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Original Article

Converging or unequal retirement patterns? Late working lives, retirement trajectories, and pension income in Germany over three decades of cohorts

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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 welfare state reforms and socioeconomic transformations. Germany presents a unique case where late working lives are highly stratified, yet early retirement trends have dramatically reversed since major reforms in the 1990s, while facing multiple recessions. Against this backdrop, our study examines the dynamics of social stratification in retirement processes and their relationship with pension income following major transformations in Germany after reunification. Using administrative pension insurance records linked with survey data, we combine sequence and cluster analyses with regression models to study the late working lives in Germany across three decades of birth cohorts 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 the East and West. Differences in retirement trajectories significantly explain variations in public pension income, net of socio-demographic characteristics and lifetime work histories.

Key words: retirement; life course; welfare state; social stratification; pensions.

Introduction

Being retired is not the same phenomenon as going on retirement. Retirement is not merely the state of drawing a pension after a long working life ("being retired") but also a complex transition from work to full non-working activity in old age ("going on retirement"). The transition

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paths are unequally distributed as older workers with lower skills or less 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 average workers (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 (Heisig 2015; Blossfeld et al. 2011). Furthermore, flexible retirement options that meet individual preferences often remain the privilege of high-skilled workers with sufficient resources (Eurofound 2016). Moreover, women's retirement transitions are further diversified, as their late careers are dependent on earlier often interrupted work trajectories, part-time work experience, family care responsibilities, and their partnership situation such as coordinating retirement with their spouses (Ehrlich et al. 2020).

Social inequalities in retirement transitions stem from structural labor market constraints and welfare state institutions facilitating early retirement, though interacting with individual-level heterogeneities in late careers (Ebbinghaus and Radl 2015; Mäcken et al. 2022). Economic crises, globalization, and rising labor market uncertainties have been identified as the main drivers of massive early retirement in the 1970s and 1980s, mainly affecting male blue-collar workers (Blossfeld et al. 2011; Ebbinghaus 2006). Public benefits for unemployment and disability were used as socially peaceful tools to discharge older industrial workers from the labor force. Recent policy shifts toward active aging 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 (Turek and Henkens 2023; Hofäcker et al. 2016).

Germany is a quintessential case deserving attention due to its recent precipitous shift from early to late retirement. The employment rate of older workers aged 55 to 64 increased from 46.2 percent in 2000 to 77.1 percent in 2019 for men, and even more dramatically from 28.7 percent to 68.4 percent for women (see Table 1). Alongside the Netherlands and Hungary, this was among the steepest rises in late-career employment in Europe since the European Union's Lisbon Agenda set activation targets in 2000 (Ebbinghaus and Hofäcker 2013). This upward trend has been steady even despite multiple economic shocks from German reunification in 1990 and the Great Recession, following various reforms aimed at older workers' activation (Hess 2016). Relevant changes include major pension and labor market reforms implemented to close down various early exit pathways since the late 1990s, thus offering a prototypical case for studying the interaction between path-shifting institutional changes and individual life course patterns (Mayer 2009).

Moreover, Germany provides a unique context to compare the impact of the sudden system change with unification in 1990, and the subsequent convergence but also remaining regional differences between the new federal states in the East compared to West Germany, with higher unemployment rates until today, use of early retirement in the 1990s, and higher female employment rates. A related and notable development is the substantial reduction of (West) Germany's gender-employment gap due to policies reconciling work and family (Zoch and Heyne 2023). Consequently, German women's employment in later life rose from an average level in 2000 to one of the highest within two decades (see Table 1), although more than half of working women aged 55 or over are still in part-time jobs (Eurostat 2025).

Germany's active aging strategy has likely impacted social inequalities in retirement transitions because reforms phased out public benefits that had offered early retirement pathways for mainly those with lower skills and long working careers. However, the changing later–life dynamics and inequalities after such radical institutional and structural changes are still not well understood. This is partly due to data limitations of existing studies, relying on panel surveys spanning over 10 to 15 years that typically allow a 10-year longitudinal analysis of a five-year cohort (e.g., see Baumann and Madero-Cabib, 2021; Fasang, 2010; Worts et al., 2016). Such annual surveys do not reveal life trajectories with sufficient granularity and only cover retired cohorts up to the 2000s. A few studies based on register data focus on a narrow birth cohort, which cannot analyze the interaction between long-term societal transformation and

Table 1. Changes in employment rates, age 55–64, 2000–2019.

	Male			Female		
	2019	2000	Diff (%p)	2019	2000	Diff (%p)
Germany	77.1	46.2	30.9	68.4	28.7	39.7
Netherlands	78.3	49.9	28.4	61.2	25.8	35.4
Estonia	69.1	47.6	21.5	74.3	39.9	34.4
Hungary	69.3	33.0	36.3	46.1	13.0	33.1
Belgium	57.3	35.1	22.2	47.0	15.4	31.6
Italy	64.6	40.3	24.3	44.6	15.2	29.4
Austria	63.1	41.4	21.7	46.0	17.8	28.2
Finland	64.8	41.8	23.0	68.6	40.7	27.9
Spain	61.1	54.7	6.4	46.9	20.0	26.9
Ireland	69.9	62.9	7.0	53.9	27.1	26.8
France	55.5	32.9	22.6	50.9	26.1	24.8
Denmark	75.8	61.9	13.9	66.9	46.2	20.7
United Kingdom	70.9	59.8	11.1	61.9	41.4	20.5
Poland	61.0	37.4	23.6	39.0	21.8	17.2
Switzerland	79.4	77.0	2.4	66.6	50.1	16.5
Sweden	79.8	67.0	12.8	75.6	61.7	13.9
Norway	76.8	71.9	4.9	68.7	59.3	9.4
United States	69.8	65.7	4.1	58.0	50.6	7.4
Greece	56.1	55.7	0.4	31.6	24.8	6.8

Source: Eurostat LFS Series. OECD Annual Labor Statistics for the US data. Diff means percentage point difference between 2019 and 2000.

retirement patterns (Riekhoff 2019; Riekhoff and Järnefelt 2018). Today, we have multiple data sources including surveys and administrative records that enable tracing individuals' life histories with more precision for larger cohorts including the most recent retirees.

For our study, we profit from the Data Center of the German Pension Insurance (FDZ-RV) which provides administrative pension insurance records linked with social surveys that allow a rich analysis of socio-demographic differences in life course patterns up until 2022. With such data, our study addresses two main questions. First, we explore the dynamics of social stratification in retirement transitions from the 1980s to 2019 (the most recent year prior to the COVID-19 pandemic): have retirement trajectories changed in line with the reform directions and rapid macro-social transformations in Germany? Specifically, we focus on social inequalities: has there been any convergence across social groups following the closing down of early retirement pathways and the promotion of female employment? Second, we explore how different work-retirement trajectories are linked with post-retirement outcomes: given the significance of life course in shaping old-age inequalities (Fasang and Mayer 2023), to what extent do later-life trajectories explain inequalities in pensions?

To address these questions, we study late working lives and retirement trajectories across three decades, distinguishing five cohorts in Germany born between 1925 and 1954 whose ages between 51 and 65 spanned from 1976 to as late as 2019. We track the whole trajectory of each individual's working and non-working statuses over the 15 years of late working life, as we define retirement as a gradual and longitudinal process rather than a one-time event, following recent trends in retirement research (Fasang 2010; Baumann and Madero-Cabib 2021; Riekhoff 2019; Worts et al. 2016). For empirical analysis, we combine sequence and cluster analyses to compare seven typical trajectories in the transition from work to retirement in Germany, showing the importance of East–West differences, educational background, and gender differences for several cohorts over time. Based on these seven clusters, we explore pension income penalties among the six clusters diverting from the "standard" full-time work trajectory with a set of regression models. For this

purpose, we analyze the SHARE-RV, a linked dataset of administrative pension insurance records and the German subsample of the Survey of Health, Aging, and Retirement in Europe.

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 has been some convergence in retirement trajectories between East and West Germans since reunification. We also find that differences in retirement trajectories significantly explain variations in pension income, net of socio-demographic characteristics and earlier 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.

Retirement research and recent trends in Germany

Recent trends in retirement research

From a conventional life course perspective, retirement is viewed as the "institutionalized" third stage in modern societies, assuming a tripartite partition into education, working life, and retirement phases (Kohli 2007). In this framework, retirement is defined as a transition between two chronologically ordered life stages—from one fully dedicated to employment to the next, described as a permanent exit from work and subsequent pension receipts during old age. Retirement transitions are thus often measured by identifying the status change between paid work and old–age pension receipt, a one-time event during the life course.

Instead of such a cliff-edge transition, recent research emphasizes the gradual, dynamic, and complex nature of retirement (Turek and Henkens 2023; Riekhoff 2019; Han and Moen 1999; Fasang 2010; Baumann and Madero-Cabib 2021). From a holistic viewpoint, such studies conceptualize retirement transition as a trajectory rather than an event, highlighting sequential complexities during late working life (*differentiation*) and heterogeneity between individual life trajectories (*de-standardization*) (Brückner and Mayer 2005; Fasang 2012). The *differentiation* and *de-standardization* of retirement transitions are closely linked to country–specific institutional features and their evolution.

Until the 1990s, social benefits, including unemployment benefits, pre-retirement programs, and disability pensions, had offered alternative income for older workers before reaching the statutory pension age, functioning as bridge pathways to permanent retirement (Ebbinghaus 2006). More recently, with reversed policy goals of reducing early retirement and promoting active aging in Europe (Hofäcker et al. 2016), more older 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).

Empirical studies from the past decade take these aspects into account and highlight how changing institutional contexts reshape retirement patterns and late-career inequalities. In a comparative study of Germany and the United States spanning three decades from the 1980s to the 2000s, Heisig (2015) shows that the risk of severe income loss following involuntary early retirement steadily increased in line with welfare state retrenchments in both countries, resulting in increased re-employment after career exit, especially in the United States. A similar analysis by Cahill et al. (2015), using different data on older Americans, confirms that early boomer cohorts who retired during the Great Recession were more likely than earlier cohorts to return through secondary jobs after being laid off from their main career positions. While these studies reveal that multiple retirement transitions have become common, their approach remains focused on job loss events and their consequences rather than providing a holistic view of trajectories over the late working life.

In contrast, Fasang's (2010) study employs sequence analysis to demonstrate how overall retirement pathways in Britain and Germany are defined by institutional features. The study tracks individuals' main income sources over a 16-year period in late working life and thereby

shows that female trajectories are structured by the "institutions of family", including spouses' income, part-time work, and widows' pensions. Subsequent studies have adopted this approach, supporting de-standardization and stratification hypotheses by linking retirement trajectories and institutional characteristics in the United States (Calvo et al. 2018) and Finland (Riekhoff and Järnefelt 2018). However, these findings mainly cover the 1990s to the mid-2000s, focusing on one particular cohort.

A more recent study that closely aligns with the aims and contribution of our research is that of Turek et al. (2024). Using cross–nationally harmonized longitudinal surveys from seven high-income countries, they investigate gender and educational inequalities in later–life employment trajectories and how these disparities evolved across three decades of cohorts until recently. Their combination of comparative and longitudinal methods effectively stresses the role of institutional contexts, as well as the persistence of educational and gender inequalities. However, their use of latent class growth analysis, solely based on employment probabilities at each age, does not sufficiently capture the diversity of (non-)employed statuses.

Our study builds on these precursors by examining holistic later–life trajectories and their stratification over an extended time span. We thereby contribute to a deeper understanding of the interplay between institutions, changes in life course across cohorts, gender differences, and social inequalities, because pluralized life–course patterns in old age are not only shaped by institutional contexts but also reflect social advantages and disadvantages accumulated during earlier phases (Fasang and Mayer 2023). Although we adopt an approach similar to Fasang (2010), we exploit more granular and up-to-date data. Our design also differs from Turek et al. (2024) since we analyze more nuanced aspects of diverse labor market and benefit statuses, which are particularly useful for illustrating stratified life courses by gender and SES in addition to contextual differences between East and West in Germany.

Welfare reforms in Germany

Given our analytical focus, understanding institutional and macro-structural transformations in Germany is crucial for two reasons. Firstly, institutional arrangements, in particular pension systems and labor market policies, offer financial opportunities and enforce structural constraints affecting retirement transitions. These arrangements are also likely to affect late-career outcomes differently, depending on individual characteristics including gender, education, occupation, health, and family situations (Radl 2013; Worts et al. 2016; Carr et al. 2018; Mäcken et al. 2022). 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 and the Great Recession could reorient individual choices, thereby changing retirement patterns. Therefore, historical and geographical contexts should be taken into account when analyzing the social dynamics of life trajectories (Fasang and Mayer 2023).

In Germany, retirement is primarily shaped by its dominant "Bismarckian" public pension insurance, which mandatorily insures most employees (with contributions paid by employee and employer), while civil servants and free professions have different systems, and it is only voluntary for many self-employed. The public pension is 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, though major reforms cut its value. While there is no legal age of mandatory retirement in Germany, the actual retirement age has been historically determined by the statutory pension age as typical employment contracts terminate at this point, and working pensioners were rare before the 2000s. Moreover, early retirement options and special pre-retirement benefits for older workers have led to earlier withdrawal from work (Börsch-Supan and Schnabel 1998). 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 benefits and special pre-retirement options at age 60 (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 could retire at 55 through an old–age transition option to ease the transition shock from a socialist to a market economy with sudden mass unemployment.

Since the 1990s, Germany has experienced massive transformations due to unification and globalization, which led to concerns over demographic aging 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 age 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 and benefits were reduced. Furthermore, the overall benefit generosity in the defined-benefit system has been reduced gradually after a series of reforms that introduced a demographic factor and readjusted other indexation rules, while also fostering voluntary private saving schemes (Ebbinghaus et al. 2011; Hess 2016). Pension incomes have also become subject to taxation at least partially or fully since 2005. The statutory pension age has been increasing gradually from 65 for those born in 1947 up to 67 for those born in 1964 or later. However, since 2014 early pension withdrawals without reductions 2 years prior (*Rente mit 63*) were allowed again under the condition of 45 contribution years.

Labor market policy reforms implemented in the post-unification period were oriented towards the same direction of activation, though gaining momentum in the early 2000s. Part of the so-called "Hartz" reforms, a package of labor market policies aimed at deregulating existing 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 unemployment benefits (*Arbeitslosenhilfe*) into the means–tested social assistance (*Sozialhilfe*). For older workers, this meant that reduced (earnings-related) benefits, exploited after exhausting the standard benefit before pension receipt, were no longer accessible. The maximum duration of the standard earnings–related benefits, the first of the restructured (two-tiered) unemployment benefit system, was cut from 36 months to 15 months for those aged 50 or over and to 18 months for those aged 55 or over (Hess 2016).

Following these major pension and labor market reforms, employment and activity rates among older workers have increased remarkably since the 2000s (Ebbinghaus and Hofäcker 2013; Hess 2016). However, it is less clear whether these institutional changes intensified or reduced labor market stratification. The mentioned reforms might homogenize late-career trajectories as pre-retirement benefit cuts mainly affected medium– or low–skilled older workers, and the impact of the Hartz reforms on labor force participation was more pronounced among women (Ehrich et al. 2018). In contrast, there are signs that inequalities have risen due to labor market restructuring. Evidence suggests that, while unemployment declined following the Hartz reforms, this is primarily explained by reductions in job separation rather than improved job finding among those already unemployed, implying outsider disadvantages (Hartung et al. 2018). Low-educated workers who increasingly retire later mainly stay in precarious jobs motivated by financial pressures (Hess 2017; Hofäcker and Naumann 2015). Furthermore, part-time work has been a strong driver of the activation of married women. Overall, we expect that stratified patterns and outcomes would be more visible among recent cohorts who entered their late working lives in the mid-2000s or later, given the incremental nature of the reforms.

Socioeconomic 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 due to delayed progress in East German regions, with unemployment levels nearly double as high as in the West (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 job losses during the Great Recession (Dustmann et al. 2014). Meanwhile, women's education levels and labor market participation have gradually increased over time, resulting in partial homogenization of careers between women and men (Brückner and Mayer 2005).

These structural transformations in the past three decades are likely to have altered labor market constraints on late careers, especially among lower-SES groups. Birth cohorts that 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. During this transition period, early retirement was even more accelerated through a temporary old-age program for East German employees facing plant closure or downsizing. In contrast, more recent cohorts enjoying the economic rebound might have displayed 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 have withered away with gradual economic integration.

Gendered retirement trajectories are anticipated to show more complicated dynamics, as typical life courses among women in the East and West were already dissimilar before reunification. On the one hand, West German women tend to have engaged in part-time and flexible careers or stayed as homemakers to take care of children, though their career trajectories have gradually converged with those of men. On the other, East German female employment trajectories resembled those of men, yet women in the East were allowed to retire five years earlier than men. 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 the mentioned welfare state reforms and socioeconomic transitions to influence 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 socio-demographic variables

The main data source for this study is the SHARE-RV, administrative pension records from the German Pension Insurance (*Deutsche Rentenversicherung*: RV) linked with the German subsample of the Survey of Health, Aging and Retirement in Europe (SHARE), a survey of older people aged 50 and older (FDZ-RV and MPI für Sozialrecht und Sozialpolitik 2022). The full SHARE-RV sample includes 4,482 respondents who participated in any of the nine SHARE waves and consented to the linkage of their RV pension records. Since the linkage sample does not provide its own weighting, we restricted our analytical sample to individuals who participated in the 2013 wave (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 (at age 51) from 1976 (for the earliest cohort) to 2005 (for the latest cohort), resulting in 2,765 respondents.

The dataset contains both time-invariant and longitudinal information for each respondent. The time-invariant variables are socio-demographic characteristics, including cohort, gender, education, region, partner status, number of children, occupation, years of prior work (until age 50), and expected pension income in 2022 (see Table 2). When extracting these variables, we prioritized those from RV over the SHARE survey, as the former is based on more recent 2020 insurance data, and administrative records are in general more accurate than self-reports. However, we use survey data to supplement missing information in RV—in particular, education and number of children are extracted completely from SHARE because the equivalent RV variables contain high shares of missing values. Occupation is also obtained exclusively from

Table 2. List of time-invariant variables.

Variable name	Definition	Source
Cohort	Categorical variable that involves five groups of birth cohorts. The oldest group is a ten-year cohort born from 1925 to 1934 due to its small sample size. The remaining 20-year cohorts born between 1935 and 1954 are split into four and five-year cohorts.	RV
Gender	Dummy variable. (Male = 0; Female = 1)	RV
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 residence was in the former East Germany in 2020.	RV
Partner status	Dummy variable indicating whether the respondent was living with a married or civil partner.	RV & SHARE
Number of Children	Continuous variable. Top-coded for four or more children.	SHARE
Occupation	Categorical variable of the respondent's main career job based on the International Standard Classification of Occupations (ISCO). The variable contains 848 missing cases (weighted percentage = 32.0) 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. The calculation is based on one's total personal earnings points accrued until 2020. Personal earnings points were multiplied by the pension value per point (EUR 36.01) in 2022. Earnings points are top-coded to seventy four, the share of which was 2.8 percent (weighted). Missing values (N = 118, 4.2 percent of the sample) were imputed using the sum of accrued earnings points in the East and West regions.	RV
Years of Work (before age 51)	Total months of full employment or self-employment between the year one reaches age 14 and the year one reaches age 50, divided by 12.	RV

Note: RV means the administrative data (*Deutsche Rentenversicherung*) measured at the time of pension request. SHARE means the Survey of Health, Aging and Retirement in Europe, surveyed in 2013 (Wave 5).

SHARE (despite a 32 percent missing rate), as it is unavailable in RV data. An exception is partner status, where both the RV and SHARE Waves 5 (2013) and 7 (2017) are utilized. To incorporate the most up-to-date information, we use the RV data as the baseline and imputed missing observations first with Wave 7 and then with Wave 5 data. While some of these time-invariant characteristics, including partner status and occupation, may change over time for certain individuals, our data structure does not allow us to identify these changes over the entire period.

Table 2 summarizes the concept and measurement of each time-invariant variable (in addition, Table A1 in Appendix 2 presents descriptive statistics for our SHARE-RV sample in comparison to the full SHARE Wave 5 sample). We do not find evidence of concerning selection bias due to non-consent to data linkage, as most variables display similar distributions between the SHARE-RV and Wave 5 samples. Small but noticeable differences are found in the distributions of cohort and education level: the oldest cohort and the low-educated group are underrepresented in SHARE-RV

Figure 1. Longitudinal data structure: observation period by age and cohort.

compared to the full sample. Lower rates of consent to record linkage in these groups may be attributed to higher mortality among older and lower-educated groups, as linkage consent was later than 2013 for part of the SHARE sample. Table A2 shows that the underrepresentation of the low-educated group is concentrated within the oldest cohort, consistent with this interpretation.

Defining late working life states

The RV administrative data provides the respondent's *social income situation*, a categorical variable of one's monthly status of employment, education, childcare, and social benefit receipt classified into sixteen qualitative states (for the original classification, see Appendix 1), provided between the ages of 14 and 65. We reconstructed this variable into nine states that we consider meaningful to capture individual work-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 180-month period from January of respondents' fifty-first year from birth to December of their sixty-fifth year from birth. For instance, the oldest cohort born between 1925 and 1934 entered their first month of observation (January) between 1976 and 1985 and reached the final month (December) between 1990 and 1999. Likewise, the first month of observation for the latest cohort (1950–1954) was between 2001 and 2005 and the final month was between 2015 and 2019.[1] Among the five groupings, those born between 1935 and 1939 belong to the "transition cohort", as their late working lives were most directly exposed to the socioeconomic transitions related to reunification. More recent cohorts were gradually affected by the economic rebound and the stepwise reform implementation, while the latest cohort may have also been affected by the Great Recession. The longitudinal data structure by age and cohort is illustrated in figure 1.

While the re-coding of the longitudinal variable was primarily based on the RV's *social income situation* records, the Job Episodes Panel (JEP) of SHARE was also utilized to obtain some non-existing information in the RV. The JEP is a yearly panel dataset generated from SHARELIFE, a retrospective survey on life histories in Waves 3 and 7 of SHARE (Brugiavini et al. 2019).[2] We first duplicated each yearly observation in JEP twelve times to match with the monthly RV panel structure.[3] We then identified individuals who worked part-time or switched between full-time and part-time work within the same job spell reported in JEP and labelled them as "employed in part-time or flexible jobs (PT)". This is because RV's *social income situation* variable does not specify working hours in gainful employment status. Those recorded as "marginally employed (earning less than 400 Euros per month)" in the administrative data were also classified as PT (see Appendix 1 for details).

Similarly, "partial work & pension receipt (PENw)" is differentiated from "full retirement (PEN)" based on self-reported employment in the JEP survey while receiving pensions, because RV's biographical data does not indicate whether respondents receiving old-age pensions also had additional income from paid work. Therefore, the states of PEN and PENw 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 RV data on *social income situation* recorded as missing or "others": about every fourth person-month cell fell into these categories (about 22 percent were missing, 3 percent were "others"). We assume that most of them are non-employment statuses without identifiable reasons since the administrative record captures all recognizable employment and benefit statuses. However, a sizeable share of them also includes tenured civil servants, the self-employed, and those in foreign residence who were not obliged to be insured by RV. After imputing those cells using JEP data, the remaining share of "others/missing (M)" dropped to 7.3 percent.[4] (see Appendix 1 for further details).

Sequence analysis and cluster analysis

Our analytical strategy consists of three stages. In the first stage, we use 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 in event history analysis (Aisenbrey and Fasang 2010; Abbott 1995). 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, timing, and frequency within the sequence.

In order to classify diverse and complex trajectories into several clusters, we must define and measure (dis)similarities between sequences. We used 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 into 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 based on transition rates between two different states to address concerns that cost assignment could be arbitrary (Fasang 2010). Nevertheless, we use theoretically defined substitution costs with the insertion/deletion cost as one, rather than the data-driven method. A high transition rate between two states does not necessarily mean that the two are functionally close in distinguishing working versus non-working 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 A3 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 highly similar to one produced by the "mechanical" OM that defines all substitution costs as two and the insertion/deletion cost as one.

Therefore, we construct a matrix of substitution costs between states (see Table A4), based on whether respondents were in paid work or not. 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. This is because in the German context, 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. 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 treat "missing/others (M)" as a non-working state here because most gainful employment is identified in the administrative record and the JEP survey. One exception is that the substitution cost between PEN and PENw is assigned as one, since the two states can be considered similar functionally and conceptually.[5]

The distance matrix calculated by the OM algorithm based on our cost specification 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 is sensitive to the starting point. The number of clusters was then selected based on widely known cutoff criteria, including the average silhouette width (ASW), point biserial correlation (PBC), and Huber's C (see fig. A1).

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).[6] 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 (Studer and Ritschard 2016; Fasang 2010). As we elaborate in Appendix 2 (see figs A2, A3, A4, A5, and A6), 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 by gender, education, and region. The models are specified as follows:

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

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

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

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 are more dissimilar among women between East and West Germany than among men.

Late working lives and pension income penalties

In the final stage, we investigate the extent to which the patterns of late working lives matter in explaining pension income differences. We regress expected pension income in 2022 on the seven clusters of retirement trajectories while controlling for relevant socio-demographic factors, and in stepwise models also for years of work (until age 50) and occupation types. Our ordinary least squares (OLS) estimation is specified as follows:

$$\mathrm{Pension} = \alpha + \beta\mathrm{CL} + \gamma_1\mathrm{SD} + \gamma_2\mathrm{yrswork} + \gamma_3\mathrm{occupation} + \varepsilon \tag{4}$$

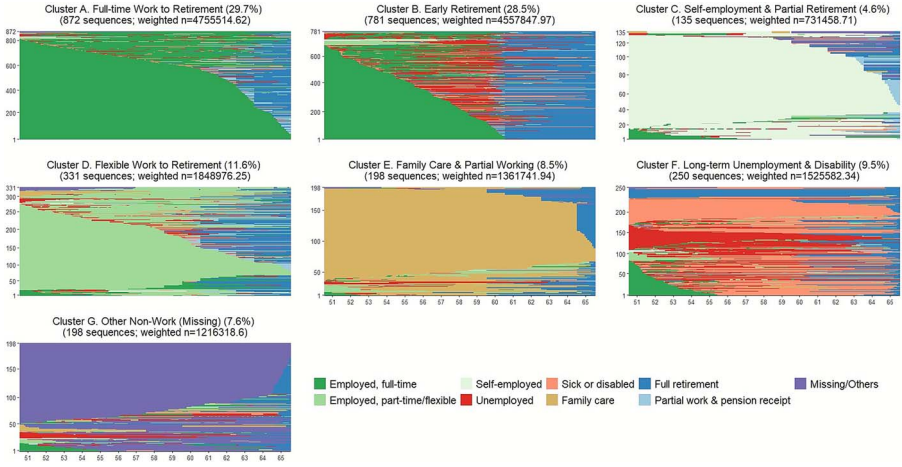

Figure 2. Sequence index plots of seven clusters of retirement trajectories in Germany across birth cohorts 1925–1954.

CL is a categorical variable indicating the set of clusters drawn from the sequence and cluster analyses, excluding the reference cluster. SD indicates the same vector of socio-demographic variables as in Models (1)–(3) but also includes cohort dummies. ε denotes the error term in the model. Estimated standard errors in this model are heteroscedasticity-consistent.

The vector of regression coefficients β captures pension income penalties among non-standard clusters in comparison to the reference cluster, net of relevant individual characteristics. However, note that estimates from this model are associational and unable to establish causality, and thus our interpretations implying relevant causal mechanisms are theory-based. Finally, as a substantial share of the occupation data is missing, we conduct a supplementary analysis comparing models excluding the occupation variable between the full sample and a subsample with individuals without missing observations.

Results

Patterns of late working lives in Germany

The first step in our analysis is identifying typical patterns of late working lives drawn from sequence and cluster analyses. All three measures for cluster evaluation consistently indicate that the seven-cluster solution is optimal, where ASW and PBC are locally maximized and Huber's C is minimized (see fig. A1). Figure 2 displays sequence index plots for the seven typical patterns of late working lives. In each plot, one horizontal line represents a sequence of 180 states from January of one's fifty-first year (month 1) to December of one's sixty-fifth year (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 colors. In addition, we provide descriptive statistics in Table 3 for the seven clusters cross-tabulated by cohort, gender, education, and region.

Cluster A includes the most standard type of trajectories described 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 ages 62 and 65, mostly after the earliest pension age of 63. Although some disruptions through unemployment and sickness/disability are observed between employment spells, they are short-lived. This cluster is therefore labeled as "full-time work to retirement" and set as the reference group in our regression models. It is the largest cluster, accounting for about 30 percent of individuals, though its relative frequency declined among the "transition cohort" (birth years 1935–1939) but steadily increased afterward.

Table 3. Descriptive statistics for seven clusters of late working lives, by cohort, gender, education, and region.

	A. Full-time work to retirement	B. Early retirement	C. Self-employment & partial retirement	D. Flexible work to retirement	E. Family care & partial working	F. Long-term unemployment & disability	G. Other non-work (missing)	N (%)
Cohort								
1925–1934	25.5	31.1	4.2	5.5	16.6	5.4	11.6	323 (16.6)
1935–1939	20.6	39.3	3.7	8.2	9.7	9.1	9.6	462 (18.5)
1940–1944	30.9	32.7	3.2	9.6	9.6	9.3	4.8	586 (21.3)
1945–1949	31.2	27.1	6.2	14.6	4.4	11.2	5.4	624 (19.2)
1950–1954	37.4	15.9	5.5	17.6	4.5	11.6	7.6	770 (24.3)
Gender								
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)
Education								
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	1,586 (56.5)
High	43.9	28.6	6.8	7.6	2.1	4.4	6.6	808 (28.1)
Region								
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)
Total	29.7	28.5	4.6	11.6	8.5	9.5	7.6	100.0

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 in SHARE Wave 5. N values are unweighted, but their percentages are weighted.

Cluster B is the second largest (28.5 percent) including individuals with "early retirement" trajectories who retired already around age 60. Many experienced relatively long spells of unemployment or sickness/disability in their late 50s, utilized as bridge pathways to full retirement. Its share peaked among individuals in the transition cohort who were heavily affected by the economic downturn after reunification, in contrast to the full-time trajectory (Cluster A). Moreover, East Germans are nearly twice as represented as West Germans. Men are also more likely to experience this trajectory, while high-educated persons are less likely to do so than the mid- and low-educated.

Cluster C ("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 occurred 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, higher-educated persons, and West Germans are more likely to sort into this group than their counterparts, while the cluster's proportion in the sample was relatively stable across cohorts with some fluctuations.

Cluster D ("flexible work to retirement") is mostly characteristic among women, low- to mid-educated persons, and those residing in 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. Most of them worked in part-time or flexible jobs and made full transitions to old–age pension receipt between the ages of 61 and 65. Those who retired earlier often experienced short-term disruptions through unemployment or family care.

Cluster E is also highly represented by West German women whose trajectories are primarily characterized as family care with a small number of individuals involved in part-time/flexible employment—therefore labeled as "family care & partial working". Very few men are included, while the low-educated are also highly represented in this cluster much more than the others. The proportion among all respondents was overall 8.5 percent, but the figure had continuously declined over time.

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

Finally, there are about 7.6 percent of respondents in Cluster G whose late-career states are 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 this anticipation, more women and West Germans belong to this group than their counterparts. Moreover, the low-educated and the oldest cohort were more likely to sort into this group than others, though the share of this cluster rebounded among the recent two cohorts.

Social stratification and its changes over time

As a second step, we explore in multivariate analysis the socio-demographic factors associated with each cluster. Figures 3 to 6 show the predicted probabilities of sorting into each cluster across cohorts after controlling for other socio-demographic variables, and how the trajectories are stratified by gender, education, and region (see Tables A5, A6, A7, and A8 for predicted probabilities).

Figure 3 illustrates how gender differences in the predicted probabilities of cluster membership changed across five cohorts. Men were substantially more likely to sort into the standard type (Cluster A) than women, and the difference was relatively stable across all cohorts, though slightly reduced in the latest group. Men also show a higher probability of being in Cluster B (early

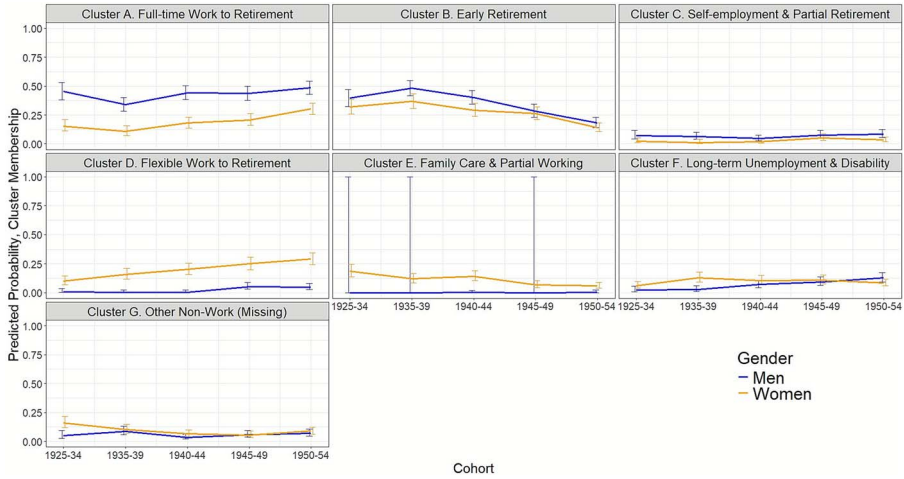

Figure 3. Predicted probabilities of cluster membership, by cohort and gender. *Note*: Figures illustrate multinomial regression results based on Model (1). Control variables include education, region, partner status, and the number of children.

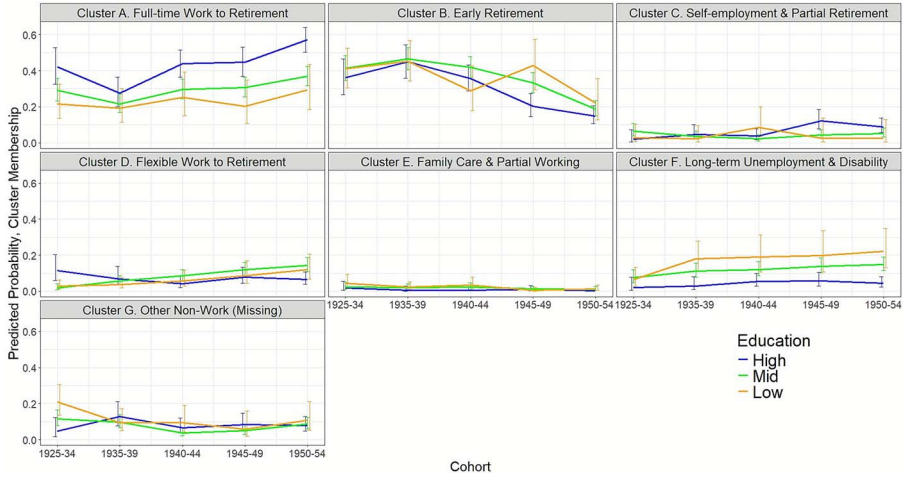

Figure 4. Predicted probabilities of cluster membership, by cohort and education. *Note*: Figures illustrate multinomial regression results based on Model (2). Control variables include gender, region, partner status, and the number of children.

retirement) among the earlier three cohorts, but the difference almost disappeared in the latter two groups. The gender gap in the probability of being in Cluster D steadily increased over time in later cohorts, whereas the gap in Cluster E significantly declined in the latest cohort compared to earlier ones. Meanwhile, gender differences have been relatively trivial in Clusters C, F, and G in most cohorts.

Figure 4 also demonstrates that educational inequalities in retirement trajectories have been relatively persistent over time. High-educated individuals were consistently more likely to sort into Cluster A than the mid- and low-educated. The gaps between the high-educated and the rest were the smallest and non-significant in the transition cohort (1935–1939) but then have continuously widened. The educational gradient in the probability of being in Cluster F is opposite to that in Cluster A, where low-educated persons were more likely to be included than mid- and

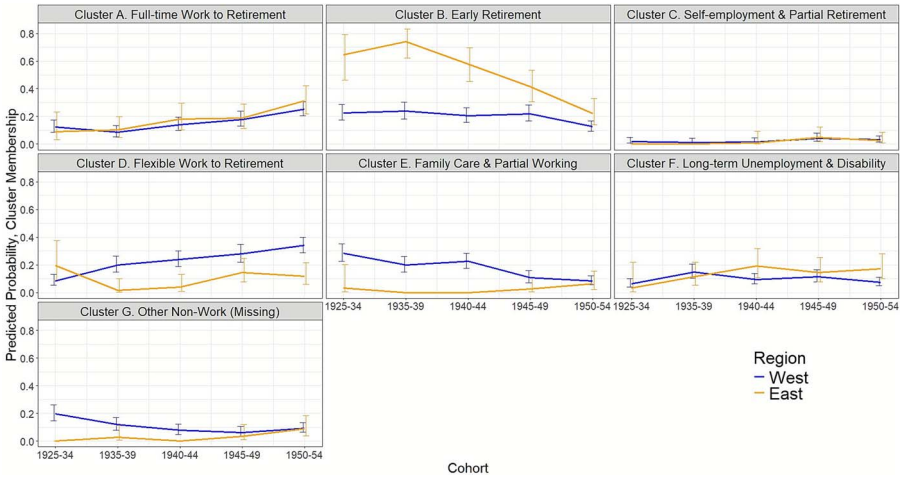

Figure 5. Predicted probabilities of cluster membership, by cohort and region (Female). *Note*: Figures illustrate multinomial regression results based on Model (3). Control variables include education, partner status, and the number of children.

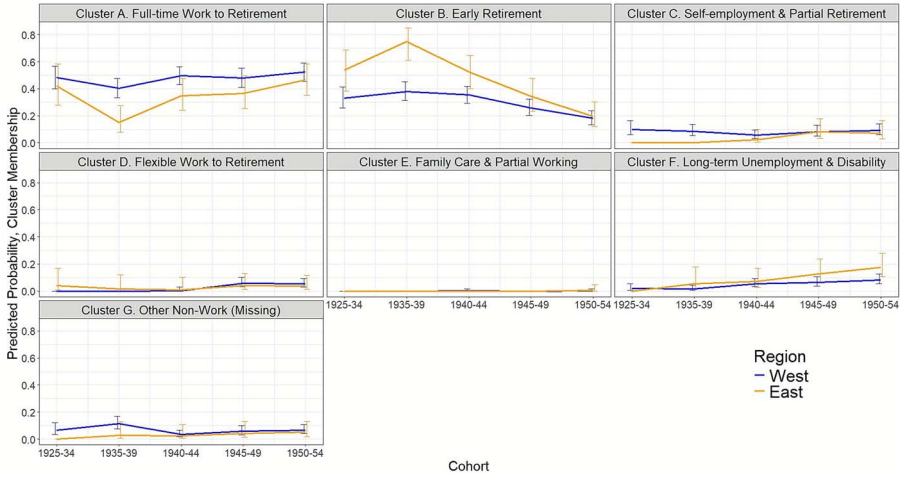

Figure 6. Predicted probabilities of cluster membership, by cohort and region (Male). *Note*: Figures illustrate multinomial regression results based on Model (3). Control variables include education, partner status and the number of children.

particularly high-educated persons except for the oldest cohort. The educational difference in Cluster B resembles that in Cluster F in the 1945–1949 cohort but among the others they were not significant. In Cluster D, the mid– and low–educated groups' representation has increased steadily and eventually surpassed that of the high-educated. The educational gaps in Clusters C, E, and G were mostly not significant. The only negative and significant educational gradient was observed in Cluster G among the oldest cohort.

Figure 5 illustrates differences in women's late working lives between East and West regions. While women's probabilities of being in Cluster A were at similarly low levels in both regions, the figures have been 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 trajectories among

East German women declined sharply, and among the most recent cohorts, the East–West gap narrowed down to about 10 percentage points (see Table A7). 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 have been different. Whereas the chances of being in Clusters E and G among West German women display overall downward trends, the incidence of flexible careers (Cluster D) has been on a steady increase. By contrast, East German women's probabilities of being in the three clusters were relatively flat 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 (fig. 5), figure 6 reveals that men's retirement patterns show some convergence between both regions. Among West German men, Clusters A and B have been the first and second most common types of retirement transitions, respectively, while the latter has become less prevalent among recent cohorts. Among East Germans, the probability of being in standard 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) among East German men surged in the transition cohort but rapidly declined to the level of their Western peers in the latest cohort. In all other clusters, the overall probability of being in each cluster was relatively low in both regions, and the regional gaps were mostly non-significant. A notable pattern, however, is that the chance of being in Cluster F had been on a continuous rise in the East compared to the West, reflecting higher unemployment risks.

Late working lives and pension income after retirement

Our final analysis step explores the pension income consequences of the identified clusters of late working lives. Table 4 presents the OLS regression results of expected public pension income in 2022 on the cluster type, with different sets of control variables. Column (1) shows crude differences in pension income between the reference Cluster A and the other six clusters, based on the baseline model without any covariates. The average monthly public pension income in Cluster A was about 1,597.5 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 below that of Cluster A. In the middle ranks are 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 average pension income differences are likely to be slightly underestimated because about 2.8 percent of pension point values are top-coded in the RV data.

Column (2) displays the result when adding basic socio-demographic controls to the baseline model, including cohort, gender, level of education, region (last residence in 2020), partner status, and number of children. While the sizes of the coefficients corresponding to each cluster are all reduced compared to Column (1), the largest reductions are seen in Clusters D (36 percent) and E (26 percent). The strong attenuation effect implies that substantial parts of pension income differences are explained by socio-demographic divergence in later life, in particular, by gender and education levels.

Columns (3) and (4) respectively show results when including years of work (before age 51) and occupation types as control variables. The models estimate the net effect of retirement trajectories on expected pension income while additionally controlling for two major factors that shape the accrual of public pension points. The adjusted R-squared value jumps remarkably by nearly 30 percentage points between columns (2) and (3), suggesting that the length of career in earlier life (or contribution records) is the greatest factor explaining variation in pension income. Indeed, the contributory earnings-related pension benefit in Germany is closely linked through the point system to the contribution years. Moreover, the estimates for Clusters C to G in columns (3) and (4) are attenuated by over 60 percent compared to column (2), implying that pension income disadvantages in these groups are strongly explained by shorter lengths of lifetime employment and less privileged occupations. It is also important to note that column (4) is

Table 4. Regression results predicting pension income in 2022.

	(1)	(2)	(3)	(4)
(Intercept)	1,597.49***	1,794.16***	1,689.91***	1,717.41***
	(25.65)	(58.01)	(48.23)	(64.83)
Cluster membership (ref.: A. Full-time work to retirement)				
B. Early retirement	−197.25***	−183.67***	−242.84***	−198.11***
	(33.00)	(32.61)	(23.08)	(26.42)
C. Self-employment & partial retirement	−783.43***	−769.00***	−308.21***	−279.27***
	(53.86)	(52.25)	(44.22)	(55.93)
D. Flexible work to retirement	−637.50***	−404.69***	−211.66***	−209.25***
	(40.69)	(43.89)	(35.77)	(38.01)
E. Family care & partial working	−1,064.75***	−786.63***	−228.20***	−187.05***
	(35.37)	(40.24)	(37.66)	(42.71)
F. Long-term unemployment & disability	−565.11***	−444.88***	−259.71***	−215.01***
	(41.48)	(41.37)	(32.64)	(37.59)
G. Other non-work (missing)	−992.72***	−858.95***	−372.63***	−333.64***
	(39.82)	(40.33)	(33.83)	(40.12)
Demographic controls	No	Yes	Yes	Yes
Control: years of work	No	No	Yes	Yes
Control: occupation types	No	No	No	Yes
Adj. R-squared	0.311	0.388	0.680	0.678
N	2,765	2,765	2,765	1,917

Note: *$P < .05$, **$P < .01$, ***$P < .001$. In parentheses are robust standard errors. Demographic controls include cohort, gender, level of education, region, partner status, and number of children.

not directly comparable with the other three models due to its smaller sample size, which results from substantial missing data in the occupation variable. Nevertheless, sensitivity analyses in Table A9 comparing results in columns (1)–(3) with the equivalent models estimated with the same subsample in column (4) yield broadly similar results.

Another caveat is that the average years of work until age 50 differ substantially between clusters, and thus comparing individuals with the same years of work across clusters may sound unrealistic. For example, a hypothetical comparison between Clusters A and E "holding years of work constant" risks linear extrapolation. There are systematic differences in the distribution of employment history between Clusters A and E because career trajectories among women in earlier life are most likely interrupted by family obligations. Few cases in Cluster E are thus directly comparable to those in Cluster A. Therefore, it should be noted that these comparisons are hypothetical scenarios to estimate marginal associations between late-career trajectories and expected pension income.

Discussions and conclusion

In this study, we investigate the typical patterns of late working lives and retirement trajectories as well as their link with pension incomes in Germany. Our findings are consistent with the recent shift from early retirement to active aging, demonstrating a gradual decline in early retirement trajectories replaced by standard work-to-retirement transitions. However, persistent group-level disparities remained stable by education level, where the full-time work to retirement was most 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 full-time work, 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 has been more pronounced in the West. Differences in retirement trajectories are significantly associated with

variations in public pension income, net of relevant socio-demographic characteristics, previous employment records, and occupation types.

Although we see convergence in later life courses between the East and West of Germany, our findings show that social stratification in retirement processes has been largely persistent until recently. Later retirement through standard trajectories has been predominantly enjoyed by high-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 among the low-educated and in the East, suggesting that, for those unable to work until statutory retirement age, this became the next best pathway to retirement after phasing out early exit options. The results indicate that the main drivers of social stratification in retirement patterns are structural forces, including differential opportunities in the labor 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 women's late careers may have been driven by changing educational compositions among later cohorts, more so than the direct effects of welfare state reforms. This interpretation is supported by recent research using decomposition analysis (Riekhoff and Kuitto 2024).

Our analysis of pension income differences also suggests that social stratification in retirement patterns could independently contribute to retirement income inequality, net of other individual characteristics, although our evidence per se is associational. This is likely because public pension benefits in Germany largely reflect lifetime average earnings, and earnings inequality tends to accumulate over the life course and is augmented at older ages (Westhoff et al. 2022). Since we do not take into account private pensions, which are more concentrated and higher among high-income workers with stable careers, the full effect of late working–life patterns on post–retirement income inequality would be even larger than shown for public pensions only. Even public pension income differences in our study are also underestimated due to the truncated coding of public pension points that only affect the top end of the distribution.

One caveat, however, is that our analysis of pension income inequality does not fully factor in earlier life experiences in career and family, which are likely to influence late career trajectories through cumulative (dis)advantages (Worts et al. 2016). Although we take into account lifetime years of work, previous occupations, and number of children, these variables do not capture every aspect of earlier-life trajectories, e.g., young women's part-time careers due to care burdens. Therefore, pension gaps between different clusters of late working lives are subject to omitted variables bias associated with career disadvantages at younger ages. Another limitation of this study is that we cannot distinguish and estimate the exact contributions of institutional and macro-social factors to late-career outcomes, since our focus has been on providing a holistic view of late working lives and their changes over time. Nonetheless, this has been addressed by other recent studies (e.g., Dudel et al., 2023; Riekhoff and Kuitto, 2024).

Overall, our study on retirement and pension income in Germany contributes to the international literature in two ways. First, it enhances the understanding of the interaction between life course and changing societal contexts, including welfare state reforms and socioeconomic transitions. Since the retirement process is a life stage heavily influenced by welfare state institutions, Germany's paradigmatic shifts in pension and labor market policies as well as the dramatic transformation following unification serve as a compelling case for studying how life course patterns respond to major changes in these macro-social conditions. One important implication is that structural constraints tend to matter more for low-SES groups than financial incentives to work longer. This offers a critical lesson for other aging societies pursuing activation through benefit cuts: such policies are likely to exacerbate income inequality while having a limited effect on extending working lives among low-status workers. If anything, those in disadvantaged positions may be pushed into precarious jobs due to financial pressures in later life.

Our second contribution is to the literature on social stratification, by showing a long-term evolution of life course patterns in old age. The retirement process and late working life have gained less attention in stratification research than other relevant topics, e.g., non-standard work, 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 demonstrate not only that the social stratification of retirement trajectories is long-lasting under changing institutional and structural conditions, but also that it has tangible implications for income inequality after retirement. These effects could be even larger when considering the more recent trend toward private, funded pensions that tend to reproduce inequalities more than public pensions.

Endnotes

1. While some individuals work beyond age 65, RV does not provide biographical data beyond this point. As the administrative record is based on 2020 data, pension points for some respondents in the most recent cohort may not reflect the finalized value. However, those are few cases unlikely to cause a meaningful bias.
2. We used an imputed version of JEP provided by Rowold (2024) that addresses missing information in the JEP's *situation* variable by filling in family care status. Her coding procedure significantly reduces the share of missing person-year cells, especially for German women, whose percentage of missing observations declines from 12.4 percent to 1.1 percent. For German men, the reduction is from 2.9 to 1.3 percent.
3. Although not fully accurate, matching yearly observations with monthly data should not cause serious bias in capturing the holistic retirement trajectory, since it mainly affects 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.
4. Large shares of the imputed states were family care (about 23.9 percent), full-time employment (18.9 percent), and self-employment (12.7 percent).
5. Moreover, there might be some measurement errors when differentiating PENw from PEN based on self-reported employment status by matching the yearly JEP observations with the monthly RV.
6. The DHD technique uses time-dependent substitution costs derived from transition rates between two states at each time point without operating insertion or deletion.

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None declared.

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