Job Loss and Retirement*

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Abstract

This paper provides the first evidence of the long-term effects of job loss on age at retirement, pension benefits and lifetime income. Exploiting plant closures and using German administrative data, I compare displaced workers with similar non-displaced workers. I show that displaced workers delay their retirement in response to the shock and ineligibility for early pension claims is the main driver of this response. Despite adjustments in retirement behavior, displaced workers face significant losses in pension benefits and lifetime income. Compared to similar non-displaced workers, displaced workers experience losses in the present discounted value of their lifetime income of 26%.

Keywords: job loss, plant closure, retirement
JEL codes: J18, J26, J63, J65

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1 Introduction

Job loss is a persistent negative career shock that affects many workers. In the US, for example, around 8.6 million workers involuntarily lost their jobs between 2019 and 2021 (US Bureau of Labor Statistics 2022).[1] A number of studies establish that displaced workers experience significant reductions in earnings and employment (e.g., Jacobson et al. 1993; Couch and Placzek 2010; Schmieder et al. 2023).[2] However, there is little evidence of the long-term impacts of job loss, as most studies follow individuals for no more than 10 to 15 years after the event. In particular, we do not know how job loss influences retirement, pension benefits, and lifetime income. This gap is notable, as job loss may not only lead to substantial income losses during working life, but also to reduced pension benefits. For some workers, this may increase the risk of old-age poverty, a major issue given increasing life expectancy and reduced pension replacement rates.

In this paper, I shed light on two key questions: first, do displaced workers adjust their retirement behavior in response to the job loss? Second, how large are the lifetime costs associated with job loss? Answering these questions is challenging, as there is little comprehensive data to track workers from job loss until retirement. To make progress, I leverage German administrative data spanning over more than 40 years, which allow me to analyze how job loss among young and middle-aged workers affects their retirement decisions and assess its full lifelong impact. This contrasts with work that thus far examined the short-term impacts of job loss on workers close to retirement (Chan and Huff Stevens 2001; Chan and Stevens 2004; Merkurieva 2019).

I begin my analysis by investigating the long-term impact of job loss on retirement. To do this, I use social security data and leverage quasi-exogenous variation in job loss due to plant closures. I identify young and middle-aged workers who have been displaced and match them with observably similar non-displaced workers. This allows me to compare the retirement behavior of displaced workers with that of otherwise similar workers who did not experience job loss.

I show that workers who lose their jobs delay their retirement. Between the ages of 60 and 64, displaced workers are about 4 percentage points (pp) (10%) less likely to be retired compared to similar non-displaced workers. This delay in retirement is equally driven by extended periods of employment and unemployment, with displaced workers being about 2 pp more likely to be employed and 2 pp more likely to be unemployed. The delay in retirement is similar for men

[1] 3.6 million of the 8.6 million were workers with more than three years of tenure (US Bureau of Labor Statistics 2022).

[2] Throughout the paper, I refer to displaced workers as high-tenured workers who lose their jobs.

and women but it is only observed among earlier birth cohorts. As statutory retirement ages have increased over time, these earlier birth cohorts had more flexibility in their retirement timing, giving them a greater margin to adjust. After the age of 64, there is no longer a difference in the retirement probability between displaced and non-displaced workers. Most workers in my sample can only retire early between the ages of 60 and 64 if they meet certain eligibility criteria (e.g., a specific number of contribution years). However, in most cases, they still have to accept pension deductions. After the age of 64, workers are entitled to their full pension, and the requirements for pension claiming are less stringent, requiring only five contribution years.

The delay in retirement among displaced workers suggests that displaced workers retire later to avoid the financial penalty and/or to meet less stringent eligibility criteria. I provide evidence that the latter is the primary driver. To evaluate the role of the two mechanisms – lack of pension benefits eligibility and financial incentives – I complement my analysis with administrative pension data. This dataset provides detailed information on the complete contribution history of each worker, allowing me to observe the amounts and eligibility of the pension benefits. First, I examine the effect on pension benefits eligibility. I show that displaced workers are about 9% less likely to qualify for pension benefits between the ages of 60 and 64 compared to matched non-displaced workers. This difference in eligibility accounts for roughly half of the gap in the retirement probability between displaced and non-displaced workers.

Second, I asses the role of financial incentives and show that they play a less important role. Financial incentives for retirement are influenced by a worker's cumulative income and their wage income near retirement. A substantial reduction in cumulative income is expected to decrease retirement incentives, as the negative wealth effect increases the need for additional income. In contrast, a reduction in wage income near retirement is expected to increase retirement incentives, as a lower wage income compared to potential pension benefits implies a high pension replacement rate and thus relatively low opportunity costs of retirement. I show that, compared to non-displaced workers, displaced workers experience significant cumulative income losses, but there is no impact on the pension replacement rate. Together, financial incentives explain only about 1% of the gap in the retirement probability between displaced and non-displaced workers. Overall, this provides suggestive evidence that the lack of pension benefits eligibility rather than financial incentives is the main driver mediating the impact of job loss on retirement.

In the second part of the paper, I quantify the losses in pension benefits and lifetime income. First, I show that although displaced workers delay their retirement, they still face losses in annual pension benefits of approximately €1,600 (13%). Put differently, this is equivalent to roughly 1.5 months of pension payments. The losses in pension benefits are similar in proportional terms for men and women, but smaller for earlier birth cohorts, who are responsible for the delay in retirement.

Second, I show that displaced workers experience large losses in lifetime income. Displaced workers experience a reduction in the present discounted value (PDV) of income of about €138,000 (26%) relative to the non-displaced counterfactual. Lifetime income losses are larger for women than for men in proportional terms, driven by larger post-displacement earnings losses for women. To assess the role of delayed retirement in mitigating the lifetime losses, I construct a counterfactual income scenario using non-displaced workers. The analysis reveals that lifetime income losses would increase by only 2 pp without delayed retirement. This finding shows that delaying retirement cannot offset the significant costs of job loss, which are predominantly driven by substantial reductions in post-displacement earnings.

The results of this paper relate to two strands of literature. First, this paper shows that job loss leads to substantial lifetime costs. As such, it improves our understanding of the long-term effects of job loss and relates to a large body of work that examines the impacts of job loss. Prior research has shown that job loss leads to large and long-lasting earnings losses (e.g., Couch and Placzek 2010; Lachowska et al. 2020; Jacobson et al. 1993), higher job instability (Jarosch 2023), higher incidence of future job losses (Stevens 1997, 2001), and more severe losses during economic downturns (Davis and von Wachter 2011; Schmieder et al. 2023). Most closely related within this literature are studies that examine the effects of late-career job loss on workers' retirement decision. These studies document that job loss later in life leads to significantly lower re-employment probabilities (Chan and Huff Stevens 2001) and earlier retirement (Chan and Stevens 2004; Merkurieva 2019).[3] Another study examining the short-term effects of job loss is Rege et al. (2009), who show that downsizing increases disability pension utilization for up to four years after the event. While these studies focus on the immediate effects of job loss, my research provides the first evidence on its long-term impact on retirement decisions, particularly for young and middle-aged workers. I show that early career job loss leads to later retirement, which complements existing papers on

[3] Chan and Stevens (2004) highlight that, beyond financial incentives, barriers to reemployment, such as age discrimination and high search costs, are crucial for understanding this behavior.

life-cycle differences in the effects of job loss (Salvanes et al. 2024; Ichino et al. 2017). Salvanes et al. (2024) show that job loss influences major life decisions: early-career job loss leads to increased human capital investment, mid-career job loss triggers family-related adjustments, and late-career job loss results in earlier retirement. My findings highlight another dimension: early-career job loss leads to later retirement. I contribute to the job loss literature in two ways. First, I provide new insights into the full extent of the lifetime costs associated with job loss, accounting for changes in retirement and pension benefits. Second, using data over more than 40 years, I provide the first evidence on how job loss affects retirement of displaced workers in the long term.

Next, this paper studies responses in retirement behavior after job loss. Thus, it also relates to a large literature about workers' retirement behavior. A number of theoretical models of retirement decisions focus on different approaches to specify the financial incentive to retire (Stock and Wise 1990; Gustman et al. 1986; Rust and Phelan 1997). More recently, studies take advantage of pension reforms to investigate how changes in statutory retirement ages affect workers' timing of retirement (e.g., Brown 2013; Manoli and Weber 2016; Seibold 2021), as well as how such amendments lead to program substitution effects (Inderbitzin et al. 2016; Geyer and Welteke 2021). While most of these studies exploit quasi-experimental variation in statutory retirement ages to estimate the short-term effects on retirement behavior, I examine how a negative labor market shock impacts workers' retirement behavior in the long term.

The remainder of the paper proceeds as follows. Section 2 describes the institutional setting. Section 3 describes the different datasets and analysis samples. The empirical strategy is described in section 4. Section 5 presents the results and section 6 concludes.

2 Institutional Setting

Key Features of the Public Pension System The German public pension system has a pay-as-you-go scheme and covers most private sector employees. For most retirees, public pension is the most important income source, with income of occupational pensions or individual retirement accounts not playing a major role (Börsch-Supan and Wilke 2004).

There are two types of statutory retirement ages: the normal retirement age (NRA) and the early retirement age (ERA), which depend on the birth cohort, gender, and contribution history of the worker. The NRA is the age at which an individual can claim the full pension. For workers in the analysis samples, whose birth cohort is between 1938 and 1954, the NRA varies between 60 and 65. In general, retirement age has increased over time, allowing earlier cohorts to retire at earlier ages.[4]

In contrast to the NRA, the ERA is the age at which a worker can claim a pension at the earliest point, but only with deductions. Specifically, a 0.3% deduction is imposed for each month a worker retires before reaching the NRA. For example, if a worker decides to go into early retirement two years before reaching the NRA, the pension benefits would be 7.2% less. For workers in the analysis samples, the ERA varies between 60 and 63. In addition to retiring earlier, it is also possible for workers to work beyond the NRA, if an employer agrees to extend their contract. For each month a worker retires after the NRA, a reward of 0.5% is paid.

Depending on workers' pathway into retirement, they have to fulfill different requirements to claim a pension.[5] For claiming a regular pension, the only requirement is to have at least five contribution years (Rentenversicherung 2021b). Early pension claiming has stricter requirements and requires in general more contribution years.[6] If job loss leads to losses in contribution years, displaced workers may face difficulties in retiring early.

Calculation of Pension Benefits Pension benefits are calculated according to a pension formula based on the worker's lifetime contribution history:

$$B_i(R_i) = \sum_{t=0}^{R_i-1} p_{it} \times a(R_i) \times PV,$$

where $B_i(R_i)$ are pension benefits of worker i retiring at age R_i, p_{it} are worker i's contribution points at age t, $a(R_i)$ is the adjustment factor, and PV the pension value.

[4] See appendix table B2 for more information on how the ERA and NRA vary by birth cohort and pathway.

[5] There is more information on the different pathways in appendix B.1.

[6] In Germany, there is an earnings test for pensioners between the ERA and NRA, under which earnings above €450 per month result in reductions to pension benefits. Early retirement while working in a regular job is therefore not attractive.

This formula has three components: the first component is the sum of the contribution points, which is the main determinant of a worker's pension.[7] In Germany, all pension contributions collected throughout working life are taken into account to calculate pension benefits. Pension contributions cannot only be acquired during periods of employment, but also during other insurance periods such as unemployment, sickness, military service, or child raising. The number of pension contribution points is roughly proportional to workers' earnings or replacement payments, but there is a maximum number of points a worker can contribute per year. In general, workers with only a few contribution points will receive a low pension.

The second part of the formula is the adjustment factor ($a(R_i)$), which depends on a worker's age at the time of pension claiming. Workers have to a bear a penalty for claiming early, whereas they receive a reward if they retire after the NRA.[8] The third part of the formula is the current pension value (PV), which translates the adjusted contribution points into euros of pension benefits.

UI Benefits as Bridge to Retirement Many workers do not directly transition from employment to retirement but use unemployment insurance (UI) benefits as a stepping stone into retirement (Hairault et al. 2010; Giesecke and Kind 2013; Inderbitzin et al. 2016; Gudgeon et al. 2023). In Germany, unemployed workers receive about 60% of their last net earnings as replacement payments and job search requirements are very low for older workers. Depending on workers' birth cohort and age, the maximum duration of UI benefits ranged from 18 to 32 months for workers aged 55 or above. During periods of receiving UI benefits, workers continue to acquire pension contributions, which increase future pension benefits and make it attractive to use unemployment as a stepping stone into retirement. However, because UI benefits are lower than earnings, pension contributions made during unemployment will be lower.

3 Data

This paper uses two administrative datasets from Germany to estimate the effect of job loss on retirement and to measure the lifetime costs of job loss. These datasets have several valuable, complementary features. The following sections describe each dataset and the analysis samples.

[7] Contribution points are determined by an individual's income relative to the average income of all insured individuals. For example, a person will receive exactly one contribution point in a year if their yearly income is equal to the average yearly income of all insured individuals.

[8] $a(R_i) < 1$ if a worker retires at the ERA, $a(R_i) = 1$ if a worker retires at the NRA, and $a(R_i) > 1$ if a worker retires after the NRA.

3.1 SIAB

The first dataset comprises a 2% random sample of employment biographies from 1975 to 2021 (SIAB), provided by the Institute for Employment Research.[9] This dataset allows me to follow each worker from the time of displacement until their exit from the labor market. It consists of daily information on all periods in employment covered by social security, all periods of receiving UI benefits, and all periods registered as searching for a job. Each period contains information on the corresponding wages and benefit levels. The wage information is very accurate, as employers have to report wages for social security purposes. However, wages are right-censored at the social security contribution ceiling, so I impute right-censored wages.[10] The dataset also includes a rich set of personal and job-related characteristics, such as gender, education, occupation, and year of birth. Finally, the data allows to identify plant closures, which I use as exogenous job separations.[11]

A caveat is that the data does not include information on pension claims and pension benefits. Therefore, I use the year of labor market exit as a proxy for the year of retirement.[12] In addition to retirement, there are few other reasons why people can exit the dataset, such as becoming self-employed, starting a civil service job, emigrating, or dying. For these individuals, the year of retirement entry is not correctly identified. To avoid misclassification, I exclude workers in the public sector (where transitions to civil service jobs are likely) and deceased workers.

As shown in appendix figure A-1, the data exit rates after job loss are very similar between the treatment and control group, indicating that there is no differential dropout. In addition, results are very similar using an alternative sample that includes only those workers who exit the data specifically due to retirement.[13]

[9] This study uses the weakly anonymous version of the Sample of Integrated Labour Market Biographies (SIAB) – Version 7521 v1 (DOI: 10.5164/IAB.SIAB7521.de.en.v1). This dataset does not include civil servants and self-employed people.

[10] For this imputation and other steps of data preparation, I follow the suggestions in Dauth and Eppelsheimer (2020).

[11] To identify plant closures, I use an extension file that contains information on the type of plant exit (Hethey-Maier and Schmieder 2013).

[12] I allow workers to work in small, irregular employment relationships while in retirement. More specifically, I consider workers as retired if they only work in marginal employment in a given year and have already reached the normal retirement age.

[13] There is more information on this alternative sample in section 5.4.

3.2 VSKT

To complement my analysis, I use administrative pension data, provided by the German Federal Pension Register. I use a 25% sample of individuals with an active public pension insurance account (SUFVSKT), covering those who had an active insurance account between the ages of 15 and 67 at the time of data collection.[14]

The dataset consists of monthly information on all periods of employment, periods of receiving UI benefits, and other insurance periods, such as sickness, child care, care-giving, and military service. Each individual account can be observed from the age of 14. The dataset includes some personal characteristics such as gender and year of birth.

Unlike the SIAB, this dataset contains accurate information on the age of the pension claim, the accumulated pension contribution points, and the pension contribution years.[15] This allows me to calculate each workers' pension benefits. Thus, I use this dataset to examine the effects of job loss on pension benefits and the associated lifetime costs of job loss. However, it lacks information on employers, making it impossible to link plant closures to workers, and workers cannot be linked across the two different datasets.

3.3 Analysis Samples

In my analysis, displaced workers are considered as workers who (involuntarily) separate from their long-term jobs. For these workers, job loss is likely to be unexpected and costly, as they would most likely not have changed jobs otherwise. To focus on this group, I consider workers with at least three years of tenure in the year before job loss ($t-1$). In my analysis, I aim to estimate the long-term effects of job loss. Therefore, I focus on workers aged 35 to 45 (in $t-1$), excluding those closer to retirement.[16] I consider all birth cohorts that can be observed from ages 35 to 66 to be able to identify workers' retirement entry. In the SIAB, this includes birth cohorts between 1943 and 1954. In the VSKT, this includes birth cohorts between 1938 and 1952. In the following, I explain how displaced workers are defined in each dataset. The definitions differ slightly between the datasets due to their specific characteristics.

[14] The main dataset is assembled from 16 years of cross-sectional waves (2002, 2004 to 2018) (SUFVSKT2002, SUFVSKT2004-SUFVSKT2019, source: FDZ-RV).

[15] In the VSKT, the year of retirement is defined as the year in which the worker claims their pension benefits.

[16] The SIAB does not allow identification of job loss at earlier ages for all birth cohorts.

SIAB In the SIAB, I exploit plant closures as quasi-random job losses. A plant closure is defined as an establishment with at least 10 employees that closes between June 30 of two consecutive years.[17] I then define a worker as displaced in year t if he leaves the plant in year t and the plant has a closure in year t or $t+1$.

For each worker, I consider the first displacement, as future outcomes may be influenced by this initial event. To construct a control group of non-displaced workers, each non-displaced worker is randomly assigned a "placebo job loss". I only consider non-displaced workers who are also employed at plants with at least 10 employees and meet the sample restrictions. In both analysis samples, the control group consists of never-treated individuals. Before matching, the sample consists of 1,981 displaced and 59,616 non-displaced workers.[18]

VSKT In the VSKT, I identify job losses through transitions between employment and unemployment, as I cannot link plant closures to workers. Thus, unlike the SIAB sample, which includes individuals who involuntarily lost their job due to plant closures, the VSKT sample captures both voluntary and involuntary job losses. To limit the number of voluntary job losses, I restrict the analysis to high-tenured workers (with at least three years of employment tenure), as job mobility in Germany declines sharply with increasing tenure, making it less likely that many of these workers left voluntarily.

In the VSKT sample, a worker is defined as displaced in year t if he transitions from employment to unemployment between year $t-1$ and t. For each worker, I only consider the first job loss and randomly assign each non-displaced worker a "placebo job loss". I only consider non-displaced workers who fulfill the sample restrictions. Before matching, the final sample consists of $2,291$ displaced and $17,740$ non-displaced workers.

[17] The definition also requires that no more than 40% of the outflow is to one particular establishment (Hethey-Maier and Schmieder 2013). This restriction is to identify "true" closures from those that could be spin-offs of existing plants, takeovers, or ID changes.

[18] The relatively small sample size compared to other studies on the effects of job loss comes from the fact that I have to restrict my analysis to cohorts that I can observe until their retirement.

4 Empirical Strategy

My analysis focuses on estimating the causal effect of job loss on retirement. To estimate this effect, ideally, I would randomly assign job losses to workers. As this is not feasible in practice, I use a setting where high-tenured workers lose their jobs (due to plant closures) and employ a matching procedure to compare displaced workers with similar non-displaced workers. In this section, I describe the matching procedure, the main empirical specifications, and the main identification assumption.

4.1 Matching procedure

Even though a setting where high-tenured workers lose their jobs (due to plant closures) leads to plausibly exogenous events for those workers, there are still observable differences between displaced and non-displaced workers that make comparison difficult. For example, displaced workers tend to be older, less educated, and have lower earnings. These differences may affect retirement choices.

To address this, I employ coarsened exact matching (Iacus et al. 2011, 2012) and match displaced workers with similar non-displaced workers. I match exactly on the worker's age and birth cohort, and coarsely on the worker's cumulative pension contribution points, tenure, age at data entry, education (all measured in $t-1$), and log earnings (in $t-1$ and $t-2$).[19]

Matching exactly on the birth cohort is important for the analysis, as statutory retirement ages vary from one cohort to another. If displaced and non-displaced workers are from different birth cohorts, comparison could be biased due to different retirement rules. Matching on cumulative contribution points and age at data entry ensures that each displaced worker is paired with control workers who have similar contribution histories before the job loss. Finally, matching on tenure and earnings ensures that displaced workers are compared to non-displaced workers with similar work experience and earnings histories. By matching exactly on age and birth cohort, I also ensure that the comparison between displaced workers and matched control workers occurs at the exact same age and calendar year.[20]

[19] There are three education categories in the SIAB: compulsory schooling, high school/vocational training, and college. In the VSKT, I can only distinguish between those with and without a college degree. In the SIAB, I use tertiles of cumulative contribution points, tenure and age of data entry, and quantiles of log earnings. In the VSKT, I use only two groups for all covariates because of the smaller pool of potential control workers.

[20] In an extension, I also control for firm characteristics, specifically firm size and industry (see section 5.4), and the results remain very similar.

The matching procedure creates cells in which displaced and non-displaced workers have identical coarsened characteristics. The matched sample includes all displaced and non-displaced workers in cells containing at least one displaced and one non-displaced worker. Non-displaced workers are weighted to account for the different numbers of displaced and non-displaced workers within each cell.[21] After matching, the SIAB sample includes 1,658 displaced and 13,001 non-displaced workers, and the VSKT sample includes 1,737 displaced and 4,873 non-displaced workers.

Summary Statistics before and after Matching Table 1 and table 2 present summary statistics for the SIAB and VSKT sample before and after matching. The first two columns report statistics before matching and columns 3 and 4 after matching. Before matching, displaced workers are somewhat negatively selected compared to non-displaced workers. They have lower earnings and are less likely to have a college degree. They tend to retire later than non-displaced workers.

After matching, only small differences remain between displaced and non-displaced workers, indicating that the matching procedure works well. By construction, displaced and non-displaced workers are identical in terms of all coarsened covariates used in the matching procedure. After matching, the gap in the retirement age between displaced and non-displaced workers becomes smaller, suggesting that part of the unconditional gap can be attributed to pre-displacement differences in worker characteristics.

Comparison of the two analysis samples shows that the VSKT sample includes a larger share of women and has lower earnings compared to the SIAB sample. Since the SIAB starts in 1975, some variables are left-censored, leading to differences in these variables across the samples.

[21] Each displaced worker is assigned a weight of one. In cells where there are more displaced workers than non-displaced workers, each non-displaced worker receives a weight greater than one. Conversely, in cells with more non-displaced workers, each non-displaced worker receives a weight smaller than one. This matching procedure successfully matches 84% of displaced workers in the SIAB sample and 76% of displaced workers in the VSKT sample to similar control workers.

Table 1: Summary Statistics SIAB

	Before Matching		After Matching	
	Displaced	Controls	Displaced	Controls
	(1)	(2)	(3)	(4)
Age	40.75	40.34	40.72	40.72
	(3.21)	(3.29)	(3.28)	(3.27)
Birth year	1949.38	1948.89	1949.27	1949.27
	(3.45)	(3.50)	(3.51)	(3.51)
Female	0.35	0.37	0.34	0.34
	(0.48)	(0.48)	(0.47)	(0.47)
Education				
Compulsory schooling	0.19	0.17	0.17	0.17
	(0.39)	(0.38)	(0.38)	(0.38)
High school/vocational training	0.75	0.72	0.78	0.78
	(0.43)	(0.45)	(0.41)	(0.41)
College	0.06	0.11	0.05	0.05
	(0.24)	(0.31)	(0.21)	(0.21)
Yearly labor earnings (in 1000s)	38.90	45.20	38.70	39.15
	(21.47)	(29.49)	(21.75)	(23.51)
Job tenure*	8.92	8.70	9.12	9.09
	(4.90)	(4.60)	(5.02)	(5.03)
Experience in employment*	11.90	11.46	11.91	11.81
	(5.33)	(4.83)	(5.48)	(5.46)
Cumulative pension contribution points*	12.15	12.52	12.20	12.10
	(7.46)	(7.10)	(7.78)	(7.71)
Retirement age	60.82	60.28	60.86	60.53
	(5.97)	(6.43)	(5.90)	(6.18)
Observations	1981	59616	1658	13001

Notes: This table displays means and standard deviations (in parentheses) for different variables in the period before the job loss ($t-1$) for the SIAB sample. For the variable retirement age, right-censored observations contribute one observation at age 66 to the sample. Variables marked with * are left-censored in 1975. Columns (1) and (2) show the unmatched sample and columns (3) and (4) the matched sample. Columns (3) and (4) are weighted. Earnings are measured in 2015 Euros.

Table 2: Summary Statistics VSKT

	Before Matching		After Matching	
	Displaced	Controls	Displaced	Controls
	(1)	(2)	(3)	(4)
Age	40.42	39.98	40.36	40.36
	(3.23)	(3.30)	(3.29)	(3.29)
Birth year	1946.04	1944.65	1945.94	1945.94
	(4.44)	(4.30)	(4.44)	(4.44)
Female	0.56	0.48	0.59	0.59
	(0.50)	(0.50)	(0.49)	(0.49)
Education				
No college	0.92	0.89	0.95	0.95
	(0.27)	(0.32)	(0.22)	(0.22)
College	0.08	0.11	0.05	0.05
	(0.27)	(0.32)	(0.22)	(0.22)
Yearly labor earnings (in 1000s)	30.45	34.27	29.99	30.38
	(12.63)	(13.77)	(12.92)	(13.54)
Employment tenure	7.94	9.05	7.94	7.87
	(5.38)	(5.83)	(5.36)	(5.51)
Experience in employment	18.51	18.50	18.50	18.17
	(5.70)	(5.41)	(5.81)	(5.75)
Cumulative pension contribution points	19.26	21.13	19.17	19.37
	(7.23)	(7.28)	(7.46)	(7.39)
Retirement age	62.96	62.46	62.90	62.54
	(2.45)	(2.32)	(2.45)	(2.49)
Yearly pension benefits (in 1000s)	17.01	22.39	16.85	19.25
(at retirement)	(7.88)	(9.17)	(7.87)	(8.69)
Observations	2291	17740	1737	4873

Notes: This table displays means and standard deviations (in parentheses) for different variables in the period before the job loss ($t-1$) (if not stated differently) for the VSKT sample. Columns (1) and (2) show the unmatched sample and columns (3) and (4) the matched sample. Columns (3) and (4) are weighted. Earnings and pension benefits are measured in 2015 Euros.

4.2 Empirical Specifications

This section describes the main specifications and identification assumption used to estimate the impact of job loss. The analyses are essentially based on a simple comparison of (weighted) means of the matched samples.

Retirement Timing To examine the effect of job loss on retirement timing, I use quasi-experimental variation in job loss induced by plant closures (using the SIAB). I match displaced workers to non-displaced workers, which enables me to compare similar workers, with some experiencing the shock and the others not. To show how job loss affects retirement timing, I simply compare the (weighted) means of displaced and matched non-displaced workers. The main specification is:

$$y_{i,k} = \sum_{k=55}^{66} \gamma_k \times \mathbb{1}[\text{Age} = k] + \sum_{k=55}^{66} \beta_k \times \mathbb{1}[\text{Age} = k] \times \text{Disp}_i + \varepsilon_{i,k}, \tag{1}$$

where $y_{i,k}$ is the probability that worker i is retired at age k (an indicator equal to one if worker i is retired at age k and zero otherwise), $\mathbb{1}$ is an indicator equal to one at age k and zero otherwise, and Disp_i is an indicator equal to one if worker i has been displaced. Standard errors are clustered at the worker level.

In this specification, the main coefficients of interest are the β_k's, which measure the effect of job loss on the probability to be retired at age k. More precisely, the coefficient β_k estimates the change in the retirement probability of displaced workers relative to similar non-displaced workers at age k. The coefficient γ_k is the (weighted) mean of the matched non-displaced workers at age k and $\beta_k + \gamma_k$ the mean of the displaced workers at age k.

Pension Benefits To examine the effect of job loss on pension benefits, I compare displaced workers to similar non-displaced workers using the VSKT. The specification is:

$$y_i = \beta_0 + \beta_1 \times \text{Disp}_i + \varepsilon_i, \tag{2}$$

where y_i are annual pension benefits of worker i, and Disp_i is an indicator equal to one if worker i has been displaced.

In this specification, β_1 measures the effect of job loss on pension benefits. The coefficient β_0 is the (weighted) mean of the matched non-displaced workers, and $\beta_0 + \beta_1$ the mean of the displaced workers.

Lifetime Costs of Job Loss In the final part of the paper, I provide summary measures of the lifetime costs associated with job loss. To do this, I use the VSKT and estimate the difference in the present discounted value (PDV) of lifetime income for displaced workers relative to matched control workers. I begin by computing the PDV of income for each worker i:

$$PDV(y_i) = \sum_{t=D}^{T} \frac{1}{(1+r)^{(t-D)}} y_i,$$

where y_i is income, D is the year of job loss, T the year of the final pension payment, and r the discount rate. Since workers can only be observed until they retire, I assume that all workers receive pension benefits until the age of 80. I assume a discount rate of 3%.[22]

I then simply use the values of $PDV(y_i)$ to estimate the difference between the PDV of income of displaced workers and that of matched non-displaced workers:

$$PDV(y_i) = \beta_0 + \beta_1 \times \text{Disp}_i + \varepsilon_i, \tag{3}$$

where Disp_i is an indicator equal to one if worker i has been displaced.

Identification Assumption For the analysis, the key identification assumption is that, without job loss, the change in the retirement probability (pension benefits/lifetime income) would have been comparable between displaced and matched non-displaced workers. While I cannot directly test this assumption, I can examine how labor market outcomes for displaced and matched non-displaced workers evolved around the time of the job loss. Ideally, pre-displacement trends for both groups should be very similar.

Figure 1 shows the (weighted) means of labor market outcomes for displaced and matched control workers from five years before to ten years after job loss. The figure shows that job loss leads to long-term losses in earnings and employment. Panel (a) shows that the earnings of displaced workers drop sharply in the year after the displacement. The earnings recover only partially

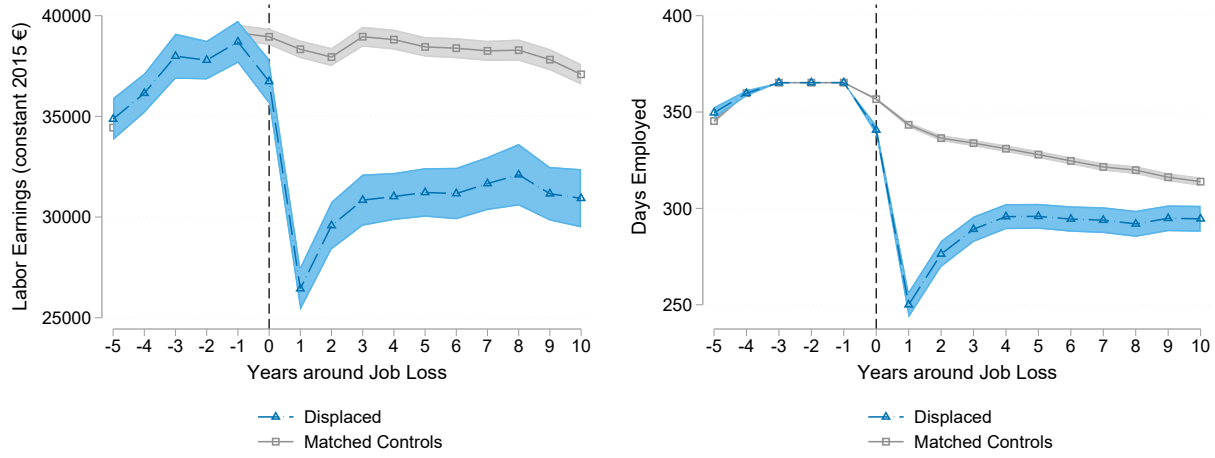
[22] Appendix table A-3 and table A-4 show that the results remain largely unchanged when using alternative assumptions regarding the discount rate and the age until which workers would receive pension benefits.

in subsequent years and a significant earnings gap remains even ten years after the job loss. Panel (b) shows that displaced workers experience large immediate employment losses, but there is only a small gap in employment ten years after the job loss. Overall, figure 1 shows that the outcomes of the two groups evolved very similarly before the shock, suggesting that the groups would have followed similar trajectories had the plant closure not taken place.[23]

Figure 1: Relationship between Job Loss and Labor Earnings, and Employment

(a) Labor Earnings

(b) Days Employed



Notes: This figure displays weighted means (with 95% confidence intervals) for displaced and matched non-displaced workers for different variables from $t-5$ to $t+10$ relative to job loss using the SIAB.

5 Results

5.1 Impact of Job Loss on Retirement Timing

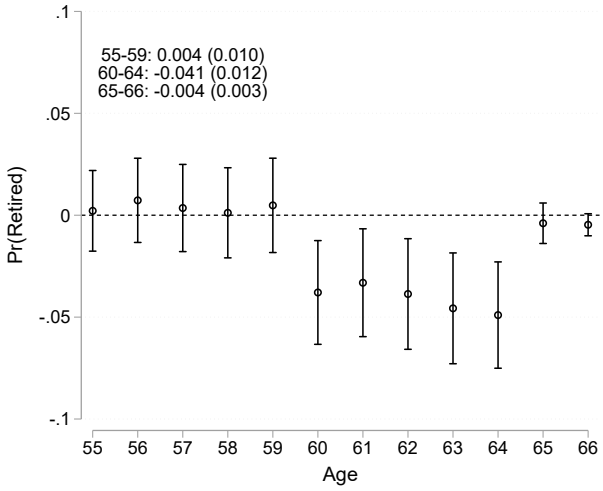
I begin by investigating the impact of job loss on retirement timing. Figure 2 shows the difference in the retirement probability between displaced and matched non-displaced workers, estimated using specification (1). The figure shows that before age 60, the difference in the retirement probability is close to zero. However, after the age of 60, the retirement probability decreases significantly

[23] Appendix figure A-2 shows the same figure using the VSKT.

for displaced workers relative to their matched control workers, indicating that displaced workers are less likely to retire. Displaced workers are about 4 percentage points (pp) (10%) less likely to be retired from ages 60 to 64, a period when most workers can only retire early. Early retirement is only possible with pension deductions and for those who meet the eligibility criteria.

After age 64, when all workers are eligible for their full pension under less stringent criteria, the difference in the retirement probability diminishes. This pattern suggests that displaced workers tend to delay their retirement to avoid pension deductions and/or to meet less stringent eligibility criteria.[24] Appendix figure A-4 shows similar findings when using the VSKT sample and for men and women.

Figure 2: Effect of Job Loss on Retirement

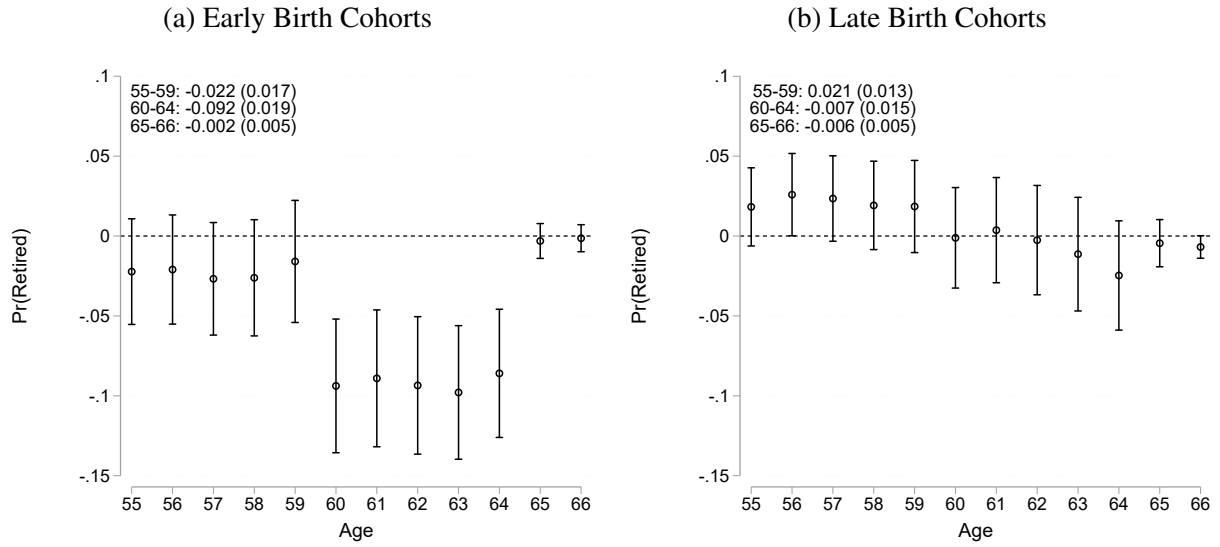


Notes: This figure shows the effect of job loss on the retirement probability of displaced workers relative to matched control workers using the SIAB. Coefficients are estimated using specification (1). 95% confidence intervals are derived from standard errors clustered at the worker level. The coefficients and standard errors (in parentheses) in the upper left corner are averages of the point estimates from age 55 to 59, 60 to 64, and 65 to 66.

[24] Appendix figure A-3 shows descriptive figures for the retirement probability for the matched and unmatched sample.

After presenting the overall effect, I next explore whether the effect on retirement varies by birth cohorts. Statutory retirement ages have increased over time, and some early retirement options have been abolished for later cohorts. As a result, individuals born later have fewer choices in their retirement decision, which should limit displaced workers' ability to adjust. Figure 3 presents the results for early and late birth cohorts.[25] The results indicate that the delay in retirement is entirely driven by the earlier birth cohorts, who had a greater margin to adjust their retirement.

Figure 3: Effect of Job Loss on Retirement by Birth Cohort



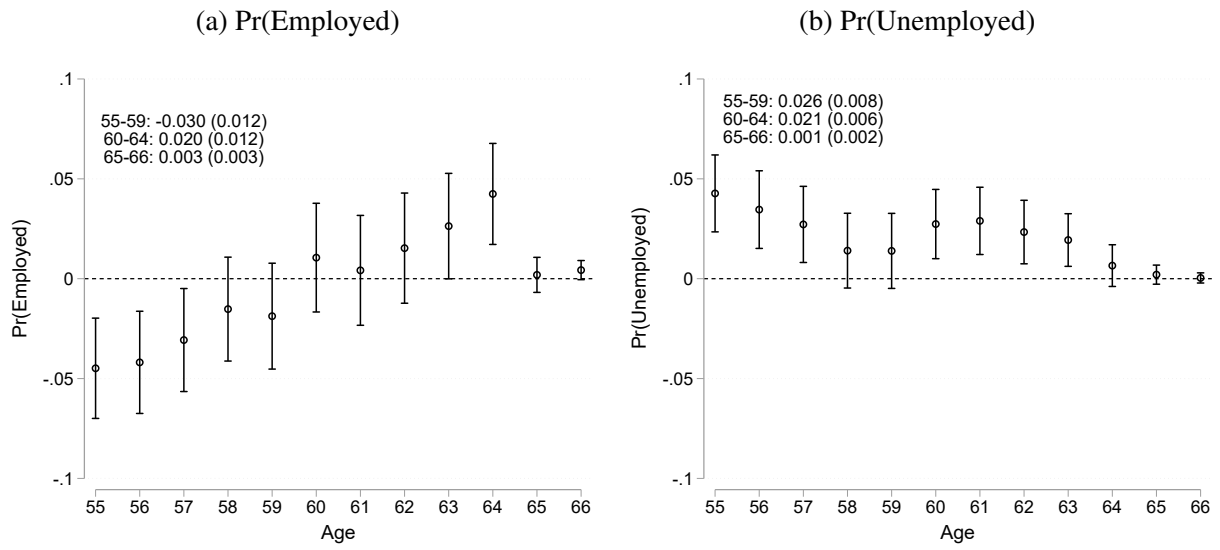
Notes: This figure shows the effect of job loss on the retirement probability of displaced workers relative to matched control workers by birth cohorts using the SIAB. Coefficients are estimated using specification (1). 95% confidence intervals are derived from standard errors clustered at the worker level. The coefficients and standard errors (in parentheses) in the upper left corner are averages of the point estimates from age 55 to 59, 60 to 64, and 65 to 66.

Pathways into Retirement The results showed that displaced workers respond to job loss by delaying retirement. They can do this by working longer or taking up other social insurance programs, such as UI benefits, often referred to as program substitution (Inderbitzin et al. 2016). In both cases, future pension benefits will increase and displaced workers can avoid the penalty for early pension claiming if they delay retirement to the normal retirement age. Future pension benefits will increase more if they stay in employment longer, since pension contributions from wage income are higher than those from UI benefits.

[25] I define early birth cohorts as those born between 1943 and 1947 and late birth cohorts as those born between 1948 and 1954. This split is made to ensure comparable group sizes.

To understand how much of the decrease in the retirement probability is driven by increases in employment versus increases in unemployment, figure 4 shows the impact of job loss on the probability of being employed or unemployed. Figure 4 shows that displaced workers are less likely to be employed and more likely to be unemployed before the age of 60, resulting in a retirement probability close to zero.[26] After age 60, displaced workers delay retirement, which can be attributed to an equal increase in both employment and unemployment.[27] From ages 60 to 64, displaced workers are approximately 2 pp more likely to be employed and 2 pp more likely to be unemployed, explaining the overall 4 pp decrease in the retirement probability. This suggests that while some displaced workers delay retirement by staying in the workforce longer, others do so by using UI benefits.

Figure 4: Pathways into Retirement



Notes: This figure shows the effect of job loss on the probability to be employed (panel a) and the probability to be unemployed (panel b) for displaced workers relative to matched control workers using the SIAB. Coefficients are estimated using specification (1). 95% confidence intervals are derived from standard errors clustered at the worker level. The coefficients and standard errors (in parentheses) in the upper left corner are averages of the point estimates from age 55 to 59, 60 to 64, and 65 to 66.

[26] Note that the effects on employment and unemployment are not fully symmetric, as there is a small effect on retirement.

[27] The increase in employment among displaced workers relative to non-displaced workers is driven by a reduction in employment among non-displaced workers, rather than an increase in employment among displaced workers (see appendix figure A-5).

5.2 What Influences Displaced Worker's Delay in Retirement?

The previous section showed that displaced workers react to job loss by delaying retirement. I now examine factors that may influence this response.

Pension Benefits Eligibility I begin by examining how pension benefits eligibility may influence displaced workers' delay in retirement. Workers who experience job loss may face difficulties in meeting the eligibility criteria for claiming pension benefits at early retirement age (60-64). Generally, early retirement eligibility is more stringent than normal retirement eligibility, and displaced workers may struggle to meet these requirements due to periods of non-employment or irregular work.

To investigate the effect of job loss on pension benefit eligibility, I use the VSKT data. This dataset provides precise information on all contribution periods necessary to determine eligibility. Figure 5 presents the results. Panel (a) shows the effect of job loss on the probability of being eligible to claim any pension (early or full), and panel (b) shows the probability of being eligible to claim a full pension. Age 60 marks the earliest possible claim age, and age 65 marks the age at which all workers in the sample can claim a pension without deductions.[28]

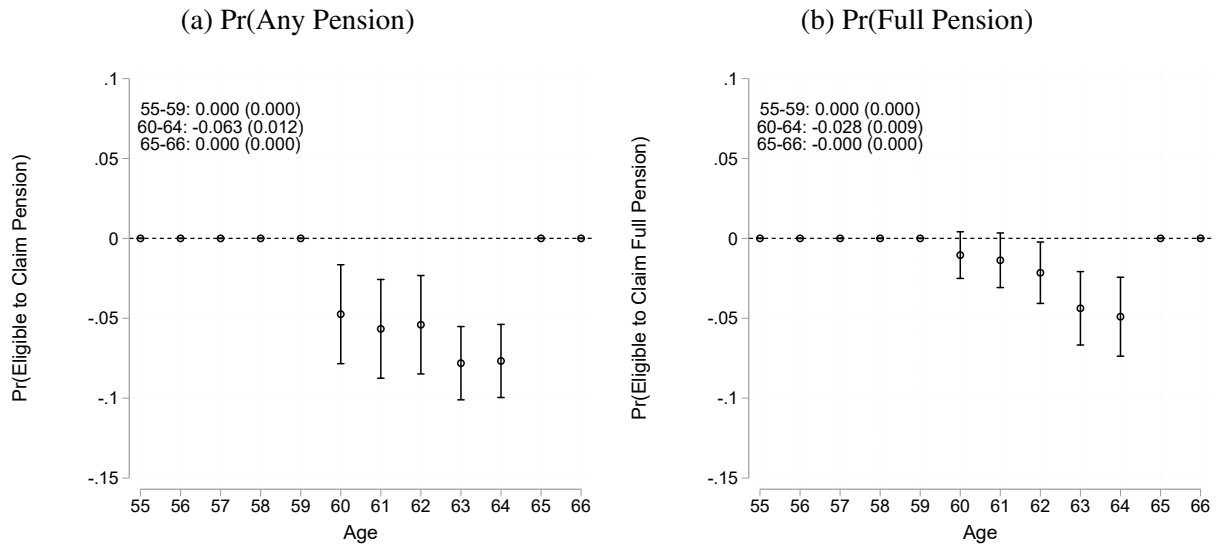
Figure 5 shows that workers who experience job loss are significantly less likely to be eligible for pension benefits between the ages of 60 and 64. They are about 6 pp (9%) less likely to qualify for any pension benefits and about 3 pp (14%) less likely to qualify for a full pension. This suggests that pension benefits eligibility may explain the observed delay in retirement of displaced workers.

To further explore the role of pension benefits eligibility in the delay of retirement for displaced workers, I correlate pension benefits eligibility with the retirement probability and estimate the following specification:

$$R_i = \beta_0 + \beta_1 \times \text{Disp}_i + \beta_2 \times \text{X}_i + \varepsilon_i, \tag{4}$$

[28]The only requirement to claim a pension at the normal retirement age is to have at least five contribution years, which all workers in the sample fulfill.

Figure 5: Impact of Job Loss on Pension Benefits Eligibility



Notes: This figure shows the effect of job loss on the probability to be eligible to claim any pension (early or normal) (panel a) and the probability to be eligible to claim a full pension (panel b) for displaced workers relative to matched control workers using the VSKT. Coefficients are estimated using specification (1). 95% confidence intervals are derived from standard errors clustered at the worker level. The coefficients and standard errors (in parentheses) in the upper left corner are averages of the point estimates from age 55 to 59, 60 to 64, and 65 to 66.

where R_i is an indicator equal to one if worker i is retired, Disp_i is an indicator equal to one if worker i has been displaced, and X_i includes variables that are tested for correlation with workers change in retirement. The specification is estimated from age 60 to 64, as the delay in retirement is observed during this age window. Standard errors are clustered at the worker level.

I include the eligibility for pension claiming (early and full) as variables (X_i). Table 3 shows the results. Column 2 suggests a large correlation between the change in eligibility for pension benefits and the change in the retirement probability. Once I include pension benefits eligibility as a control variable, the treatment effect declines by around half relative to the baseline result in column 1. This provides suggestive evidence of the role of pension benefit eligibility in mediating the impact of job loss, which is in line with evidence from Seibold (2021), who shows that responses to statutory retirement ages are seven times larger than those to pure financial incentives. However, it is important to note that omitted variables, such as differences in contribution points, could affect both eligibility and retirement, meaning that the relationship between eligibility and retirement is not necessarily causal.

Table 3: Correlates of Workers Response to Job Loss

	(1) Pr(Retired)	(2) Pr(Retired)	(3) Pr(Retired)	(4) Pr(Retired)
Displaced - Non-displaced	-0.0612	-0.0311	-0.0554	-0.0213
	(0.0118)	(0.0105)	(0.0120)	(0.0108)
Early Pension Benefits Eligibility		0.374		0.368
		(0.0103)		(0.0105)
Full Pension Benefits Eligibility		0.215		0.225
		(0.0131)		(0.0131)
Cumulative Income Age 50			3.85e-08	6.81e-08
			(1.39e-08)	(1.27e-08)
Pension Replacement Rate			0.151	0.0437
			(0.0522)	(0.0248)
Mean Non-displaced	0.524	0.524	0.524	0.524
% of Non-displaced	-11.68	-5.925	-10.56	-4.059
N	43630	43630	43630	43630

Notes: This table displays the effect of job loss on the retirement probability (from age 60-64) using the VSKT, estimated using specification (4). Standard errors (in parentheses) are clustered at the worker level. Column 1 shows the baseline result. Column 2 adds pension benefit eligibility (early and full) as controls. Column 3 adds the pension replacement rate and the cumulative income at age 59 as controls. Column 5 adds all variables as controls.

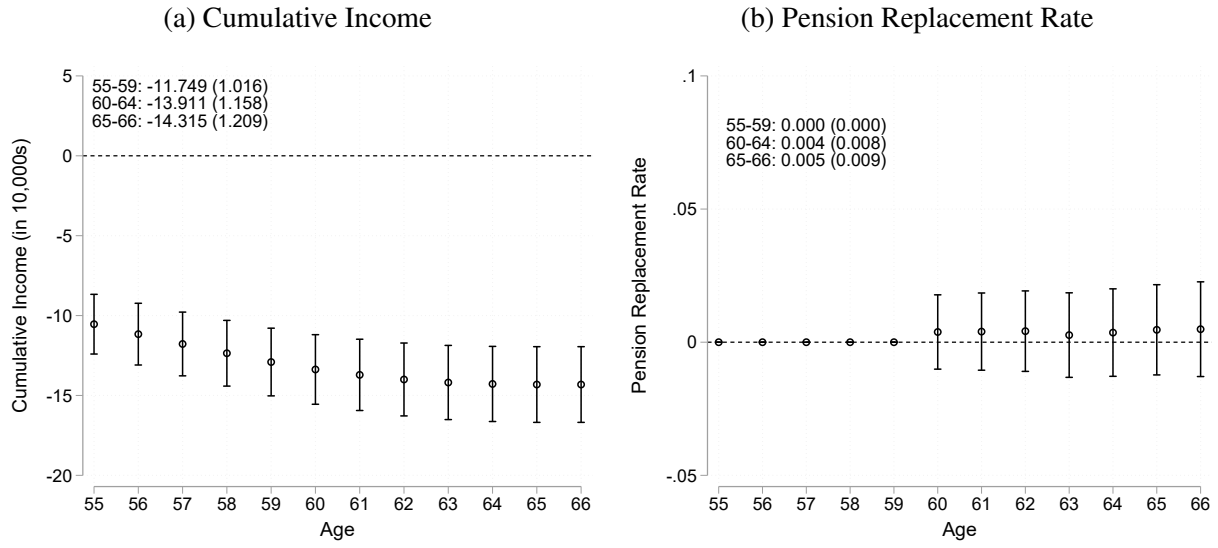
Financial Incentives In addition to displaced workers being less likely to qualify for early pension claiming, financial incentives may also influence their delay in retirement. According to theory, job loss affects financial incentives for retirement through its effect on cumulative income and wage income near retirement. A substantial reduction in cumulative income due to job loss is expected to decrease retirement incentives because the large negative wealth effect increases the need for additional income. Hence, if displaced workers experience large cumulative income losses, this may explain their delay in retirement.

Conversely, a reduction in wage income near retirement is expected to increase retirement incentives, as it decreases the relative attractiveness of working versus retiring. In particular, a (relatively) lower wage income near retirement implies (relatively) low opportunity costs of retirement due to both few foregone wage income and few losses in additional pension contribution points. If displaced workers were to have a much higher wage income relative to their potential pension benefits (a lower pension replacement rate), this could lead to later retirement.

To investigate the role of financial incentives, I use the VSKT and begin by showing the effect of job loss on cumulative income and the pension replacement rate. For each individual, I define the pension replacement rate as the potential pension benefits received if retiring at a given age, divided by workers' pre-retirement earnings.[29] Figure 6 shows that displaced workers experience significant losses in cumulative income. However, there is no effect on the pension replacement rate.

To further explore the role of financial incentives, I correlate cumulative income (at age 59) and the pension replacement rate with the change in the retirement probability and estimate specification (4). Column 3 of table 3 shows that accounting for financial incentives decreases the treatment effect by only about 1%. This suggests that the main factor driving the delay in retirement for displaced workers is the lack of pension benefits eligibility, rather than financial incentives.

Figure 6: Job Loss and Financial Incentives for Retirement



Notes: This figure shows the effect of job loss on cumulative income (panel a) and the pension replacement rate (panel b) for displaced workers relative to matched control workers using the VSKT. Coefficients are estimated using specification (1). 95% confidence intervals are derived from standard errors clustered at the worker level. The coefficients and standard errors (in parentheses) in the upper left corner are averages of the point estimates from age 55 to 59, 60 to 64, and 65 to 66.

[29] For example, the pension replacement rate at age 61 is calculated as the pension benefits received if retiring at age 61, divided by pre-retirement earnings. I measure pre-retirement earnings at age 55. For workers who are not employed for the full year at age 55, I use the last year in which they are employed for the full year.

Alternative Explanations Finally, there may be some further explanations for the delay in retirement of displaced workers. First, displaced and non-displaced workers may end up in different types of jobs after job loss. If displaced workers are more likely to be employed in jobs that allow them to work longer, this could be an alternative explanation for their delay in retirement. However, appendix figure A-6 indicates that displaced workers are more likely to be employed in physically demanding jobs, which does not support this hypothesis.[30]

Second, job loss has been shown to impact family formation, leading to fewer children (Del Bono et al. 2012; Lindo 2010) and an increased probability of divorce (Foerster et al. 2022). These post-displacement changes may also influence retirement behavior. Several studies have examined joint retirement among spouses (e.g., Johnsen et al. 2022; García-Miralles and Leganza 2024; Gustman and Steinmeier 2000)). If displaced workers are more likely to be single and therefore do not need to coordinate their retirement with a partner, this increased flexibility could offer an alternative explanation for their delayed retirement. Unfortunately, both datasets lack information on marital status, preventing me from testing this hypothesis.

5.3 Impact of Job Loss on Pension Benefits

Although displaced workers do delaying retirement, they still experience losses in pension benefits. Table 4 presents the results for the impact of job loss on pension benefits using the VSKT and estimating specification (2). Column 1 shows that displaced workers experience significant losses in pension benefits, amounting to about €1600 (13%) in annual pension benefits. Put differently, this is equivalent to roughly 1.5 months of pension benefits.

This difference in pension benefits can result from three factors: cumulative pension contribution years, average yearly pension contribution points, and/or the pension adjustment factor. Table 4 shows the impact of job loss on these factors. The results show that losses in pension benefits are driven primarily by significant reductions in average yearly pension contribution points. Column 3 shows that displaced workers experience a decrease of approximately 9.2% in contribution points per year. This reduction can be attributed to lower post-displacement earnings and periods of non-employment, both of which lead to fewer pension contribution points.

[30] I use the classification by Kroll (2015) to categorize jobs into physically demanding and non-demanding jobs. Physically demanding jobs are those that score at least 9 out of 10 on the overall physical exposure index.

In contrast to yearly pension contribution points, the impact of job loss on cumulative pension contribution years is much smaller. This can be explained by the fact that, in Germany, pension contribution years can be accumulated not only during periods of employment but also during other insurance periods such as unemployment, sickness, or child care.

Column 4 shows the effect on the pension adjustment factor, which accounts for earlier or later retirement. Retiring before the normal retirement age results in pension deductions, while retiring after the normal retirement age leads to pension rewards. Column 4 indicates a positive effect on the pension adjustment factor, as displaced workers delay retirement, and later retirement leads to a more favorable pension adjustment factor.

Table 4: Impact of Job Loss on Determinants of Pension Benefits

	(1) Yearly Pension Benefits	(2) Cumulative Contribution Points	(3) Average Yearly Contribution Years	(4) Pension Adjustment Factor
Displaced - Non-displaced	-1588.0	-1.371	-0.0907	0.00903
	(132.0)	(0.260)	(0.00904)	(0.00222)
Non-displaced Mean	12239.1	37.13	0.990	0.933
% of Non-displaced Mean	-12.97	-3.693	-9.166	0.967
N	8726	8726	8726	8726

Notes: This table displays point estimates and robust standard errors (in parentheses) for the impact of job loss on pension benefits and its determinants using the VSKT and estimating specification (2).

Overall, displaced workers experience a large decrease in pension benefits. Appendix table A-1 shows how the overall effect varies for different subgroups. Columns 1 and 2 show that in absolute terms, men experience larger losses in pension benefits than women. However, in proportional terms, the effect sizes are very similar. Columns 3 and 4 show how the effect differs between early and late birth cohorts.[31] Since the delay in retirement is only observed among the earlier birth cohorts, these cohorts are expected to experience smaller losses in pension benefits. Columns 3 and 4 show that losses are in fact smaller for early birth cohorts.

[31] Early birth cohorts are defined as those born before 1948, and late cohorts as those born in 1948 or later.

5.4 Robustness

I perform several robustness checks. I show results for an alternative estimation strategy, for a different set of control variables, and for an alternative sample.

Alternative Estimation Strategy Matching displaced and non-displaced workers using coarsened exact matching avoids imposing any functional form relationship between the covariates and the outcomes. However, it comes at the cost of reducing the sample size. To address this, I estimate the impact of job loss using the full sample, controlling for pre-displacement characteristics. I use the following specification to estimate the effect on retirement timing:

$$y_{i,k} = \sum_{k=55}^{66} \gamma_k \times \mathbb{1}[\text{Age} = k] + \sum_{k=55}^{66} \beta_k \times \mathbb{1}[\text{Age} = k] \times \text{Disp}_i + \delta \times X_{i,t-1} + \varepsilon_{i,k}, \tag{5}$$

where $y_{i,k}$ is the probability that worker i is retired at age k (an indicator equal to one if worker i is retired at age k and zero otherwise), $\mathbb{1}$ is an indicator equal to one at age k and zero otherwise, Disp_i is an indicator equal to one if worker i has been displaced, and $X_{i,t-1}$ are pre-displacement worker characteristics. Standard errors are clustered at the worker level.

To estimate the effect of job loss on pension benefits, I use the following specification:

$$y_i = \beta_0 + \beta_1 \times \text{Disp}_i + \delta \times X_{i,t-1} + \varepsilon_i, \tag{6}$$

where y_i are pension benefits of worker i, and Disp_i is an indicator equal to 1 if worker i has been displaced, and $X_{i,t-1}$ are pre-displacement worker characteristics.

In both specifications, I use the same set of covariates ($X_{i,t-1}$) as in the matching procedure, and measure the covariates in $t-1$. The results of this alternative strategy, shown in panel (a) of appendix figure A-7 and table A-2 are largely unchanged compared to the baseline findings.

Controlling for Plant Characteristics In addition to worker-level characteristics, the SIAB provides information on plant characteristics. Plant characteristics, such as firm size and industry, could influence workers' post-displacement career prospects, potentially influencing their retirement decisions. To account for pre-displacement differences in plant characteristics between displaced and non-displaced workers, I add controls for 1-digit industry and plant size to specification (5). The results, shown in panel (b) of appendix figure A-7, are very similar to the baseline findings.

Alternative SIAB Sample A caveat of the SIAB is that it does not include information on pension claims. The year of retirement entry is defined as the last year a worker is observed in the data as either employed or unemployed. However, there are other reasons why workers may leave the dataset, such as becoming self-employed, entering civil service, or emigrating. For these individuals, the year of retirement entry may not be correctly identified. To address this limitation, I use an alternative sample that includes only those workers who exit the data specifically due to retirement. This sample contains individuals for whom the reason for terminating their employment or unemployment spell is recorded as retirement.[32] The results, shown in panel (c) of appendix figure A-7, are largely unchanged compared to the baseline findings.

5.5 The Lifetime Costs of Job Loss

The previous results showed that displaced workers not only experience substantial income losses during their working lives, but also face reductions in pension benefits extending beyond their working years. In this section, I provide summary measures of the lifetime costs of job loss. To do so, I use the VSKT and estimate the difference in the present discounted value (PDV) of income for displaced workers relative to matched control workers using specification (3).

The analysis of the lifetime consequences of job loss, as shown in table 5, reveals large costs for affected workers. Column 1 shows that job loss leads to large income losses, with displaced workers losing about €138,000 (26%) in the PDV of income on average. These income losses are largely driven by substantial earnings losses, as shown in column 2. Displaced workers also experience considerable reductions in pension benefits, but they receive much more UI benefits.[33]

[32] Note that most employers do not specify the reason for the end of the employment relationship, typically reporting it as "Deregistration due to end of employment." As many employers do not report the retirement entry of their employees, the sample size for this robustness check is smaller than that of the main sample.

[33] Appendix tables A-3 and A-4 show that the results remain largely unchanged when using alternative assumptions regarding the discount rate and the age until which workers would receive pension benefits.

Appendix Table A-5 presents the lifetime costs of job loss by gender. Both displaced men and women experience significant reductions in the PDV of income and labor earnings, with men experiencing a 23% decrease and women a 27% decrease. The larger loss in lifetime income for women in proportional terms is driven by their larger earnings losses compared to men.

Table 5: Lifetime Costs of Job Loss

	(1) PDV Total Income	(2) PDV Labor Earnings	(3) PDV Pension Benefits	(4) PDV UI Benefits Benefits
Displaced - Non-displaced	-137616.5	-141380.3	-12366.3	16130.2
	(7633.2)	(7026.4)	(934.4)	(845.9)
Non-displaced Mean	534693.8	436035.6	86501.2	12156.9
% of Non-displaced Mean	-25.74	-32.42	-14.30	132.7
N	8726	8726	8726	8726

Notes: This table displays point estimates and robust standard errors (in parentheses) for the impact of job loss on the PDV of income, labor earnings, pension benefits, and UI benefits using the VSKT and estimating specification (3).

Gains in Lifetime Income from Adjusting Retirement Behavior Despite their adjustment in retirement timing, displaced workers still experience large losses in lifetime income. One may therefore ask: what would income losses amount to if displaced workers had not adjusted their retirement timing? Answering this question is challenging, as one needs to know the counterfactual (unobserved) retirement behavior of displaced workers had they not lost their jobs. To overcome this challenge, I take advantage of having matched each displaced worker with similar non-displaced workers.

For this analysis, I pair each displaced worker with exactly one non-displaced worker who is in the same matching cell (i.e., has identical coarsened characteristics). If there are multiple control workers in a cell, I select the control worker with the most similar pre-displacement earnings.[34] I then assign each displaced worker the retirement age of their matched "twin" and calculate the corresponding pension benefits and income in this hypothetical scenario. I estimate specification (3) using the hypothetical income as the outcome variable. Table 6 shows the results.

[34]Each control worker is used only once (i.e., matching is performed without replacement).

The table shows that lifetime losses would be only slightly larger if displaced workers had not adjusted their retirement timing. Displaced workers would have experienced losses in the PDV of income of about €155,000 (27%), compared to about €144,000 (25%) in the baseline scenario.[35] This shows that changes in age at retirement cannot compensate the large costs of job loss. Overall, the results highlight that the costs of job loss are substantial and extend beyond what short- or medium-term estimates of earnings losses can show.

Table 6: Gains in Lifetime Income from Adjusting Retirement Behavior

	(1) Total Income	(2) Hypothetical Total Income
Displaced - Non-displaced	-144010.5	-154718.2
	(8923.4)	(8772.8)
Non-displaced Mean	543834.2	543834.2
% of Non-displaced Mean	-24.94	-26.79
N	3664	3664

Notes: This table displays point estimates and robust standard errors (in parentheses) for the impact of job loss on the PDV of income and the PDV of hypothetical income using the VSKT and estimating specification (3). Hypothetical income is calculated by assigning each displaced worker the retirement age of their matched non-displaced "twin" and then calculating the corresponding income.

6 Conclusion

Economists have long been interested in studying the effects of job loss. It has been shown that job loss leads to large and persistent earnings losses (e.g., Jacobson et al. 1993; Couch and Placzek 2010; Davis and von Wachter 2011; Jarosch 2023; Lachowska et al. 2020; Schmieder et al. 2023) and impacts workers across various dimensions, such as family formation, health, and crime (e.g., Del Bono et al. 2012; Carneiro et al. 2023; Foerster et al. 2022; Sullivan and Von Wachter 2009; Black et al. 2015; Khanna et al. 2021). Yet, there is limited evidence on the impact of job loss on

[35] Note that column 1 in table 6 uses only one non-displaced worker as control group and therefore the estimate is slightly different than column 1 in table 5.

retirement and how if affects lifetime income. Some studies have examined how late-career job loss affects workers' retirement behavior (Chan and Huff Stevens 2001; Chan and Stevens 2004; Merkurieva 2019), but there is no evidence on how job loss at young and middle age impacts age at retirement, pension benefits, and lifetime income.

In this study, I provide the first evidence on the long-term effects of job loss on retirement and lifetime income. I document several new findings. First, I show that displaced workers react to the shock by delaying retirement. Between the ages of 60 and 64, displaced workers are about 10% less likely to be retired compared to similar non-displaced workers. Ineligibility for early pension claiming appears to be the main driver of this response. Second, although displaced workers do delay retirement, they still experience losses in pension benefits. On average, job loss results in a 13% reduction in annual pension benefits, which is equivalent to about 1.5 months of pension payments. Finally, I show that displaced workers experience substantial income losses. Taking into account changes in retirement and pension benefits, displaced workers experience losses of about 26% in the PDV of income.

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A Online Appendix: Additional Tables and Figures

Table A-1: Impact of Job Loss on Pension Benefits by Subgroups

	(1) Men	(2) Women	(3) Early Birth Cohort	(4) Late Birth Cohort
Displaced - Non-displaced	-1936.9	-1341.3	-1540.8	-1650.4
	(208.7)	(143.2)	(173.9)	(194.7)
Non-displaced Mean	15059.6	10244.9	12912.5	11349.6
% of Non-displaced Mean	-12.86	-13.09	-11.93	-14.54
N	4018	4708	5748	2978

Notes: This table displays point estimates and robust standard errors (in parentheses) for the impact of job loss on pension benefits by subgroups using the VSKT. Coefficients are estimated using specification (2).

Table A-2: Robustness Check - Impact of Job Loss on Determinants of Pension Benefits

	(1) Yearly Pension Benefits	(2) Cumulative Contribution Points	(3) Average Yearly Contribution Years	(4) Pension Adjustment Factor
Displaced - Non-displaced	-1527.5	-0.951	-0.0957	0.00787
	(68.71)	(0.173)	(0.00495)	(0.00165)
Non-displaced Mean	13886.3	37.64	1.090	0.932
% of Non-displaced Mean	-11.00	-2.527	-8.779	0.844
N	20031	20031	20031	20031

Notes: This table displays point estimates and robust standard errors (in parentheses) for the impact of job loss on pension benefits and its determinants using the VSKT. Coefficients are estimated using specification (6).

Table A-3: Robustness Check - Lifetime Costs of Job Loss I

	(1) PDV Income	(2) PDV Labor Earnings	(3) PDV Pension Benefits	(4) PDV UI Benefits Benefits
Panel A: Baseline (Until Age 80)				
Displaced - Non-displaced	-137616.5	-141380.3	-12366.3	16130.2
	(7633.2)	(7026.4)	(934.4)	(845.9)
Non-displaced Mean	534693.8	436035.6	86501.2	12156.9
% of Non-displaced Mean	-25.74	-32.42	-14.30	132.7
N	8726	8726	8726	8726
Panel B: Until Age 70				
Displaced - Non-displaced	-132236.2	-141380.3	-6986.1	16130.2
	(7261.0)	(7026.4)	(552.9)	(845.9)
Non-displaced Mean	492572.6	436035.6	44380.0	12156.9
% of Non-displaced Mean	-26.85	-32.42	-15.74	132.7
N	8726	8726	8726	8726
Panel C: Until Age 75				
Displaced - Non-displaced	-135124.8	-141380.3	-9874.7	16130.2
	(7459.6)	(7026.4)	(746.5)	(845.9)
Non-displaced Mean	515186.6	436035.6	66994.1	12156.9
% of Non-displaced Mean	-26.23	-32.42	-14.74	132.7
N	8726	8726	8726	8726
Panel D: Until Age 85				
Displaced - Non-displaced	-139765.8	-141380.3	-14515.7	16130.2
	(7784.6)	(7026.4)	(1104.0)	(845.9)
Non-displaced Mean	551520.7	436035.6	103328.2	12156.9
% of Non-displaced Mean	-25.34	-32.42	-14.05	132.7
N	8726	8726	8726	8726
Panel E: Until Age 90				
Displaced - Non-displaced	-141619.9	-141380.3	-16369.7	16130.2
	(7916.3)	(7026.4)	(1253.8)	(845.9)
Non-displaced Mean	566035.9	436035.6	117843.3	12156.9
% of Non-displaced Mean	-25.02	-32.42	-13.89	132.7
N	8726	8726	8726	8726

Notes: This table displays point estimates and robust standard errors (in parentheses) for the impact of job loss on the PDV of income, labor earnings, pension benefits, and UI benefits using the VSKT and estimating specification (3). The panels show results for different age windows. Panel A shows the baseline scenario assuming that workers receive pension benefits until age 80. All panels assume a discount rate of 3%.

Table A-4: Robustness Check - Lifetime Costs of Job Loss II

	(1) PDV Income	(2) PDV Labor Earnings	(3) PDV Pension Benefits	(4) PDV UI Benefits Benefits
Panel A: Baseline (r = 3%)				
Displaced - Non-displaced	-137616.5	-141380.3	-12366.3	16130.2
	(7633.2)	(7026.4)	(934.4)	(845.9)
Non-displaced Mean	534693.8	436035.6	86501.2	12156.9
% of Non-displaced Mean	-25.74	-32.42	-14.30	132.7
N	8726	8726	8726	8726
Panel B: r = 2%				
Displaced - Non-displaced	-153096.7	-153404.8	-16414.4	16722.5
	(8757.8)	(7891.1)	(1235.6)	(924.6)
Non-displaced Mean	606117.8	476028.3	115954.6	14134.9
% of Non-displaced Mean	-25.26	-32.23	-14.16	118.3
N	8726	8726	8726	8726
Panel C: r = 4%				
Displaced - Non-displaced	-124629.4	-130818.5	-9379.4	15568.5
	(6724.5)	(6300.0)	(716.8)	(779.9)
Non-displaced Mean	476775.0	401312.0	64961.3	10501.8
% of Non-displaced Mean	-26.14	-32.60	-14.44	148.2
N	8726	8726	8726	8726
Panel D: r = 5%				
Displaced - Non-displaced	-113625.6	-121501.5	-7160.6	15036.6
	(5981.5)	(5685.8)	(557.2)	(724.0)
Non-displaced Mean	429233.6	371018.9	49103.7	9111.0
% of Non-displaced Mean	-26.47	-32.75	-14.58	165.0
N	8726	8726	8726	8726

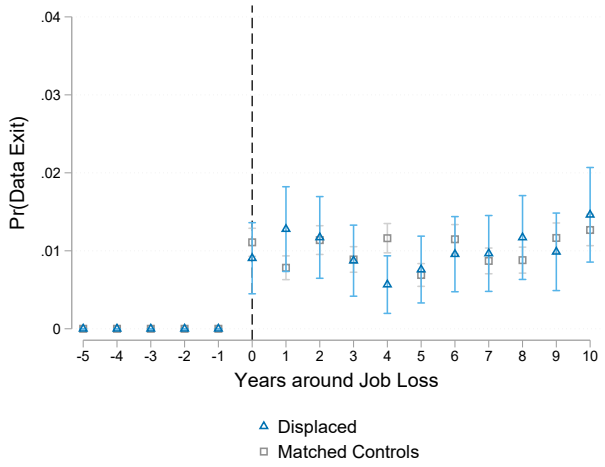
Notes: This table displays point estimates and robust standard errors (in parentheses) for the impact of job loss on the PDV of income, labor earnings, pension benefits, and UI benefits using the VSKT and estimating specification (3). The panels show results for different discount rates. Panel A shows the baseline scenario with a discount rate of 3%. All panels assume that workers receive pension benefits until age 80.

Table A-5: Lifetime Costs of Job Loss for Men and Women

	(1) PDV Income	(2) PDV Labor Earnings	(3) PDV Pension Benefits	(4) PDV UI Benefits Benefits
Panel A: Men				
Displaced - Non-displaced	-168745.2	-166730.7	-19876.5	17862.0
	(13229.6)	(11981.2)	(1960.9)	(1374.7)
Non-displaced Mean	729577.7	573169.6	142184.4	14223.7
% of Non-displaced Mean	-23.13	-29.09	-13.98	125.6
N	4018	4018	4018	4018
Panel B: Women				
Displaced - Non-displaced	-122441.4	-123456.7	-13890.3	14905.7
	(8235.3)	(7310.8)	(1452.3)	(1057.7)
Non-displaced Mean	450406.1	339077.1	100633.4	10695.7
% of Non-displaced Mean	-27.18	-36.41	-13.80	139.4
N	4708	4708	4708	4708

Notes: This table displays point estimates and robust standard errors (in parentheses) for the impact of job loss on the PDV of income, labor earnings, pension benefits, and UI benefits using the VSKT and estimating specification (3), separately for men and women.

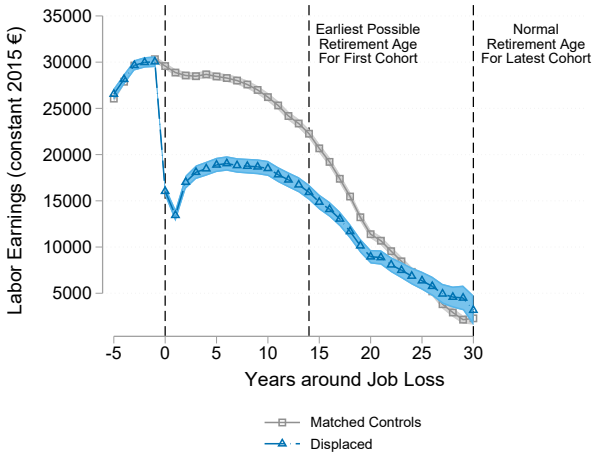
Figure A-1: Relationship between Job Loss and Data Exit



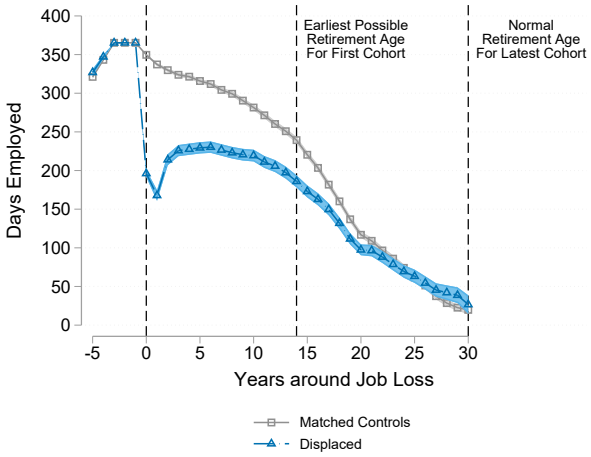
Notes: This figure displays weighted means (with 95% confidence intervals) for the probability to exit the data for displaced and matched non-displaced workers from $t-5$ to $t+10$ relative to job loss using the SIAB.

Figure A-2: Relationship between Job Loss and Labor Earnings and Employment

(a) Labor Earnings



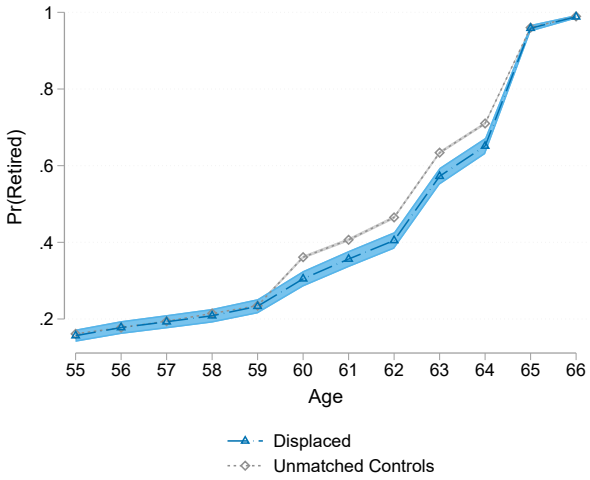
(b) Days Employed



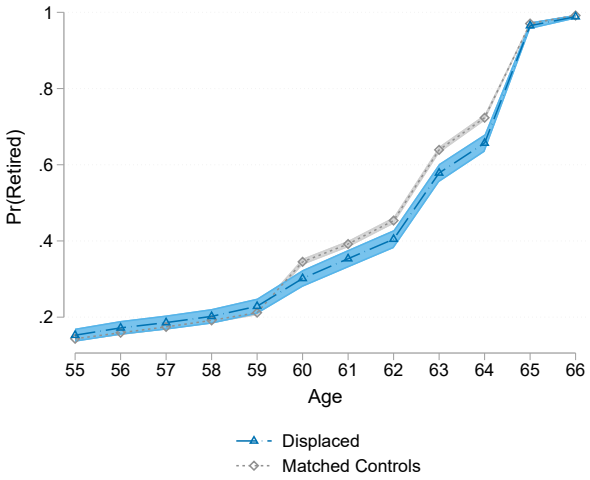
Notes: This figure displays weighted means (with 95% confidence intervals) for earnings and employment from $t-5$ to $t+10$ relative to job loss using the VSKT.

Figure A-3: Relationship between Job Loss and Retirement

(a) Unmatched Sample



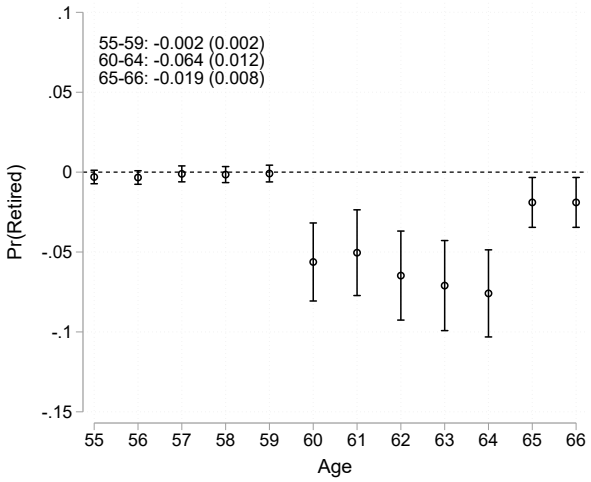
(b) Matched Sample



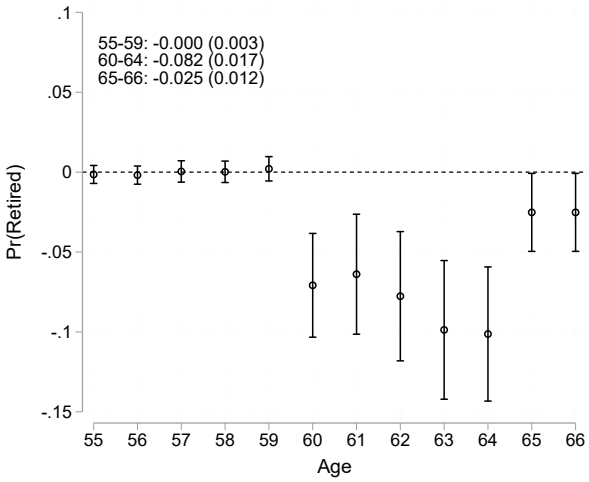
Notes: This figure displays means (with 95% confidence intervals) for the retirement probability for displaced and non-displaced workers from 55 to 66 using the SIAB. Panel (a) shows the unmatched sample and panel (b) the matched sample. Panel (a) shows unweighted means and panel (b) weighted means.

Figure A-4: Effect of Job Loss on Retirement

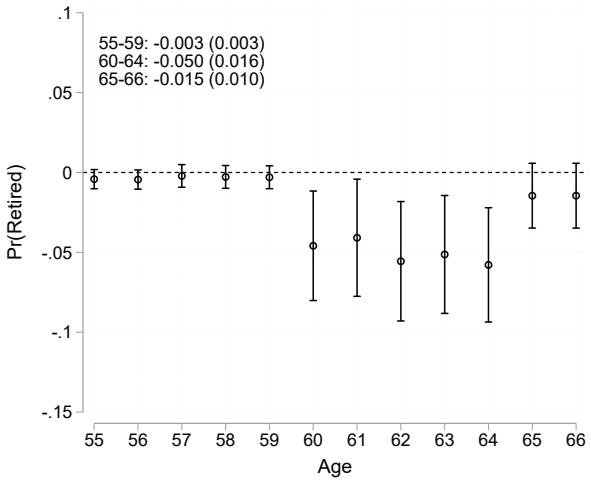
(a) Overall



(b) Men

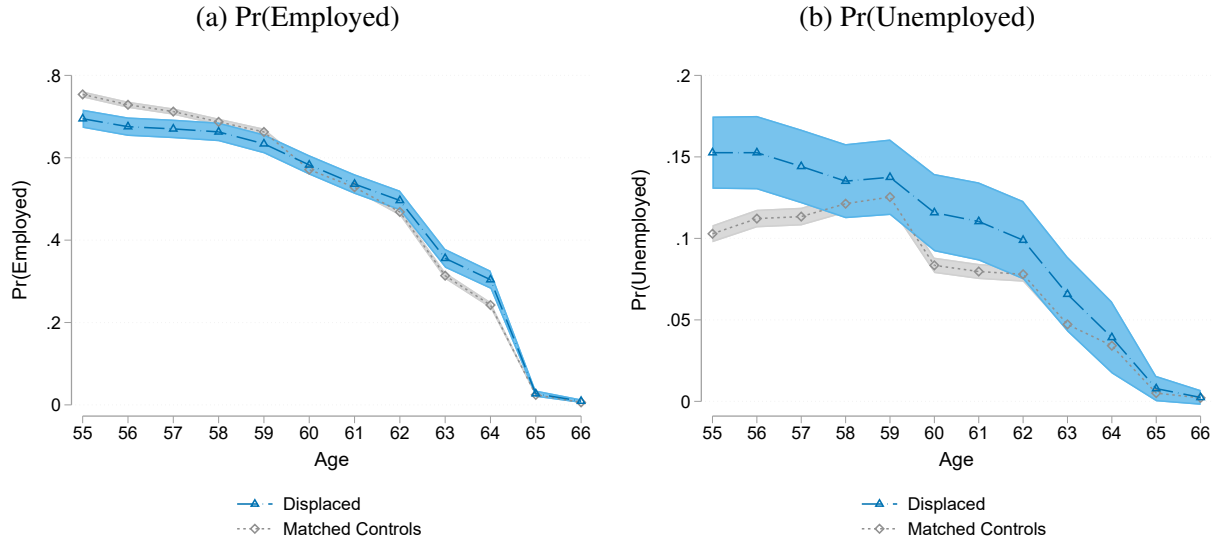


(c) Women



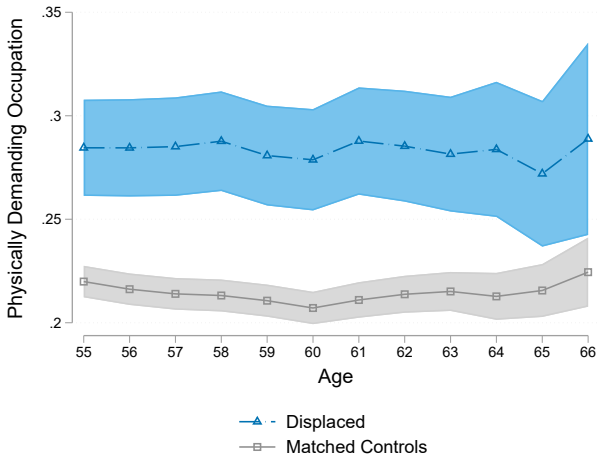
Notes: This figure shows the effect of job loss on the retirement probability of displaced workers relative to matched control workers using the VSKT. Coefficients are estimated using specification (1). 95% confidence intervals are derived from standard errors clustered at the worker level. The coefficients and standard errors (in parentheses) in the upper left corner are averages of the point estimates from age 55 to 59, 60 to 64, and 65 to 66.

Figure A-5: Pathways into Retirement



Notes: This figure displays weighted means (with 95% confidence intervals) for the probability to be employed (panel a) and the probability to be unemployed (panel b) for displaced and matched non-displaced workers using the SIAB.

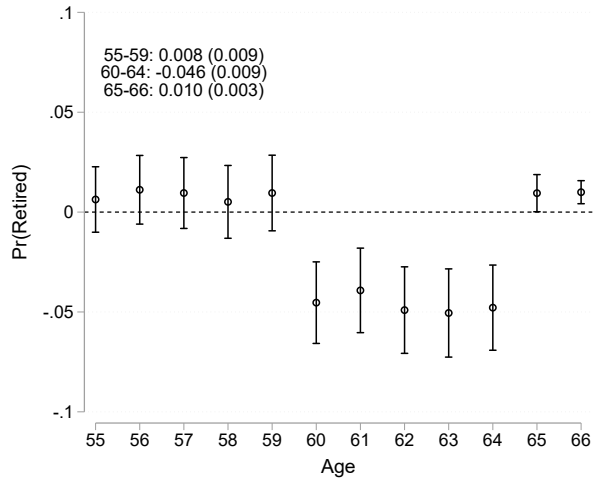
Figure A-6: Relationship between Job Loss and Job Type



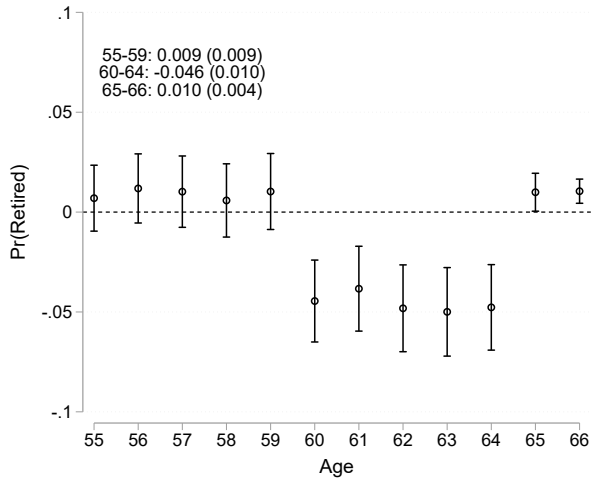
Notes: This figure displays weighted means (with 95% confidence intervals) for the probability to work in a physically demanding job for displaced and matched non-displaced workers using the SIAB. Jobs are classified as physically demanding or non-demanding following the method of Kroll (2015).

Figure A-7: Robustness Checks

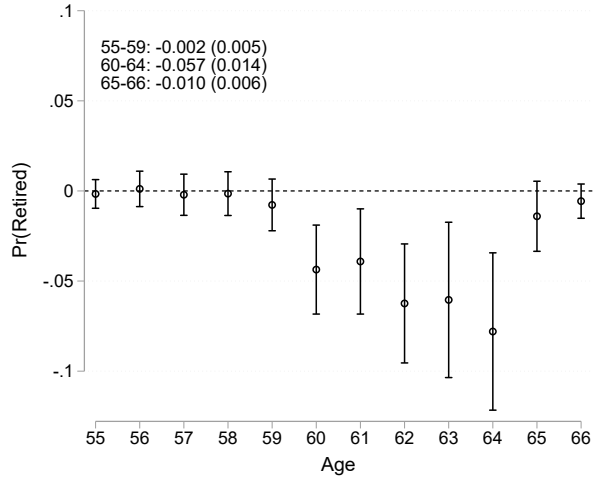
(a) Alternative Estimation Procedure



(b) Controlling for Plant Characteristics



(c) Alternative Sample



Notes: This figure shows the effect of job loss on the retirement probability of displaced workers relative to matched control workers using the SIAB. Coefficients are estimated using specification (5) (panel (a) and (b)) or specification (1) (panel (c)). 95% confidence intervals are derived from standard errors clustered at the worker level. The coefficients and standard errors (in parentheses) in the upper left corner are averages of the point estimates from age 55 to 59, 60 to 64, and 65 to 66.

B Online Appendix: Institutional Setting

This section provides additional information on the institutional setting in Germany. For more details on the public pension system, see Börsch-Supan and Wilke (2004).

B.1 Pathways

Over the observation period, the German public pension system has different pathways through which workers can enter retirement, which vary in the statutory retirement ages and requirements. Table B1 summarizes the requirements for the different pathways. To claim a regular pension, workers only need a minimum of five contribution years, but there is no possibility of early retirement. For all other pathways, the eligibility requirements are stricter than for claiming a regular pension, but each pathway offers an opportunity for early retirement. In case of early retirement, a worker has to bear a penalty of 0.3% for each month retiring before the NRA. Table B2 shows the statutory retirement ages corresponding to the different pathways. The statutory retirement ages vary by birth cohort due to pension reforms. In table B2, the NRA is shown along with the ERA in brackets (if the respective pathway offers an early retirement option).

Table B1: Requirements under Different Pathways

Pathway	Requirements	Early Retirement Possible
Regular	At least 5 contribution years	No
Especially Long-term Insured	At least 45 contribution years	No
Long-term Insured	At least 35 contribution years	Yes
Unemployment	At least 15 contribution years and at least contributions in 8 out of 10 years before claiming and born before 1952 and (i) unemployed for at least 1 year after age 58 and 6 months or (ii) worked in old-age part-time employment for at least 24 months after age 55	Yes
Women	At least 15 contribution years and at least 10 contribution years after age of 40 and born before 1952	Yes

Notes: This table shows the requirements for the different pathways. Sources: Börsch-Supan and Wilke (2004), Rentenversicherung (2021b).

Table B2: Statutory Retirement Ages under Different Pathways

Cohort	Regular Pathway	Especially Long-term Insured Pathway	Long-term Insured Pathway	Unemployed Pathway	Women Pathway
1938	65	-	63+13/24 (63)	61+1/12 (60)	60 (60)
1939	65	-	65 (63)	62+1/12 (60)	60 (60)
1940	65	-	65 (63)	63+1/12 (60)	60+1/12 (60)
1941	65	-	65 (63)	64+1/12 (60)	61+1/12 (60)
1942	65	-	65 (63)	65 (60)	62+1/12 (60)
1943	65	-	65 (63)	65 (60)	63+1/12 (60)
1944	65	-	65 (63)	65 (60)	64+1/12 (60)
1945	65	-	65 (63)	65 (60)	65 (60)
1946	65	-	65 (63)	65 (60+1/12)	65 (60)
1947	65+1	-	65 (63)	65 (61+1/12)	65 (60)
1948	65+2	-	65 (63)	65 (62+1/12)	65 (60)
1949	65+3	-	65+1/3 (63)	65 (63)	65 (60)
1950	65+4	-	65+4 (63)	65 (63)	65 (60)
1951	65+5	63	65+5 (63)	65 (63)	65 (60)
1952	65+6	63	65+6 (63)	-	-
1953	65+7	63	65+7 (63)	-	-
1954	65+8	63+2	65+8 (63)	-	-

Notes: This table shows the NRA for the different pathways along with the ERA in brackets. A hyphen (-) indicates that a specific pathway is not applicable (anymore). Sources: Börsch-Supan and Wilke (2004), Rentenversicherung (2021a).