A4).

For older men, educational differences in the effect of public pensions are only marginal in Beveridgean systems relative to the Bismarckian. This may be because private pensions are the primary source of income inequality among older men in

Beveridgean systems, which aligns with the logic of the ‘Paradox of Redistribution’ (Korpi and Palme, 1998). In Bismarckian countries, in contrast, private pensions play only a marginal role and remain a privilege of high-educated men, which explains why this group appears to be least affected by public pension spending. Moreover, common reform measures in Bismarckian countries, such as restricting access to early retirement programmes, may have affected low-educated workers disproportionately.

One caveat is that the pension regime is a simplified concept that reduces the idiosyncratic and complex features of public pensions for analytical parsimony. For example, the way public earnings-related schemes are managed varies hugely within the Bismarckian group. The redistributive effects of earnings-related schemes may differ between defined-benefit and defined-contribution systems and depend on the presence and generosity of means-tested social assistance. Moreover, some countries could be seen as ambiguous cases to fit into one group. Greece, for example, has gone through radical reforms since 2010, including the implementation of basic pensions, though the overall architecture has remained Bismarckian by nature. Czechia is another ambiguous case due to its exceptionally high RRR for a Mixed system. We therefore re-assigned Czechia to the Beveridgean group for a sensitivity analysis, which generated results that partly weaken but do not overturn our argument (see Table A3).

A related limitation is that the results may be changeable by including other non-European countries, such as Australia, Canada, South Korea and Japan, which were not selected due to data limitations. Moreover, the role of private pensions in different institutional contexts was not examined in this study and thus should be further investigated in future research. We also did not identify specific components of public pensions – i.e., eligibility age or benefit generosity – that drive changes in employment

rates, due to the all-inclusive nature of pension spending. Finally, the results do not attest to causal relationships, though the estimates from our models may be highly conservative. However, such limitations could be complemented by existing studies using microdata in a single-country context, mainly from the labour economics literature (Etgeton, 2018; Geyer and Welteke, 2021; Rabaté and Rochut, 2020). The main contribution of our study instead lies in demonstrating the role of long-established institutional structures, which is difficult to examine in a single-case study.

Given women's career disadvantages in many countries and low-educated workers' shorter retirement life spans (Shi et al., 2023), it is unjust if these groups are involuntarily working longer due to financial difficulties. Since our findings suggest that public pensions tend to hit women and low-educated workers disproportionately, future pension reforms should consider varying outcomes of different pension designs to balance the goal of active ageing with social equity. If the overall public expenditure needs to be cut, the minimum income floor should be the last component to be affected, as non-contributory basic or targeted pensions can effectively protect the most vulnerable group. Furthermore, state pension ages could be applied differently based on educational or occupational characteristics and prestige.

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Appendix Paper 1

Table A1. Net Pension Replacement Rates by Level of Earnings

		2004	2006	2008	2010	2012	2014	2016	2018	Mean
Austria	0.5*AE	91.2	90.4	90.5	91.3	91.2	92.1	92.2	89.7	91.08
	1.5*AE	93.5	89.2	86.3	84.6	86.2	88.9	90.9	89.6	88.65
	Ratio	0.98	1.01	1.05	1.08	1.06	1.04	1.01	1.00	1.03
Belgium	0.5*AE	82.7	77.3	78.7	74.9	72.9	64.2	62.6	70.7	73.00
	1.5*AE	53.3	51.1	51.7	42.5	39.9	49.1	50.1	48.3	48.25
	Ratio	1.55	1.51	1.52	1.76	1.83	1.31	1.25	1.46	1.51
Czechia	0.5*AE	88.3	98.8	95.3	93.5	79.7	93.1	88.3	91.6	91.08
	1.5*AE	42.9	49.3	49.4	47	40.1	51.9	48.7	47.9	47.15
	Ratio	2.06	2.00	1.93	1.99	1.99	1.79	1.81	1.91	1.93
Denmark	0.5*AE	95.6	132.7	137	131.9	117.5	103.2	110.3	104.5	116.59
	1.5*AE	42.5	77	82.7	80.8	67.4	57.2	76.2	63.3	68.39
	Ratio	2.25	1.72	1.66	1.63	1.74	1.80	1.45	1.65	1.70
Finland	0.5*AE	90.7	77.4	73.2	72	71.3	66.6	66.9	65.1	72.90
	1.5*AE	79.2	70.3	63.8	64.4	63.2	65	65.1	64.9	66.99
	Ratio	1.15	1.10	1.15	1.12	1.13	1.02	1.03	1.00	1.09
France	0.5*AE	84.2	78.4	76.2	69.4	75.9	66.9	70.4	71.4	74.10
	1.5*AE	58.7	58	60.2	53.1	60.9	62	70.3	69	61.53
	Ratio	1.43	1.35	1.27	1.31	1.25	1.08	1.00	1.03	1.20
Germany	0.5*AE	61.7	53.4	59.2	54.8	55.9	53.4	54.7	56.1	56.15
	1.5*AE	79.2	59.2	60.3	55.6	54.4	49	49.8	51.4	57.36
	Ratio	0.78	0.90	0.98	0.99	1.03	1.09	1.10	1.09	0.98
Greece	0.5*AE	99.9	113.6	113.6	113.6	92.5	82.9	60.7	57.6	91.80
	1.5*AE	99.9	110.3	106.7	106.8	65	73.3	54.1	50.3	83.30
	Ratio	1.00	1.03	1.06	1.06	1.42	1.13	1.12	1.15	1.10
Hungary	0.5*AE	86.6	94.7	94.3	96.3	94.4	89.6	89.6	84.3	91.23
	1.5*AE	99.1	98.5	99.2	103.2	96.1	89.6	89.6	84.3	94.95
	Ratio	0.87	0.96	0.95	0.93	0.98	1.00	1.00	1.00	0.96
Ireland	0.5*AE	63	65.8	68.4	60.8	71.4	70.1	70	60.5	66.25
	1.5*AE	27.4	29.3	30.3	22.5	27.9	32.5	32.4	26.7	28.63
	Ratio	2.30	2.25	2.26	2.70	2.56	2.16	2.16	2.27	2.31

Source: *OECD Pensions at a Glance – OECD and G20 Indicators* (OECD, 2019). AE=Average Earnings.

Note: Ratios are the ratio of low earners (0.5*AE) to high earners (1.5*AE) in net replacement rates.

Table A1. Net Pension Replacement Rates by Level of Earnings (Continued)

		2004	2006	2008	2010	2012	2014	2016	2018	Mean
Italy	0.5*AE	89.3	81.8	74.8	72.0	78.0	82.2	93.0	92.0	82.89
	1.5*AE	88.4	78.1	77.1	71.8	77.9	81.6	93.8	94.4	82.89
	Ratio	1.01	1.05	0.97	1.00	1.00	1.01	0.99	0.97	1.00
Netherlands	0.5*AE	82.5	97	105	104.5	104.8	101.3	105.1	78.0	97.28
	1.5*AE	85.8	96.3	98.6	96.4	97.2	94.1	100.2	78.5	93.39
	Ratio	0.96	1.01	1.06	1.08	1.08	1.08	1.05	0.99	1.04
Norway	0.5*AE	85.5	77.1	76.7	72.9	78.3	80.1	64.8	57.0	74.05
	1.5*AE	58.2	62.5	60.6	49.2	47.8	48.6	41.3	43.0	51.40
	Ratio	1.47	1.23	1.27	1.48	1.64	1.65	1.57	1.33	1.44
Poland	0.5*AE	69.6	74.5	74.4	68.1	60.6	54.0	37.2	35.9	59.29
	1.5*AE	69.8	75	75.0	68.3	59.1	52.4	37.9	34.7	59.03
	Ratio	1.00	0.99	0.99	1.00	1.03	1.03	0.98	1.03	1.00
Portugal	0.5*AE	115.9	81.6	73.2	73.4	77.7	87.7	92.9	88	86.30
	1.5*AE	84.4	72.2	72.0	70.5	68.4	88.4	93.1	89	79.75
	Ratio	1.37	1.13	1.02	1.04	1.14	0.99	1.00	0.99	1.08
Slovakia	0.5*AE	58.2	66.4	66.3	68.3	88.1	84.0	85.0	71.7	73.50
	1.5*AE	63.1	75.4	74.9	76.7	84.7	79.4	83.5	63.3	75.13
	Ratio	0.92	0.88	0.89	0.89	1.04	1.06	1.02	1.13	0.98
Spain	0.5*AE	88.7	82	82.1	82.3	79.5	89.1	79.3	78.6	82.70
	1.5*AE	88.4	85.2	85.3	85.4	79.8	89.3	81.7	82.8	84.74
	Ratio	1.00	0.96	0.96	0.96	1.00	1.00	0.97	0.95	0.98
Sweden	0.5*AE	90.2	81.4	79.3	67.0	68.8	56.7	62.4	60.7	70.81
	1.5*AE	70.1	71.9	81.2	72.6	72.9	70.1	67.6	68.9	71.91
	Ratio	1.29	1.13	0.98	0.92	0.94	0.81	0.92	0.88	0.98
Switzerland	0.5*AE	71.4	75	68.8	78.6	78.4	61.4	57.4	54.3	68.16
	1.5*AE	53	45.7	44.3	46.2	49.1	31.5	31.5	31.7	41.63
	Ratio	1.35	1.64	1.55	1.70	1.60	1.95	1.82	1.71	1.64
United Kingdom	0.5*AE	78.4	66.1	63.8	62.0	61.7	51.7	52.1	51	60.85
	1.5*AE	38.2	30.6	29.2	26.8	27.2	20.3	20.7	20.2	26.65
	Ratio	2.05	2.16	2.18	2.31	2.27	2.55	2.52	2.52	2.28
United States	0.5*AE	61.4	67.4	57.9	61.0	56.2	54.3	59.9	61.2	59.91
	1.5*AE	44.9	47.9	39.5	44.1	40.4	38.9	42.4	42.7	42.60
	Ratio	1.37	1.41	1.47	1.38	1.39	1.40	1.41	1.43	1.41

Source: *OECD Pensions at a Glance – OECD and G20 Indicators* (OECD, 2019). AE=Average Earnings.

Note: Ratios are the ratio of low earners (0.5*AE) to high earners (1.5*AE) in net replacement rates.

Table A2. List of Variables

Variable Name	Definition	Source
Employment Rate	Employment-to-population ratio of the aged 60 to 64 and of the aged 65 to 69, disaggregated by gender and level of education	EU-LFS CPS
Pension Regime	A set of three indicator variables for the Bismarckian, Mixed and Beveridgean pension regimes	-
Public Pension Spending	Public expenditure on old-age and survivors cash benefits and early retirement programmes, divided by the number of persons aged 65 and above and adjusted by PPP and price levels fixed to the 2015 value	OECD-SOCX**
Unemployment Benefit Spending*	Public spending on cash benefits for people to compensate for unemployment, % of GDP	
Disability Benefit Spending	Public spending on incapacity-related cash benefits, % of GDP	
Healthy Life Expectancy	Gender-specific healthy life expectancy at birth	GBD 2019***
Share of Older Population	Share of people aged 65 or over in the population	OECD Labour Force Statistics
Unemployment Rate	Unemployment rate of prime-aged workers (aged 25 to 54)	
Output Gap	The difference between actual and potential GDP, % of potential GDP.	
Log GDP Per Capita	Natural logarithm of GDP per capita, adjusted by purchasing power parity and price levels fixed to the 2015 value	OECD National Accounts Statistics
Government Debt	Gross debt of the general government, % of GDP	
At-Risk-of-Poverty Rate ****	Share of people whose equivalised household disposable income is below 60% of the national median equivalised disposable income, among people aged 65 and above	Eurostat Database

* For Denmark, public spending on out-of-work income maintenance and support is used instead of public unemployment spending data, as the latter is not available for Denmark.

** OECD Social Expenditure Database

*** Global Burden of Disease Study 2019

**** At-risk-of-poverty rate is not available for the USA and is only used for supplementary analysis.

Table A3. Sensitivity analysis: Assigning Czechia to the Beveridgean regime

Dependent Variable: ΔEmp_{it}	Age 60-64			Age 65-69		
	All Groups	Female	Male	All Groups	Female	Male
$\text{Emp}_{i,t-1} (\alpha)$	-0.086*** (0.009)	-0.102*** (0.014)	-0.108*** (0.017)	-0.146*** (0.019)	-0.284*** (0.046)	-0.146*** (0.026)
$\text{PenSp}_{i,t-1} (\beta_{112})$	-0.095*** (0.020)	-0.106*** (0.028)	-0.090** (0.034)	-0.039+ (0.020)	-0.076** (0.024)	-0.009 (0.029)
$\text{PenSp}_{i,t-1} \times \text{Mid}_i (\beta_{122})$	-0.070*** (0.011)	-0.076*** (0.016)	-0.092*** (0.018)	-0.056*** (0.011)	-0.065*** (0.016)	-0.075*** (0.020)
$\text{PenSp}_{i,t-1} \times \text{Low}_i (\beta_{132})$	-0.107*** (0.011)	-0.126*** (0.017)	-0.123*** (0.019)	-0.068*** (0.013)	-0.084*** (0.021)	-0.088*** (0.023)
$\text{Mix}_i \times \text{PenSp}_{i,t-1} (\beta_{212})$	-0.072*** (0.013)	-0.095*** (0.019)	-0.028 (0.018)	0.001 (0.019)	0.036 (0.034)	0.009 (0.024)
$\text{Mix}_i \times \text{PenSp}_{i,t-1} \times \text{Mid}_i (\beta_{222})$	0.039* (0.015)	0.046+ (0.024)	0.040* (0.018)	0.005 (0.018)	-0.013 (0.035)	0.014 (0.024)
$\text{Mix}_i \times \text{PenSp}_{i,t-1} \times \text{Low}_i (\beta_{232})$	0.041* (0.016)	0.050* (0.020)	0.033 (0.023)	-0.023 (0.019)	-0.074* (0.034)	-0.007 (0.026)
$\text{Bev}_i \times \text{PenSp}_{i,t-1} (\beta_{312})$	-0.064*** (0.019)	-0.080** (0.030)	-0.047 (0.030)	0.001 (0.028)	-0.003 (0.038)	0.026 (0.028)
$\text{Bev}_i \times \text{PenSp}_{i,t-1} \times \text{Mid}_i (\beta_{322})$	0.039* (0.020)	0.023 (0.031)	0.061+ (0.033)	0.013 (0.029)	-0.020 (0.027)	0.030 (0.029)
$\text{Bev}_i \times \text{PenSp}_{i,t-1} \times \text{Low}_i (\beta_{332})$	0.015 (0.027)	-0.023 (0.035)	0.046 (0.041)	-0.001 (0.033)	-0.076** (0.028)	0.029 (0.035)
Adjusted R ²	0.097	0.092	0.105	0.079	0.151	0.085
$N \times T$	2,568	1,284	1,284	2,568	1,284	1,284

Note: + $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; In parentheses are standard errors. All models include year-fixed effects, first-differenced public pension spending and its interaction terms with pension regimes and education levels, with the full list of control variables. One unit of pension spending equals to PPP USD 1,000 per older person fixed to the price level and PPP of 2015.

Table A4. Marginal effects of public pension spending on at-risk-of poverty rates, age 65+, by pension regime (illustrated in Figure A4)

	At-risk-of-poverty rate, age 65+		
	All Groups	Female	Male
<i>PenSp_{i,t-1}</i>	-1.245 *** (0.255)	-1.188 *** (0.221)	-1.104 * (0.493)
<i>PenSp_{i,t-1} × Mix_i</i>	0.637 (0.428)	0.109 (0.347)	1.047 + (0.627)
<i>PenSp_{i,t-1} × Bev_i</i>	-0.562 (0.510)	-0.972 * (0.461)	-0.034 (0.397)
Adjusted R ²	0.546	0.611	0.521
<i>N × T</i>	748	374	374

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; In parentheses are standard errors clustered by country. One unit of pension spending equals to PPP USD 1,000 per older person fixed to the price level and PPP of 2015. All models include country- and year-fixed effects, with the same set of control variables as in the main analysis.

For the definition of the at-risk-of-poverty rate and its data source, see Table A2. Table A4 presents the estimates drawn from a two-way fixed-effect model:

$$Poverty_{it} = \alpha + \beta_{11}PenSp_{i,t-1} + \beta_{12}Mix_iPenSp_{i,t-1} + \beta_{13}Bev_iPenSp_{i,t-1} + \beta_2X_{it} + \gamma_i + \tau_t + \varepsilon_{it}$$

Poverty_{it} denotes gender-specific at-risk-of-poverty rates of the aged 65 or over, and γ_{it} signifies country-fixed effects. Instead of the error correction model, the country-fixed-effect model is employed as spurious correlations and reverse causality are less of a concern in the relationship between public pension spending and old-age poverty.

The negative association between public pension spending and women's poverty rates is significantly stronger in Beveridgean countries than in Mixed or Bismarckian countries, whereas the differences across regimes are less clear in the effects on male poverty rates.

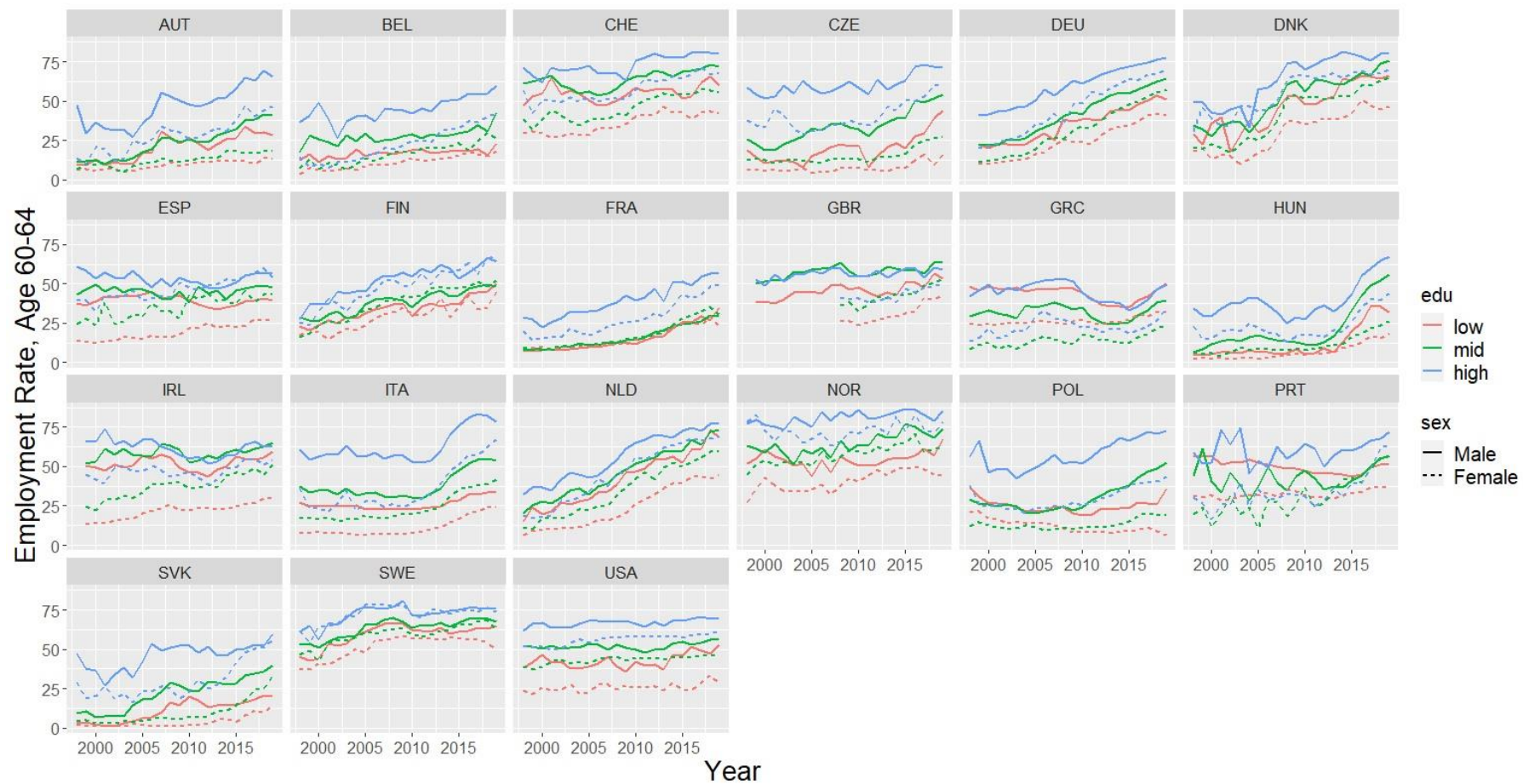


Figure A1. Old-age employment rates, age 60-64, by gender and level of education, 1998-2019

Source: EU-LFS; Note: Vacant years are missing values; AUT=Austria, BEL=Belgium, CHE=Switzerland, CZE=Czechia, DEU=Germany, DNK=Denmark, ESP=Spain, FIN=Finland, FRA=France, GBR=United Kingdom, GRC=Greece, HUN=Hungary, IRL=Ireland, ITA=Italy, NLD=Netherlands, NOR=Norway, POL=Poland, PRT=Portugal, SVK=Slovakia, SWE=Sweden, USA=United States

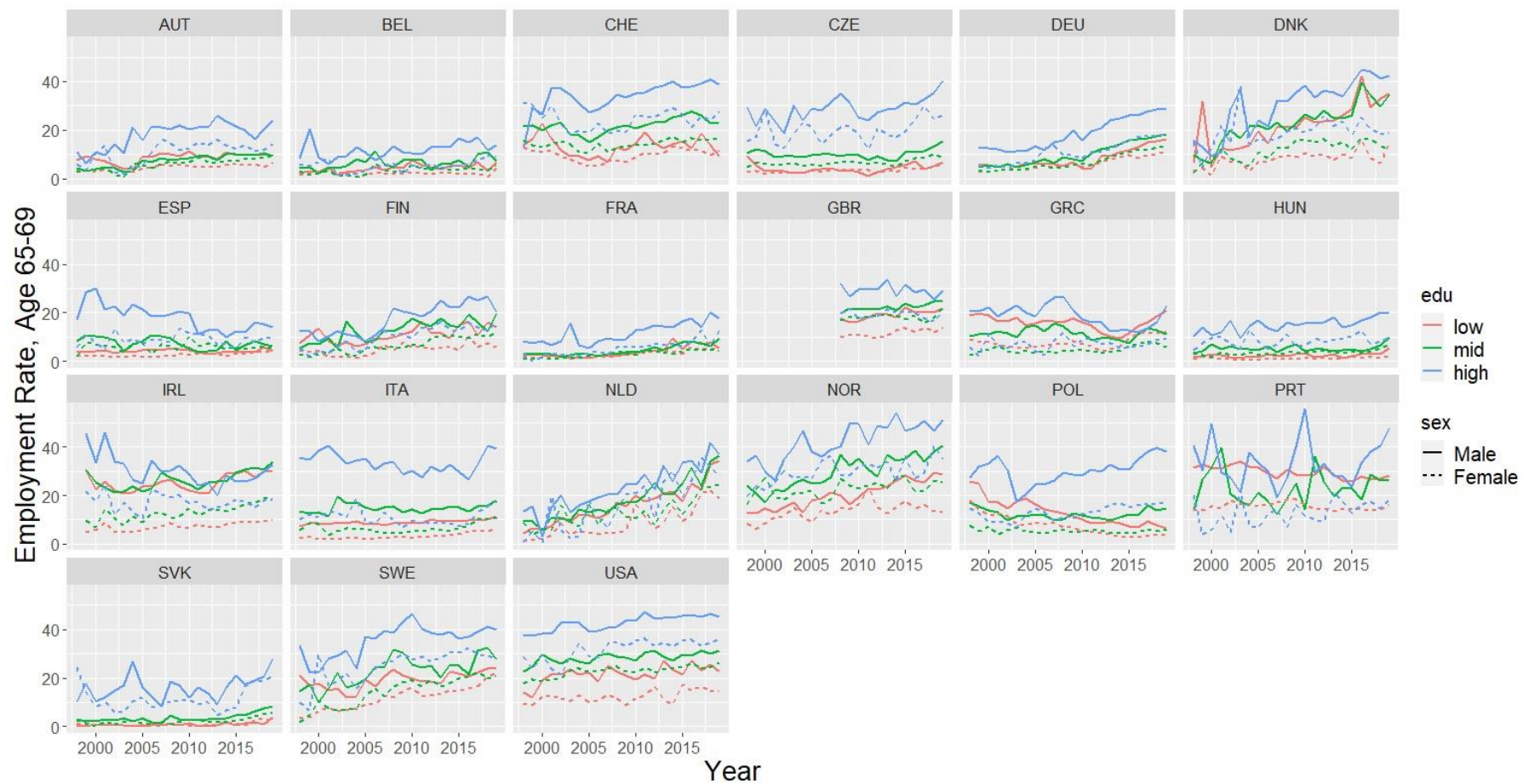


Figure A2. Old-age employment rates, age 65-69, by gender and level of education, 1998-2019

Source: EU-LFS; Note: Vacant years are missing values; AUT=Austria, BEL=Belgium, CHE=Switzerland, CZE=Czechia, DEU=Germany, DNK=Denmark, ESP=Spain, FIN=Finland, FRA=France, GBR=United Kingdom, GRC=Greece, HUN=Hungary, IRL=Ireland, ITA=Italy, NLD=Netherlands, NOR=Norway, POL=Poland, PRT=Portugal, SVK=Slovakia, SWE=Sweden, USA=United States

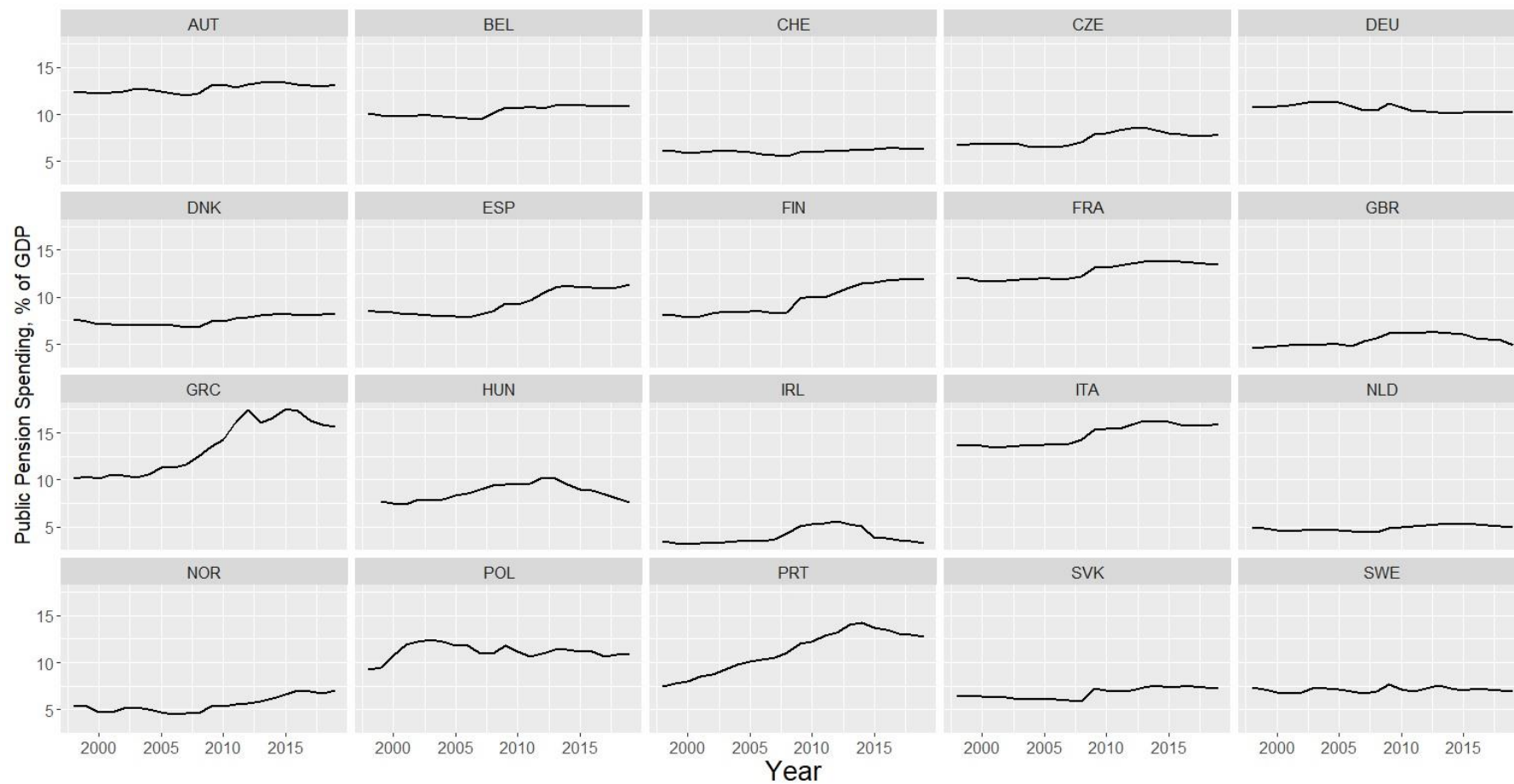


Figure A3. Public spending on old-age pensions and early retirement programmes, percentage of GDP, 1998-2019

Source: OECD Social Expenditure Database; AUT=Austria, BEL=Belgium, CHE=Switzerland, CZE=Czechia, DEU=Germany, DNK=Denmark, ESP=Spain, FIN=Finland, FRA=France, GBR=United Kingdom, GRC=Greece, HUN=Hungary, IRL=Ireland, ITA=Italy, NLD=Netherlands, NOR=Norway, POL=Poland, PRT=Portugal, SVK=Slovakia, SWE=Sweden, USA=United States

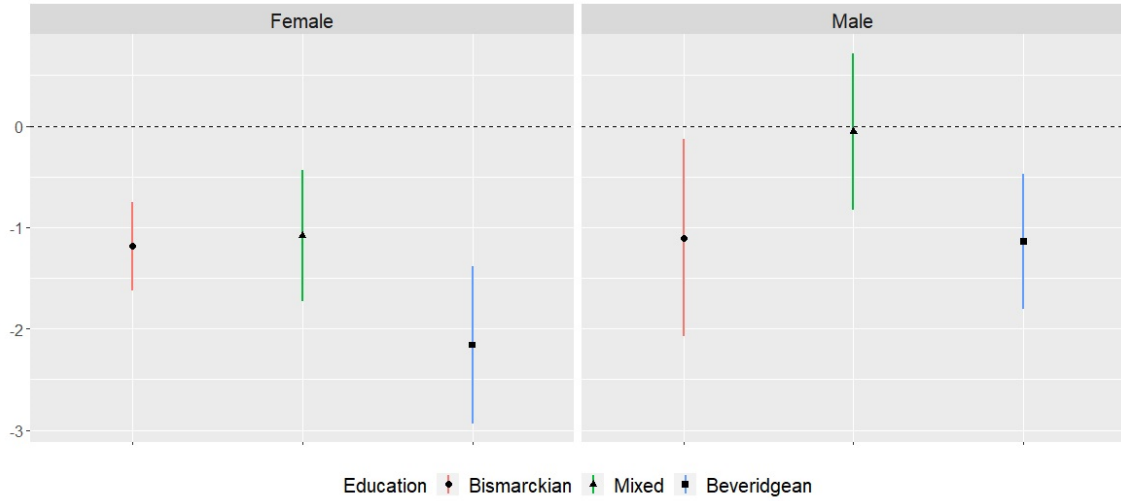


Figure A4. Marginal effects of public pension spending on at-risk-of-poverty rates, age 65+, by pension regime (Based on Table A4)

Paper 2

Old and New Welfare States Retaining Older Workers in the Face of Crisis: The Case of COVID-19 in Europe

* This paper has received *Revise & Resubmit* from a peer-reviewed academic journal.

Abstract

The Coronavirus pandemic was a unique crisis in Europe as the unprecedented health and labour market shock barely disrupted long-term trends toward active ageing. We study the role of policy responses to the crisis and pre-existing welfare state institutions in moderating older workers' labour market exit. Using a cross-national panel survey and exploiting institutional variations across Europe, we examine the association between older workers' exit outcomes during COVID-19 and a set of macro-institutional indicators, net of the economic shock and the pre-pandemic activation level. Results show that novel job retention schemes likely contributed to retaining older workers, whereas expanded unemployment insurance facilitated their exit but only among mid-educated workers. Higher retirement ages and greater reliance on private pensions are associated with lower exit rates, while the retirement age is particularly influential among lower-educated workers. Our findings highlight the significance of welfare states managing the crisis-driven economic shock and offer useful policy implications.

Keywords: COVID-19, retirement, labour market policies, pensions, welfare state

Introduction

During economic recessions, older workers face an increased risk of retreating from the labour force, often leading to permanent retirement even during the subsequent recovery phase. Historically in Western welfare states, institutions promoting early retirement, such as pre-retirement programmes, disability pensions, special unemployment benefits for older workers and even private occupational pensions, were developed during economic downturns as a socially peaceful means to prevent mass unemployment (Ebbinghaus, 2006). For most older workers, such systems tend to offer alternative ‘pathways’ to permanent retirement before reaching the normal retirement age (Kohli et al., 1991). The trend of early retirement began to reverse in the late 1990s thanks to major pension and labour market reforms across Europe aimed at promoting active ageing (Ebbinghaus and Hofäcker, 2013; Hofäcker et al., 2016). However, the Great Recession once again disrupted a long-term rise in old-age employment, although swift recoveries followed in the 2010s.

The Coronavirus pandemic posed even greater challenges for older workers than previous recessions, due to the augmented risk of fatal illness in addition to the labour market crisis. The pandemic could thus potentially halt or even overturn the decades-long trend towards active ageing in Europe. However, the pandemic’s impact on old-age employment seems marginal and short-lived compared to those in previous recessions. Table 2.1 compares changes in employment rates of those aged 55 to 64 after the Great Recession and after the recent pandemic among countries that showed a downturn or stagnation in either of the two periods. Most countries, except for Sweden, the United Kingdom, Germany and Italy, experienced much bigger disruptions after the Great Recession, whereas the pandemic resulted in, if any, only trivial declines in employment

rates. Overall, old-age employment in Europe reached the pre-pandemic level already by mid-2021 (Ando et al., 2022), which was a stark contrast to the case of the United States, where older workers had not fully returned to the labour market until early 2022 (Goda et al., 2023).

Table 2.1. Changes in employment rates, age 55-64, Great Recession and COVID-19 Pandemic

Country	2007	Lowest 2008-12	Diff	2019	Lowest 2020-22	Diff
Nordic						
Denmark	58.9	54.7	-4.2	71.3	71.4	0.1
Sweden	70.0	70.0	0	77.7	76.9	-0.8
Liberal						
United Kingdom	57.4	56.7	-0.7	66.3	64.8	-1.5
Ireland	53.8	49.3	-4.5	61.8	61.8	0
Central						
Switzerland	67.2	66.2	-1	73.0	72.3	-0.7
Germany	51.3	53.7	2.4	72.7	71.7	-1
France	38.2	38.2	0	53.1	53.8	0.7
Southern						
Italy	33.7	34.3	0.6	54.3	53.4	-0.9
Malta	29.5	29.1	-0.4	50.1	51	0.9
Spain	44.5	43.5	-1	53.8	54.7	0.9
Portugal	51.0	46.5	-4.5	60.4	60.4	0
Greece	42.7	36.5	-6.2	43.2	44.6	1.4
Eastern						
Hungary	32.2	30.9	-1.3	56.7	59.6	2.9
Romania	41.4	39.9	-1.5	47.8	43.8	-4
Slovenia	33.5	31.2	-2.3	48.6	50.5	1.9
Baltic						
Estonia	59.9	53.8	-6.1	71.9	71.3	-0.6
Latvia	58.0	47.8	-10.2	67.3	67.8	0.5
Lithuania	53.2	48.3	-4.9	68.4	67.6	-0.8

Source: Eurostat Database. Data for United Kingdom is from the OECD.

The fast recovery across European labour markets has been mainly attributed to an immediate and widespread adoption of job retention schemes (Ando et al., 2022; Müller and Schulten, 2022). Nevertheless, the extent of initial economic shocks and fiscal responses to address them varied significantly across countries, depending on the intensity of virus containment measures (Capano et al., 2020; Hale et al., 2021) and social policy strategies to protect workers and support businesses (Béland et al., 2021; Ebbinghaus and Lehner, 2022). Moreover, studies evaluating employment and job loss outcomes during COVID-19 have shown that the shock affected workers heterogeneously depending on their socio-economic status (SES): those not able to work from home or in non-standard contracts, mostly low-educated and female workers, were particularly more affected than others (Adams-Prassl et al., 2020; Cortes and Forsythe, 2023). Given that inequalities have already existed in late working lives by social class and gender (Radl, 2013; Riekhoff and Kuitto, 2022), concerns are raised that the COVID-19 crisis could exacerbate the pre-existing inequalities among older workers in Europe.

The unexpectedly modest disruptions in old-age employment rates, despite massive economic downturns and their variation across European countries (see Figure B1), require institutional explanations – those related to policy responses in the labour market and existing welfare state institutions. Similarly, the unequal nature of the pandemic offers a unique test case to examine the welfare state as a crisis management tool, since the primary goal of social policy is to protect the most disadvantaged groups from social risks.

Against this backdrop, we study how labour market policy responses as well as existing pension systems shaped older workers' labour market exit across Europe following the COVID-19 pandemic. We assess the role of novel job retention schemes,

the core policy innovation introduced in the wake of the pandemic, which we label as the ‘new’ welfare state. We also analyse the significance of temporary expansions of unemployment insurance and pension systems associated with early or late retirement – conventional (‘old’) welfare states that are known to have influenced older workers’ retirement patterns in the face of previous economic downturns (Duval, 2003; O’Brien, 2010).

The study design mainly utilizes cross-national variations in labour market policies and pension institutions to explore how older workers’ exit outcomes in a later stage of the pandemic were related to country-specific institutional features. Using a cross-national panel survey of older Europeans combined with macro-level economic and institutional indicators, the study employs a set of multilevel models to estimate the marginal associations between older workers’ medium-term exit rates and relevant institutional factors, controlling for the degree of the exogenous shock and pre-pandemic activation levels across countries. We also examine how these relationships differ by older workers’ level of education, as the policy effects as well as the exposure to labour market shocks tend to vary across individuals in different SES groups.

Our results show that the rollout of job retention schemes in 2020 was systematically related to lower exit rates in 2021 across older workers in all socioeconomic groups. In contrast, expanded unemployment insurance seems to have contributed to higher exit rates but only among mid-educated workers. Pension systems with a higher (early) retirement age and greater reliance on private pensions were associated with lower exit rates, while the earliest retirement age was particularly significant among lower-educated workers.

Our contributions to the literature are threefold. First, we contribute to the longstanding literature on comparative retirement systems, mainly studied in public economics, macro-sociology and comparative political economy. While economic studies focus on social security programmes imposing ‘implicit taxes’ on individuals working additional years in old age by proposing dynamic labour supply models (Blundell et al., 2016; Börsch-Supan, 2000; Börsch-Supan et al., 2021; Duval, 2003; Geyer and Welteke, 2021; Gruber and Wise, 1998, 2004; Stock and Wise, 1990), sociological and political approaches emphasize structural constraints on older workers and their interactions with welfare states that facilitate socially peaceful early departures from the labour force (Ebbinghaus, 2006; Guillemard and Rein, 1993; Kohli et al., 1991; Walker, 1981). More recent studies also highlight the role of workplace organizations and their practices as significant moderators of macro-structural and institutional factors (Mertens and Romeu-Gordo, 2023; Qvist, 2023). We advance this line of literature by demonstrating that country-specific institutions and ad-hoc policy responses play a significant role in shaping early exit outcomes against a common crisis across countries.

Our second contribution is to the studies of the social stratification of retirement transition (Turek and Henkens, 2023). These studies find that retirement timing and processes are stratified by gender, level of education and occupational class (Fasang, 2010; Radl, 2013; Riekhoff and Kuitto, 2022), while their social gradients are also related to macro-structural and institutional factors (Mäcken et al., 2022). Our study adds to these findings by exploring educational differences in early exit patterns during an economic crisis and whether the differences are moderated by institutional conditions.

Finally, the study advances the understanding of welfare states as a crisis management tool by providing empirical investigation on the effectiveness of social policy responses

to the pandemic (Béland et al., 2021; Moreira and Hick, 2021). Previous studies have established distinct purposes and functions of two policy approaches to tackling the labour market crisis: protecting jobs (job retention schemes) versus supporting income against job losses (unemployment insurance) (Birinci et al., 2021; Ebbinghaus and Lehner, 2022; Giupponi et al., 2022). Building on their theoretical models and discussions, our findings show that job retention schemes and unemployment insurance policies had opposite effects in mitigating employment shocks among older workers, suggesting the former is generally preferred while the latter can also be used in a complementary manner.

Background and Framework

Institutional framework to understand early retirement patterns across countries

To understand cross-national variations in early retirement and its reversals, comparative institutional studies have developed a framework identifying push, pull and retention factors (Ebbinghaus and Hofäcker, 2013; Hofäcker et al., 2016). *Push* factors are institutional features or structural constraints that undermine the demand for older workers, including economic recessions and seniority-related wage systems or employment protections. Conversely, *pull* factors mainly consist of public welfare benefits, such as early retirement pensions, special unemployment programmes and disability pensions for older workers that offer financial pathways to exit the labour market earlier than the normal retirement age. Finally, *retention* factors involve labour market policies aimed at activating the older labour force, primarily through training and matching programmes for older job seekers and wage subsidies for hiring older workers.

The COVID-19 pandemic was a common shock across Europe, creating additional structural constraints that *push* older workers out of the labour market through the dual

risk of fatal illness and unemployment, albeit the extent of the shock varied across countries. However, the patterns of exit from work among older workers and its social gradients during the crisis are unlikely to unfold uniformly between countries, not least due to the variation in the intensity of the shock but also to its interactions with ad-hoc policy responses and established welfare state institutions. Therefore, the cross-country patterns of early exit during the pandemic should be understood as an outcome of the interplay between the demand-side shocks and institutions moderating them.

Protecting jobs versus income: policy responses to the labour market crisis

As the pandemic broke out in early 2020, European welfare states reacted to the crisis immediately with strong fiscal expansions at a much larger scale than those during the Great Recession. A striking feature in the domain of labour market policy was a massive rollout of job retention schemes (JRSs) in nearly all European countries, including those in Southern and Eastern Europe. Inspired by the success story of short-time work during the Great Recession and facilitated by the EU's temporary Support to mitigate Unemployment Risks in an Emergency (SURE) programme, governments swiftly introduced novel wage subsidies and furlough schemes or expanded existing short-time work policies (Ebbinghaus and Lehner, 2022; Müller and Schulten, 2022). Countries also amended existing unemployment insurance (UI) schemes to support income for workers against the risk of job loss. Temporary UI measures included increasing benefit durations, relaxing eligibility requirements to cover non-standard workers and the self-employed, raising benefit levels and providing additional lump-sum payments for low-wage workers (Moreira and Hick, 2021).

JRSs and UI share the aim of insuring workers against the risk of severe income losses

during economic recessions and thereby function as automatic stabilizers, but they do so through different instruments: the former protects jobs by supporting firms' payroll conditional to preserving the existing employment relationships, whereas the latter transfers benefits to individuals who lost their job while seeking new work. Therefore, JRSs are more effective in preventing unemployment from skyrocketing, as seen in the robust inverse relationship between the take-up rates of JRSs and unemployment rates across countries during the first year of the pandemic (Ebbinghaus and Lehner, 2022; Giupponi et al., 2022). On the other hand, generous UI payments tend to keep the level of unemployment high during crises by affecting the reservation wage of job seekers, leading to entrenched long-term unemployment (Boeri and Ours, 2013).

JRSs are generally preferred over UI benefits as the crisis management strategy because they facilitate a swift return of workers without causing training costs and frictions in job matching when the demands start to rebound (Birinci et al., 2021; Giupponi et al., 2022). However, the conceptual distinction between the two approaches is not always clear-cut. Beyond maintaining existing employment contracts, the conditionality of JRSs varies hugely from partial or full reductions of working hours to pure wage subsidies without any requirement for working-time reductions. Short-time work with full reductions of working hours or temporary layoff subsidies, also known as furlough schemes, are not clearly distinguished from partial unemployment benefits. In practice, many countries implemented short-time work schemes as part of existing UI systems (Müller and Schulten, 2022).

The two policy tools are also complementary to each other, as the rollout of JRSs tends to limit the upsurge of (more expensive) UI expenditures, and UI benefits can protect workers who are not covered by JRSs (Birinci et al., 2021; Giupponi et al., 2022).

While most European governments during the pandemic utilized combinations of both, their relative importance within the fiscal packages appeared different across countries: Continental and Southern European countries and the United Kingdom adopted JRSs as their main strategy, whereas Nordic countries relied more on conventional UI tools (Ebbinghaus and Lehner, 2022). Our hypotheses are based on the idea that these policy variations could lead to different exit outcomes among older workers in the subsequent recovery phase.

We hypothesize that a greater scale of JRS utilization contributed to limiting older workers' exit from work during the pandemic (*Hypothesis 1-1*). This is because the requirement to preserve employment relationships would function as a *retention* factor against the labour market crisis. JRSs also tend to prefer labour market insiders who are in stable employment relationships (Giupponi et al., 2022), which is often the case for older workers in firms. Nevertheless, the socioeconomic gradient in the JRS effect is less straightforward, since low-SES workers were more likely to experience initial job losses and thus were less likely to be covered by JRSs (*Hypothesis 1-2a*). On the other hand, low-productivity firms that hire more low-SES workers could benefit more from JRSs than high-productivity firms, especially when the schemes are generous (*Hypothesis 1-2b*).

Contrary to JRSs, expanding UI policies in the face of economic crises often means providing extra incentives to firms for discharging redundant workers, as seen in the explicit case of Finland during the pandemic (Greve et al., 2021). Generous UI benefits are also strongly associated with longer unemployment spells (Giupponi et al., 2022). For older workers, UI benefits are provided longer than for other age groups in many countries, and longer unemployment spells significantly reduce their chances of re-employment,

often leading to permanent retirement (Heisig and Radl, 2017). Therefore, a greater emphasis on UI expansions in response to the pandemic should increase the incidence of older workers' exit from work (*Hypothesis 2-1*). Low-SES workers would be more likely to be affected by these policies due to their higher risk of job loss in the early pandemic (*Hypothesis 2-2*).

Role of pension institutions as pull factors

In addition to ad-hoc social policies to mitigate the initial shock, existing welfare state institutions could also play a significant role in moderating the crisis. Studies across social sciences have identified national pension systems as one of the most important institutional determinants shaping older workers exit rates and timing (Blundell et al., 2016; Börsch-Supan et al., 2021; Ebbinghaus, 2006; Gruber and Wise, 1998; Hofäcker et al., 2016). Among many relevant components of pension systems, eligibility rules allowing pension receipts prior to the standard pension age are likely to create financial incentives for early retirement. Though countries have recently imposed more restrictions on receiving early pensions, such as increasing financial penalties and raising the early retirement age, the availability of these options can still provide exit incentives when facing labour market shocks. Therefore, lower early pension ages are likely to be associated with higher exit rates following the pandemic, net of pre-existing levels of activation (*Hypothesis 3-1*). This association could be greater for lower-SES groups, not only because they are more likely affected by the labour market crisis but also because in many countries, more generous early pension schemes are offered for older workers in low-skilled occupations (*Hypothesis 3-2*).

The overall generosity of public pension benefits could similarly function as a pull

factor for early exit, even though average benefit levels are mostly applied to retirees above the standard pension age. Generous and guaranteed future pension income in defined-benefit systems may incentivize older workers to retire early, especially in hard times like the COVID-19 pandemic. This would be more of a case for individuals who can afford their living through private wealth or rely on social programmes until they reach the normal pension age. Generous benefit levels of public pensions would thus be related to higher exit rates (*Hypothesis 4-1*). The educational gradient in this case is ambiguous, as low-SES workers are less likely to have accrued private wealth to afford pre-pension-age retirement (*Hypothesis 4-2a*), but also more likely to be eligible for pre-retirement programmes (*Hypothesis 4-2b*).

Pull factors linked with public pensions could be less salient in systems where private occupational or individual pension schemes prevail. As most private schemes nowadays are defined contribution plans, older workers would gain much higher pension income from additional years of employment than they would have under public systems. Moreover, as pension wealth accruals are heavily influenced by financial market fluctuations, economic crises could force older workers to postpone their planned retirement, as observed during the Great Recession (Goda et al., 2011; Mcfall, 2011). Therefore, a pension system's greater reliance on private pension schemes would incentivize older workers to immediately return to the labour market in the subsequent recovery, resulting in lower exit rates (*Hypothesis 5-1*). However, a notable phenomenon during the pandemic was that the initial stock market crash recovered swiftly and transformed into a boom within a year of the outbreak. Among high-SES older workers with sufficient wealth accruals, private pensions could offer a financial route to early retirement, provided that the health risk was present. We thus expect the negative

association between the scale of private pensions and exit rates would be less evident among high-SES older workers (*Hypothesis 5-2*).

Data and Methods

Individual-level data and variables

This study uses the SHARE Corona Survey, a questionnaire of the Survey of Health, Ageing and Retirement in Europe (SHARE) specialized for studying socio-economic and health situations among older adults during the COVID-19 pandemic. The SHARE Corona Survey is particularly useful for our study design since it is a cross-nationally comparable panel survey targeting individuals aged 50 or over in Europe and contains information on respondents' socio-demographic characteristics as well as labour market situations before and during the pandemic. Unlike the usual SHARE that collects data through face-to-face interviews, the SHARE Corona survey was conducted through computer-assisted telephone interviews as in-person fieldwork was suspended (SHARE-ERIC, 2024).

Our analysis mainly draws on the second round of the SHARE Corona Survey (SCS 2, Wave 9) conducted between June and August 2021. The time frame of the survey is appropriate to capture older workers' exit patterns during the recovery phase, as the overall labour market performance in Europe had already returned to the pre-pandemic level by the third quarter of 2021 (Ando et al., 2022). We also use the first round of the survey (SCS 1, Wave 8) carried out between June and August 2020, in order to exploit pre-pandemic employment statuses and socio-demographic variables for our sample selection. The sample is restricted to birth cohorts born between 1957 and 1967 – individuals reaching the age of 54 to 64 in 2021 – who were employed at the time of the

COVID-19 outbreak.⁷ Among 28 EU nations and Israel included in SHARE, Cyprus, Ireland and Israel are excluded for data availability reasons. For Israel and Cyprus, comparable macro-level variables (see the next section) are not available, whereas Ireland did not participate in SHARE Waves 8 and 9.

Our main dependent variable is *exit from the labour market*, a dummy variable that indicates whether the respondents were economically inactive at the time of the SCS 2 interview. Since our analytical sample is restricted to individuals who were employed at the beginning of the pandemic, the variable counts individuals who switched from employment in February or March 2020 to one of the retired, permanently sick or disabled, homemaker and other inactive statuses in June, July or August 2021. For older people close to the age of 65, inactivity statuses other than retirement could be seen as a transitory state before eventual retirement, as only a small proportion of inactive older adults return to employment at later ages. We exclude those unemployed when calculating the exit rate because the distinction between employment and unemployment is vague if the worker was enrolled in a JRS. Since the variable is based on a self-reported labour force status, same practical situations – i.e., being on a work contract but working zero hours – could be either reported as employed or unemployed depending on the respondent’s perception. However, as unemployment in old age is associated with a higher risk of leaving the labour market subsequently (Heisig and Radl, 2017; Marmora and Ritter, 2015), we also consider *exit from work* that includes unemployment as an alternative measure for a sensitivity analysis.

⁷ The selection is based on a retrospective question in SCS 1 (Wave 8), “At the time when Corona broke out, were you employed or self-employed, including working for family business?”. Respondents who answered “Yes” were selected as our sample.

The main explanatory variable representing one's SES is the level of education, an ordinal variable of three levels (low, mid and high). The levels are based on the International Standard Classification of Education (ISCED) for comparability across countries, where ISCED 0-2 is coded as low-educated, ISCED 3-4 as mid-educated and ISCED 5 or above as high-educated. For respondents who are missing the ISCED information in Wave 8, those with below 11 years of education are classified as low-educated, from 11 to 15 years as mid-educated and 16 years or above as high-educated. As we could not use one's occupation as a predictor because of large missing data of about 60 percent, the level of education is the most appropriate proxy for one's skill level and occupational class. The other variables are gender, age and partnership status, all of which are relevant demographic factors that predict one's retirement decision. The list of individual-level variables and sample characteristics are summarized in Table B1.

Country-level data and variables

To test our hypotheses on the role of institutional factors, we use five main institutional variables with two economic indicators at the country level. The first institutional variable is the government expenditure on JRSs in 2020 (*JRS Spending*). JRS Spending adds up all expenditures on short-time work benefits, furlough schemes and wage subsidies from March to December 2020, extracted from country reports provided by Drahekoupil and Müller (2021). The total expenditures were divided by the nominal GDP of 2019 to adjust for the pre-pandemic size of the economy. As aggregate spending is a combined product of benefit generosity, eligibility, coverage and take-up rates, JRS Spending effectively captures the relative scale of the JRS rollouts throughout 2020 across countries with dissimilar designs. As the expenditure data for Hungary were not

available, we imputed the missing observation using similar data provided by the European Social Policy Network (Baptista et al., 2021).

The second variable is the degree of UI expansions in 2020 relative to 2019 (*UI Expansion*). This variable calculates the difference between government expenditures on UI policies in 2020 and 2019, divided by the nominal GDP of 2019. The UI expenditure data are drawn from the Eurostat database, but we exclude expenditures on partial unemployment benefits from the aggregate expenditure because this category is conceptually identical to the JRS (Eurostat, 2022). UI Expansion here therefore includes full-time unemployment benefits plus lump-sum payments and early retirement benefits for unemployment reasons.

The third variable is the earliest age one is eligible to withdraw national pension benefits in 2021 (*Retirement Age*). In some countries, this is identical to the standard pension age, while most countries allow receiving pensions earlier at a reduced rate. Since retirement ages are lower for women in some countries, we use gender-specific retirement ages in models fitted to male- or female-specific samples. In the full-sample models, gender-averaged values are used. The data are mostly drawn from the OECD's pensions at a glance (OECD, 2021), complemented by descriptions from the EU Social Security Coordination (European Commission, 2024).

The average benefit levels in public old-age pensions are represented by net pension replacement rates in 2020 (*Pension RR*). The replacement rate is based on the standard yearly net pension income paid to the average production worker living in a single household. The indicator is available from the Social Insurance Entitlements Dataset, part of the Social Policy Indicator database (Nelson et al., 2020).

Finally, we use the OECD's private pension spending (*Private PS*) that measures

expenditures on retirement income from all private pension plans in 2019 as a percentage of GDP (OECD, 2021). The variable is a proxy for a country's overall reliance on private pensions for old-age income security. As a few countries (i.e., Denmark, Switzerland and the Netherlands) show exceptionally high spending on private pensions compared to most other cases, we take a natural logarithm so that results are not driven by the outliers.

Our macro-level control variables include the GDP growth rate in 2020 (*GDP Growth*) and the employment rate of the population aged 55 to 64 in 2019 (*Employment 2019*). The former captures the degree of economic shocks during the first year of the pandemic that varied substantially across countries. We do not control the unemployment rate since they are highly responsive to the use of JRSs and thus cannot capture exogenous labour market shocks. *Employment 2019* controls the pre-pandemic level of old-age activation, which reflects pre-existing norms and institutions of early or late retirement so that our main institutional variables capture value-added effects during the pandemic. For models using the male- or female-specific samples, gender-specific employment rates are used.

We additionally control the Oxford COVID-19 Stringency Index (*Stringency*) and the cumulative COVID-19 death rates (*Covid Death*) for robustness checks, as *GDP Growth* could be an incomplete measure to capture all sources of exogenous shocks during the pandemic. The Stringency Index is a composite indicator encapsulating non-pharmaceutical containment measures in nine domains (Hale et al., 2021). We took country-specific averages for the first 12 months since March 2020 for the cross-sectional analysis as the figures evolved over time. *Covid Death* counts the number of cumulative confirmed COVID-19 deaths per 100 million people until 1 March 2021, obtained from Our World in Data (Mathieu et al., 2020). Our complete macro-level dataset is available in Tables B2 and B3.

Analytical strategy

Our analytical strategy comprises a set of two-level hierarchical models with country-level random effects. The baseline models for estimating aggregate institutional effects include one of the five institutional variables plus GDP Growth and Employment 2019 as controls, in addition to the four individual-level predictors. The baseline models are also fitted separately to male- and female-specific samples as the same institutional factor may influence exit patterns differently between older men and women. To examine whether the institutional effect differs by one's SES, we add cross-level interaction terms between the institutional variable of interest and education levels to the baseline model. We include additional control variables (*Stringency* and *Covid Death*) only in our robustness checks due to concerns over low degrees of freedom at the country level.

All models contain random intercepts and random slopes for all individual-level predictors because assuming invariant individual-level effects across countries is likely to produce imprecise estimates for country-level effects (Heisig et al., 2017). Our data structure may be susceptible to this problem given that gender and educational gradients in labour market exit significantly vary across countries (Riekhoff and Kuitto, 2022). Moreover, failure to include random slopes when testing cross-level interactions could severely underestimate standard errors, resulting in an overly optimistic inference (Heisig and Schaeffer, 2019). Finally, all models use linear probability models that employ restricted maximum-likelihood estimation combined with Satterthwaite's (1946) method for approximating the degrees of freedom. These methods enable a robust inference against concerns over the small level-2 sample size of 26 (Bryan and Jenkins, 2016; Elff et al., 2021). The sampling weights are adjusted to assume an equal population size across all countries so that the institutional effects are not dominated by countries with large

populations.

For supplementary analysis, we estimate models without country-level variables to explore average socioeconomic differences across all 26 countries in older workers' exit from the labour market during the pandemic. In addition to the same random-effects models with maximally flexible random slopes and intercepts, we employ country-level fixed effects models that exploit only within-country variations to estimate individual-level effects. This is because fixed effects models eliminate bias from unobserved heterogeneities across countries that may be present in random effects models (Wooldridge, 2010).

Results

Descriptive results

Figure 2.1 illustrates employment rates of individuals born between 1957 and 1967 (aged 54 to 64 in 2021) in 26 European countries at the outbreak of COVID-19 (early 2020) and in mid-2021. The overall employment rates in both periods were the highest in Sweden and Switzerland, which were over 85 percent, followed by Denmark, the Netherlands and Finland, showing pre-pandemic levels of around 80 percent. Czechia's employment rate was also about the same level in the beginning but dropped substantially to 69 percent in mid-2021. Countries with low pre-pandemic employment rates of below 60 percent are mostly in Southern and Eastern Europe but also Austria and Luxembourg. The figures are even below 50 percent in Croatia, Spain and Romania.

Most countries do not show considerable changes between the two periods. Nevertheless, some countries with low initial employment rates demonstrate significant

risers, such as Spain, Greece, Luxembourg and Italy, whereas Austria’s employment rate decreased to one of the lowest levels in 2021 (49 percent). Note that these changes are not only due to exit from work but also to the switch from non-employment to employment during COVID-19. Cross-country exit patterns by mid-2021 therefore do not always correspond to the changes in employment rates, though the two are highly correlated (for country-specific exit rates, see Figure B2).

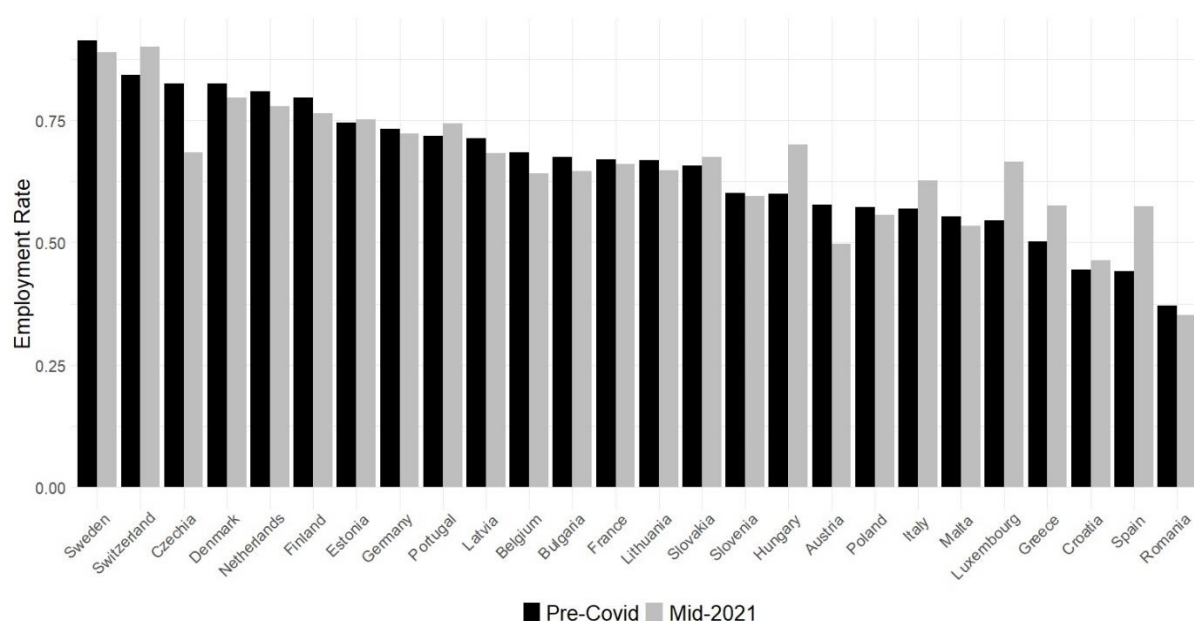


Figure 2.1. Employment rates (weighted), birth cohorts 1957-1967, February/March 2020 and June-August 2021

Note: Pre-pandemic figures are calculated based on SHARE Corona Survey 1 (Wave 8).

Table 2.2. Pearson's Correlations between Macro-level Predictors

	JRS Spending	UI Expansion	Ret. Age	Pension RR	Private PS	Empl. 2019	GDP Growth
JRS Spending	1.0						
UI Expansion	0.12	1.0					
Ret. Age	0.05	0.11	1.0				
Pension RR	0.33 ⁺	0.20	0.12	1.0			
Private PS	0.20	0.11	0.61 ***	0.02	1.0		
Empl. 2019	-0.38 ⁺	0.11	0.35 ⁺	-0.56 **	0.48 *	1.0	
GDP Growth	-0.59 **	-0.26	0.03	-0.45 *	-0.08	0.50 **	1.0

Note: ⁺ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Logged values are used for Private PS.

Table 2.2 presents simple bivariate correlations between country-level variables used. JRS Spending shows a strong negative correlation with GDP Growth, suggesting that countries with larger economic shocks in 2020 spent more budgets on JRSs. Another negative correlation between JRS Spending and the 2019 employment rate reflects the fact that countries in Southern and Eastern Europe (those with typically low levels of activation in old age) were heavily affected by the labour market crisis. However, no meaningful correlation is found between JRS Spending and UI Expansion, implying that the two policy tools are not necessarily complementary or in a trade-off (see Panels A and B in Figure B3). Nor do UI Expansion and GDP Growth show a significant correlation.

Among the elements of pension systems, a notable correlation was shown between Retirement Age and Private Pension Spending. This means that countries relying on large private pension schemes for retirement income security also tend to have high retirement ages. However, we do not see any significant relationships between the generosity of public pensions (Pension RR) and the other two pension indicators (see Panels C and D in Figure B3). All three variables were also highly correlated with the employment rate

in 2019, which confirms that the latter is a reasonable proxy for the pre-existing systems of early or late retirement in a country.

Multilevel regression results: the role of labour market policies

Table 2.3 displays multilevel regression results of labour market exit in 2021 on JRS Spending and UI Expansion. Overall, columns (1) and (2) in Table 2.3 confirm *Hypothesis 1-1* by showing that higher JRS Spending in 2020 is associated with lower exit rates during the pandemic, holding the degree of economic shocks (GDP Growth) and pre-existing employment patterns (Employment 2019) constant. The average marginal effect of JRS Spending (Institution) shown in column (1) is negative and statistically significant. One percentage point higher JRS Spending in 2020 per 2019 GDP is, on average, associated with 4.2 percentage points lower exit rates in mid-2021. The coefficient is smaller in gender-specific models (columns (2) and (3)) and no longer statistically significant among females. Regarding *Hypotheses 1-2a* and *1-2b*, the educational differences estimated in column (4) are imprecise due to relatively large standard errors, while the JRS effect among low-educated workers is also not statistically significant. Note that the effect size among the mid-educated ($0.028 + 0.014 = 0.042$) is relatively larger than the other education groups.

Table 2.3. Multilevel regression results of labour market exit on labour market policies

Institution	JRS Spending			UI Expansion				
	(1) All	(2) Male	(3) Female	(4) All	(5) All	(6) Male	(7) Female	(8) All
GDP Growth	-0.000 (0.003)	0.001 (0.003)	-0.002 (0.004)	-0.001 (0.003)	0.004 (0.003)	0.005 + (0.003)	-0.002 (0.004)	0.003 (0.003)
Employment 2019	-0.004 *** (0.001)	-0.004 *** (0.001)	-0.003 *** (0.001)	-0.003 *** (0.001)	-0.003 *** (0.001)	-0.004 *** (0.001)	-0.003 *** (0.001)	-0.003 *** (0.001)
Institution	-0.042 *** (0.012)	-0.034 * (0.016)	-0.028 (0.019)	-0.028 (0.025)	0.003 (0.024)	-0.003 (0.026)	-0.019 (0.033)	-0.074 + (0.045)
Institution × Mid-Edu				-0.014 (0.026)				0.168 ** (0.056)
Institution × High-Edu				0.008 (0.026)				0.049 (0.049)
<i>Log-Likelihood</i>	-3208.78	-1270.18	-1924.50	-3207.536	-3204.78	-1273.29	-1929.41	-3204.84
<i>N. Country</i>	26	26	26	26	26	26	26	26
<i>N. Individual</i>	6,647	2,863	3,784	6,647	6,647	2,863	3,784	6,647

Note: + $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. In parentheses are standard errors. Survey weights assume equal population across countries. Significance tests use t-statistics and p-values drawn from Satterthwaite's method. All models include the level of education, gender, age, and partner status and allow random intercepts and slopes for all individual-level predictors. All country-level predictors are mean-centred. Employment 2019 is gender-specific.

Columns (5) to (7) in Table 2.3 show that UI Expansion is, on average, not meaningfully linked with higher exit outcomes after controlling GDP Growth and Employment 2019 (*Hypothesis 2-1*). However, column (8) reveals that the positive association between UI Expansion and the exit rate exists but is concentrated in the mid-educated group. One percentage point bigger UI Expansion per 2019 GDP is related to 9.4 percentage points ($-0.074 + 0.168 = 0.094$) higher exit rate among mid-educated workers. This result is different from the negative and linear educational gradient expected in *Hypothesis 2-2*, where lower-educated workers are more likely to benefit from the extension of UI policies.

Multilevel regression results: the role of pension institutions

Table 2.4 shows multilevel regression results of labour market exit on institutions of public and private pensions, net of the GDP growth in 2020 and the employment rate in 2019. The coefficients of Institution in columns (1)-(3) exhibit no statistical significance regarding the earliest retirement age on average and among males and females (*Hypothesis 3-1*). Cross-level interaction effects in column (4) demonstrate that the association between the retirement age and the exit rate varies significantly by the level of education, consistent with *Hypothesis 3-2*. For example, higher retirement age by one year is associated with a lower exit by 1.3 percentage points among the low-educated, but the effect is close to zero ($-0.013 + 0.016 = 0.003$) among the high-educated.

Regarding the effect of the Pension Replacement Rate, none of the results in columns (5) to (7) support *Hypothesis 4-1*. The only statistically significant coefficient is rather negative in column (6). Moreover, educational differences estimated in column (8) are also not significant (*Hypotheses 4-2a* and *4-2b*).

Table 2.4. Multilevel regression results of labour market exit on pension institutions

Institution	Early Retirement Age			Pension Replacement Rate				(Log) Private Pension Spending				
	(1) All	(2) Male	(3) Female	(4) All	(5) All	(6) Male	(7) Female	(8) All	(9) All	(10) Male	(11) Female	(12) All
GDP Growth	0.004 (0.002)	0.005 * (0.003)	-0.000 (0.004)	0.004 (0.002)	0.003 (0.002)	0.003 (0.003)	0.000 (0.004)	0.003 (0.002)	0.003 (0.002)	0.005 + (0.003)	-0.001 (0.004)	0.001 (0.003)
Employment 2019	-0.003 *** (0.001)	-0.004 *** (0.001)	-0.003 ** (0.001)	-0.003 *** (0.001)	-0.004 *** (0.001)	-0.005 *** (0.001)	-0.003 ** (0.001)	-0.004 *** (0.001)	-0.002 ** (0.001)	-0.003 * (0.001)	-0.002 * (0.001)	-0.002 ** (0.001)
Institution	-0.001 (0.004)	-0.007 (0.005)	-0.002 (0.005)	-0.013 + (0.007)	-0.000 (0.000)	-0.001 * (0.000)	0.000 (0.001)	-0.000 (0.001)	-0.008 * (0.004)	-0.010 + (0.006)	-0.006 (0.006)	-0.003 (0.010)
Institution × Mid-Edu				0.012 (0.009)				-0.001 (0.001)				-0.007 (0.010)
Institution × High-Edu				0.016 * (0.008)				-0.000 (0.001)				-0.003 (0.010)
<i>Log-Likelihood</i>	-3206.66	-1272.26	-1927.73	-3213.47	-3208.47	-1273.78	-1928.80	-3221.00	-3206.53	-1271.59	-1926.04	-3212.55
<i>N. Country</i>	26	26	26	26	26	26	26	26	26	26	26	26
<i>N. Individual</i>	6,647	2,863	3,784	6,647	6,647	2,863	3,784	6,647	6,647	2,863	3,784	6,647

Note: + $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. In parentheses are standard errors. Survey weights assume equal population across countries. Significance tests use t-statistics and p-values drawn from Satterthwaite's method. All models include the level of education, gender, age, and partner status and allow random intercepts and slopes for all individual-level predictors. All country-level predictors are mean-centred. Employment 2019 and Early Retirement Age are gender-specific.

Finally, models estimating the marginal effect of Private Pension Spending consistently show negative coefficients in columns (9) to (12). One-unit higher value in the log of Private PS (equivalent to a larger scale by double) is associated with a lower exit rate by about 0.8 percentage points on average and one percentage point among males, consistent with *Hypothesis 5-1*, though the coefficient for females is not statistically significant. On the other hand, the educational gradient expected in *Hypothesis 5-2* is not supported by the cross-level interaction model. All three coefficients of interest are not precisely estimated by the model in column (12).

Supplementary analysis: individual-level regression results

We present supplementary results from estimations without any macro-level predictors in Table 2.5 because the coefficients of individual-level predictors in multilevel models included in Tables 2.3 and 2.4 are contingent on the distribution of macro-level variables used. As the age is centred at 59, the intercepts in Table 2.5 represent the exit rate of low-educated workers without a partner at the age of 59, averaged across countries. In columns (1) and (4), those are the exit rate of low-educated male workers.

Both fixed- and random-effects models in columns (1) and (4) show that the exit rate of high-educated workers is significantly lower than that of low-educated workers by about 5.6 to 6.1 percentage points holding gender, age, and partner status constant. The difference in mean exit rates between low- and mid-educated workers is about 2.0 to 3.1 percentage points but is only significant based on the fixed-effects model. Female workers are substantially more likely to exit from the labour market than males by about 5.1 to 5.3 percentage points.

Table 2.5. Linear probability models, labour market exit on individual-level predictors

	Fixed Effect			Random Effect (intercept & slope)		
	(1) All	(2) Male	(3) Female	(4) All	(5) Male	(6) Female
(Intercept)	0.103 *** (0.019)	0.059 * (0.024)	0.190 *** (0.023)	0.082 ** (0.026)	0.078 ** (0.030)	0.131 *** (0.030)
Mid-Edu	-0.031 * (0.015)	-0.012 (0.016)	-0.024 (0.022)	-0.020 (0.017)	-0.011 (0.017)	-0.021 (0.027)
High-Edu	-0.061 *** (0.016)	-0.042 * (0.021)	-0.064 ** (0.023)	-0.056 ** (0.017)	-0.041 * (0.020)	-0.068 ** (0.026)
Female	0.053 ** (0.017)			0.051 ** (0.018)		
Age	0.028 *** (0.003)	0.025 *** (0.004)	0.032 *** (0.005)	0.029 *** (0.003)	0.024 *** (0.004)	0.034 *** (0.005)
Partner	0.012 (0.012)	0.017 (0.015)	0.006 (0.016)	0.004 (0.013)	0.007 (0.018)	0.004 (0.020)
<i>Adj. R-squared</i>	0.078	0.076	0.111			
<i>Log-Likelihood</i>				-3198.18	-1264.23	-1917.23
<i>N. Country</i>	26	26	26	26	26	26
<i>N. Individual</i>	6,647	2,863	3,784	6,647	2,863	3,784

Note: + $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; In parentheses are standard errors. Survey weights assume equal population across countries. Age is centered at 59. Standard errors are clustered by country in fixed effect models.

Moreover, gender-specific models in columns (2)-(3) and (5)-(6) reveal that the educational difference is in general larger among females. The estimated difference in exit rates between the low- and high-educated groups is around 4.1 to 4.2 percentage points among males but 6.4 to 6.8 percentage points among females. The difference between the low- and mid-educated groups is not significant in both gender groups. The gender gap in the exit rate is particularly huge among the low-educated, women showing a higher rate by 5.3 (random effects) to 13.1 percentage points (fixed effects) than men.

Overall, age is a consistently significant predictor of exit to inactivity across all models. Having a partner is not shown as a significant predictor across all models.

Robustness checks

We provide five sets of robustness checks in Appendix Paper 2 (see Tables B4-B8). First, we use *exit from work* as an alternative measure for the dependent variable that counts the unemployed. Results in Table B4 are mostly similar to our main results with larger coefficient sizes. A notable difference is that the negative coefficient of Private Pension Spending among low-educated workers is now significantly larger, demonstrating additional incentives to stay employed under huge private pension schemes. Although the estimated educational differences are still not statistically significant, the reduction in the effect size is non-negligible by about 57 percent for high-educated workers ($-0.021 + 0.012 = -0.09$).

Secondly, we add the COVID-19 stringency index (*Stringency*) and cumulative COVID-19 death rates (*Covid Death*) as control variables to the main models. This is to address the concern that the GDP decline may not adequately represent the exogenous shock of COVID-19 to the economy. The results in Table B5 show that models taking into account the degree of health shocks and government interventions produce nearly identical results to the initial findings, confirming that our main results are robust.

The third and fourth checks are for testing independent effects when multiple institutional factors that are conceptually or empirically related to each other are included in a single model. Specifically, we first construct models testing independent effects of JRS Spending and UI Expansion when each other is controlled, as the two policy tools in practice exist in a continuum and are often used complementarily. The results in Table B6

demonstrate that the independent effects do exist and are consistent with the main results in Table 2.3. The only difference is that the effect of JRS Spending is also significant among females when UI Expansion is controlled. Similarly, Table B7 presents combined models of Retirement Age and Private Pension Spending, two highly correlated variables. These results also validate the independent effects of both factors that are in line with those in Table 2.4.

Finally, we use the peak JRS take-up rate in 2020 (*JRS Take-up*) and logged pension fund assets in 2019 as a percentage of GDP (*Pension Fund*) as alternative measures, instead of JRS Spending and Private Pension Spending, respectively. Table B8 presents that models using JRS Take-up produce highly similar results to those using JRS Spending. On the other hand, the average effect is no longer visible when using Pension Fund as the key variable, suggesting that the association between the scale of private pensions and the exit outcome is less robust.

Discussions and Conclusion

In this study, we investigate the role of novel JRS rollouts in response to the crisis ('new' welfare states), temporary expansions of UI and existing pension institutions ('old' welfare states) in shaping older workers' labour market exit in a later phase of the COVID-19 pandemic, by exploiting cross-national variations in policy responses and institutional features in Europe. We also test how the institutional effects vary by older workers' level of education. Our findings largely support our hypotheses that JRS rollouts and UI expansions in 2020 had opposite effects: higher JRS spending is, on average, systematically related to lower exit rates of older workers, whereas greater UI expansions are associated with higher exit rates but only among mid-educated workers. Nevertheless,

cross-country correlations between policy indicators show that there is no trade-off in the utilization of the two policies, suggesting that many countries during the pandemic combined both approaches complementarily. Meanwhile, the educational gradient in the effect of JRS spending looks unclear from our results due to imprecise estimates. It was also unexpected that the positive association between UI expansions and exit rates is only observed among mid-educated workers.

Among existing pension institutions, we find that higher retirement ages and greater reliance on private pension schemes are both associated with lower exit outcomes. However, the significant negative effect of the earliest retirement age is only found among the low-educated, exhibiting a clear negative educational gradient. On the other hand, the role of private pension spending is visible in aggregate but not in the education-specific effect. These findings are robust when the two indicators are controlled for each other in a single model despite their strong correlation at the country level. However, we do not find any evidence supporting that generous benefit levels in public pension schemes, measured by net pension replacement rates, are related to higher exit rates. While most of our main findings are supported by diverse sets of robustness checks, the system-level reliance on private pension schemes does not seem influential when using pension fund assets as an alternative measure.

Our findings overall display the significance of old and new welfare states in moderating the labour market shock among older workers by mitigating or facilitating their exit from the labour market during the pandemic. Policy implications are many. JRSs are supported by our study as an effective crisis management tool by retaining existing employment relationships, consistent with previous studies (Ebbinghaus and Lehner, 2022; Giupponi et al., 2022). The pattern is even more evident when including exit to

unemployment, implying that JRS effectively reduced the incidence of job loss during the pandemic (see Table B4). However, one important limitation of the JRS is its insider bias – JRSs cannot protect the income of workers who already lost their job in the early phase of the crisis. This may explain why employment disruptions were more salient among younger workers who are normally in less protected positions (Ando et al., 2022). UI expansions should therefore be utilized as a complementary tool by prioritizing non-standard workers in the outsider positions to reduce the risk of poverty during economic recessions.

Another implication is related to the negative educational gradient in the effect of higher retirement ages. Although our evidence is cross-sectional, findings from other studies also suggest that raising the retirement age to constrain public pension expenditures increases old-age employment but worsens financial status among low-status workers (Etgeton, 2018; Lee, 2024). Therefore, it needs to be sufficiently emphasized that minimum social protection should be strengthened for older adults when retirement ages are raised and public spending on older workers is reduced.

Meanwhile, an unexpected finding is that the significance of UI expansions is highly concentrated and only observed among mid-educated workers, in contrast to our hypothesis assuming a linear educational gradient. This pattern may reflect a unique labour market situation during the pandemic that augmented the demand for frontline or ‘essential’ but low-skilled service jobs at the expense of the demand for medium-skilled jobs. Alternatively, it may reflect a longer-term trend of occupational restructuring towards job polarization in European labour markets, which may have been accelerated by the pandemic-induced economic crisis (Autor and Dorn, 2013; Oesch, 2013). This interpretation is consistent with our individual-level regression results that show no

significant differences in the exit rate between low- and mid-educated groups. Nevertheless, verifying this account empirically is beyond the scope of this study.

One important caveat is that our empirical analysis is based on a selective sample – individuals employed at the beginning of the pandemic. This means that our findings do not apply to older adults who had already retreated from the labour market due to permanent sickness or disability or to become homemakers, who are more likely to be lower-educated and female. Secondly, our findings regarding the role of macro-institutions should not be misinterpreted as individual-level policy effects. For example, the strong association between private pension spending and the exit outcome does not necessarily mean that older workers are responding to an increase or decline in private pension income. The institutional effect in this case rather means that under pension systems with a large share of private pensions, older workers are more financially motivated to retain employment when facing economic crises. Similarly, our results do not establish any causal relationships based on the potential outcomes framework, and thus our estimates do not represent behavioural responses to exogenous policy changes. For instance, the strong effect of UI expansions only among mid-educated workers should not be understood as if only mid-educated workers are the most responsive to UI policies. It is more sensible to say that other structural conditions adversely affected mid-educated workers more than other education groups during the pandemic, and UI schemes facilitated their exit from work.

It should also be noted that the exit rates in mid-2021 only show medium-term outcomes of the pandemic-induced labour market shock. Given that old-age employment rates in most countries have swiftly recovered to the upward trend, it is unlikely that most older workers who were economically inactive (or unemployed) in 2021 will transfer to

permanent retirement afterwards. However, our findings showing clear socioeconomic gradients in exit rates are alarming that the pandemic could intensify educational inequalities among older workers. Future research should therefore closely monitor how inequalities in old age evolve from a long-term perspective.

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Appendix Paper 2

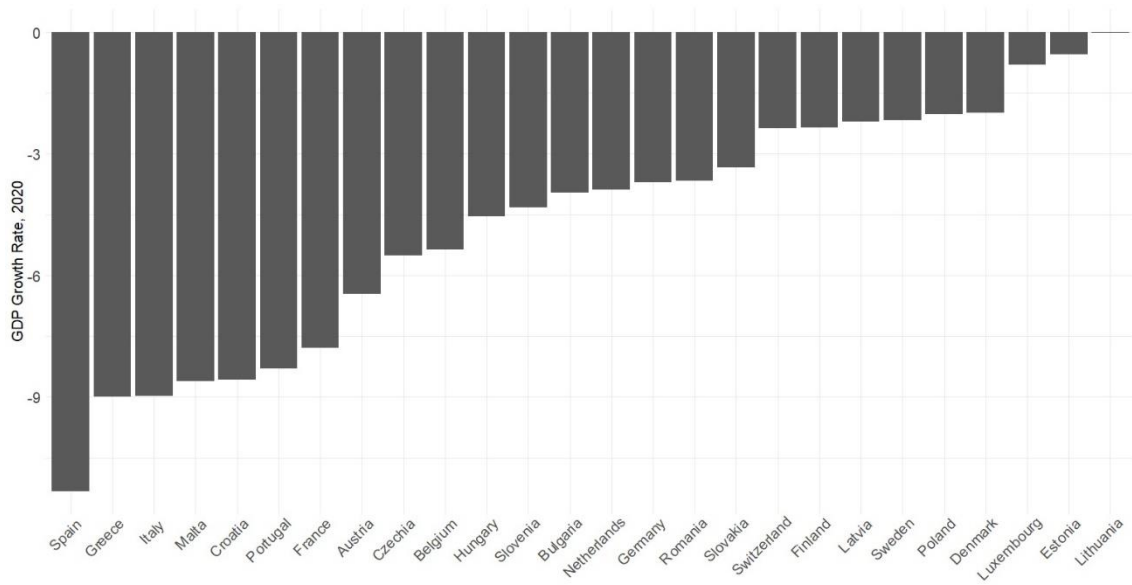


Figure B1. GDP decline in European countries, 2020

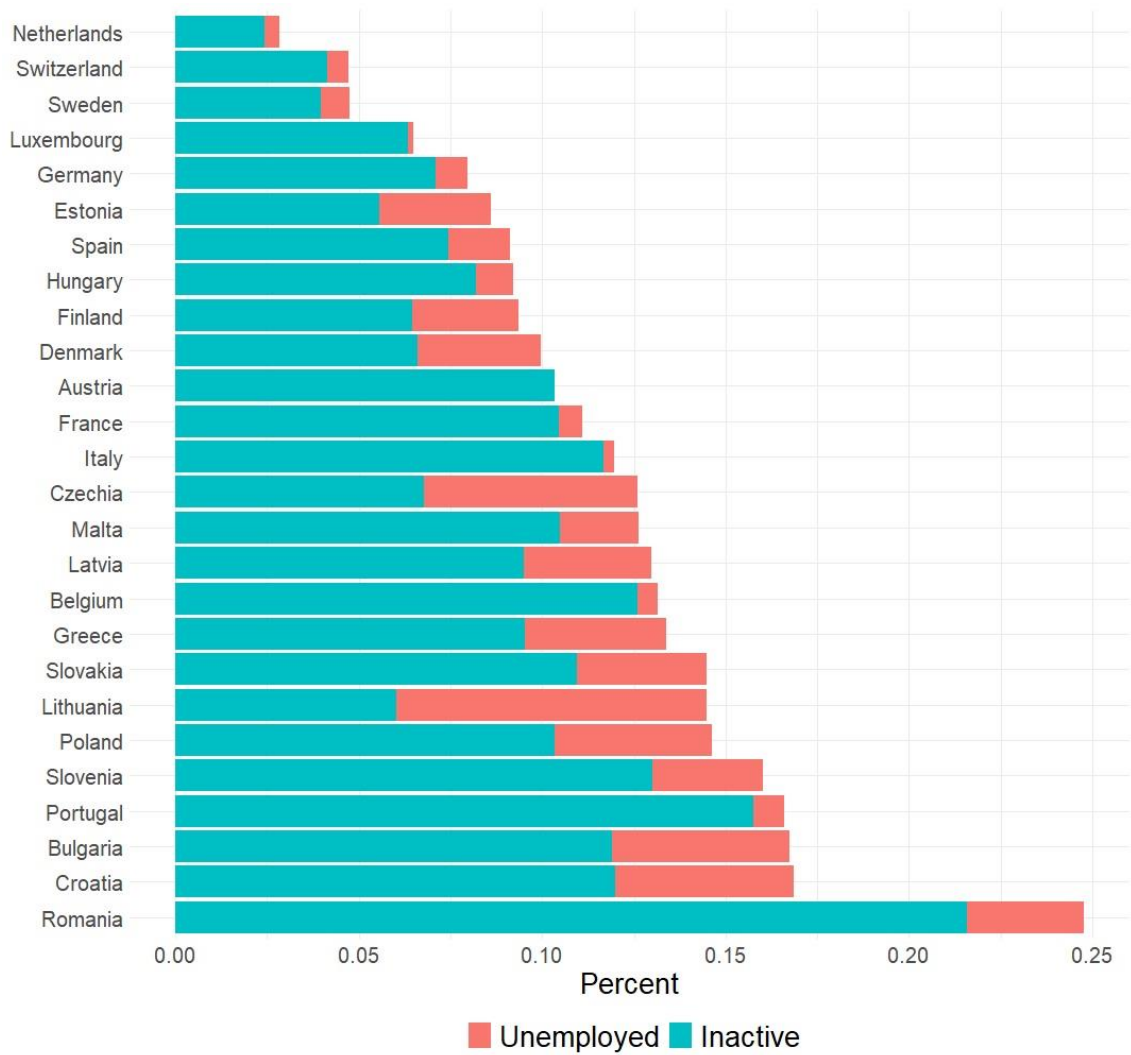


Figure B2. Country-specific rates of exit from employment (weighted) in mid-2021, birth cohorts 1957-1967 who were employed at the outbreak of COVID-19

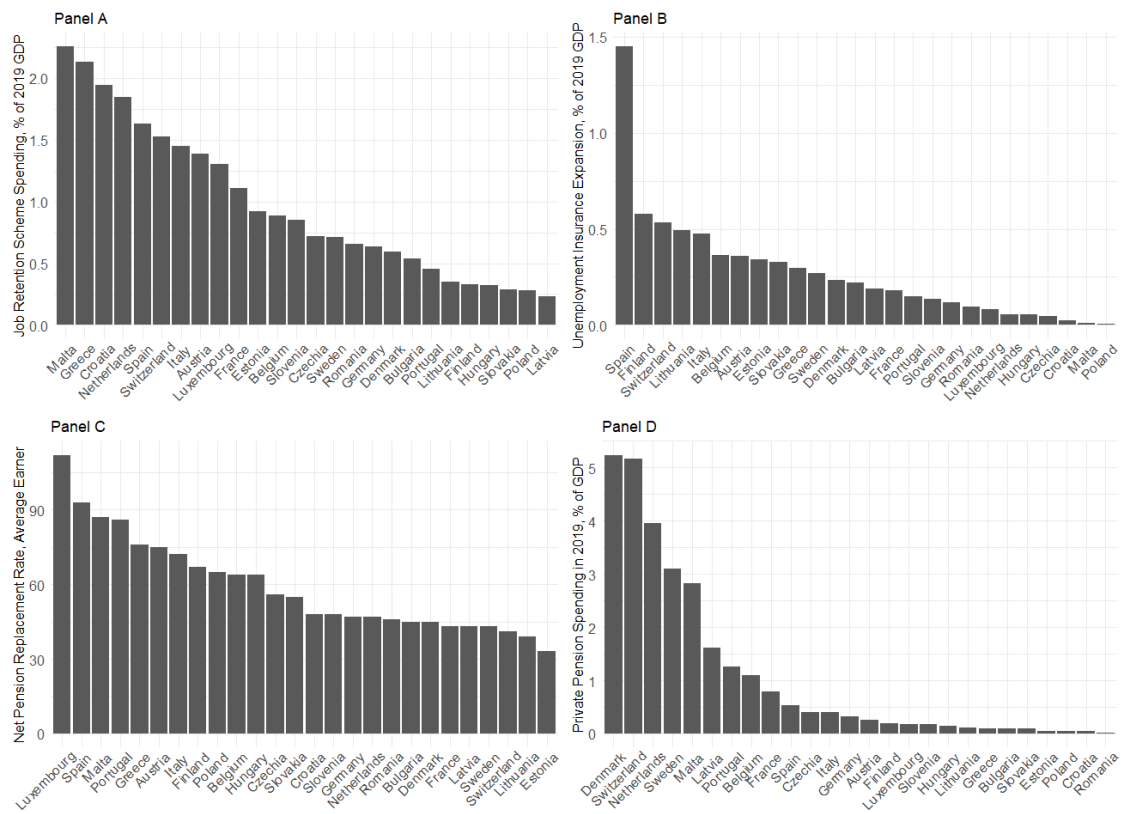


Figure B3. Cross-country distribution of major institutional variables (Panel A: JRS Spending / Panel B: UI Expansion / Panel C: Pension RR / Panel D: Private PS)

Table B1. Individual-level sample characteristics (weighted)

	N	Mean (SD)
Inactive	6,647	0.091
Non-employed	6,647	0.116
Education	6,647	
High	2,271	0.317
Mid	3,422	0.515
Low	954	0.168
Female	6,647	0.461
Age	6,647	59.51 (2.36)
Partner	6,647	0.797

Note: Weights assume equal population across countries. SD=standard deviation

Table B2. Country-level data of institutional variables used in the study

Country	JRS Spending	JRS Take-up	UI Expansion	Ret. Age	Ret. Age (Men)	Ret. Age (Women)	Pension RR	Private PS	Pension Fund
Austria	1.38	0.27	0.36	61	62	60	75	0.25	6.11
Belgium	0.89	0.28	0.36	63	63	63	64	1.10	8.45
Bulgaria	0.54	0.06	0.22	61.9	63.3	60.5	45	0.10	13.07
Czechia	0.72	0.22	0.05	60	60	60	56	0.40	8.77
Croatia	1.95	0.4	0.02	58.75	60	57.5	48	0.04	29.18
Denmark	0.60	0.09	0.23	65.5	65.5	65.5	45	5.24	48.95
Estonia	0.92	0.22	0.34	60.8	60.8	60.8	33	0.05	17.15
Finland	0.33	0.08	0.58	63	63	63	67	0.20	52.09
France	1.11	0.34	0.18	62	62	62	43	0.79	1.31
Germany	0.64	0.15	0.12	63.7	63.7	63.7	47	0.33	7.45
Greece	2.13	0.25	0.30	62	62	62	76	0.10	0.85
Hungary	0.32	0.06	0.05	63.25	64.5	62	64	0.15	3.78
Italy	1.45	0.22	0.48	62	62	62	72	0.40	8.38
Latvia	0.23	0.06	0.19	61.8	61.8	61.8	43	1.62	1.83
Lithuania	0.35	0.14	0.49	58.5	59	58	39	0.11	8.23
Luxembourg	1.30	0.34	0.08	62	62	62	112	0.18	2.87
Malta	2.26	0.42	0.01	61	61	61	87	2.83	46.18
Netherlands	1.84	0.34	0.06	66.3	66.3	66.3	47	3.95	194.19
Poland	0.28	0.04	0.01	62.5	65	60	65	0.04	6.79
Portugal	0.46	0.28	0.15	62	62	62	86	1.26	10.18
Romania	0.66	0.11	0.10	58	60	56	46	0.01	6.09
Slovakia	0.29	0.08	0.33	60.7	60.7	60.7	55	0.09	12.61
Slovenia	0.85	0.21	0.13	60	60	60	48	0.17	5.95
Spain	1.63	0.19	1.45	63	63	63	93	0.53	9.30
Sweden	0.71	0.12	0.27	62	62	62	43	3.10	4.21
Switzerland	1.53	0.29	0.54	62.5	63	62	41	5.17	138.22

Table B3. Country-level data of control variables used in the study

Country	Empl. 2019	Empl. 2019 (Men)	Empl. 2019 (Women)	GDP Growth	Covid Death	Stringency
Austria	54.5	63.1	46.0	-6.45	11.568	61.82
Belgium	52.1	57.3	47.0	-5.36	19.182	62.16
Bulgaria	64.4	69.2	59.9	-3.96	14.991	50.34
Czechia	66.7	74.7	58.9	-5.50	20.052	57.57
Croatia	43.9	52.6	35.9	-8.58	13.711	51.33
Denmark	71.3	75.8	66.9	-1.99	4.014	58.48
Estonia	71.9	69.1	74.3	-0.55	5.030	44.71
Finland	66.8	64.8	68.6	-2.35	1.415	47.17
France	53.1	55.5	50.9	-7.78	14.009	64.56
Germany	72.7	77.1	68.4	-3.70	9.292	66.01
Greece	43.2	56.1	31.6	-9.00	6.309	69.53
Hungary	56.7	69.0	46.2	-4.54	15.107	60.73
Italy	54.3	64.6	44.6	-8.98	16.549	74.69
Latvia	67.3	67.6	67.1	-2.20	9.553	51.52
Lithuania	68.4	69.4	67.5	-0.02	11.869	61.16
Luxembourg	43.1	48.9	37.1	-0.80	6.269	53.08
Malta	51.1	66.3	35.4	-8.61	6.282	54.96
Netherlands	69.7	78.3	61.2	-3.89	9.015	65.07
Poland	49.5	61.0	39.2	-2.02	11.005	61.23
Portugal	60.4	66.5	55.1	-8.30	15.915	68.27
Romania	47.8	60.1	36.5	-3.68	10.351	64.99
Slovakia	57.0	60.3	53.9	-3.34	12.882	58.54
Slovenia	48.6	53.2	44.0	-4.32	19.690	63.88
Spain	53.8	61.1	46.9	-11.33	15.804	68.59
Sweden	77.7	79.8	75.6	-2.17	12.343	61.49
Switzerland	73.0	79.4	66.6	-2.38	11.023	53.03

Note: Covid Death is per 100 million persons.

Table B4. Robustness checks 1: Exit from work as outcome variable (all-persons model only)

Institution	JRS Spending		UI Expansion		Retirement Age		Pension RR		Private PS	
	Baseline	Interaction	Baseline	Interaction	Baseline	Interaction	Baseline	Interaction	Baseline	Interaction
GDP Growth	-0.002 (0.003)	-0.002 (0.003)	0.005 + (0.003)	0.005 (0.003)	0.004 (0.003)	0.004 (0.002)	0.005 + (0.003)	0.005 + (0.003)	0.001 (0.003)	0.001 (0.003)
Employment 2019	-0.003 *** (0.001)	-0.003 *** (0.001)	-0.003 *** (0.001)	-0.004 *** (0.001)	-0.003 *** (0.001)	-0.001 (0.001)	-0.004 *** (0.001)	-0.004 *** (0.001)	-0.002 * (0.001)	-0.002 * (0.001)
Institution	-0.050 *** (0.012)	-0.017 (0.028)	0.001 (0.026)	-0.038 (0.047)	-0.006 (0.004)	-0.035 *** (0.006)	-0.001 (0.000)	-0.001 (0.001)	-0.014 ** (0.005)	-0.021 * (0.010)
Institution × Mid- Edu		-0.037 (0.026)		0.138 ** (0.053)		0.018 * (0.008)		-0.000 (0.001)		0.004 (0.009)
Institution × High- Edu		-0.024 (0.027)		0.001 (0.043)		0.030 *** (0.007)		0.000 (0.001)		0.012 (0.009)
<i>Log-Likelihood</i>	-3919.92	-3924.89	-3924.84	-3924.91	-3926.10	-3945.82	-3928.00	-3940.65	-3923.59	-3930.09
<i>N. Country</i>	26	26	26	26	26	26	26	26	26	26
<i>N. Individual</i>	6,647	6,647	6,647	6,647	6,647	6,647	6,647	6,647	6,647	6,647

Note: + $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. In parentheses are standard errors. Survey weights assume equal population across countries. Significance tests use t-statistics and p-values drawn from Satterthwaite's method. All models include the level of education, gender, age, and partner status and allow random intercepts and slopes for all individual-level predictors. All country-level predictors are mean-centered. Employment 2019 and Early Retirement Age are gender-specific.

Table B5. Robustness checks 2: Adding control variables (all-persons model only)

Institution	JRS Spending		UI Expansion		Retirement Age		Pension RR		Private PS	
	Baseline	Interaction	Baseline	Interaction	Baseline	Interaction	Baseline	Interaction	Baseline	Interaction
GDP Growth	-0.000 (0.003)	-0.002 (0.003)	0.005 (0.003)	0.005 + (0.003)	0.006 * (0.003)	0.005 (0.003)	0.004 (0.003)	0.004 (0.003)	0.003 (0.003)	0.002 (0.003)
Employment 2019	-0.004 *** (0.001)	-0.003 *** (0.001)	-0.003 *** (0.001)	-0.003 *** (0.001)	-0.003 *** (0.001)	-0.003 *** (0.001)	-0.004 *** (0.001)	-0.004 *** (0.001)	-0.002 ** (0.001)	-0.002 ** (0.001)
Stringency	0.001 (0.001)	0.001 (0.001)	0.001 (0.001)	0.001 (0.001)	0.002 (0.001)	0.001 (0.001)	0.001 (0.001)	0.001 (0.001)	0.001 (0.001)	0.001 (0.001)
Covid Death	-0.002 (0.001)	-0.002 (0.001)	-0.001 (0.001)	-0.002 (0.001)	-0.002 (0.002)	-0.001 (0.002)	-0.001 (0.001)	-0.001 (0.001)	-0.001 (0.001)	-0.001 (0.001)
Institution	-0.044 ** (0.013)	-0.032 (0.026)	0.002 (0.024)	-0.070 (0.045)	-0.004 (0.004)	-0.015 * (0.008)	-0.000 (0.000)	-0.000 (0.001)	-0.008 + (0.005)	-0.003 (0.010)
Institution × Mid- Edu		-0.014 (0.026)		0.160 ** (0.055)		0.012 (0.008)		-0.001 (0.001)		-0.007 (0.010)
Institution × High- Edu		0.008 (0.026)		0.057 (0.048)		0.016 * (0.008)		-0.000 (0.001)		-0.003 (0.010)
<i>Log-Likelihood</i>	-3219.62	-3218.56	-3215.96	-3217.36	-5908.20	-5902.40	-5914.81	-5909.36	-5894.96	-5904.04
<i>N. Country</i>	26	26	26	26	26	26	26	26	26	26
<i>N. Individual</i>	6,647	6,647	6,647	6,647	6,647	6,647	6,647	6,647	6,647	6,647

Note: + p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001. In parentheses are standard errors. Survey weights assume equal population across countries. Significance tests use t-statistics and p-values drawn from Satterthwaite's method. All models include the level of education, gender, age, and partner status and allow random intercepts and slopes for all individual-level predictors. All country-level predictors are mean-centered. Employment 2019 and Early Retirement Age are gender-specific.

Table B6. Robustness checks 3: Combined models of JRS Spending and UI Expansion

	(1) All	(2) Male	(3) Female	(4) All	(5) All
GDP Growth	-0.001 (0.003)	0.001 (0.003)	-0.005 (0.004)	-0.001 (0.003)	-0.002 (0.003)
Employment 2019	-0.003 *** (0.001)	-0.004 *** (0.001)	-0.004 *** (0.001)	-0.003 *** (0.001)	-0.004 *** (0.001)
JRS Spending	-0.037 ** (0.012)	-0.034 * (0.017)	-0.041 * (0.017)	-0.029 (0.026)	-0.036 ** (0.011)
UI Expansion	0.013 (0.023)	-0.007 (0.024)	-0.034 (0.032)	0.009 (0.023)	-0.076 + (0.042)
JRS Spending × Mid-Edu				-0.014 (0.026)	
JRS Spending × Low-Edu				0.008 (0.026)	
UI Expansion × Mid-Edu					0.158 ** (0.051)
UI Expansion × Low-Edu					0.044 (0.046)
<i>Log-Likelihood</i>	-3205.04	-1272.96	-1930.55	-3210.33	-3205.12
<i>N. Country</i>	26	26	26	26	26
<i>N. Individual</i>	6,647	2,863	3,784	6,647	6,647

Note: + $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; In parentheses are standard errors. Survey weights assume equal population across countries. Significance tests use t-statistics and p-values drawn from Satterthwaite's method; All models include the level of education, gender, age, and partner status and allow random intercepts and slopes for all individual-level predictors. All country-level predictors are mean-centered. Employment 2019 is gender-specific.

Table B7. Robustness checks 4: Combined models of Retirement Age and Private PS

	(1) All	(2) Male	(3) Female	(4) All	(5) All
GDP Growth	0.001 (0.002)	0.005 + (0.003)	-0.001 (0.004)	0.001 (0.002)	0.002 (0.002)
Employment 2019	-0.002 ** (0.001)	-0.003 * (0.001)	-0.002 * (0.001)	-0.002 ** (0.001)	-0.002 ** (0.001)
Retirement Age	0.005 (0.004)	-0.004 (0.005)	0.004 (0.006)	-0.008 (0.008)	0.005 (0.004)
(Log) Private PS	-0.012 * (0.005)	-0.008 (0.006)	-0.011 (0.008)	-0.012 * (0.005)	-0.008 (0.010)
Retirement Age × Mid-Edu				0.012 (0.008)	
Retirement Age × Low-Edu				0.016 * (0.008)	
(Log) Private PS × Mid-Edu					-0.006 (0.010)
(Log) Private PS × Low-Edu					-0.002 (0.010)
<i>Log-Likelihood</i>	-3209.09	-1277.65	-1930.87	-3215.91	-3218.42
<i>N. Country</i>	26	26	26	26	26
<i>N. Individual</i>	6,647	2,863	3,784	6,647	6,647

Note: + $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; In parentheses are standard errors. Survey weights assume equal population across countries. Significance tests use t-statistics and p-values drawn from Satterthwaite's method; All models include the level of education, gender, age, and partner status and allow random intercepts and slopes for all individual-level predictors. All country-level predictors are mean-centered. Employment 2019 and Retirement Age are gender-specific.

Table B8. Robustness checks 5: JRS Take-up and Pension Fund as alternative measures

Institution	JRS Take-up		(Log) Pension Fund	
	(1) All	(2) All	(3) All	(4) All
GDP Growth	-0.001 (0.002)	-0.001 (0.002)	0.004 (0.002)	0.003 (0.002)
Employment 2019	-0.003 *** (0.001)	-0.003 *** (0.001)	-0.003 *** (0.001)	-0.003 *** (0.001)
Institution	-0.184 *** (0.054)	0.001 (0.146)	-0.001 (0.005)	-0.001 (0.011)
Institution × Mid-Edu		-0.233 (0.151)		-0.000 (0.013)
Institution × High-Edu		-0.114 (0.150)		0.001 (0.012)
<i>Log-Likelihood</i>	-3199.94	-3201.09	-3206.28	-3213.61
<i>N. Country</i>	26	26	26	26
<i>N. Individual</i>	6,647	6,647	6,647	6,647

Note: + $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. In parentheses are standard errors. Survey weights assume equal population across countries. Significance tests use t-statistics and p-values drawn from Satterthwaite's method; All models include the level of education, gender, age, and partner status and allow random intercepts and slopes for all individual-level predictors. All country-level predictors are mean-centered. Employment 2019 is gender-specific.

Table B9. Difficulties Making Ends Meet, by Individual Predictors

	Fixed Effect			Random Effect		
	All	Male	Female	All	Male	Female
(Intercept)	0.196 *** (0.044)	0.206 *** (0.053)	0.237 *** (0.039)	0.423 *** (0.061)	0.414 *** (0.062)	0.464 *** (0.062)
Mid-Edu	0.004 (0.057)	-0.035 (0.036)	-0.062 + (0.034)	-0.042 (0.031)	-0.056 + (0.028)	-0.075 + (0.039)
High-Edu	-0.107 * (0.049)	-0.132 *** (0.038)	-0.164 *** (0.037)	-0.142 *** (0.033)	-0.149 *** (0.033)	-0.167 *** (0.044)
Female	-0.012 (0.031)			0.001 (0.024)		
Age	-0.005 (0.003)	-0.009 (0.007)	0.001 (0.005)	-0.002 (0.004)	-0.006 (0.006)	-0.001 (0.006)
Partner	-0.092 *** (0.025)	-0.065 (0.044)	-0.101 *** (0.026)	-0.079 *** (0.024)	-0.057 (0.038)	-0.113 *** (0.031)
<i>Adj. R-squared</i>	0.279	0.365	0.237			
<i>Log-Likelihood</i>				-5380.54	-2349.70	-2958.14
<i>No. of Country</i>	26	26	26	26	26	26
<i>No. of Individual</i>	6,647	2,863	3,784	6,647	2,863	3,784

Note: + $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; In parentheses are standard errors. Survey weights assume equal population across countries. Age is centered at 60. Standard errors are clustered by country in fixed effect models.

Paper 3

Convergence or Continued Stratification? Late Working Lives and Retirement Trajectories in Germany

* This paper is co-authored with Bernhard Ebbinghaus (University of Mannheim)

Abstract

Scholars increasingly recognize retirement transitions as gradual, complex, and unequal processes that shape inequalities in later-life outcomes, while the patterns of retirement are strongly influenced by macro-social environments. Germany presents a unique case where late working lives are highly stratified, yet early retirement trends have dramatically reversed since major welfare state reforms in the 1990s, despite facing multiple recessions. Against this backdrop, our study examines the dynamics of social stratification in retirement processes and their pension income consequences following major transformations in Germany after reunification. We use administrative pension insurance records linked with survey data, combining sequence and cluster analyses with regression models to study the late working lives of several cohorts in Germany across three decades until 2019. Results demonstrate a gradual shift from early retirement trajectories to the ‘standard’ type of retirement, with persistent disparities by education level. Women’s rising later-life employment has been driven more by flexible/part-time trajectories than standard forms, while some convergence is observed between East and West Germans. Differences in retirement trajectories significantly explain variations in pension income, net of socio-demographic characteristics and lifetime work histories.

Key words: retirement, life course, welfare state, social stratification, pensions

Introduction

Retirement is not only the state of drawing a pension after a long working life, but also today a complex process that involves multiple transitions between working and non-working states in old age. The process is often unequal as older workers with lower skills or occupational prestige are at higher risk of being unemployed or disabled in late working lives, often leading to involuntary early exit from work compared to the average worker (Ebbinghaus and Radl, 2015; Mäcken et al., 2022). Workers with low socioeconomic status (SES) are also more likely to face financial difficulties in old age, which nowadays are increasingly driving them to work longer due to inadequate pensions, sometimes even as working pensioners (Blossfeld et al., 2011; Heisig, 2015). On the other hand, flexible retirement options that meet individual preferences remain a privilege of older workers with long high-skilled career jobs. Moreover, women's retirement processes are more complex and further diversified, as their late careers are dependent on earlier work trajectories, family care responsibilities, and partnership situations (Bertogg, 2023; Ehrlich et al., 2020).

Scholars have long seen social inequalities in retirement processes as a product of structural labour market constraints and welfare state institutions facilitating early retirement interacting with individual-level heterogeneities in late careers (Blossfeld et al., 2011; Ebbinghaus, 2006; Guillemard and Rein, 1993; Mäcken et al., 2022). For instance, public benefits for unemployment and disability at older ages had been used as tools to discharge older workers from the labour force during the industrial era (Kohli et al., 1991), mainly targeting male blue-collar workers. Recent policy shifts toward active ageing in Europe are expected to alter the patterns of retirement transitions, while their social stratification evolved along with changing gender, educational and occupational

compositions among older people (Hofäcker et al., 2016; Turek and Henkens, 2023).

Germany presents a quintessential case that turned from early to late retirement trajectories due to various policy reforms aimed at older workers' activation. For example, the employment rate of the population aged 55 to 64 increased from about 37 percent in 2000 to about 72 percent in 2019 (Eurostat, 2024), one of the steepest rises (alongside the Netherlands) in old-age employment in Europe since the European Union's Lisbon Agenda of activation set in 2000 (Ebbinghaus and Hofäcker, 2013). This upward trend has been steady even despite multiple economic shocks from German reunification and the Great Recession. Related changes were major pension and labour market reforms implemented since the late 1990s to promote later retirement, such as closing various early exit pathways and fostering female employment through reconciling work and family from earlier life. These transformations are likely to have impacted social inequalities in retirement transitions because public benefits had offered early retirement pathways for older workers, especially those with lower education and long working careers. However, the changing social dynamics after such radical socio-economic changes are still not well understood, partly because of data restrictions in existing studies covering relatively short time frames up to the early 2000s (Baumann and Madero-Cabib, 2021; Fasang, 2010; Riekhoff, 2019; Worts et al., 2016). Today, we have data available that reaches until 2019, the year before the COVID-19 pandemic, and thus allows a longer time frame to evaluate the changes in late careers and retirement patterns following Germany's multiple reforms.

Against this background, the main questions of our study are twofold. Firstly, have the dynamics of social stratification in retirement processes changed until recently in line with the reform steps and rapid macro-social transformations in Germany? Has there been

any convergence between different social groups following the closing down of early retirement pathways and the promotion of female employment, or do we see persistent social stratification? Second, what are the implications of the stratification in late working lives on old-age income inequality? To what extent do these retirement trajectories matter in shaping post-retirement income inequality?

To address these questions, we study retirement trajectories across three decades, distinguishing five birth cohorts in Germany born between 1925 and 1954 whose late working lives spanned from 1976 to as late as 2019. We look at the whole trajectory of working and non-working statuses between the ages of 51 and 65, as we define retirement as a gradual and longitudinal process rather than a one-time event, following recent trends in retirement research (Baumann and Madero-Cabib, 2021; Fasang, 2010; Riekhoff, 2019; Worts et al., 2016). For empirical analysis, we combine sequence and cluster analyses with a set of regression models to analyse the SHARE-RV, a linked dataset of administrative pension insurance records (DRV) and the German sample of the Survey of Health, Ageing and Retirement in Europe (SHARE).

Our results demonstrate that social stratification has been largely persistent by gender and education level despite major welfare reforms, indicating the significance of structural constraints among women and the low-educated. Nevertheless, there is some convergence in retirement trajectories between East and West Germans following unification. We also find that differences in retirement trajectories significantly explain variations in pension income, net of socio-demographic characteristics and lifetime work histories. Our findings thus add to the literature on the welfare state and social stratification, contributing to the understanding of how macro-structural changes interact with later life courses.

The subsequent section develops the conceptual framework and offers an overview of institutional and macro-structural transformations in Germany since the 1990s. Thereafter, we provide a description of the data structure and analytical strategies, focusing on how late working lives and retirement trajectories are defined and measured, followed by the presentation and discussion of our main findings. Finally, we conclude by discussing policy implications, the major contributions, and the limitations of our research.

Background

Conceptual framework: retirement as a gradual process

From a conventional life course perspective, retirement is viewed as one “institutionalized” stage in modern societies, assuming a tripartite partition into education, working life, and retirement phases (Kohli, 2007). In this approach, retirement is defined as a transition between two life stages that are chronologically ordered – from one fully dedicated to employment to the other characterized as a permanent exit from work followed by receiving a pension during old age. Retirement transitions could then be empirically measured by identifying the status transition from paid work to old-age pension receipt, a timed event.

However, in recent research there has been growing emphasis on the gradual, dynamic and complex nature of retirement rather than a cliff-edge transition (Baumann and Madero-Cabib, 2021; Fasang, 2010; Han and Moen, 1999; Riekhoff, 2019; Turek and Henkens, 2023). Empirical studies therefore define the retirement transition as a trajectory rather than an event, highlighting increasing complexities within late working lives longitudinally (*differentiation*) and growing heterogeneities between individual life

trajectories (*de-standardization*) from a holistic viewpoint (Brückner and Mayer, 2005; Fasang, 2012).

The *differentiation* and *de-standardization* of retirement processes are closely linked to country-specific institutional features and their evolution over time. Until the 1990s, social benefits, including unemployment benefits, pre-retirement programmes, and disability pensions, offered alternative income sources for older workers before reaching the statutory pension age, functioning as bridge pathways to permanent retirement (Ebbinghaus, 2006; Guillemard and Rein, 1993; Kohli et al., 1991). More recently, with reversed policy goals of reducing early retirement and promoting active ageing in Europe (Hofäcker et al., 2016), more people work until the statutory pension age, and some even stay in paid work while receiving old-age pensions (Scherger, 2015). Governments in Europe have also introduced partial retirement options as a policy instrument to extend working lives by allowing reductions in working hours while subsidizing reduced wages (Eurofound, 2016).

Our analytical approach follows these recent trends in retirement studies, examining holistic late working-life trajectories to go beyond a narrow focus on retirement timing. This is particularly useful for studying social stratification and inequality in retirement processes because pluralized life-course patterns at older ages effectively capture social advantages and disadvantages accumulated over earlier life (Fasang and Mayer, 2023). It is also useful for exploring gendered patterns of retirement trajectories, as women's weaker attachment to the labour market and frequent career interruptions make female retirement transitions look less clear-cut compared to men (Worts et al., 2016). Our study therefore adopts an analytical approach similar to the one used by Fasang (2010) that reveals institutional pathways to retirement in individual trajectories.

Welfare reforms in Germany

While our analytical focus is on individual-level retirement trajectories, understanding institutional and macro-structural environments is crucial at least for two reasons. Firstly, institutional arrangements, in particular pension systems and labour market policies, shape financial opportunities and enforce structural constraints that have differential impacts on older workers' retirement outcomes depending on individual characteristics, such as gender, education, occupation, health, and family situations (Carr et al., 2018; Mäcken et al., 2022; Radl, 2013; Worts et al., 2016). Second, typical life course patterns observed in a society can be understood as a product of the interplay between structure and agency (Elder, 2001). Transformations in social, political and economic conditions such as German unification would reorient individual choices, thereby changing overall retirement patterns. Therefore, historical and geographical contexts should be taken into account when analysing the dynamics of social stratification in life trajectories (Fasang and Mayer, 2023).

In Germany, retirement patterns are predominantly affected by its large public pension scheme that mandatorily insures most employees except for civil servants and the self-employed. The Bismarckian social insurance system is based on an earnings-related, defined-benefit point system, which in the pre-reform era guaranteed generous income replacement rates to maintain the living standard achieved during working lives. The standard pension age was set at 65 before the 2010s, but early pension withdrawals at 63 were allowed with very modest actuarial deductions until the 1990s, while for women, early retirement was possible already from the age of 60. Nevertheless, many older workers in West Germany since the 1970s effectively withdrew from paid work as

early as in their mid-50s through long-term unemployment insurance and special pre-retirement schemes (Rinklake and Buchholz, 2011). Older workers with chronic illness or disability were also allowed to retire from the age of 60 (Hess, 2016). After reunification in 1990, employees in East Germany were allowed to retire at 55 through an old-age transition scheme to ease the transition from a socialist to a market economy.

Since the 1990s, Germany had experienced massive transformations due to unification and globalization, which led to public policy concerns over demographic ageing and related fiscal pressures on the welfare state. Major pension reforms in the 1990s and the early 2000s primarily focused on closing institutional pathways to early retirement. Early pension withdrawals from the age of 63 were then restricted to individuals with over 45 years of contributions, and actuarial deductions began to phase in as of 1992. State subsidies for partial retirement, often used as an alternative option for retiring early, were also abolished. The retirement age for disability pensioners was raised from 60 to 63. Furthermore, the overall benefit generosity in the defined-benefit system has been reduced gradually after a series of reforms that introduced the demographic factor and readjusted other indexation rules, while also fostering voluntary private saving schemes (Ebbinghaus et al., 2011; Hess, 2016).

Labour market policy reforms implemented in this period were oriented towards the same direction of activation. Part of the so-called 'Hartz' reforms, a package of labour market policies aimed at deregulating labour market institutions and activating the non-employed, contained several measures targeting older workers' activation. These measures included wage subsidies for employers hiring the unemployed elderly as well as for older job seekers taking up jobs with lower wages than in previous employment (Jacobi and Kluve, 2006). Moreover, the Hartz IV reforms of 2004 integrated the long-

term unemployed into the means-tested minimum income scheme, stripping older workers of any special treatment. The maximum duration of earnings-related insurance benefits under the restructured (two-tiered) unemployment benefit system was cut from 36 months to 15 months for those aged 50 or over and 18 months for those aged 55 or over (Hess, 2016).

We expect that these major pension and labour market reforms affect the social stratification of retirement as the cutbacks were aimed at reversing the trend of early retirement by activating mainly medium or low-skilled older workers who were more likely to rely on welfare benefits. Moreover, women's later-life employment has been further encouraged by abolishing special early retirement options for women. Given the special circumstances and policies in East Germany after unification, we also expect more use of early exit to last throughout the initial transition. However, as most reforms were introduced step-wisely, their impact may be visible only among recent birth cohorts who entered their late working lives in the 2010s.

Socio-economic transformations

Alongside major policy reforms, German reunification has led to considerable economic and social changes since the 1990s. Economic growth slowed down and unemployment rose to 12 percent by 2005, mainly driven by delayed progress in East German regions (Snower and Merkl, 2006). However, following the Hartz reforms, the German economy showed a dramatic turnaround in the mid-2000s and showcased an economic miracle with minor losses in employment during the Great Recession (Dustmann et al., 2014). Meanwhile, women's education levels and labour market participation have gradually increased over time, resulting in partial homogenization of

employment trajectories between women and men (Brückner and Mayer, 2005).

These structural transformations in the past three decades are likely to have altered labour market constraints on late careers, especially among lower-SES groups. Birth cohorts who spent their late working lives mostly during the 1990s and early 2000s were adversely affected by high unemployment and a deep recession especially in the East. In the 1990s, early retirement was even more accelerated through a temporary old-age transitions scheme for East German employees facing plant closure or downsizing. On the other hand, more recent cohorts enjoying the economic rebound would display more ‘standard’ full-time work trajectories with fewer disruptions in late working lives, facilitated by the stepwise implementations of welfare reforms. The East-West differences are also likely to disappear over time with gradual economic integration.

Gendered retirement trajectories would show more complicated dynamics, as typical life courses among women in the East and West were dissimilar before reunification. West German women tended to be engaged in part-time and flexible careers or stay as homemakers to take care of children, though their career trajectories have gradually converged with men. In contrast, East German female employment trajectories resembled those of men, yet women typically retired a few years earlier. Whether rising employment among older West German women led to a convergence of female retirement trajectories between East and West remains an empirical question. Overall, we expect to find the impact of welfare state reforms and socio-economic changes to impact the late career and retirement patterns, though differences between West and East, gender differences, and socioeconomic inequalities need detailed analysis of life-course data across affected cohorts.

Research Design and Methods

Data and cross-sectional variables

The main data source for this study is the SHARE-RV, administrative pension records from the German Pension Insurance (*Deutsche Rentenversicherung*: DRV) linked with the German subsample of the Survey of Health, Ageing and Retirement in Europe (SHARE) (FDZ-RV and MPI für Sozialrecht und Sozialpolitik, 2022). The full SHARE-RV sample involves 4,482 respondents who participated in any of the nine waves of SHARE and consented to the linkage of their DRV pension records to the survey data. Since the linkage sample does not provide its own weighting scheme, we restricted our analytical sample to individuals who participated in wave 5 to obtain cross-sectional survey weights with the largest number of respondents who consented to the linkage. We then selected birth cohorts born between 1925 and 1954 who entered their late working lives (from the age of 51) from 1976 for the earliest cohort to 2005 for the latest cohort, resulting in 2,765 respondents as the analytical sample.

The dataset contains both cross-sectional and longitudinal information on every respondent (see Table 3.1 for details). The time-invariant variables include cohort, gender, education, region, partner status, number of children, occupation, years of work (in lifetime), and expected pension income (in 2022). When extracting these variables, we prioritized those from DRV as the data is more accurate than self-reports. However, we also used survey data to complement some missing data in DRV: education and number of children are from the SHARE survey because the DRV data contained too many missing values. Occupation was fully obtained from SHARE (although 30.7 percent is still missing), as the variable is unavailable in DRV.

Table 3.1. List of Cross-Sectional Variables

Variable Name	Definition	Source
Cohort	Categorical variable that involves five groups of birth cohorts. The oldest group includes ten-year cohorts born from 1925 to 1934 due to their small sample sizes. The remaining 20-year cohorts born between 1935 and 1954 were split into four five-year groups.	DRV
Gender	Dummy variable. (Male=0; Female=1)	DRV
Education	Ordinal variable of education levels (low, mid, high) based on the International Standard Classification of Education (ISCED), where ISCED levels 0-2 are coded as low-educated, 3-4 as mid-educated and 5 or over as high-educated.	SHARE
Region	Dummy variable (West=0; East=1) that indicates whether one's current residence is in the former East Germany.	DRV
Partner status	Dummy variable indicating whether the respondent is living with a married or civil partner.	DRV & SHARE
Number of Children	Continuous variable. Top-coded for four or more children.	SHARE
Occupation	Categorical variable based on the International Standard Classification of Occupations (ISCO). The variable contains 848 missing cases (30.7%) Categories: (1) Legislator, senior official or manager; (2) Professional; (3) Technician or associate professional; (4) Clerk; (5) Service worker and shop and market sales worker; (6) Skilled agricultural or fishery worker; (7) Craft and related trades worker; (8) Plant and machine operator or assembler; (9) Elementary occupation; (10) Armed forces	SHARE
Expected Pension Income	Expected monthly pension income in 2022. Total personal earnings points accrued over lifetime was multiplied by EUR 36.01 to calculate monthly pension income. Earnings points are top- and bottom-coded. Missing values (N=118, 4.2% of the sample) were imputed using the sum of accrued earnings points in the East and West, multiplied by 1.036. The factor of 1.036 is the average ratio of the total personal earnings points to the sum of accrued earnings points in the West and East calculated from non-missing observations.	DRV
Years of Work	Total month of full contribution divided by 12, which indicates the period of paid work. Missing values (N=391, 14.1% of the sample) were imputed using the total month of full employment or self-employment recorded from the age of 14 to 65, multiplied by 1.105. The factor of 1.105 is the average ratio of the total month of full contribution to the total month of full employment or self-employment calculated from non-missing observations.	DRV

Note: DRV means the administrative data (Deutsche Rentenversicherung).

Defining late working life states

The longitudinal DRV data provides the respondent's *social income situation*, a categorical variable of one's monthly labour market, education, childcare, and social benefit status classified into 15 qualitative states, provided between the ages of 14 and 65. We reconstructed the variable into nine states that we consider meaningful to capture individual retirement trajectories: full-time employment (FT), part-time/flexible employment (PT), self-employment (SE), unemployment (UN), sickness or disability (DIS), family care (FAM), full retirement (PEN), partial work & pension receipt (PENw), and others/missing (M).

We selected the final period of 180 months from January of respondents' 51st year from birth to December of their 65th year from birth. For instance, the oldest cohort born between 1925 and 1934 entered their first month of observation between 1976 and 1985 and reached the final month between 1990 and 1999. Likewise, the first month of observation for the latest cohort (1950-54) was between 2001 and 2005 and the final month was between 2015 and 2019. Among the five groupings, those born between 1935 and 1939 are 'transition cohorts', as their late working lives were largely exposed to the socio-economic transitions of reunification. More recent cohorts were gradually affected by the economic rebound and the stepwise implementation of welfare reforms. The longitudinal data structure by age and cohort is illustrated in Figure 3.1.

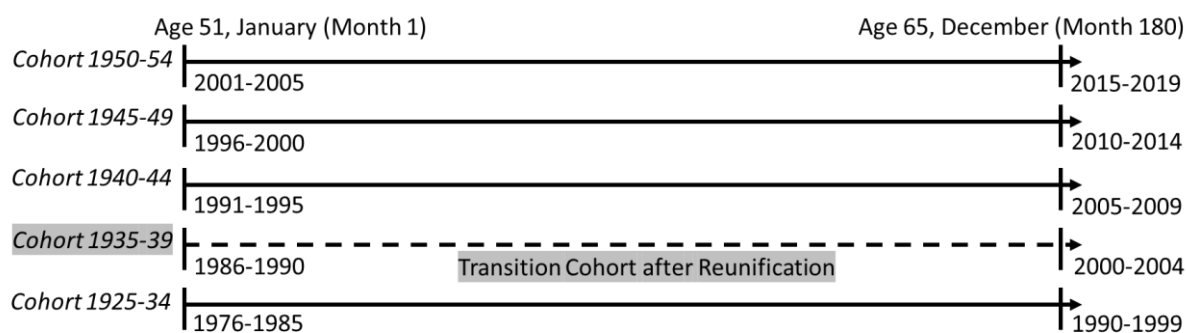


Figure 3.1. Longitudinal data structure: Observation period by age and cohort

While the re-coding of the longitudinal variable was primarily based on the DRV *social income situation* records, the Job Episodes Panel (JEP) of SHARE was also utilized to obtain some non-existing information in the administrative data. The JEP is a yearly panel dataset generated from SHARELIFE, a retrospective survey on life histories in Waves 3 and 7 of SHARE (Antonova et al., 2014; Brugiavini et al., 2019). We first imputed missing values present in the person-year cells of the JEP's *situation* variable that were concentrated on women's family care status, following a coding procedure proposed by Rowold (2024). We then duplicated each yearly observation twelve times to match with the monthly DRV panel structure. Although not fully accurate, it should not cause serious bias in capturing the holistic retirement trajectory, since it would mainly affect the accuracy of the start and end of each spell but less the overall pattern. Moreover, the majority of person-month observations are still fully based on administrative records.

As DRV's *social income situation* does not specify working hours in gainful employment status, we identified individuals who worked part-time or switched between full-time and part-time work within the same job spell based on the JEP survey and labelled them as employed in part-time or flexible jobs (PT). Those recorded as

marginally employed (earning less than 400 Euros per month) in the administrative data were also classified as PT. Similarly, ‘partial work & pension receipt (PENw)’ exploits self-reported employment status in the survey to be differentiated from ‘full retirement (PEN)’ because DRV’s biographical data does not indicate whether respondents receiving old-age pensions also have additional income from paid work. Therefore, the PEN and PENw states both indicate that one was receiving old-age pensions, while the latter denotes simultaneous participation in any kind of paid work.

We also imputed a large proportion of the DRV data on *social income situation* that were recorded as missing or others: about every fourth person-month cells fell into these categories (22 percent were missing, 3 percent were others). We assume that most of them were non-employed without identifiable reasons since the administrative record captures all recognizable employment and benefit statuses. However, a sizeable share of them may also include tenured civil servants, the self-employed, and those in foreign residence who were not obliged to be insured by DRV. After imputing those cells using JEP data, the remaining share of ‘others/missing (M)’ dropped to 7.3 percent. Most of the imputed states were family care (about 23.9 percent), full-time employment (18.9 percent), and self-employment (12.7 percent).

Sequence analysis and cluster analysis

Our analytical strategy consists of three stages. The first uses sequence and cluster analyses to identify core patterns of retirement trajectories in Germany across the five cohorts spanning over three decades. Sequence analysis allows us to observe late working lives from a holistic viewpoint rather than solely focusing on the timing of transitions between different states, as common in event history analysis (Abbott, 1995; Aisenbrey

and Fasang, 2010). Sequence analysis is particularly useful here since our analytical focus is to discover overall patterns of retirement in late working lives, where the same spells – i.e., unemployment – can have different meanings or different spells are functionally equivalent depending on their length and timing within the sequence.

In order to classify diverse and complex trajectories into several clusters, we must define and measure (dis)similarities between sequences, using the most common method in life course studies – optimal matching (OM) analysis (Abbott, 1995; Abbott and Forrest, 1986). The OM algorithm measures the distance between two sequences by calculating the minimum possible cost of transforming one sequence to another, through insertion and deletion of states or substitution between different states within the sequences. The costs of operating insertion, deletion, and substitution are assigned by the researcher. Based on a fully specified cost scheme, the OM algorithm creates a distance matrix representing the degree of dissimilarity between all possible sequence pairs.

Researchers often assign data-driven substitution costs calculated based on transition rates between different states to address common criticisms that cost assignment would be arbitrary (Fasang, 2010). Nevertheless, we use theoretically defined substitution costs with the insertion/deletion cost as one rather than the data-driven method. This is because a high transition rate between two states does not necessarily mean that the two are functionally close in distinguishing working versus non-working/full retirement statuses, with partial retirement in between. For instance, one of the highest transition rates between distinct successive states (DSS) in our sequence data is observed between full-time employment (FT) and sickness or disability (DIS), which we consider are qualitatively distant states (see Table C1 for the full transition matrix in DSS format). Moreover, given that most transitions in monthly sequence data occur within the same

state, the data-driven substitution costs are likely to produce a dissimilarity matrix very similar to one produced by the ‘mechanical’ OM that defines all substitution costs as two and the insertion/deletion cost as one.

Table 3.2. Matrix of substitution costs between sequence states

	FT	PT	SE	UN	DIS	FAM	PEN	PENw	M
FT	0	1	1	2	2	2	2	1	2
PT	1	0	1	2	2	2	2	1	2
SE	1	1	0	2	2	2	2	1	2
UN	2	2	2	0	1	1	1	2	1
DIS	2	2	2	1	0	1	1	2	1
FAM	2	2	2	1	1	0	1	2	1
PEN	2	2	2	1	1	1	0	1	1
PENw	1	1	1	2	2	2	1	0	2
M	2	2	2	1	1	1	1	2	0

Note: FT=full-time employment; PT=part-time/flexible employment; SE=self-employment; UN=unemployment; DIS=sickness or disability; FAM=family care; PEN=full retirement; PENw=partial work & pension receipt; M=others/missing.

Therefore, we construct a matrix of substitution costs between states (see Table 3.2), based on whether respondents were in paid work or not. This is because non-working states other than receiving old-age pensions, such as unemployment or disability benefit statuses, have been widely used as bridge pathways to early retirement in the German context. Similarly, family care or homemaking statuses prevalent among older women are not clearly distinguished from retired status, especially if the person has not worked for prior years. We thus assign one as the substitution cost between all working states (FT, PT, SE, PENw) and between all non-working states (UN, DIS, FAM, PEN, M), and double the cost (two) for the substitution between working and non-working states. We treat ‘missing/others (M)’ as a non-working state because most gainful employment is

identified in the administrative record. One exception is that the substitution cost between PEN and PEN_w is assigned as one, since the two states can be considered similar functionally and conceptually. Moreover, there might be some measurement errors when differentiating PEN_w from PEN based on self-reported employment status.

The distance matrix calculated by the OM algorithm based on our cost matrix is then used to identify the core patterns of late working lives and retirement trajectories. We combine the partitioning around medoids (PAM; or k-medoids clustering) method with Ward's hierarchical clustering to classify individual trajectories into several meaningful types. The PAM algorithm identifies k central sequences (or medoids) that minimize the sum of distances to all other cases. Every sequence is then assigned to its closest medoid group. Ward's hierarchical clustering solution was used to initialize the central cases as the PAM-based cluster solution may be sensitive to the starting point. The number of clusters was then selected based on widely known cutoff criteria, including the average silhouette width and point biserial correlation (see Figure C1).

As our OM-based cluster solution may be sensitive to the choice of cost specification, we conducted a secondary analysis for robustness checks using data-driven dynamic hamming distance (DHD) matching proposed by (Lesnard, 2010). This technique uses time-dependent substitution costs derived from transition rates between two states at each time point without operating insertion or deletion. The core advantages of using DHD are that arbitrary cost assignment can be avoided and the distances calculated take into account differences in transition rates at each time point, making the cluster solution time-sensitive (Fasang, 2010; Studer and Ritschard, 2016). As we show in the Appendix Paper 3 (see Figures C2 to C6), the OM and DHD methods yield highly similar seven-cluster solutions with only modest differences in their compositions.

Predicting retirement trajectories in late working lives

The second stage of our analysis predicts the group-specific probabilities of sorting into specific types of retirement trajectories based on the cluster solution obtained from the first-stage analysis. We employ a set of multinomial logistic regression models to estimate the predicted probability of cluster memberships across cohorts and examine the extent to which cross-cohort patterns vary between gender, education, and region. The models are specified as follows:

$$\log \frac{\text{Pr}(\text{CL})}{\text{Pr}(\text{REF})} = \alpha + \beta_1 \text{Cohort} + \beta_2 \text{Cohort} \times \text{Gender} + \gamma \text{SD} \quad (1)$$

$$\log \frac{\text{Pr}(\text{CL})}{\text{Pr}(\text{REF})} = \alpha + \beta_1 \text{Cohort} + \beta_2 \text{Cohort} \times \text{Education} + \gamma \text{SD} \quad (2)$$

$$\log \frac{\text{Pr}(\text{CL})}{\text{Pr}(\text{REF})} = \alpha + \beta_1 \text{Cohort} + \beta_2 \text{Cohort} \times \text{Region} + \gamma \text{SD} \quad (3)$$

CL indicates the cluster of interest, whereas REF is the reference cluster, to which we assign the most ‘standard’ retirement trajectory – the one closest to the cliff-edge transition from full-time employment to full retirement. SD is a vector of socio-demographic variables including gender, education, region, partner status and the number of children. Models (1)-(3) enable us to explore group-specific changes over time by gender, education, and region in the predicted probability of sorting into each cluster. Moreover, model (3) is estimated separately by gender since late working lives were more dissimilar among women between East and West Germany than among men.

Late working lives and pension income inequality

The final stage of analysis investigates the extent to which late working lives matter in shaping income inequality after retirement. We regress expected pension income in

2022 on the clusters of retirement trajectories while controlling for relevant socio-demographic factors, and in stepwise models also for lifetime years of work and occupation types. Our ordinary least square (OLS) estimation is specified as follows:

$$\text{Pension} = \alpha + \beta\text{CL} + \gamma_1\text{SD} + \gamma_2\text{yrswork} + \gamma_3\text{occupation} + \varepsilon \quad (4)$$

CL is a categorical variable indicating the set of clusters drawn from the cluster solution, excluding the reference cluster. SD indicates the same vector of socio-demographic variables as in models (1)-(3) but also includes cohorts. ε denotes the error term in the model. Estimated standard errors are heteroskedasticity-consistent in this model.

Results

Patterns of late working lives in Germany

The first step in our analysis is the description of seven typical patterns of work-to-retirement trajectories drawn from sequence and cluster analyses (see Figure 3.2 displaying sequence index plots). In each plot, one horizontal line represents a sequence of late working lives from January of one's 51st year from birth (month 1) to December of one's 65th year from birth (month 180), ticked along the horizontal axis. The vertical axis shows the number of sequences in each plot. The nine qualitative states are differentiated by distinct colours. In addition, we provide the descriptive statistics for the seven clusters cross-tabulated by cohort, gender, education and region (see Table 3.3).

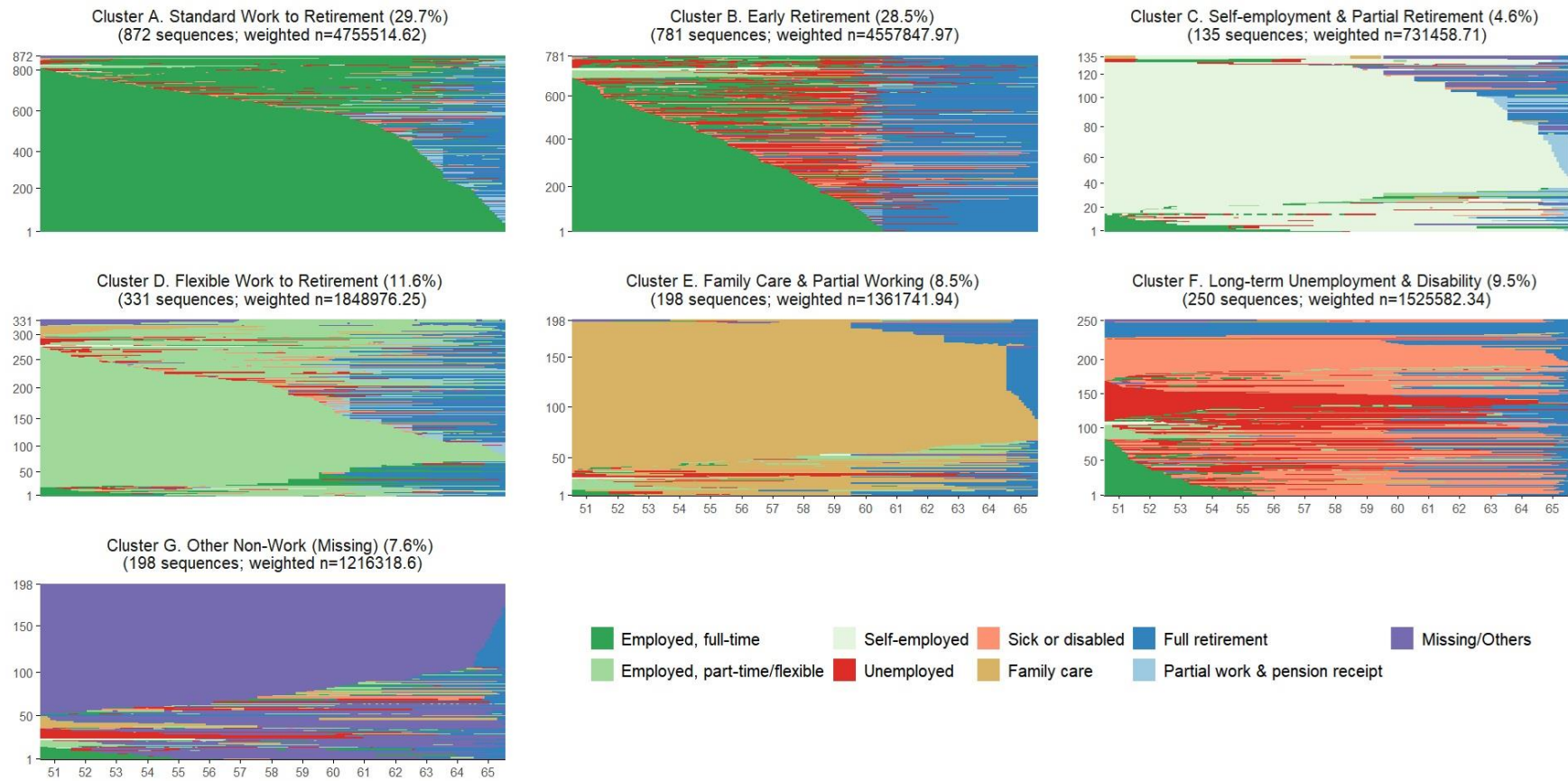


Figure 3.2. Sequence index plots of seven clusters of retirement trajectories in Germany, 1976-2019

Table 3.3. Descriptive Statistics for Seven Clusters of Late Working Lives, by Cohort, Gender, Education and Region

	Standard Work to Retirement	Early Retirement	Self-employment & Partial Retirement	Flexible Work to Retirement	Family Care & Partial Working	Long-term Unemployment & Disability	Other Non-work (Missing)	N (%)
<i>Cohort</i>								2,765 (100)
1925-34	25.5	31.1	4.2	5.5	16.6	5.4	11.6	323 (16.6)
1935-39	20.6	39.3	3.7	8.2	9.7	9.1	9.6	462 (18.5)
1940-44	30.9	32.7	3.2	9.6	9.6	9.3	4.8	586 (21.3)
1945-49	31.2	27.1	6.2	14.6	4.4	11.2	5.4	624 (19.2)
1950-54	37.4	15.9	5.5	17.6	4.5	11.6	7.6	770 (24.3)
<i>Gender</i>								
Male	43.9	32.5	7.1	2.5	0.2	7.7	6.1	1,369 (46.0)
Female	17.6	25.0	2.5	19.3	15.6	11.1	8.9	1,396 (54.0)
<i>Education</i>								
Low	15.1	24.5	2.5	12.0	20.9	13.1	11.9	371 (15.4)
Mid	26.6	29.5	4.1	13.4	8.3	11.1	6.9	1586 (56.5)
High	43.9	28.6	6.8	7.6	2.1	4.4	6.6	808 (28.1)
<i>Region</i>								
East	29.1	44.7	3.2	6.2	1.2	12.2	3.4	650 (21.4)
West	29.9	24.1	5.0	13.0	10.5	8.8	8.8	2,115 (78.6)

Note: All numbers are percentage values summed up by row, except for the right-end column presenting sample sizes (N). All percentage values are weighted by cross-sectional weights of SHARE wave 5. N values are unweighted, but their percentages are weighted.

Cluster A comprises the most standard type of trajectories characterized as full-time employment followed by old-age pension receipt, more commonly observed among men and high-educated persons than among women and the lower-educated. Full retirement transitions in this group occurred between the ages of 62 and 65, mostly after the earliest pension age of 63. Although some disruptions through unemployment or sickness/disability are observed between employment spells, they are short-lived. This group is therefore labelled as ‘standard work to retirement’ and set as the reference cluster in our regression models. It is also the largest cluster and accounts for about 30 percent of individuals throughout the period. The share of individuals in this trajectory initially declined among the ‘transition cohort’ (birth years 1935-39) but steadily increased afterwards.

Cluster B is the second largest cluster (about 28.5 percent of the sample) including individuals with ‘early retirement’ trajectories who retired already around the age of 60. Most of them experienced relatively long spells of unemployment or sickness/disability in their late 50s, utilized as bridge pathways to full retirement. The group’s share peaked among individuals in the transition cohort who were heavily influenced by the economic downturn after reunification, in contrast to the standard trajectories in Cluster A. Moreover, East Germans are nearly twice as much represented as West Germans. Men were also more likely to experience this trajectory, whereas the educational gradient is relatively unclear.

Cluster C, labelled as ‘self-employment & partial retirement’, applies only to about 4.6 percent of respondents who spent most of their later careers in self-employment. The transition to full retirement among these individuals was even later than those in Cluster A, as many of them still participated in paid work while receiving often rather low old-

age pensions. Men and higher-educated persons were more likely to sort into this group, while its proportion in the sample was relatively stable across cohorts. Individuals in West German regions were also more represented than those in the East.

Cluster D, representing ‘flexible work to retirement’ trajectories, is most represented by women, low- to mid-educated persons, and those residing in the Western regions. Its share has also steadily increased over time from 5.5 percent in the earliest cohort to 17.6 percent in the latest group. Most of them worked in part-time or flexible jobs and were fully retired between the ages of 61 and 65. Those who experienced short-term disruptions through unemployment or family care tend to have retired earlier.

Cluster E is also highly represented by West German women whose trajectories are primarily described by family care with a small number of individuals involved in part-time or flexible employment – therefore labelled as ‘family care & partial working’. Very few men are included, while the low-educated are also highly represented in this cluster more than the other education levels. The proportion of individuals in this group among all respondents is overall 8.5 percent, but the figure has continuously declined over time.

Cluster F (‘long-term unemployment & disability’) accounts for about 9.5 percent, they mostly relied on long-term unemployment benefits and disability pensions throughout their late working lives. A fraction of individuals in this cluster are those with self-reported retirement status but recorded as missing or others in the DRV data. Employment spells observed in this group were concentrated on the ages prior to 55. Females, the lower-educated, and East Germans were also more likely to sort into this group than males, higher-educated persons, and West Germans. The relative size of this cluster did not diminish but rather increased slightly among recent cohorts.

Finally, there are about 7.6 percent of respondents in Cluster G whose late-career

states were mostly missing or reported as ‘others’ in both the survey and administrative data. We label this cluster as ‘other non-work (missing)’ because the ‘missing/others’ observations are most likely non-employed states without identifiable reasons. Consistent with gendered career patterns in West Germany, more females and West Germans were sorted into this group than their counterparts. Moreover, the low-educated and the oldest cohort were more included than the others, though the percentage of this cluster rebounded among the recent two cohorts.

Social stratification and its changes over time

As the second step we explore in multivariate analysis socio-demographic factors associated with the respective cluster. Figures 3.3-3.6 show the predicted probabilities of sorting into each cluster across cohorts after controlling other socio-demographic variables, and how the trajectories are stratified by gender, education and region (see Tables C2 to C5 for exact numbers).

Figure 3.3 illustrates how gender differences in the predicted probabilities of cluster membership changed over time. Men were substantially more likely to sort into the standard trajectories (Cluster A) than women, and the difference was relatively stable across all cohorts, though slightly reduced in the latest group. Men also showed a higher probability of being in Cluster B (early retirement trajectories) among the earlier three cohorts, but the difference almost disappeared afterwards. Gender gaps in the probability of belonging to Cluster D steadily increased over time across cohorts, whereas the gaps in Cluster E significantly declined in the latest group compared to the earlier ones. Meanwhile, gender differences were relatively trivial in Clusters C, F and G in most cohorts.

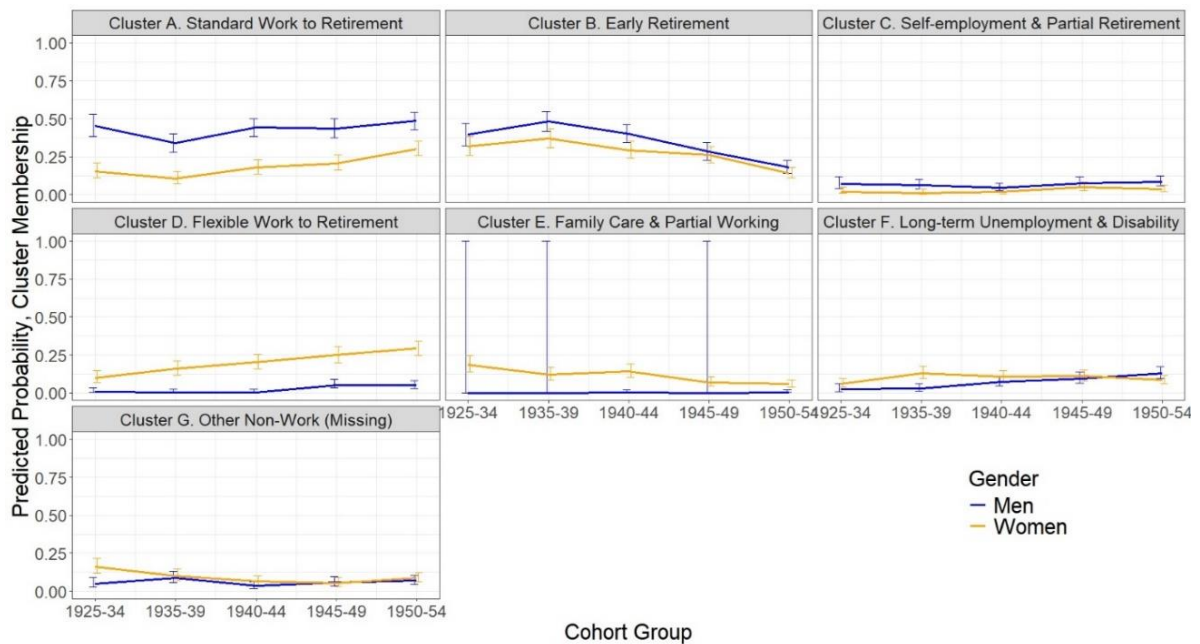


Figure 3.3. Predicted Probabilities of Cluster Membership, by Cohort and Gender

Note: Figures illustrate multinomial regression results based on Model (1). Control variables include education, region, partner status and the number of children.

Figure 3.4 also demonstrates that the educational stratification of retirement trajectories was relatively persistent over time. The high-educated group was consistently more likely to sort into standard trajectories in Cluster A than the mid- and low-educated. The gap between the high-educated and the others was the smallest and non-significant in the transition group of 1935-39 cohorts but then continuously widened over time. The educational gradient in the probability of being in Cluster F was completely reversed from that in Cluster A, where low-educated persons were more likely to be included than mid- and particularly high-educated persons except for the oldest cohort. The educational difference in Cluster B resembles that in Cluster F in the 1945-49 cohort but was trivial

among the others. In Cluster D, the mid- and low-educated groups' representation increased steadily and eventually surpassed that of the high-educated. Educational gaps regarding Cluster C, E and G were mostly not significant. Only the negative and significant educational gradient was observed in Cluster G in the 1925-34 cohort.

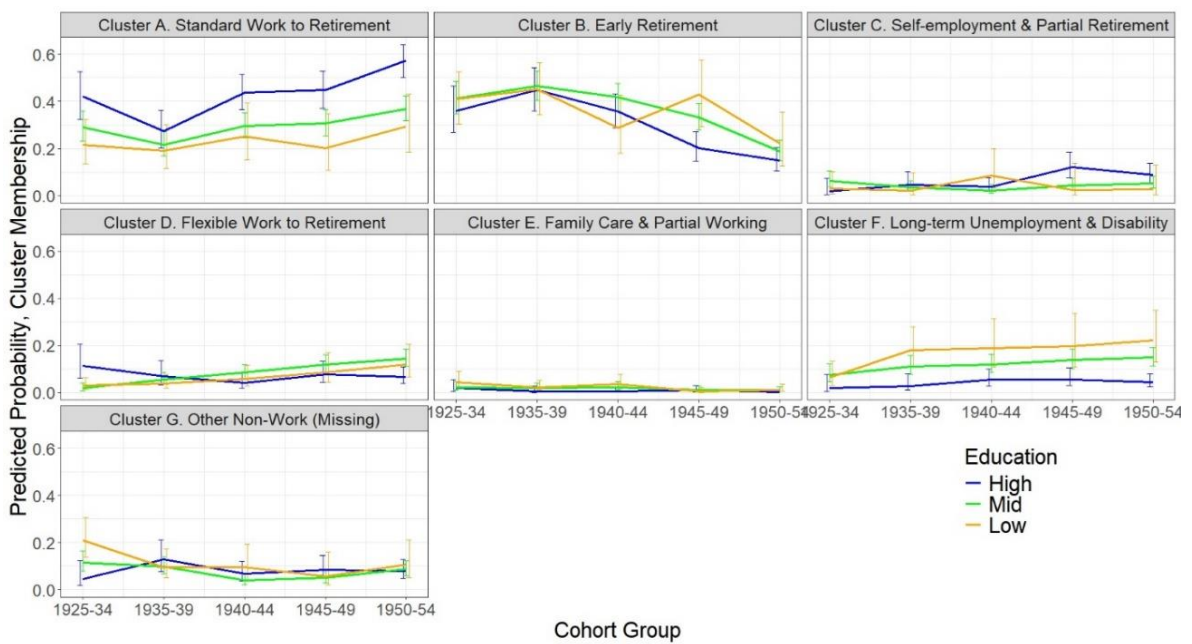


Figure 3.4. Predicted Probabilities of Cluster Membership, by Cohort and Education

Note: Figures illustrate multinomial regression results based on Model (2). Control variables include gender, region, partner status and the number of children.

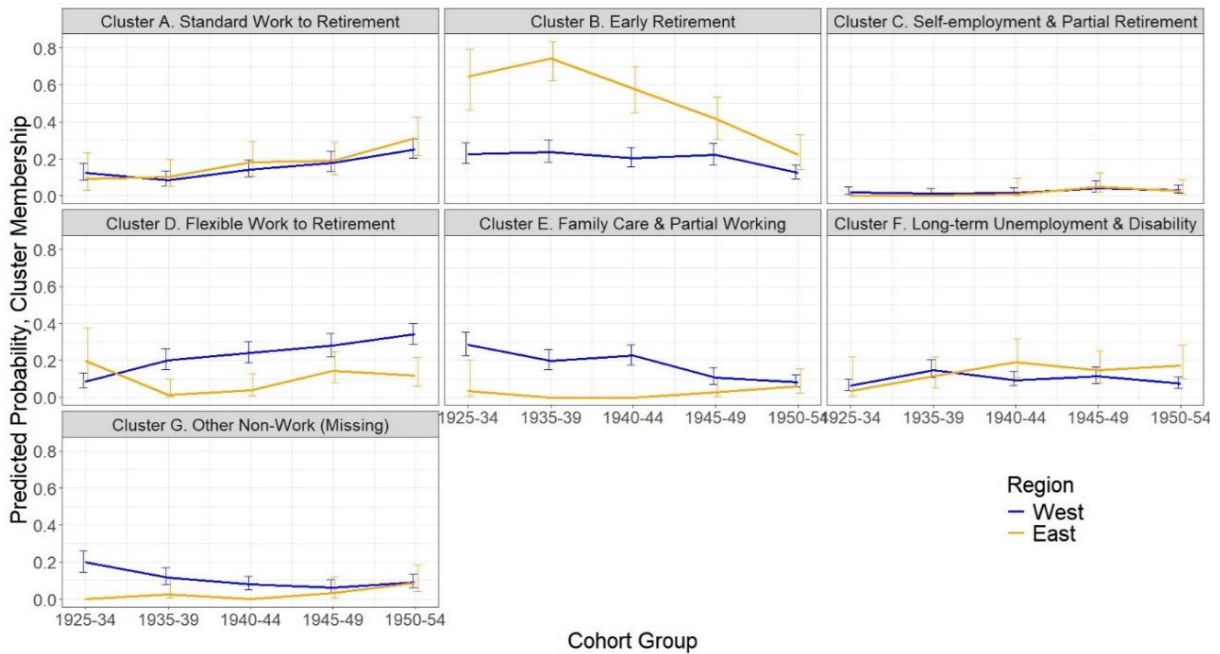


Figure 3.5. Predicted Probabilities of Cluster Membership, by Cohort and Region (Female)

Note: Figures illustrate multinomial regression results based on Model (3). Control variables include education, partner status and the number of children.

Figure 3.5 shows differences in women’s retirement trajectories between East and West regions. While women’s probabilities of being in Cluster A were at similarly low levels in both regions, the figures were on the rise until recently. The probability of sorting into Cluster B was substantially higher among women in the East than those in the West, by almost 50 percentage points in the earliest two cohorts. However, the prevalence of early retirement among East German women presented a steep decline, and among the most recent cohorts, the East-West gap was narrowed down to about 10 percentage points (see Table C4). West German women’s probabilities of being in Clusters D, E, and G were significantly higher than those of East Germans in most cohorts, but their trends over time were different. Whereas the chance of being in Clusters E and G among West German women displayed overall downward trends, their propensity to be in flexible

careers (Cluster D) was on a steady increase. By contrast, East German women's probabilities of being in the three clusters were relatively stable and low across cohorts. Regional differences regarding Clusters C and F were mostly not significant, while the risk of being in long-term unemployment & disability trajectories modestly increased in the East among recent cohorts.

Compared to women's late working lives, Figure 3.6 reveals that men's retirement patterns showed some degree of convergence between both regions. Among West German men, Clusters A and B were respectively the first and second most common types of retirement transitions, while the latter has become less prevalent among recent cohorts. Among East Germans, the probability of being in standard retirement trajectories (Cluster A) initially dropped but then recovered steadily, narrowing down the gap against their Western peers. Conversely, the relative incidence of early retirement trajectories (Cluster B) upsurged in the transition cohort but rapidly declined afterwards to the level of West German men in the latest cohort. In all other clusters, the overall probabilities of being in each cluster were relatively low in both regions, and regional gaps were mostly non-significant. A noticeable pattern is that the chance of being in Cluster F among men was on a continuous rise in the East compared to the West.

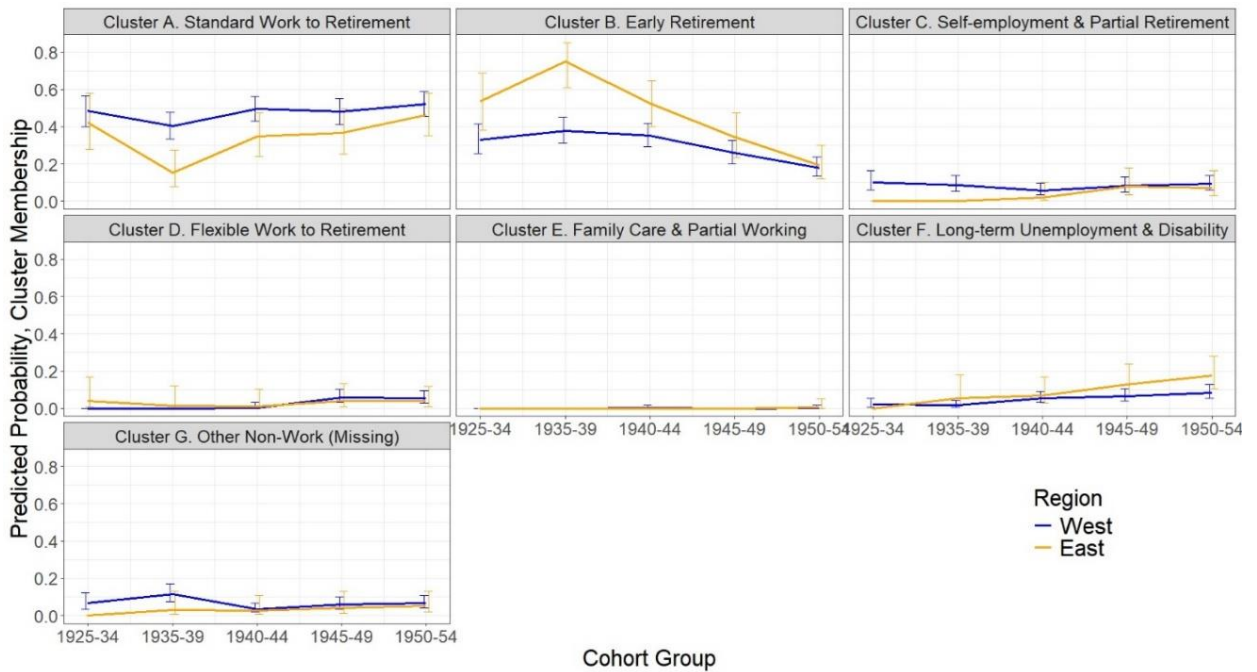


Figure 3.6. Predicted Probabilities of Cluster Membership, by Cohort and Region (Male)

Note: Figures illustrate multinomial regression results based on Model (3). Control variables include education, partner status and the number of children.

Late working lives and pension income after retirement

Our final analysis step explores the pension income consequences of the found clusters. Table 3.4 presents the results from the OLS regressions of expected public pension income in 2022 on the cluster membership, using different sets of control variables. Column (1) shows crude differences in expected pension income between the reference cluster and the other six clusters, based on the baseline model without any control. The average monthly pension income in the reference cluster was about 1597.5 Euros in 2022. Individuals with early retirement trajectories (Cluster B) had the second highest pension income, about 200 Euros lower than the reference group. Clusters E and G are the groups with the lowest average pension income, nearly 1,000 Euros below that

of Cluster A. In the middle of the distribution were the remaining clusters representing long-term unemployment or disability (Cluster F), flexible or part-time trajectories (Cluster D), and self-employment (Cluster C), in descending order. Note that the estimated pension income differences are likely to be biased downward because pension points are top- and bottom-coded in the DRV data.

Table 3.4. Regression Results Predicting Pension Income in 2022

	(1)	(2)	(3)	(4)
(Intercept)	1597.49*** (25.65)	1794.16*** (58.01)	1596.16*** (40.63)	1600.85*** (49.39)
Cluster Membership (ref.: A. Standard Work to Retirement)				
B. Early Retirement	-197.25*** (33.00)	-183.67*** (32.61)	-97.19*** (21.43)	-49.80* (24.42)
C. Self-employment & Partial Retirement	-783.43*** (53.86)	-769.00*** (52.25)	-259.25*** (42.60)	-189.50*** (49.30)
D. Flexible Work to Retirement	-637.50*** (40.69)	-404.69*** (43.89)	-142.85*** (32.28)	-124.93*** (34.68)
E. Family Care & Partial Working	-1064.75*** (35.37)	-786.63*** (40.24)	-58.97 + (34.76)	0.19 (39.65)
F. Long-term Unemployment & Disability	-565.11*** (41.48)	-444.88*** (41.37)	20.36 (32.50)	72.71 + (38.21)
G. Other Non-Work (Missing)	-992.72*** (39.82)	-858.95*** (40.33)	-187.81*** (31.72)	-145.89*** (37.14)
Demographic Controls	No	Yes	Yes	Yes
Control: Years of Work	No	No	Yes	Yes
Control: Occupation types	No	No	No	Yes
<i>Adj. R-squared</i>	0.311	0.388	0.703	0.710
<i>N</i>	2,765	2,765	2,765	1,917

Note: + $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. In parentheses are robust standard errors. Demographic controls include cohort, gender, level of education, region, partner status, and number of children.

Column (2) displays the result when controlling for basic socio-demographic variables from the baseline model, including cohort, gender, level of education, region (last residence), partner status, and number of children. While the sizes of the coefficients related to each cluster are all reduced compared to Column (1), the largest reductions are seen in Clusters D and E, implying that strong gender gaps in pension income explain substantial parts of the group-level differences.

Columns (3) and (4) respectively show results when adding years of work and occupation types as controls to the model. By additionally controlling for the two major factors in calculating public pension points, the models show the net effect of retirement trajectories on expected pension income. The adjusted R-squared value jumps remarkably between columns (2) and (3), suggesting that the lifetime length of work (or contribution records through employment) is the greatest factor explaining the variation in pension income. Moreover, the coefficients of Clusters E and F are no longer statistically significant at 0.95 level, implying that lower pension incomes in these groups are almost fully explained by shorter lengths of lifetime employment and less privilege in occupation types. Note that column (4) is not directly comparable with the other models and thus must be interpreted with caution, as its sample size is smaller due to large missing data in the occupation variable.

Another notable aspect is that years of work are at systematically different levels between clusters, and therefore comparing individuals with the same years of work but in different clusters may sound unrealistic. For example, a hypothetical comparison between Clusters A and E 'holding years of work constant' in column (3) is prone to linear extrapolation. There are few cases in Cluster E whose employment history is comparable to those in Cluster A because lifetime career trajectories among individuals in Cluster E

are interrupted by family obligations. Nevertheless, the disadvantages in pension income relative to Cluster A are still significant among individuals in Clusters B, C, D, and G, meaning that pension gaps associated with typical retirement patterns are not fully explained by socio-demographic characteristics, work histories, and occupational types.

Discussions and Conclusion

In this study, we investigated the typical patterns of late working lives and retirement trajectories in Germany, the changing dynamics of social stratification in these trajectories and the extent to which particular clusters of trajectories matter in explaining the variation in pension income after retirement. Our findings are consistent with the recent shift from early retirement to active ageing, demonstrating a gradual decline in early retirement trajectories replaced by standard work-to-retirement transitions. However, persistent group-level disparities remained by education level, where standard trajectories were much more common among high-educated older workers. Moreover, women's rising participation in paid work at older ages is attributed mainly to flexible/part-time trajectories rather than standard employment, shaping new gender dynamics in later-life patterns. Still, retirement trajectories in former East and West Germany, especially among men, display some convergence after a huge divergence in the transition cohort. Among women, the rise in flexible/part-time trajectories is more pronounced in the West. The differences in retirement trajectories overall explain variations in pension income, after controlling relevant socio-demographic characteristics, lifetime employment records, and occupation types.

Our findings show that, although we see convergence in life courses between East and West Germans, social stratification in late working lives and retirement processes has

been largely persistent until recently. Later retirement through standard work trajectories was predominantly enjoyed by highly educated workers despite institutional reforms scaling back financial support for mid- and low-educated workers' early exit. While the incidence of early retirement has overall declined since the mid-2000s, the share of individuals in long-term unemployment and disability trajectories has increased slightly among the low-educated and East Germans, suggesting that after phasing out early exit options this became the next best pathways to retirement for those unable to work until statutory retirement age. The results indicate that the main drivers of social stratification in retirement processes are structural forces, such as differential opportunities in the labour market at older ages and cumulative (dis)advantages from lifetime career trajectories. It is also implied that the overall rise in old-age employment and older women's late careers may be driven by changing educational compositions among later cohorts and rising female employment from earlier ages, more so than the direct effects of policy reforms.

Our analysis of pension income differences also demonstrates that the social stratification of retirement patterns would independently contribute to retirement income inequality, net of individual characteristics, the length of lifetime employment and occupational differences. This may be because public pension benefits in Germany largely reflect lifetime average earnings, and earnings inequality tends to accumulate over the life course and are augmented at older ages (Westhoff et al., 2022). Since we do not take into account private pensions, which tend to be concentrated among high-earners with stable career trajectories, the full effect of late working-life patterns on income inequality after retirement would be even larger than shown for public pensions only. Even public pension income differences in our study are underestimated values due to the

truncated coding structure.

One caveat, however, is that our analysis does not fully capture earlier life experiences in career and family, which are likely to influence late career trajectories through cumulative (dis)advantages (Hoven et al., 2018; Worts et al., 2016). Although we factor in years of work and the number of children, divergence in retirement trajectories to some extent reflects differential lifetime career patterns, for example young women's part-time careers due to care burdens. Therefore, pension gaps between different clusters of late working lives after controlling work years and occupation types can still be partly explained by omitted variables in our models, such as career disadvantages at younger ages. Another limitation of this study is that we do not estimate the exact contributions of institutional and macro-social factors to the outcome since our focus has been on identifying longitudinal patterns and their changes over time. Nonetheless, this can be addressed by recent studies using decomposition analysis (for example, Dudel et al., 2023; Riekhoff and Kuitto, 2024).

Overall, our study contributes to the literature in two ways. First, we enhance the understanding of the interaction between life course and changing societal contexts, including welfare state reforms and socio-economic transitions. Since the retirement process is one stage of the life course strongly shaped by welfare state institutions, Germany's paradigmatic shifts in pension and labour market policies but also the dramatic transformation following unification offer an informative case study of how life course patterns respond to major changes in these macro-social conditions. One important implication regarding this aspect is that among low-SES groups, structural constraints matter more than financial incentives provided by the welfare state.

Our second contribution is to the literature on social stratification, showing long-term

consequences of life course patterns in old age. The retirement process and late working lives have gained less attention in the studies of social stratification than other subjects focusing on younger age groups, gender wage gaps, or social mobility. However, retirement processes are central to understanding the dynamics of social stratification as they reproduce advantages and disadvantages shaped by social inequalities accumulated over the life course (Turek and Henkens, 2023). We not only show that the social stratification of retirement trajectories is long-lasting under changing institutional and structural conditions but also that it contributes to income inequality in the post-retirement period.

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Appendix Paper 3

Table C1. Matrix of transition rates between distinct successive states (DSS)

	-> FT	-> PT	-> SE	-> UN	-> DIS	-> FAM	-> PEN	-> PENw	-> M
FT ->	0	0.026	0.013	0.343	0.319	0.016	0.145	0.106	0.033
PT ->	0.137	0	0.011	0.197	0.212	0.087	0.149	0.107	0.100
SE ->	0.203	0.104	0	0.115	0.058	0.036	0.086	0.282	0.115
UN ->	0.361	0.104	0.026	0	0.161	0.023	0.236	0.058	0.031
DIS ->	0.443	0.108	0.005	0.197	0	0.013	0.195	0.024	0.014
FAM ->	0.092	0.228	0.020	0.058	0.045	0	0.454	0.006	0.096
PEN ->	0.045	0.480	0	0.132	0.085	0.104	0	0.033	0.120
PENw ->	0	0.016	0	0	0.001	0	0.979	0	0.004
M ->	0.155	0.238	0.003	0.088	0.050	0.036	0.429	0	0

Note: FT=full-time employment; PT=part-time/flexible employment; SE=self-employment; UN=unemployment; DIS=sickness or disability; FAM=family care; PEN=full retirement; PENw=partial work & pension receipt; M=others/missing.

Table C2. Predicted Probabilities of Cluster Membership, by Cohort and Gender

Gender	Cohort	Cluster A	Cluster B	Cluster C	Cluster D	Cluster E	Cluster F	Cluster G
Men	1925-34	0.454	0.394	0.071	0.008	0.000	0.023	0.050
	1935-39	0.339	0.481	0.061	0.003	0.000	0.028	0.087
	1940-44	0.442	0.402	0.045	0.005	0.002	0.070	0.034
	1945-49	0.436	0.282	0.077	0.053	0.000	0.094	0.058
	1950-54	0.486	0.180	0.083	0.049	0.004	0.128	0.070
Women	1925-34	0.154	0.318	0.021	0.100	0.186	0.060	0.161
	1935-39	0.107	0.369	0.011	0.159	0.121	0.130	0.102
	1940-44	0.179	0.292	0.017	0.202	0.140	0.107	0.063
	1945-49	0.207	0.260	0.050	0.249	0.069	0.110	0.054
	1950-54	0.302	0.141	0.035	0.291	0.059	0.085	0.088

Note: Numbers in this table are point estimates in Figure 3.3 (excluding error bars).

Cluster A=Standard Work to Retirement; Cluster B=Early Retirement; Cluster C=Self-employment & Partial Retirement; Cluster D=Flexible Work to Retirement; Cluster E=Family Care & Partial Working; Cluster F=Long-term Unemployment & Disability; Cluster G=Other Non-Work (Missing)

Table C3. Predicted Probabilities of Cluster Membership, by Cohort and Education

Education	Cohort	Cluster A	Cluster B	Cluster C	Cluster D	Cluster E	Cluster F	Cluster G
High	1925-34	0.422	0.360	0.019	0.114	0.018	0.020	0.046
	1935-39	0.275	0.449	0.046	0.068	0.004	0.028	0.129
	1940-44	0.438	0.356	0.038	0.042	0.006	0.054	0.066
	1945-49	0.448	0.202	0.120	0.079	0.010	0.056	0.085
	1950-54	0.573	0.148	0.088	0.066	0.003	0.044	0.079
Mid	1925-34	0.291	0.413	0.064	0.019	0.023	0.076	0.114
	1935-39	0.215	0.466	0.035	0.056	0.019	0.111	0.097
	1940-44	0.296	0.418	0.021	0.085	0.023	0.119	0.038
	1945-49	0.306	0.332	0.042	0.119	0.012	0.139	0.050
	1950-54	0.369	0.188	0.053	0.144	0.012	0.149	0.086
Low	1925-34	0.215	0.411	0.029	0.029	0.045	0.064	0.208
	1935-39	0.191	0.452	0.021	0.038	0.023	0.180	0.095
	1940-44	0.252	0.288	0.084	0.058	0.035	0.190	0.094
	1945-49	0.201	0.429	0.025	0.087	0.004	0.197	0.057
	1950-54	0.294	0.220	0.026	0.120	0.012	0.221	0.107

Note: Numbers in this table are point estimates in Figure 3.4 (excluding error bars).

Cluster A=Standard Work to Retirement; Cluster B=Early Retirement; Cluster C=Self-employment & Partial Retirement; Cluster D=Flexible Work to Retirement; Cluster E=Family Care & Partial Working; Cluster F=Long-term Unemployment & Disability; Cluster G=Other Non-Work (Missing)

Table C4. Predicted Probabilities of Cluster Membership, by Cohort and Region (Female)

Region	Cohort	Cluster A	Cluster B	Cluster C	Cluster D	Cluster E	Cluster F	Cluster G
West	1925-34	0.123	0.226	0.020	0.085	0.285	0.064	0.197
	1935-39	0.085	0.237	0.013	0.200	0.199	0.149	0.117
	1940-44	0.142	0.204	0.016	0.241	0.225	0.094	0.078
	1945-49	0.178	0.220	0.041	0.279	0.108	0.114	0.060
	1950-54	0.252	0.125	0.031	0.341	0.082	0.075	0.092
East	1925-34	0.091	0.645	0.000	0.197	0.034	0.034	0.000
	1935-39	0.103	0.742	0.000	0.015	0.000	0.113	0.027
	1940-44	0.181	0.579	0.008	0.039	0.000	0.192	0.000
	1945-49	0.188	0.415	0.048	0.143	0.026	0.145	0.034
	1950-54	0.312	0.221	0.026	0.119	0.062	0.173	0.087

Note: Numbers in this table are point estimates in Figure 3.5 (excluding error bars).

Cluster A=Standard Work to Retirement; Cluster B=Early Retirement; Cluster C=Self-employment & Partial Retirement; Cluster D=Flexible Work to Retirement; Cluster E=Family Care & Partial Working; Cluster F=Long-term Unemployment & Disability; Cluster G=Other Non-Work (Missing)

Table C5. Predicted Probabilities of Cluster Membership, by Cohort and Region (Male)

Region	Cohort	Cluster A	Cluster B	Cluster C	Cluster D	Cluster E	Cluster F	Cluster G
West	1925-34	0.484	0.330	0.100	0.000	0.000	0.021	0.065
	1935-39	0.404	0.380	0.086	0.000	0.000	0.017	0.114
	1940-44	0.495	0.353	0.057	0.003	0.002	0.055	0.035
	1945-49	0.480	0.258	0.081	0.058	0.000	0.064	0.058
	1950-54	0.523	0.180	0.092	0.053	0.001	0.083	0.067
East	1925-34	0.422	0.538	0.000	0.040	0.000	0.000	0.000
	1935-39	0.151	0.750	0.000	0.015	0.000	0.055	0.029
	1940-44	0.348	0.524	0.021	0.011	0.000	0.070	0.026
	1945-49	0.366	0.345	0.080	0.040	0.000	0.127	0.042
	1950-54	0.464	0.194	0.072	0.038	0.004	0.176	0.051

Note: Numbers in this table are point estimates in Figure 3.6 (excluding error bars).

Cluster A=Standard Work to Retirement; Cluster B=Early Retirement; Cluster C=Self-employment & Partial Retirement; Cluster D=Flexible Work to Retirement; Cluster E=Family Care & Partial Working; Cluster F=Long-term Unemployment & Disability; Cluster G=Other Non-Work (Missing)

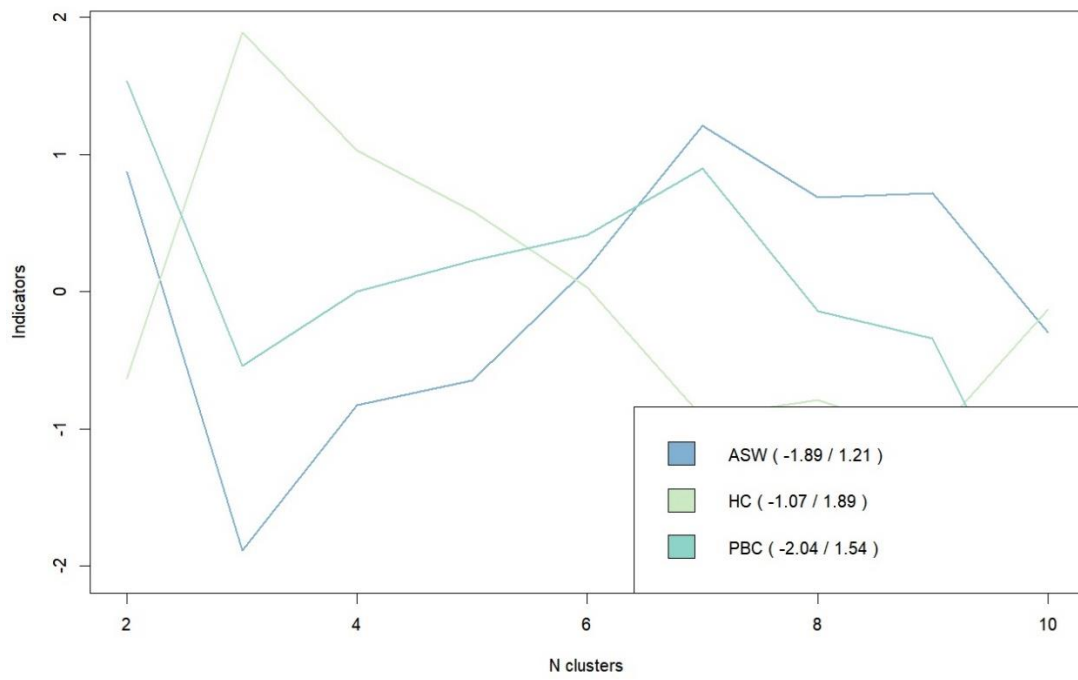


Figure C1. Outcomes of cluster evaluation, by number of clusters
Note: ASW=Average Silhouette Width, HC=Huber's C, PBC=Point Biserial Correlation. All indicators are normalized for comparison.

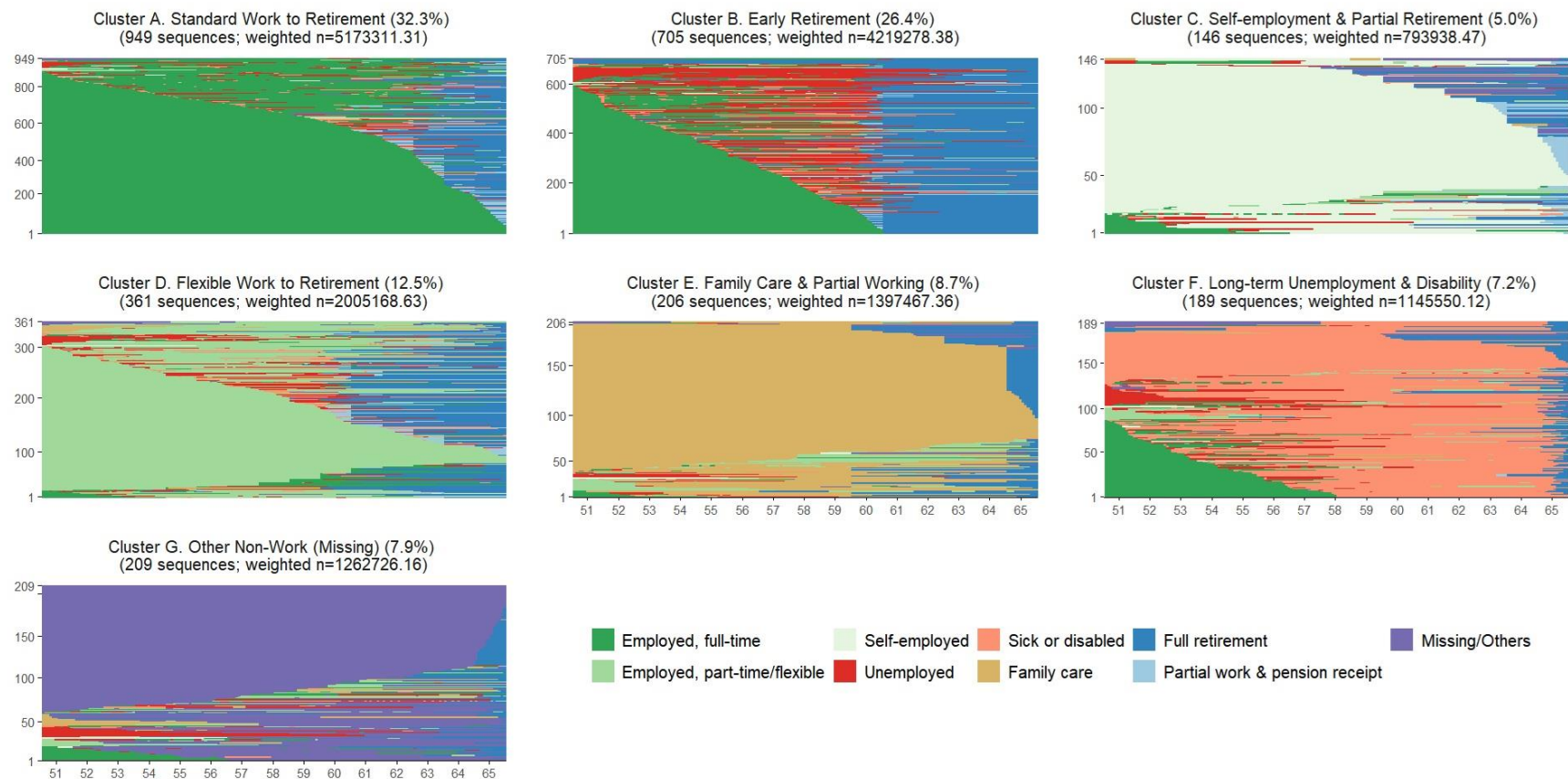


Figure C2. Sequence index plots of seven clusters of retirement trajectories in Germany, 1976-2019 (DHD Method)

Note: DHD=Dynamic Hamming Distance. The result is highly similar to the main result based on optimal matching.

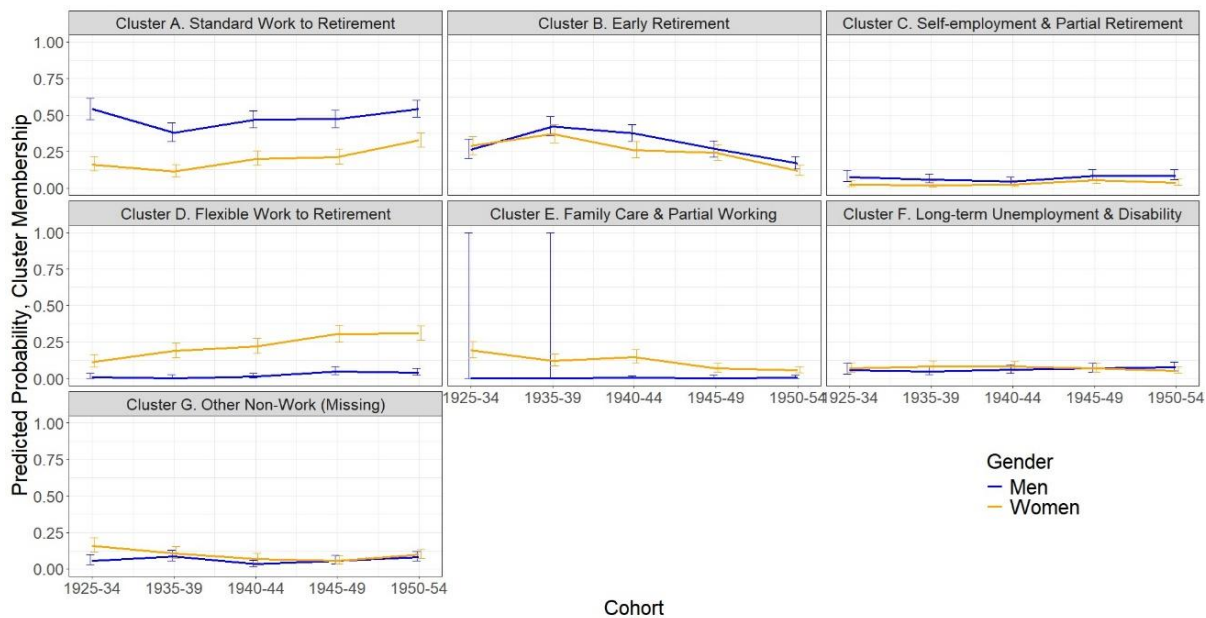


Figure C3. Predicted Probabilities of Cluster Membership, by Cohort and Gender (DHD Method)

Note: Figures illustrate multinomial regression results based on Model (1). Control variables include education, region, partner status and the number of children.



Figure C4. Predicted Probabilities of Cluster Membership, by Cohort and Education (DHD Method)

Note: Figures illustrate multinomial regression results based on Model (2). Control variables include gender, region, partner status and the number of children.



Figure C5. Predicted Probabilities of Cluster Membership, by Cohort and Region (Female; DHD Method)

Note: Figures illustrate multinomial regression results based on Model (3). Control variables include education, partner status and the number of children.

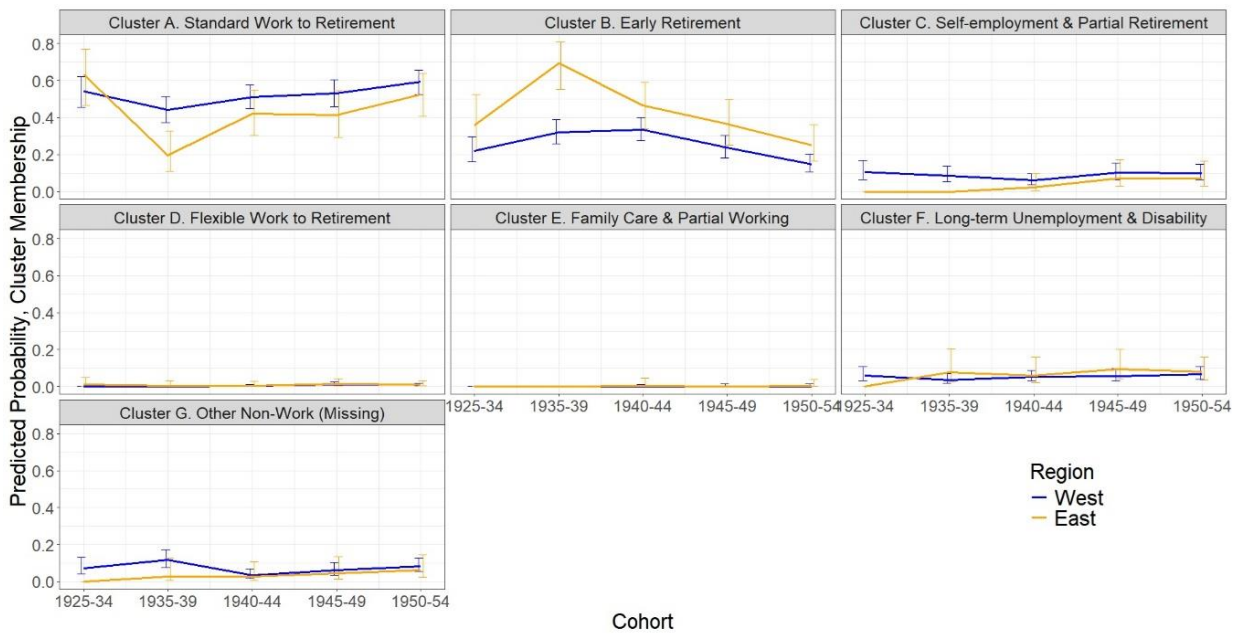


Figure C6. Predicted Probabilities of Cluster Membership, by Cohort and Region (Male; DHD Method)

Note: Figures illustrate multinomial regression results based on Model (3). Control variables include education, partner status and the number of children.

Paper 4

Old-age Poverty in a Pension Latecomer: The Impact of Basic Pension Expansions in South Korea

* This paper has been published in *Social Policy & Administration*, Vol. 56, No. 7.

Abstract

Pension systems and old-age poverty have been studied mainly from comparative perspectives, but causal evidence on the relationship between the two is still rare. This study investigates to what extent implementing non-contributory pensions to a latecomer contributory pension system with a wide coverage gap alleviates old-age poverty, based on the case of recent Basic Pension expansions in South Korea. Using nationally representative household data from 2011 to 2019, we employ a quasi-experimental difference-in-difference design to estimate the impact of policy expansions on a set of outcomes measuring old-age poverty, employment and household income components. The results show that three reforms in 2014, 2018 and 2019 have significantly reduced older people's poverty rate, and they were more effective in reducing extreme poverty. While policy effects after the 2014 expansion are robust in our set of alternative estimations, those after the joint reforms of 2018 and 2019 are less consistent and show signals of a stronger 'crowding-out' effect on private transfer income than those after 2014. We found no convincing evidence that non-contributory pensions discourage older people's labour market participation. Our findings contribute to the literature on public pension evaluations by elucidating how non-contributory pensions affect old-age poverty and tackle social and economic inequalities via various channels of income components, while also mitigating endogeneity biases observed in previous studies.

Keywords: non-contributory pensions; old-age poverty; income inequality; quasi-experimental methods; South Korea

Introduction

Since the 2000s, countries with large pension gaps owing to a short history of public pension development have gone through a series of public pension expansions to tackle poverty and inequality within the older population. The main features of these countries, mostly in East and Southeast Asia and Latin America, include limited social security systems with large segments of the informal economy, leading to high social inequalities and widespread exclusion of older adults from formal pension systems. Following democratisation and exploding social movements calling for basic social security, these countries have introduced non-contributory pension schemes to deal with the challenge of old-age income security amidst rapid population ageing (Barrientos, 2006). Also known as social pensions, non-contributory pensions mostly provide flat-rate benefits without conditions of minimum contributions, financed by tax revenues. Entitlement is often determined on a means-tested basis, while some countries offer universal minimum benefits.

However, to what extent these non-contributory schemes, developed on top of existing employment-based pension systems, are effective on poverty alleviation still needs to be better understood. The discipline of social policy has focused on providing evidence from comparative perspectives (Been et al., 2017; Ebbinghaus, 2021; Möhring, 2015), while causal analysis on old-age poverty has been rare, particularly in the context of pension ‘latecomers’. One might argue that poverty rates would apparently decline as a result of public pension expansions, but the degree of impact can be contested due to several impeding mechanisms. In countries where workers tend to stay employed until older ages, a negative impact on older workers’ employment would cancel out increased public transfer income. The same mechanism applies to the impact on private transfers.

In familistic societies where a large proportion of income in later life relies on family support, expanding social assistance for older adults may simply substitute informal transfers from family ties (Juarez, 2009). Given that the level of benefit is often very low in these countries, social pensions may not substantially change old-age poverty rates if counterbalanced by decreases in incomes from the market and family.

The Basic Pension scheme in South Korea (hereafter Korea) can be a useful case for studying the impact of non-contributory pensions. Old-age poverty has long been a serious problem in Korea, and the country has been notorious for its extremely high poverty rate among the elderly. Though now perceived as a high-income country, Korea's social and economic backgrounds surrounding the implementation of the Basic Pension are essentially similar to other developing countries that are 'latecomers' of public pensions. A considerable proportion of the older population excluded from existing earnings-related pension schemes and older adults' high labour force participation but predominantly in low-wage sectors and self-employment, all characterise the challenges of old-age income security in Korea. Moreover, a rapid decline in economic support from adult children in recent decades has further raised the necessity of non-contributory pensions (Ku, Lee & Lee, 2021). Korea first introduced the Basic Senior Pension for low-income elderly households in 2008 on top of the existing earnings-related pension scheme to tackle its severe old-age poverty. Despite several expansions of the programme in the 2010s and other policy efforts, the income poverty rate of older people, defined as the proportion of those aged above 65 living below 50 percent of the median household income, has only marginally decreased and is still 43.4 percent in 2018, the highest level in the OECD (see Figure 4.1).

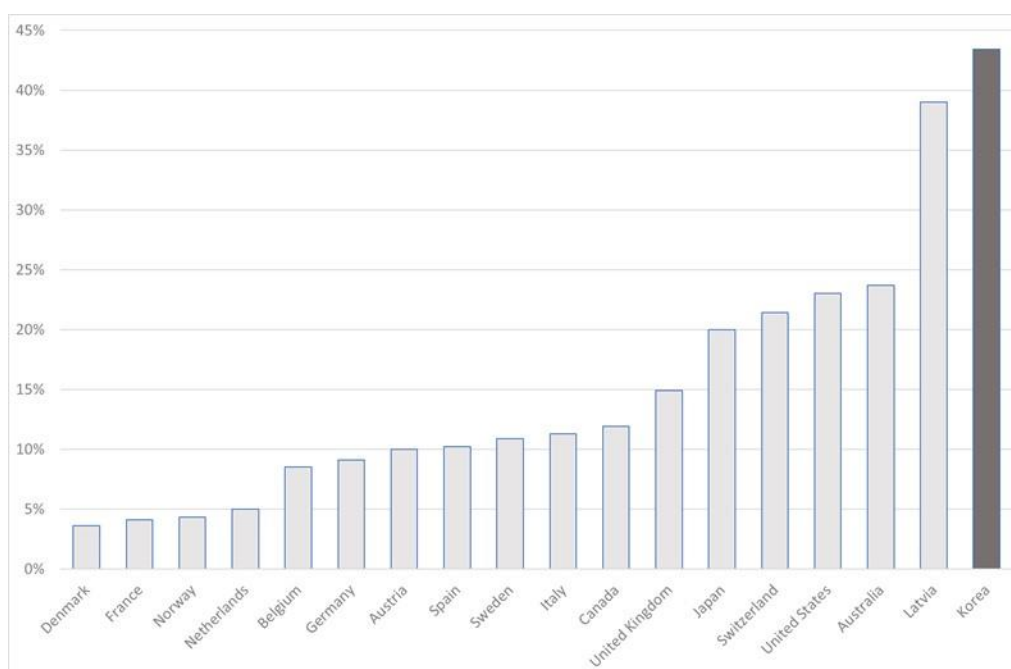


Figure 4.1. Income poverty rates of OECD countries, aged over 65 (OECD, 2019)

This study investigates the impact of Basic Pension expansions, recently undertaken in Korea, on old-age poverty. The Korean government doubled the standard level of benefit from July 2014 and again raised it by 25 percent from September 2018. In April 2019, the benefit was increased selectively for the lower 20 percent of the elderly. The series of reforms, which have generated exogenous changes in economic outcomes of older people, create an opportunity to evaluate the impact of non-contributory pensions with varying size of changes. Drawing nationally representative data from a monthly panel survey, we use a difference-in-difference (DiD) approach to examine the effects of Basic Pension expansions on old-age poverty rates. Our selection of dependent variables, including older people’s employment status, market income, public and private transfer

income, enables us to explore causal mechanisms on how non-contributory pensions affect old-age poverty.

Our results show that the recent benefit expansions have effectively reduced old-age poverty, despite the presence of ‘crowding-out’ effects on private transfer income. We find no significant evidence supporting that raising the level of benefit decreases older people’s economic activities. We also observe that the crowding out of private transfers was significant in the recent reforms of 2018 and 2019 but not in 2014, despite their smaller scale than the earlier one. We suggest that this unexpected finding might be related to waning family support in East Asian society but also implies overall social welfare improvement from the policy expansions, as rising pension incomes can reduce burdens for adult children and promote older adults’ economic independence. Our results also provide smaller but arguably more precise estimates than existing studies, suggesting that previous findings may be biased due to methodological issues.

Background and Literature Review

Overview of the Korean pension system and the Basic (Senior) Pension

The historical institutionalist literature identifies two types of pension systems in mature welfare states. The Bismarckian system tends to provide status maintenance after retirement, providing earnings-related benefits financed by social insurance contributions. On the other hand, the Beveridgean system, focusing on poverty alleviation, is characterised as universal, though sometimes means-tested, flat-rate benefits financed by taxes (Hinrichs & Lynch, 2010). The Korean pension system has been evolved through a similar process to Bismarckian pensions, related to its developmentalist origin of protecting core workers and privileged occupations (Kwon, 2005). Therefore, studying

the Basic Pension in Korea can examine the marginal outcome of layering flat-rate pensions on top of a latecomer Bismarckian system with a large pension gap.

The main components of the Korean public pension system involve conventional earnings-related schemes and the recently added Basic Pension. The Basic Pension is a flat-rate, non-contributory scheme that primarily aims for minimum income provision and poverty alleviation for older adults. The public earnings-related component includes the National Pension Scheme (NPS) and occupational pensions for three special professions – teachers, civil servants and military personnel. The benefit levels of these mandatory, earnings-related schemes are linked to past contribution periods and salaries, while also containing redistributive elements to some degree. The role of private pensions is overall limited in Korea's old-age income security, despite a long history of corporate-based welfare arrangements and state-regulated retirement allowances.

The current architecture of the Korean pension system has been constructed fairly recently due to a relatively short history of public pensions. Whereas the three occupational pensions for the privileged class were introduced in the 1960s and 70s, the NPS was first launched in 1988 and achieved universal coverage only in 1999 after several expansions. However, the poverty rate of older Korean adults has not shown a substantial decline. This is attributed to the fact that the NPS entitlement was restricted to older people with at least 15 years of contributions at the time of the first implementation, automatically excluding most of the older generation of that period. Though the proportion of beneficiaries among older people has been steadily increasing with the compulsory enrolment of the working-age population, only 43 percent of older adults aged 65 or above are the recipients of the NPS in 2019 (National Pension Service, 2020). Those not eligible for the NPS or the three occupational pension schemes are excluded

from public earnings-related pension schemes.

The Basic Senior Pension (BSP) scheme was introduced in 2008 as part of a comprehensive pension reform of 2007 and later transformed into the Basic Pension (BP) in 2014 to deal with the coverage gap of the NPS and tackle severe old-age poverty among older Korean adults. Unlike universal basic pensions in Europe, the Korean BSP or BP is a targeted scheme for the lower 70 percent of older people aged 65 or above on a means-tested basis.⁸ The flat-rate benefit was initially indexed to five percent of the average salary of wage earners, but the reform in 2014 replacing the BSP with the BP raised the level of benefit to more than twice the initial level, up to KRW 200,000 (PPP \$229)⁹ from July 2014. Two more reforms have been undertaken in 2018 and 2019, which raised the standard level of benefit to KRW 250,000 (PPP \$294) from September 2018 and, from April 2019 to KRW 300,000 (PPP \$349) only for the lower 20 percent (see Table D1 in the Appendix Paper 4 in for the details of eligibility and benefit rules).

Learnings from the international literature

Comparative studies on European pensions provide good evidence that generous universal or targeted pensions tend to compensate for older people at high risk of poverty (Möhring, 2015; Ebbinghaus, 2021). Other studies from non-Western countries illustrate variations of policy designs (Arza, 2017; Barrientos, 2006) and outcomes (Barrientos, 2003) of non-contributory pensions implemented to address wide coverage gaps and high

⁸ The Basic Senior Pension initially targeted the lower 60 percent of older adults aged 70 or above, and the coverage was expanded to the lower 60 percent of those aged 65 or above from July 2008 and to the lower 70 percent of those aged 65 or above from January 2009.

⁹ We converted Korean Won (KRW) to US Dollar (USD) based on purchasing power parity (PPP) published by the OECD. KRW/USD rates used for 2014, 2018 and 2019 are 871.878, 849.237 and 860.529, respectively. All USD values are rounded numbers.

old-age poverty in such latecomer employment-based pension systems. For example, the Non-contributory Pensions and Poverty Study (NCPPS) in Brazil and South Africa suggests that even highly selective cash transfers can support older people in the most disadvantaged socioeconomic and ethnic groups (Ferreira, 2006). However, due to their descriptive and cross-national settings, identifying causal relationships and the size of policy impacts in comparison to the ‘counterfactuals’ of introducing non-contributory pensions are restricted in these studies.

Studies adopting quasi-experimental designs address this limitation and offer causal evidence on the effects of non-contributory pensions. A seminal work by Case & Deaton (1998) on the redistributive and behavioural effects of South Africa’s social pension represents early policy evaluation research. They found that the means-tested pension scheme, predominantly reaching poor, non-white households in South Africa, functioned as an effective tool for redistribution and even supporting low-income children living with older grandparents. Notably, they avoided selection bias among pensioner households by constructing instrumental variables of pension income using the household’s non-pension income, demographic composition and geographical location.

Recent studies are also in line with this research. Galiani, Gertler & Bando (2016) exploit exogenous geographical and age cutoffs in Mexico’s *Adultos Mayores* Programme, a universal pension scheme for older adults in small villages, to generate quasi-experimental settings. Kaushal (2014) employs multiple fixed effects exploiting regional and temporal variations of India’s means-tested National Old Age Pension Scheme (NOAPS) to estimate policy impacts. The two studies report similar findings that even a modest amount of cash transfer can have substantial positive effects on household consumption and mental health among older people, with a mild reduction of labour

supply. Studies from China also show that the New Rural Pension Scheme (NRPS) has reduced the risk of food poverty (Zhang, Luo & Robinson, 2018), while *Dibao*, a means-tested cash transfer programme where older adults account for about 39% of rural beneficiaries, increased health expenditures among the elderly in rural China (Zhang & Gao, 2021).

However, similar policy evaluation studies also reveal impeding mechanisms that could undermine the poverty-reducing effects of non-contributory pensions. The first notable mechanism is a reduction of *labour supply*. For example, Shu (2018) finds that the Chinese NRPS substantially reduced older women's work hours in rural China. A study by Unnikrishnan & Imai (2020), using an extended dataset and more sophisticated models than in Kaushal (2014), also shows that the Indian NAOPS reduced older people's labour supply by 10 percent and had no significant impact on poverty reduction. The labour-supply effect could be particularly relevant to the Korean context where post-retirement-age employment rates are exceptionally high (OECD, 2019). Moreover, non-elderly household members' labour supply can be negatively affected by the existence of pensioners in the household (Abel, 2019).

Another mechanism is that the income effect of public pensions can be countervailed by a decrease in *private transfers*, pertinent to the Korean society where older people's living arrangement has traditionally been reliant on their adult children. A sizeable crowding-out effect on private transfers, up to 86 percent of increased pension income, was observed from Mexico's *Adultos Mayores* Programme (Juarez, 2009). Nevertheless, pension income substituting private transfer and labour income may also imply well-being enhancement even without significant poverty reductions, as considerable economic burdens can be relieved for low-income older adults and their children.

Recent evidence from Korea

A number of studies have been carried out in the recent decade and presented redistributive impacts of the Korean BSP and BP, though many of them provide mere descriptive analysis undertaking pre-post comparisons on older people's income and poverty (for example, Lim, 2016). Studies addressing unobserved heterogeneity and selection bias across individuals also report positive results. The introduction of the BSP in 2008 (Shin & Do, 2015) and the extended BP in 2014 (Pak, 2020) are shown to have improved older adults' financial well-being by reducing unmet basic needs and raising financial satisfaction. The closest to the present study is a triple-difference approach by Lee, Ku & Shon (2019), which examines the impact of the 2014 BP expansion on older people's income, consumption and poverty. They estimate that the policy reform reduced the poverty rate by 9.3 percentage points and led to substantial increases in consumption among elderly households.

However, the robustness of these findings is still questionable as studies often use endogenous treatment variables in their research designs. For example, fixed-effect modelling by Shin & Do (2015) uses beneficiary status to measure policy effects while Lee, Ku & Shon (2019) exploit pre-treatment disposable income to assign treatment and control groups, both of which can be influenced by the anticipation of the treatment exposure and are thus susceptible to an overestimation of policy effects.

Studies have also examined the potential impeding mechanisms against poverty reductions – labour-supply effects and crowding out of private transfers. Studies on the labour-supply effect of the BP expansion report only trivial or non-significant estimates (Sung & Lee, 2018; Kim & Kim, 2021). This may be due to the fact that the entitlement

of the BP is not conditional to retirement and the magnitude of the benefit increase was not very large, about five percent of the median wage. On the contrary, the crowding-out effect does seem to exist, as recent evidence supports that about 33-41 percent of Basic Pension benefits were crowded out by reductions in private transfer income (Kum & Kum, 2018; Yi, 2018).

The final concern is whether policy effects would remain persistent over time. Even if the reforms were effective at the initial stage of implementation, their long-term impact could be blurred due to behavioural adjustments of individuals responding to policy changes. For instance, private transfers may not shrink immediately after policy reforms but show a gradual decline (Seol & Lim, 2019). Similarly, members of the recipient households may adjust their work hours and labour market participation incrementally over time. Nevertheless, studies mentioned here mostly examine short-term effects of the BP expansions.

This article contributes to the literature of non-contributory pensions by investigating the impact of the Korean BP expansions in 2014, 2018 and 2019 and by elucidating potential impeding mechanisms and long-term effects. Our focus is on the impact of the BP reforms on income poverty rates among the elderly, which are not often analysed directly in the international literature compared to behavioural effects. A DiD design is employed drawing nationally representative household income data to capture changes in old-age poverty rates and various income components caused by policy reforms. As further elaborated in the following section, our empirical models are constructed to avoid endogeneity issues and deal with the violation of the ‘common-trends’ assumption in DiD designs, overcoming the methodological limitations in previous studies. Our data that span from 2011 to 2019 also enable us to incorporate the most recent reforms into our

analysis that are not yet investigated in the literature, while also evaluating whether policy effects are persistent over time.

Data

Our analysis relies on nationally representative data extracted from the Household Income and Expenditure Survey (HIES) released by Statistics Korea. The HIES is a monthly survey that includes major components of household-level income and expenditure as well as demographic and socioeconomic characteristics of household members such as age, sex, level of education and employment status. It provides relatively accurate information on household income and its changes because household heads report their account book every month. This method of data collection would minimise recall errors in various income components, especially in private transfer income.

Given that the old-age poverty rate counts individuals – not households – as the unit of calculation, we set individuals as the unit of our analysis by transforming wide-shaped household-level data into long-shaped individual-level observations. Each observation then corresponds to individual members of households, though income variables are still household-level aggregates. Moreover, though the HIES is a rotating panel survey released quarterly, we use them cross-sectionally to gain a sufficient sample size (see Table D2). Individuals without a college degree are selected as they are most likely to be influenced by the means-tested BP scheme targeting the lower 70 percent. Finally, we focus on the period between 2011 and 2019 to obtain an adequate range of pre- and post-treatment periods and accommodate the most recent reforms of 2018 and 2019.

Identification Strategies and Empirical Models

Baseline model and variables

We use a difference-in-difference approach to exploit sudden increases in the BP benefit implemented in July 2014, September 2018 and April 2019. We first divide the whole period of our data into three time-frames: the pre-2014 reform (Period 1), between the 2014 and 2018 reforms (Period 2), and the post-2018 reform (Period 3). We compare differences in economic outcomes of older people aged 65 or over between Period 1 and Period 2 and between Period 2 and Period 3, with the same differences in outcomes of a younger age group. We omit the third quarter of 2018 in our analysis as both pre- and post-reform outcomes are mixed in this period (see Table 4.1). As the comparison between Period 2 and Period 3 reveals the combined effect of the 2018 and 2019 reforms, we separate the two effects in our empirical models.

Table 4.1. Time frame of DiD analysis

2014 Reform:	Period 1	2011 (Q1 - Q4), 2012 (Q1 - Q4), 2013 (Q1 - Q4), 2014 (Q1, Q2)
Period 1 vs Period 2	Period 2	2014 (Q3, Q4), 2015 (Q1 - Q4), 2016 (Q1 - Q4), 2017 (Q1 - Q4),
2018 Reform:		2018 (Q1, Q2)
Period 2 vs Period 3	Period 3	2018 (Q4), 2019 (Q1 - Q4)

We set individuals aged 65 or above as the treatment group and those from 55 to 64 as the control group. Since pre-treatment outcomes should not be influenced by behavioural changes in anticipation of the future treatment (Lechner, 2010), we divide our treatment and control groups by age which cannot be manipulated by individual behaviours. We avoid using household income or beneficiary status as a treatment variable as in previous studies (Shin & Do, 2014; Lee, Ku & Shon, 2019), as the “strict exogeneity” assumption of the DiD approach will be violated (Wing, Simon & Bello-Gomez, 2018). Within the control group, we drop individuals whose household members – most likely their partners – received the BP benefit, as they might share household income with the recipients and would thus be affected by the policy changes.

Based on this time-group setting, we construct our baseline DiD model to estimate the effects of BP expansions on older people’s economic outcomes:

$$\text{Model [1]: } Y_{iyq} = \beta_0 + \beta_1 \text{Treat}_i + \beta_2 \text{Post}_{yq} + \beta_3 (\text{Treat}_i \cdot \text{Post}_{yq}) + \beta_4 X_{iyq} + \gamma_y + \delta_q + \varepsilon_{iyq}$$

Y_{iyq} denotes an outcome variable of individual i in year y and quarter q . Treat_i is a dummy variable showing whether the individual is assigned to the treatment group ($\text{Treat}_i = 1$) or the control group ($\text{Treat}_i = 0$). Post_{yq} is also a dummy variable indicating whether the period is before or after the policy change. In the case of evaluating the BP expansion in 2014, Period 1 represents the pre-period ($\text{Post}_{yq} = 0$) while Period 2 the post-period ($\text{Post}_{yq} = 1$). For the 2018 reform, Period 2 is defined as the pre-period and Period 3 as the post-period. β_3 is the parameter of interest interpreted as the policy impact. X_{iyq}

includes both time-constant and varying covariates, and γ_y and δ_q denote year- and quarter-fixed effects, respectively.

Outcome variables of interest are standard poverty, extreme poverty, employment status, market income, public and private transfer income. Poverty outcomes are dummy variables indicating if the respondent's equivalised household disposable income is below poverty thresholds. The *standard* and *extreme poverty* thresholds are measured in relative terms by 50 percent and 30 percent of the median equivalised household disposable income, respectively. The extreme poverty measure is used to examine if the BP expansions have been more influential on households in the bottom income quintile, considering the meagre level of benefits relative to the average salary. *Employment status* equals one if the respondent is employed and zero if not employed. *Market income*, on the other hand, is a household-level variable that aggregates both the respondent's and other household members' labour and asset income. *Public transfer* income also counts public pensions and social security benefits received by the respondent and other household members. *Private transfer* income mainly comprises informal transfers from external households. All three income components are equivalised by the square root of family size so that the estimates do not exaggerate individual net gains from household-level income changes.

Our covariates include time-constant socio-demographic characteristics such as *sex*, *age* and *level of education*. We also control the number of household members aged 65 or above and the number of those below 65. The former shapes the level of public transfer income eligible for the household; the latter strongly affects older people's decision to stay employed. However, as such time-varying controls may be endogenous to the treatment, we checked if the policy implementation systematically changed the number

of the elderly and non-elderly household members and obtained non-significant results (see Table D3 in the Appendix Paper 4). Year- and quarter-fixed effects accommodate year-specific trends and seasonal economic fluctuations that uniformly influence outcome variables across households.

Identification challenges and model adjustments

The core assumption of the DiD design is that pre-treatment trends of the treatment and control groups are parallel so that the treatment creates a quasi-experimental situation. However, meeting the ‘common-trends’ assumption is not sufficient to believe that counterfactual post-treatment outcomes would also be parallel if the baseline characteristics and outcomes of the two groups are structurally different (Kahn-Lang & Lang, 2020). In our case, as the age-65 cutoff is used to assign the treatment and control groups, the two groups may fundamentally differ in characteristics. The descriptive statistics in Table D4 confirms that the younger-age (control) group is on average better educated and includes a larger share of males.

Not surprisingly, Figure 4.2 displays that trends of our selected outcomes are hardly parallel in the assigned pre-treatment periods (Period 1 and 2), particularly in market and public transfer income. The violation of the common-trends assumption and the difference in group characteristics pose challenges in our identification strategy. Though controlling socio-demographic covariates can mitigate biases from the compositional difference, the two groups might show structurally different behaviours in the labour market and are likely to be affected heterogeneously by external factors confounding our baseline policy impact. For example, the impact of the NPS coverage expansion, which may have disproportionately affected the treatment group gradually over the period,

would produce an upward bias in our estimates.

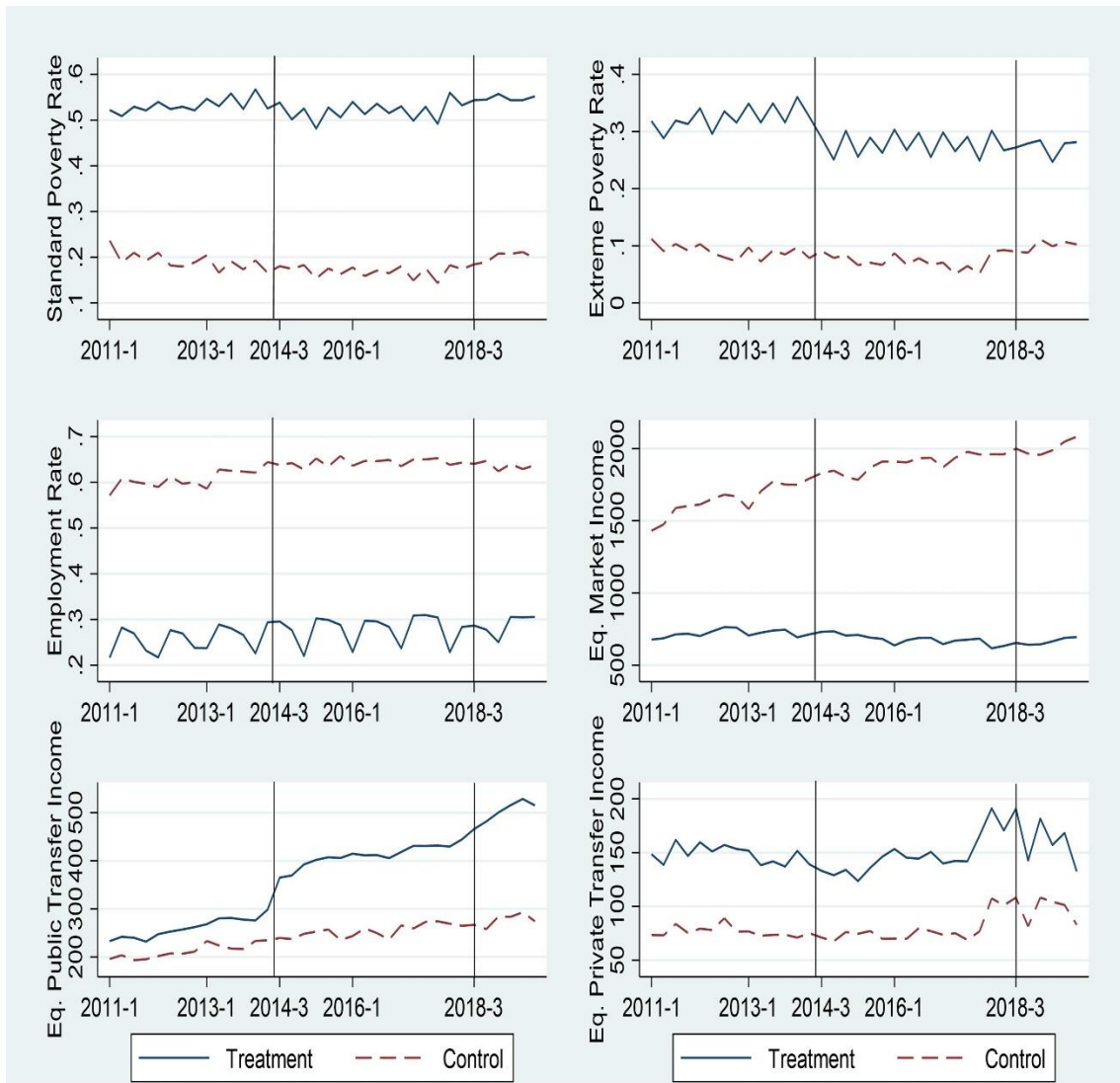


Figure 4.2. Trends in economic outcomes of treatment and control groups.

Vertical lines indicate the implementation of 2014 and 2018 reforms

However, the exogeneity of the age variable would still be useful if such non-parallel trends could be controlled. Following Autor (2003) addressing similar issues, we modify the baseline model to introduce group-specific linear time trends for precise estimation:

$$\text{Model [2]: } Y_{iyq} = \beta_0 + \beta_1 \text{Treat}_i + \beta_2 \text{Post}_{yq} + \beta_3 (\text{Treat}_i \cdot \text{Post}_{yq}) + \beta_4 \text{Time}_{yq} + \beta_5 (\text{Treat}_i \cdot \text{Time}_{yq}) + \beta_6 X_{iyq} + \gamma_y + \delta_q + \varepsilon_{iyq}$$

Model [2] adds a linear deterministic trend (Time_{yq}) to Model [1] and its interaction with Treat_i to deal with heterogeneous time trends throughout the whole period. Time_{yq} is a continuous variable indicating year-quarter time cells, coded from zero to 35. The group-specific time trends that span over the pre- and post-periods capture the pre-treatment divergence associated with unobserved external factors affecting the two groups differentially, such as the NPS coverage expansion. The coefficient β_5 denotes the difference in the linear time trends accounting for such divergence. The policy effect β_3 is equivalent to the size of discontinuity in the treatment group's linear trend at the time of policy implementation, taking the divergent time trends into account. As the models are based on a strong assumption that the time trends are linear, we introduce non-linear growth curves for robustness checks in Table D5.

Finally, we intend to observe whether policy effects are persistent over time:

$$\text{Model [3]: } Y_{iyq} = \beta_0 + \beta_1 \text{Treat}_i + \sum_K \beta_{2K} \text{PostK}_{yq} + \sum_K \beta_{3K} (\text{Treat}_i \cdot \text{PostK}_{yq}) + \beta_4 \text{Time}_{yq} + \beta_5 (\text{Treat}_i \cdot \text{Time}_{yq}) + \beta_6 X_{iyq} + \gamma_y + \delta_q + \varepsilon_{iyq}$$

$Post_{yq}$ in Model [2] is replaced with K dummy variables ($PostK_{yq}$) in Model [3] that partition the post-period into K consecutive phases. The series of interaction terms allow us to identify phase-specific effects. For analysing the 2014 reform, the post-period (Period 2) is divided equally into four phases ($K=1, 2, 3, 4$), each of which consists of four quarters. For example, $Post1_{yq}$ equals one from 2014-Q3 to 2015-Q2, while $Post4_{yq}$ equals one from 2017-Q3 to 2018-Q2. The post-period for the 2018 reform (Period 3) is split into two phases ($K=1, 2$): from 2018-Q4 to 2019-Q1 and from 2019-Q2 to 2019-Q4. As the additional benefit increase for the lower 20 percent was implemented from April 2019, the coefficient of $Post1_{yq}$ isolates the short-term effect of the 2018 reform from the combined effect of the 2018 and 2019 reforms.

In models with binary outcome variables, linear probability models (LPM) are used for the advantage of interpreting coefficients as the size of policy impact (Angrist & Pischke, 2009). Household-clustered standard errors are calculated to deal with intra-household correlations as respondents from the same household share the same economic outcomes. They would also address correlations between the same individuals included in adjacent time periods in the rotating panel data.

Empirical Findings

The 2014 reform

Tables 4.2 and 4.3 present the results of the DiD analyses estimating the impact of the 2014 BP reform on our selected outcomes after controlling individual and household characteristics and year/quarter-fixed effects.

Table 4.2. Effects of BP expansion in 2014 on old-age poverty and employment (LPM)

	Standard Poverty			Extreme Poverty			Employment Status		
	Model [1]	Model [2]	Model [3]	Model [1]	Model [2]	Model [3]	Model [1]	Model [2]	Model [3]
Treat	-0.00172 (-0.16)	-0.0114 (-0.89)	-0.0128 (-0.82)	0.0139 (1.44)	0.0113 (1.01)	0.0129 (0.93)	0.0304* (2.31)	0.0355* (2.44)	0.0344* (2.05)
Post	-0.00270 (-0.28)	0.0107 (0.95)		-0.0121 (-1.48)	-0.00850 (-0.95)		0.0116 (1.36)	0.00455 (0.43)	
Treat*Post	-0.0256** (-3.03)	-0.0479*** (-3.51)		-0.0494*** (-6.64)	-0.0554*** (-4.73)		-0.00569 (-0.67)	0.00610 (0.45)	
Treat*Post1			-0.0505** (-3.23)			-0.0582*** (-4.24)			0.00151 (0.10)
Treat*Post2			-0.0501* (-2.23)			-0.0540** (-2.76)			0.0106 (0.48)
Treat*Post3			-0.0481+ (-1.70)			-0.0377 (-1.53)			0.000532 (0.02)
Treat*Post4			-0.0560 (-1.61)			-0.0569+ (-1.87)			0.000918 (0.03)
Treat*Time		0.00147 (1.76)	0.00169 (1.09)		0.000394 (0.55)	0.000141 (0.10)		-0.000777 (-0.96)	-0.000598 (-0.40)
<i>N</i>	129096	129096	129096	129096	129096	129096	129096	129096	129096
<i>R</i> ²	0.262	0.262	0.262	0.176	0.176	0.176	0.215	0.215	0.215

t statistics in parentheses; + $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; All models include year- and quarter-fixed effects and control age, age squared, sex, level of education, number of elderly and non-elderly household members.

Table 4.3. Effects of BP expansion in 2014 on market income, public and private transfer income (OLS)

	Market Income			Public Transfer Income			Private Transfer Income		
	Model [1]	Model [2]	Model [3]	Model [1]	Model [2]	Model [3]	Model [1]	Model [2]	Model [3]
Treat	368.0*** (12.02)	496.2*** (12.68)	440.5*** (9.23)	-214.8*** (-21.12)	-234.7*** (-20.04)	-227.3*** (-16.25)	45.78*** (5.70)	40.34*** (4.34)	47.48*** (4.05)
Post	123.3*** (5.38)	-13.98 (-0.48)		-20.42** (-2.79)	7.167 (0.79)		-12.23+ (-1.90)	-4.707 (-0.58)	
Treat*Post	-200.5*** (-8.59)	28.69 (0.80)		113.9*** (14.53)	67.89*** (5.66)		-2.633 (-0.40)	-15.18 (-1.45)	
Treat*Post1			5.579 (0.14)			69.40*** (5.18)			-13.94 (-1.14)
Treat*Post2			-44.33 (-0.77)			84.86*** (4.28)			3.598 (0.20)
Treat*Post3			-76.38 (-1.06)			91.20*** (3.70)			2.842 (0.12)
Treat*Post4			-116.2 (-1.29)			93.45** (3.06)			11.23 (0.40)
Treat*Time		-15.10*** (-6.48)	-9.227* (-2.28)		3.033*** (4.05)	1.890 (1.38)		0.827 (1.30)	-0.268 (-0.21)
<i>N</i>	129096	129096	129096	129096	129096	129096	129096	129096	129096
<i>R</i> ²	0.367	0.367	0.367	0.099	0.099	0.099	0.043	0.043	0.043

t statistics in parentheses; + $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; All models include year- and quarter-fixed effects and control age, age squared, sex, level of education, number of elderly and non-elderly household members; Unit: KRW thousand, equivalised.

Our main interest is the impact on the standard and extreme poverty rates, as reported in Table 4.2. Overall, our estimates show that the BP expansion in 2014 reduced poverty risks for older people and the impact was more profound in mitigating extreme poverty. Model [1] suggests that the rise in benefits reduced the treatment group's standard poverty by 2.6 percentage points and extreme poverty by 4.9 percentage points, relative to the poverty rates of the control group. The poverty-alleviation effect becomes stronger with higher statistical significance in Model [2] when controlling the pre-existing divergence between the two groups. Those exposed to the BP scheme were 4.8 percentage points and 5.5 percentage points less likely to be in standard and extreme poverty respectively after the reform, compared to those who were not. Model [3] also shows that the policy impact on old-age poverty was generally persistent over the post-period with small variations, except for the Post3 effect on extreme poverty.

Regarding the employment status in Table 4.2 and market income in Table 4.3, we find no clear evidence that the increased level of benefits discouraged labour market participation among older people or their household members. None of the DiD estimates on employment status is statistically significant. The coefficient for market income seems negative in Model [1], but the effect vanishes after controlling the pre-existing divergence in time trends in Model [2]. Nevertheless, the negative impact on market income in Model [3] becomes increasingly visible over time, implying that behavioural adjustments may occur.

Estimates on public transfer income in Table 4.3 suggest that confounding factors may coincide with policy impacts over the period. In Model [1], the size of the DiD estimate (KRW 113,900) is larger than the standard amount of benefit increase (KRW 101,000 or PPP \$116), implying that policy effects are exaggerated in the model. In theory,

the coefficient should be smaller than the scale of the benefit increase, as household income measures are equalised by the family size and other means-tested cash transfers will be cut for those receiving the BP benefit. This problem disappears in Model [2], making the estimate about a third smaller than the size of the standard benefit increase. Meanwhile, Model [3] displays an unexpected result: the impact on public transfer income gradually rises throughout the post-period. This may be related to the modelling strategy and the fact that the treatment group's time trend and the policy impact are in the same positive direction. The upward time trend may be partially captured by the phase-specific effects, which implies that modelling group-specific linear trends undermines the accuracy of the phase-specific estimates. Finally, our estimates do not identify any significant impact on older people's private transfer income.

The 2018 and 2019 reform

Table 4.4 reports that the 2018 and 2019 reforms were jointly effective in reducing the standard and extreme poverty rates of older adults, as in 2014. The DiD estimates based on Model [2] demonstrate that the combined benefit increase in 2018 and 2019 reduced older people's risk of standard poverty by 2.7 percentage points and of extreme poverty by 3.8 percentage points, in comparison to the non-elderly group. Model [3] allows us to separate the short-term impact of the 2018 reform. The DiD estimates for Post1 specify that the 2018 reform alone lowered standard poverty by 2.2 percentage points and extreme poverty by 3.5 percentage points, though the impact on standard poverty is not statistically significant. After the 2019 reform, the effect is augmented to 3.2 percentage points on standard poverty and 4.2 percentage points on extreme poverty.

Table 4.4. Effects of BP expansion in 2018 & 2019 on old-age poverty and employment (LPM)

	Standard Poverty			Extreme Poverty			Employment Status		
	Model [1]	Model [2]	Model [3]	Model [1]	Model [2]	Model [3]	Model [1]	Model [2]	Model [3]
Treat	-0.0284** (-2.96)	-0.0530* (-2.21)	-0.0551* (-2.27)	-0.0185* (-2.30)	-0.0244 (-1.23)	-0.0257 (-1.27)	0.0414*** (3.77)	0.0628* (2.57)	0.0722** (2.91)
Post	0.0285* (2.30)	0.0362** (2.60)		0.0329** (3.24)	0.0347** (3.20)		-0.0124 (-1.06)	-0.0191 (-1.37)	
Treat*Post	-0.0146+ (-1.66)	-0.0271+ (-1.83)		-0.0354*** (-5.07)	-0.0384** (-3.29)		0.0161+ (1.87)	0.0270+ (1.89)	
Treat*Post1			-0.0222 (-1.36)			-0.0354** (-2.71)			0.00534 (0.34)
Treat*Post2			-0.0322+ (-1.89)			-0.0416** (-3.11)			0.0494** (2.99)
Treat*Time		0.00112 (1.09)	0.00122 (1.16)		0.000271 (0.33)	0.000330 (0.39)		-0.000980 (-0.96)	-0.00141 (-1.36)
<i>N</i>	91372	91372	91372	91372	91372	91372	91372	91372	91372
<i>R</i> ²	0.259	0.259	0.259	0.154	0.154	0.154	0.216	0.216	0.216

t statistics in parentheses; + $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; All models include year- and quarter-fixed effects and control age, age squared, sex, level of education, number of elderly and non-elderly household members.

Table 4.5. Effects of BP expansion in 2018 & 2019 on market income, public and private transfer income (OLS)

	Market Income			Public Transfer Income			Private Transfer Income		
	Model [1]	Model [2]	Model [3]	Model [1]	Model [2]	Model [3]	Model [1]	Model [2]	Model [3]
Treat	359.4*** (13.71)	748.1*** (10.77)	751.1*** (10.77)	-165.6*** (-17.53)	-252.6*** (-11.27)	-251.4*** (-11.11)	35.30*** (5.15)	5.782 (0.32)	2.086 (0.11)
Post	70.31+ (1.70)	-50.77 (-1.01)		-21.80+ (-1.73)	5.301 (0.37)		-13.04 (-1.44)	-3.841 (-0.38)	
Treat*Post	-153.8*** (-5.14)	44.64 (0.94)		83.44*** (9.32)	39.01** (2.72)		-15.55* (-2.30)	-30.62** (-2.92)	
Treat*Post1			38.33 (0.70)			36.35* (2.26)			-22.39* (-1.99)
Treat*Post2			51.26 (0.94)			41.77* (2.52)			-39.18** (-3.08)
Treat*Time		-17.77*** (-5.82)	-17.90*** (-5.81)		3.977*** (4.16)	3.924*** (4.05)		1.350+ (1.80)	1.518* (1.99)
<i>N</i>	91372	91372	91372	91372	91372	91372	91372	91372	91372
<i>R</i> ²	0.388	0.388	0.388	0.115	0.115	0.115	0.041	0.041	0.041

t statistics in parentheses; + $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; All models include year- and quarter-fixed effects and control age, age squared, sex, level of education, number of elderly and non-elderly household members; Unit: KRW thousand, equivalised.

Results in Tables 4.4 and 4.5 related to labour market activities seem counterintuitive. The probability of being employed rather rises by 2.7 percentage points for those affected by the two reforms relative to those who were not. When disaggregated into the two post-reform phases in Model [3], the 2018 reform did not solely generate a significant impact, while the positive effect surges to 4.9 percentage points for the 2018 and 2019 reform together. In contrast, while a substantial decrease in market income after the treatment is detected in Model [1], the effect disappears when the pre-existing divergence in time trends is controlled. We find no significant impact on market income in Model [2] and [3], which is not in line with the results vis-à-vis employment status among older people.

Finally, Table 4.5 includes the impact of the 2018 and 2019 reforms on public and private transfer income. As in the 2014 reform, the DiD estimates on public transfer income in Model [2] and [3] are lesser than the standard amount of the benefit increase in 2018 (KRW 50,000 or PPP \$59). In Model [3], a larger coefficient for the second post-reform phase reflects a slight additional increase for the lower 20 percent. However, our models report consistent adverse effects on private transfer income. A decrease in private transfer income amounts to about two-thirds of the increase in public transfer income, based on the estimation in Model [2]. Model [3] shows that the crowding-out effect is intensified after the 2019 reform, reducing private transfer income by KRW 39,180 (PPP \$46).

In sum, our results suggest that all three consecutive reforms in the recent decade have effectively relieved old-age poverty, even with a relatively meagre level of benefit expansions. Poverty rates had fallen for the treatment group in Period 2 and 3 compared to the control group, and the impact was more pronounced on extreme poverty. The estimates on older adults' employment and market income indicate that the impact on

older people's labour market participation is not conclusive. In the 2014 models, the estimates are not statistically significant for both outcomes, whereas in the 2018 models, the impact on employment is unexpectedly positive but that on market income is non-significant. Regarding the impact on private transfer income, the results identify no significant negative effect on private transfer income in 2014, whereas substantial crowding-out effects are detected from the policy expansions in 2018 and 2019.

Discussion and Conclusion

This study evaluates the impact of Korea's Basic Pension expansions implemented in 2014, 2018 and 2019, focusing on income poverty among older people. A quasi-experimental DiD design is used to investigate causal channels that non-contributory pensions alleviate old-age poverty while coping with methodological deficits of previous studies. Our empirical findings suggest that older people who are most likely to be exposed to the BP scheme experienced lower poverty risks than they would have been without the policy reforms. The fact that the poverty-reducing impact was stronger on extreme poverty than standard poverty rates indicates that older Koreans below the poverty line are concentrated on the bottom quintile of the income distribution. The amount of benefit also matters, as the size of the impact was larger after the 2014 expansion than after the small-scale increase in 2018 while the additional increase for the lower 20 percent in 2019 produced more significant results. Furthermore, our results demonstrate that the policy effects were generally persistent over time with mild fluctuations, implying that behavioural adjustments to an increased public transfer income would not be a serious concern. Robustness checks are broadly in line with the main conclusion, though the results in 2018 were not statistically significant in our

alternative estimations (see Tables D5, D6 & D7 in the Appendix Paper 4).

We do not find clear evidence that such non-contributory pensions discourage older adults' labour market participation, as none of our estimates reports a negative and significant effect on employment outcomes. This is consistent with the findings from existing studies on the Korean BP (Sung & Lee, 2018; Kim & Kim, 2021) and may be related to the fact that the absolute value of benefit increases was not considerably large in all three reforms. The findings altogether support that raising non-contributory pensions, at least until a certain level, would not generate significant disincentives to labour market participation or hamper active ageing among older adults, even with means tests that allegedly tend to create poverty traps.

One interesting finding is that the effects of the 2018 and 2019 reforms were positive on the employment rate without any increase in household market income. Two potential explanations can be drawn out: that older workers have experienced a decline in hourly wages and/or work hours; or that non-elderly household members' contributions to market income have shrunk. We find the former explanation less convincing, as the government statistics show that a slight decrease in work hours has been countervailed by about a 65-percent upsurge in hourly wages among older workers from 2011 to 2019 (Ministry of Employment and Labor, 2020). The latter interpretation seems more plausible, as the inconsistency between old-age employment and market income can be associated with a diminishing trend of older people's co-residence with their adult children (see Figure D1; also Ku, Lee & Lee, 2021).

Another puzzling result is in the crowding out of private transfers. The crowding-out effect was considerable and significant after the 2018 and 2019 reforms (more than three-quarters of the increase in public transfer income were crowded out), whereas that in 2014

was not significant. A similar pattern is also found in one of our alternative estimations (see Table D6). Such results are not only contradictory to the literature finding significant reductions in private transfers after the 2014 reform, but also counterintuitive as the magnitude of policy change was larger in 2014. The puzzling result could be interpreted by a ‘threshold effect’, suggesting that the crowding out would not occur until the benefit generosity reaches a certain threshold. In our case, the decrease in private transfer income among older households may be less clear in 2014 since the absolute level of pension income was still very low. By contrast, after the 2018 and 2019 reforms, people may have found the level of welfare benefits for older people sufficient, partly attributed to a steady expansion of earnings-related pensions (NPS) over the recent decade. Thus, adult children now can easily substitute payment to their older parents with increased BP benefits. However, we do not claim that this interpretation is conclusive, as our first alternative estimation using non-linear time trends reports that estimates on private transfer income are not significant for all three policy changes (see Table D5).

Taken together, the two puzzling findings on market income and private transfers may be linked with a long-term fading of ‘filial piety’ in contemporary Korean society. Traditionally in Korea and East Asian countries, adult children are expected to sustain their older parents’ living, while social norms have changed over the past decades and now older adults also feel it is not desirable to be economically dependent on their children (Lee, Wu & Chui, 2018). Our findings are consistent with recent research that public policy expansions in Korea have countervailed expected decreases in older people’s household income due to declining family support and co-residence with adult children (Ku, Lee & Lee, 2021). A concern of reverse causation that the BP expansion might trigger separation of older adults with adult children and thereby cancel out the

poverty-reducing impact is not supported by our findings on changes in household composition (see Table D3).

Overall, this study confirms the findings from the literature that non-contributory pensions do help mitigate old-age poverty, despite the existence of crowding out by diminishing private transfers. The findings also imply overall welfare improvement in society, as rising pension income may have reduced adult children's unequal burden to support older parents and promoted older adults' independent living. Our research offers implications to policymakers in other latecomer pension regimes that even a small amount of means-tested social pensions can tackle economic inequality among older people with long-lasting impacts. In countries with sizeable informal labour markets for older workers and large lacunae in pension coverage, non-contributory pensions can be an effective strategy for immediate poverty alleviation and well-being enhancement. Another meaningful contribution of this study is in the methodological aspect of addressing the endogeneity bias in previous studies to provide more precise estimates. For instance, our estimate showing 4.8 percentage points of the standard poverty reduction in 2014 is much smaller than 9.3 percentage points¹⁰ reported by Lee, Ku & Shon (2019).

One caveat in interpreting our results is that the estimates do not represent the full impact of the BP scheme, but the impact of the 'increased' part from the reforms in total benefit amounts. Specifically, the 4.8 percentage points of poverty reduction are not in comparison to the absence of the whole BP scheme but to the absence of the 2014 benefit increase. Another limitation related to the dynamic nature of the DiD design is that other

¹⁰ The estimate is not directly comparable to our estimates as Lee, Ku & Shon (2019) use the national poverty line published by the government, different from our relative poverty concept. However, the problem remains that their estimates are susceptible to endogeneity bias.

unobserved events coinciding with the policy reform make it difficult to correctly identify the policy effect. We address this issue by fitting the divergence of linear time trends between the treatment and control groups in our models, but the assumption of linearity may not always hold. Only using a static causal inference method would overcome this problem. Therefore, subsequent research can take advantage of static research designs, such as regression discontinuity, to capture the full impact of BP benefits and preclude distortions from external factors.

Finally, this study does not account for heterogeneities within the older-age (treatment) group encompassing broad age bands. For example, older people aged between 65 and 70 and those above 70 might have different characteristics in gender, level of education, health, labour market behaviours and household composition, and thus policy effects could be heterogeneous within the group. Lacking subgroup analysis is a non-negligible gap of this research. Future analysis should thus include an evaluation of heterogeneous treatment effects on older people's income as well as other aspects of well-being.

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Appendix Paper 4

Table D1. History of Basic Pension development in South Korea, 2008-2021

Title	Outset	Level of Benefit (KRW)		Eligibility
Basic Senior Pension	Jan. 2008	84,000 (Jan. 2008) –	20% deduction for couple beneficiaries	Lower 60%, Age 70+
	Jan. 2009	99,900 (Jun. 2014)		Lower 70%, Age 65+
	Jul. 2014	200,000		
	Sep. 2018	250,000		
Basic Pension	Apr. 2019	250,000 (standard), 300,000 (lower 20%)	20% deduction for couple beneficiaries	Lower 70%, Age 65+
	Jan. 2020	254,760 (standard), 300,000 (lower 40%)		
	Jan. 2021	300,000		

Note: This table includes the recent updates of 2020 and 2021 in the Basic Pension scheme, which are not accommodated in our empirical analysis.

Table D2. HIES sample size by years and quarters. Total sample size: 158,669

		2011	2012	2013	2014	2015	2016	2017	2018	2019
65+	1	2,353	2,506	2,698	2,635	2,746	2,765	1,782	3,043	3,193
	2	2,235	2,396	2,568	2,546	2,647	2,667	1,805	2,973	3,055
	3	2,412	2,578	2,704	2,739	2,719	2,883	1,815	3,201	3,209
	4	2,596	2,772	2,798	2,870	2,961	2,736	1,826	3,370	3,055
55-64	1	1,979	1,952	1,889	1,772	1,788	1,840	1,119	1,742	1,768
	2	1,931	1,847	1,759	1,657	1,694	1,756	1,072	1,685	1,674
	3	2,016	1,931	1,850	1,757	1,761	1,878	1,052	1,783	1,750
	4	2,069	1,988	1,876	1,891	1,926	1,819	1,026	1,876	1,639
Total		17,591	17,970	18,142	17,867	18,242	18,344	11,497	19,673	19,343

HIES: Household Income and Expenditure Survey

Note: There was an issue in the sample replenishment process of the HIES data that caused a notably small sample size for the 2017 sample, which questions the sample's representativeness. However, this issue can be addressed by year-fixed effects in our model that capture unobserved heterogeneity across years.

Table D3. Difference-in-difference estimates in the number of elderly and non-elderly household members after 2014 & 2018 policy reforms

	2014 Reform		2018 Reform	
	Number of elderly	Number of non-elderly	Number of elderly	Number of non-elderly
Treat*Post	0.0223 (1.47)	-0.00649 (-0.16)	0.0236 (1.56)	0.0229 (0.51)
Treat*Time	0.000818 (0.87)	-0.00857** (-3.29)	0.000925 (0.83)	-0.00918** (-2.90)
<i>N</i>	129096	129096	91372	91372
<i>R</i> ²	0.706	0.346	0.713	0.386

t statistics in parentheses; + $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; All models include year- and quarter-fixed effects and control age, age squared, sex, and the level of education. The difference in linear time trend between the treatment and control groups is also controlled.

Table D3 shows that there was no statistically significant change in the number of elderly and non-elderly household members among the treatment-group households compared to the control group households, both after the 2014 and 2018 policy reforms.

Table D4. Descriptive statistics, by socio-demographic variables

	Baseline Year (2011)		All Sample (2011-2019)	
	Age 65+	Age 55-64	Age 65+	Age 55-64
Age	72.72	59.23	73.49	59.26
Sex				
Female	59.77 %	56.00 %	61.45 %	57.56 %
Male	40.23 %	44.00 %	38.55 %	42.44 %
Education				
No diploma	31.29 %	6.05 %	26.18 %	3.78 %
Primary school	34.79 %	29.48 %	34.33 %	22.31 %
Middle school	15.60 %	29.04 %	18.41 %	28.88 %
High school	18.32 %	35.42 %	21.08 %	45.02 %
<i>N</i>	9,596	7,995	95,857	62,812

Alternative estimation 1: introducing non-linear time trends

We employ three different strategies of alternative estimation for robustness checks. The first is to introduce non-linear time trends that are different between the treatment and control groups, as our main analysis is based on the assumption that the pre-existing time trends in economic outcomes are linear. We added a quadratic function of $Time_{yq}$ and its interaction term with $Treat_i$ to Model [2]. Table D5 shows the result of the estimation.

$$\text{Non-linear Trend Model : } Y_{iyq} = \beta_0 + \beta_1 Treat_i + \beta_2 Post_{yq} + \beta_3 (Treat_i \cdot Post_{yq}) + \beta_4 Time_{yq} + \beta_5 Time_{yq}^2 + \beta_6 (Treat_i \cdot Time_{yq}) + \beta_7 (Treat_i \cdot Time_{yq}^2) + \beta_8 X_{iyq} + \gamma_y + \delta_q + \varepsilon_{iyq}$$

Table D5. Robustness check 1: Introducing non-linear time trends

2014 Reform						
	Standard Poverty	Extreme Poverty	Employment Status	Market Income	Public Transfer	Private Transfer
Treat*Post	-0.0493*** (-3.38)	-0.581*** (-4.56)	0.0033 (0.23)	12.92 (0.34)	71.11*** (5.58)	-12.84 (-1.12)
<i>N</i>	129096	129096	129096	129096	129096	129096
<i>R</i> ²	0.262	0.176	0.215	0.367	0.099	0.043
2018 & 2019 Reforms						
	Standard Poverty	Extreme Poverty	Employment Status	Market Income	Public Transfer	Private Transfer
Treat*Post	-0.024 (-1.10)	-0.012 (-0.71)	-0.00134 (-0.06)	30.61 (0.42)	43.09* (1.99)	-8.58 (-0.55)
<i>N</i>	91372	91372	91372	91372	91372	91372
<i>R</i> ²	0.259	0.154	0.216	0.388	0.115	0.042

t statistics in parentheses; + $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; Non-linear time trends are added based on Model [2]; Unit (income): KRW thousand, equalised.

In Table D5, the DiD estimates of all outcomes for the 2014 reform are very similar to those in the main result. However, Table D5 also shows that the result of the 2018 & 2019 reforms is considerably different from that of our main analysis. Unlike the main result, the estimates on standard and extreme poverty and private transfer income for the 2018 & 2019 reforms are not statistically significant.

Alternative estimation 2: a triple-differences approach

The second alternative approach is to design a difference-in-difference-in-difference (DDD) setting, another useful method to deal with the violation of the common-trend assumption between the treatment and control groups (Wing, Simon & Bello-Gomez, 2018). Our approach restricts pre- and post-periods within the year policy changes occurred – 2014 or 2018 in this case – and compares the DiD estimate in the year of our interest with that in a reference year. Similar to the design adopted by Lee, Ku & Shon (2019), the DiD estimates calculated by the difference between our treatment and control groups and between the first and second half of 2013 (the reference year) are deducted from those of 2014. The specification for our triple-differences estimation is:

$$\begin{aligned} \text{DDD Model: } Y_{iyq} = & \beta_0 + \beta_{11}Treat_i + \beta_{12}Post_q + \beta_{13}d.Year_y + \beta_{21}(Treat_i \cdot \\ & Post_q) + \beta_{22}(Treat_i \cdot d.Year_y) + \beta_{23}(Post_q \cdot d.Year_y) + \beta_3(Treat_i \cdot \\ & Post_q \cdot d.Year_y) + \beta_4X_{iyq} + \delta_q + \varepsilon_{iyq} \end{aligned}$$

$Post_q$ equals zero for Q1 and Q2 and one for Q3 and Q4, while Q3 is excluded in 2018 models. $d.Year_y$ is a dummy variable for comparing the year of policy change with

its previous year. In 2014 models, $d.Year_y$ equals one for 2014 and zero for 2013; in 2018 models, it equals one for 2018 and zero for 2017. $Treat_i$ and covariates are the same as in our main analysis, but only the quarter-fixed effect (δ_q) is included in the DD Model.

The core assumption of this approach is that the quarterly business-cycle effects are similar, if not identical, between the two adjacent years compared, which seems reasonable but is not always assured. Otherwise, the estimated policy impact would be distorted by unobserved differences in economic cycles between the two years. Another limitation of this approach is that only short-term effects are identified as the post-period ranges up to two quarters. This also means that we cannot integrate the 2019 reform into the analysis.

Table D6. Robustness check 2: DDD estimates

2014 Reform						
	Standard Poverty	Extreme Poverty	Employment Status	Market Income	Public Transfer	Private Transfer
DDD	-0.0415* (-2.12)	-0.0602*** (-3.56)	0.0125 (0.69)	52.04 (1.04)	60.87*** (4.64)	-28.31* (-2.26)
<i>N</i>	36009	36009	36009	36009	36009	36009
<i>R</i> ²	0.270	0.189	0.206	0.370	0.070	0.047
2018 Reform						
	Standard Poverty	Extreme Poverty	Employment Status	Market Income	Public Transfer	Private Transfer
DDD	0.0157 (0.46)	0.0278 (1.10)	0.00228 (0.07)	-41.41 (-0.39)	47.00 (1.43)	-36.03+ (-1.65)
<i>N</i>	23319	23319	23319	23319	23319	23319
<i>R</i> ²	0.257	0.159	0.234	0.388	0.109	0.043

t statistics in parentheses; + $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; All models include quarter-fixed effects and control age, age squared, sex, level of education, number of elderly and non-elderly household members; Unit (income): KRW thousand, equivalised.

Table D6 reveals that DDD estimates mostly, but not always, support our main findings. The 2014 reform markedly reduced the standard and extreme poverty rates but had no significant impact on old-age employment and market income. However, the estimates do not show that the 2018 reform significantly alleviated old-age poverty, as in the first alternative estimation. Another notable difference from our main result is that the crowding-out of private transfer is more pronounced and statistically significant in the 2014 estimate. Almost half of the increase in public transfer income is countervailed by the decrease in private transfer income. As in our main analysis, the crowding out becomes more potent in the 2018 model.

Alternative estimation 3: Pseudo-treatment group

We then formulate a pseudo-treatment group for the third strategy to check if external factors are confounding our main analysis. Based on the Model [2] specification, we assign individuals aged 61 to 64 to a treatment group and those aged 55 to 60 as a control group. Given that the NPS commencement age was 61 from 2013 to 2018, this design primarily observes whether gradual expansions of the earnings-related pension scheme would distort our main findings, after controlling the pre-existing unparallel time trends between the pseudo-treatment and control groups. Ideally, we anticipate all estimates here are not statistically significant.

Table D7. Robustness check 3: pseudo-treatment group

2014 Reform						
	Standard Poverty	Extreme Poverty	Employment Status	Market Income	Public Transfer	Private Transfer
p.Treat*Post	0.00836 (0.47)	-0.0210 (-1.54)	0.0488* (2.28)	73.69 (1.40)	2.232 (0.13)	-14.01 (-0.95)
p.Treat*Time	-0.00341** (-3.19)	-0.000653 (-0.80)	-0.00101 (-0.79)	-7.122* (-2.13)	4.223*** (4.06)	1.552+ (1.86)
<i>N</i>	58386	58386	58386	58386	58386	58386
<i>R</i> ²	0.100	0.067	0.095	0.192	0.092	0.034
2018 & 2019 Reform						
	Standard Poverty	Extreme Poverty	Employment Status	Market Income	Public Transfer	Private Transfer
p.Treat*Post	0.0334+ (1.79)	0.0110 (0.84)	-0.0377+ (-1.68)	-100.4 (-1.53)	-12.68 (-0.64)	-5.634 (-0.41)
p.Treat*Time	-0.00169 (-1.28)	0.000326 (0.34)	-0.00225 (-1.40)	-6.770 (-1.61)	4.597*** (3.33)	1.430 (1.50)
<i>N</i>	38976	38976	38976	38976	38976	38976
<i>R</i> ²	0.087	0.060	0.089	0.200	0.111	0.033

t statistics in parentheses; + $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; All models are based on Model [2]; Unit (income): KRW thousand, equalised.

Table D7 presents that the extreme poverty rate of our pseudo-treatment group decreased by 2.1 percentage points after the 2014 reform, and the standard poverty rate increased by 3.3 percentage points after the 2018 reform. We do not attribute these unexpected results to the NPS coverage expansions, given that the estimates on public and private transfer income are not statistically significant in both periods. Considering that the employment rate and market income of this group substantially increased in the former and decreased in the latter period, we cautiously interpret that the significant changes in poverty rates are associated with unidentified labour market mechanisms.

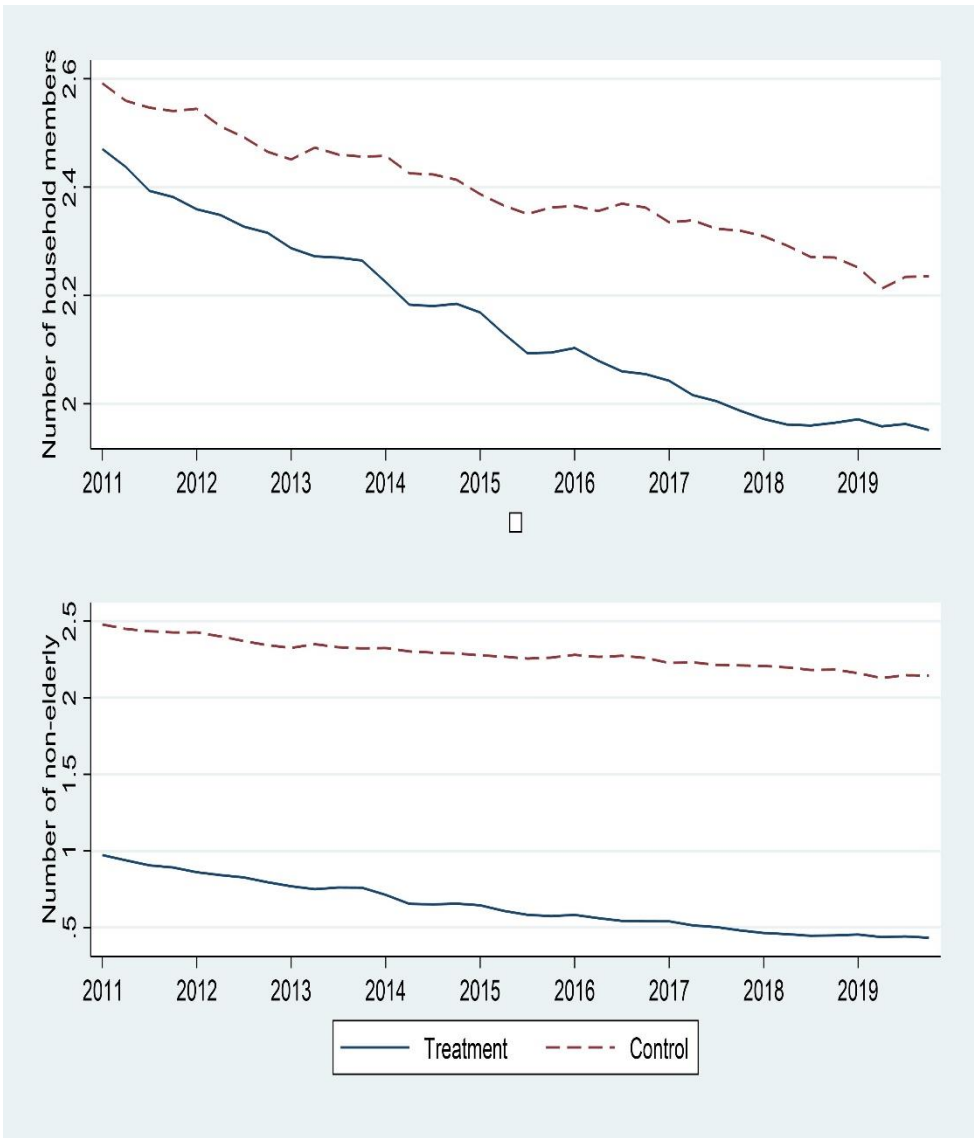


Figure D1. Changes in the number of household members in the treatment and control groups

*Upper graph: Number of total household members
 Lower graph: Number of non-elderly household members*

Conclusion

Social inequalities related to extending working lives have become a serious concern among social scientists and policymakers since major welfare state reforms in Europe, but also in North America and East Asia with conventionally long working lives. Promoting later retirement and active ageing would be an unavoidable path for most societies amidst demographic ageing and increasing labour shortages, but doing so by compromising equality is likely to threaten the social solidarity and legitimacy of welfare states. The present thesis contributes to this research agenda by investigating relevant issues of old-age inequality, including gender and educational differences in employment, retirement transitions and their link with policies, as well as poverty outcomes after retirement. The four empirical studies utilise various theoretical and methodological approaches, such as macro-comparative research to study cross-national variation in policies and institutions (Papers 1 and 2); a time-series approach to exploit within-country variations of similar policies (Paper 1); a life-course analysis of individual trajectories to explore the dynamics of social stratification (Paper 3); and a quasi-experimental design to estimate the impact of policy reforms (Paper 4). In this final chapter, I provide a synthesis of the key findings and policy implications from the four papers, discuss their limitations and suggest directions for future research.

Key Findings and Policy Implications

Heterogeneous effects of public pensions

One of the key findings from multiple papers is that the effects of public pensions are

not uniform among older population subgroups, which has often been overlooked in macro-comparative studies. This pattern is most salient in the main result of Paper 1 demonstrating that the employment effects of public pension spending are significantly larger among female and low-educated groups than among male and higher-educated groups, respectively, across different pension regimes. In the supplementary analysis of poverty risks (see Table A4 and Figure A4), public pension spending also had a greater effect on older women's poverty risks compared to men. It is also supported by findings from Paper 2 that older workers' exit rates during an economic crisis are moderated by pension institutions more strongly among low-educated workers than the high-educated.

The heterogeneous effect of public pensions by gender and level of education seems to be related to augmented financial constraints among low-educated workers and older women following pension cuts, since these groups are most likely to rely on public (early retirement) pensions. This interpretation is consistent with existing studies in labour economics (Etgeton, 2018; Rabaté and Rochut, 2020) that a substantial share of the underemployed subgroups tends to transfer to unemployment or disability schemes as a result of cutbacks in early retirement pensions, which then leads to their increased poverty risk. These findings suggest that policies solely focusing on financial incentives to work longer without addressing labour market inequalities would end up increasing old-age poverty and income inequality.

Persistent socioeconomic differences in late working lives

Another common finding is that socioeconomic differences in extending working lives have been persistent until recently, despite the aggregate trend of active ageing. This is not only seen in the results of Paper 3 based on the German case but also in the

descriptive statistics in Paper 1 illustrating recent trends in gender/education-specific employment rates across 20 European countries and the United States (see Figures A1 and A2). Despite the common rise in old-age employment, gender and educational gaps have not diminished in most countries, mainly due to a stagnant pace of activation among low-educated women (and men to some extent). This finding is also consistent with another recent study by Riekhoff and Kuitto (2022) estimating gender and educational inequalities in effective labour market exit ages in European countries.

Threefold implications can be drawn from the persistence of late-career inequalities confirmed in multiple studies. The first implication is that the overall employment rate of low-educated groups may be more strongly determined by demand-side constraints, such as macroeconomic conditions, changing skills demand and educational compositions in old-age labour markets. Note that this does not dismiss the effectiveness of welfare state reforms addressing financial incentives for labour supply. It rather means that those effects may not be large enough to meaningfully raise low-educated workers' employment rates. The second and related implication is that educational expansion has been a key driver behind the steady rise of old-age employment across Europe. A declining share of the low-educated may have even been a stronger factor than welfare state reforms, especially among women, which is supported by a recent empirical study (Riekhoff and Kuitto, 2024). Finally, the persistent stratification after early retirement reforms is likely to enlarge post-retirement poverty and income inequality, given that one's pension income adequacy would become more dependent on late-career trajectories.

Significance of country-specific institutional structures

The third key finding is that country-specific institutions matter when evaluating

similar policies of extending working lives. For example, Paper 1 mainly finds that the group-specific effects on employment and poverty rates vary depending on the longstanding institutional design of public pensions – whether public pension systems are flat-rate, tax-financed (*Beveridgean*) or earnings-related, insurance-based (*Bismarckian*). Paper 2 similarly shows that the relative scale of private pension schemes was associated with older workers' exit outcomes during the COVID-19 pandemic. These findings suggest that the consequences of pension reforms, especially on socioeconomic inequality, would be contingent on the financing and benefit structure of public pensions as well as its relation to private pensions. They also alert policymakers against drawing out lessons from other countries without considering institutional differences.

The idea of linking inequality outcomes and the institutional design of pension systems has not been widely attended even among studies using cross-national comparative datasets, as policy evaluation often relies on within-country effects over time to identify causal effects (Blöndal and Scarpetta, 1999; Duval, 2003; O'Brien, 2010). Nevertheless, the subject is now nothing new. A special issue of *Social Policy & Administration*, “Inequalities in pension and retirement: Life-courses and pension systems in comparative perspective”, contains multiple articles exploring institutional differences in public pensions across countries and income inequality in old age (for example, see Ebbinghaus, 2021; Möhring, 2021). This thesis contributes to the literature by extending these ideas and empirically examining how institutions moderate inequality outcomes of pertinence.

Role of non-contributory pensions

The core argument in Paper 4 is that non-contributory basic or targeted pensions that

offer income floors for retirees are effective in tackling older people's poverty without significantly undermining their employment outcomes. Admittedly, one should take into account the unique context of South Korea with a large pension gap and exceptionally high old-age poverty. It can also be argued that the incentive for labour supply was not harmed because payments in the Korean Basic Pension scheme are at a modest level. However, even among countries with mature pension systems, the generosity of non-contributory pensions seems to be barely correlated with old-age employment rates or effective retirement ages (OECD, 2021).

These findings support the usability of non-contributory pensions as an instrument for securing minimum protection when retrenchment is inevitable due to large fiscal burdens especially in 'Bismarckian' systems with contributory, earnings-related public pensions. Maintaining generous income replacement rates for middle- and high-income individuals has been increasingly difficult and costly as life expectancy keeps rising. At the same time, the rise of non-standard employment and frequent career interruptions among women and low-skilled groups put their retirement income at risk. Expanding the role of non-contributory pensions could also be a politically feasible strategy to balance the trade-off between social protection and fiscal sustainability in ageing welfare states (Häusermann, Kurer and Traber, 2019).

Specific policy recommendations could be drawn for pension systems in Korea and Germany, based on these findings with consideration of their institutional designs. Korea's pension gap is mainly due to a huge proportion of older adults failing to meet the minimum contribution requirement in the Bismarckian pension system. The prevalence of unstable career histories thereby creates an unintended effect of public pensions intensifying old-age income inequality rather than mitigating it (Hwang, 2016). Provided

that non-contributory pensions have strong redistributive effects without significantly reducing old-age employment, Korea could raise the benefit level of its Basic Pension scheme, which is currently about 10 percent of the average wage.

The role of non-contributory pensions could also be expanded in Germany, as the share of low-paid and non-standard work is disproportionately on the rise in low-skilled and female-dominated sectors (Eichhorst, Marx and Tobsch, 2015). This would become a bigger challenge given that the income replacement rate is gradually decreasing in the contributory public scheme. The recent implementation of the minimum pension for low-income contributors (*Grundrente*) in 2021 was intended to address this problem, but its actual effect is questionable as it requires a long contribution record of 33 years. Therefore, poverty risks in old age would be better constrained by strengthening Germany's old-age social assistance scheme (*Grundsicherung im Alter*).

Active labour market policies for older workers

Finally, the significance of job retention schemes found in Paper 2 demonstrates the potential of active labour market policies for retaining older workers. Normally during economic downturns, 'passive' policies like unemployment benefits were used as labour-shedding strategies facilitating early exit from work (Kohli et al., 1991). Such policy options would no longer be appealing given that many high-income countries experienced labour shortages during the recovery phase of the recent pandemic. As short-time work policies and wage subsidies are proven to be effective in retaining older workers against demand shocks, these tools could be utilised also in normal times to support the hiring of low-skilled workers who would otherwise face involuntary exit from work.

Limitations and Directions for Future Research

While the four studies offer meaningful findings from various institutional contexts in different time frames, those are not without limitations. Methodological limitations acknowledged in Papers 1 and 2 are that the results are sensitive to case selection and that establishing causal relationships is difficult in cross-national comparative research. Another issue present in all four studies is that it is hard to distinguish between financial and non-financial reasons for extending working lives. Studies suggest that low-educated workers, divorced women and the self-employed who work beyond the normal retirement age are doing so due to insufficient financial resources (Scherger et al., 2012; Hofäcker and Naumann, 2015; Riekhoff and Järnefelt, 2018), but these interpretations are not always based on direct surveys of individuals' motivations. While my conclusions are also in line with those in prior studies, it is also worth emphasising that many older adults now have positive attitudes towards working longer for both financial and non-financial reasons (Hokema and Scherger, 2016; Hess, Naegele and Mäcken, 2021).

Most empirical studies by far rely heavily on the dichotomy of push and pull factors to explain cross-national variation and individual-level differences in extending working lives, and this applies also to the present thesis. However, the analysis of retention factors, mainly active labour market policies for older workers (Ebbinghaus and Hofäcker, 2013), is still at an early stage. This thesis contains an analysis relevant to retention factors in Paper 2, but that has a narrow focus on job retention schemes in a specific period. Future research could thus initiate more comprehensive evaluations of active labour market policies, such as public employment services and lifelong learning, under diverse institutional contexts. Those include flexible retirement policies with various designs to combine reduced work hours with partial income support (Eurofound, 2016). Given that

the overall effect of these policies is ambiguous and contested (Börsch-Supan et al., 2013; Haan and Tolan, 2019; Berg et al., 2020), further studies could evaluate nuanced effects among population subgroups.

Finally, the analysis of later-life inequality could be extended to other dimensions. For instance, pension wealth inequality is hugely understudied both in the field of wealth inequality and comparative social policy (Marx and Nolan, 2021; Pfeffer and Waitkus, 2021). This is related to difficulties in estimating individual pension wealth under tax-financed, defined-benefit systems with varying life expectancy gaps within and across societies (Deeg, Tavernier and Breij, 2021; Shi et al., 2023). However, since pension wealth accounts for a sizeable share of household wealth, future research needs to investigate the role of pension institutions in explaining cross-national divergence in wealth inequality. Another avenue for extension is the connection between changing life-course dynamics and later career inequalities. As both labour market and family trajectories are becoming de-stabilised and diversified, the influence of earlier life course and its cumulative (dis)advantages in old age would evolve correspondingly.

My thesis overall stresses that there are multiple strategies to extend working lives in ageing welfare states and that institutional differences matter in understanding various consequences of social inequalities. To maintain the political legitimacy of welfare states under constant recalibrations, it is important to balance intergenerational fairness with intra-generational equality in pensions and labour market policies (Myles, 2002). More case studies as well as cross-national comparisons should be done to draw out lessons from success stories and failures in this policy arena.

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