

# The Effects of Unemployment Insurance for Older Workers\*

Matthew Gudgeon<sup>§</sup>   Pablo Guzman<sup>#</sup>   Johannes F. Schmieder<sup>‡</sup>  
U.S. Military Academy   Boston University   Boston University

Simon Trenkle<sup>§§</sup>   Han Ye<sup>†</sup>  
IZA, IAB   University of Mannheim

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## Abstract

Over the past 4 decades, the German unemployment rate of workers in their late 50s saw a dramatic rise (peaking in the mid 1990s) followed by a long and steady fall. This rise in the unemployment rate is much larger than for younger workers. We show that a large share of this can be explained by the interaction of Unemployment Insurance (UI) and the retirement system, where UI benefits affect labor supply by inducing individuals to leave employment. We show massive amounts of sharp bunching in UI inflows at age thresholds that allow for using UI as a bridge to early retirement. The bunching mass moves as the age threshold moves due to reforms of the UI or retirement system. To quantify the impact of this channel on labor supply, we use our reduced form evidence to estimate a dynamic life-cycle model of labor supply that endogenizes unemployment and retirement transitions. Based on this we show that the increase in potential benefit durations in the late 1980s increased unemployment rates for workers aged 56-59 by around 5 percentage points (about a 50 percent increase). Furthermore, changes to the UI and retirement system, played a key part in bringing the unemployment rate back down after the 1990s. Overall, we show that the nonemployment effects of UI extensions depend on non-UI institutions (e.g. retirement policy), in part explaining why such effects differ for younger workers and across contexts.

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<sup>§</sup> Email: matthew.gudgeon@westpoint.edu.

<sup>#</sup> Email: pguzmanp@bu.edu.

<sup>‡</sup> Email: johannes@bu.edu.

<sup>§§</sup> Email: Trenkle@iza.org.

<sup>†</sup> Email: han.ye@uni-mannheim.de.

# 1 Introduction

Unemployment insurance (UI) benefits are an important policy tool for helping workers smooth their consumption following job loss. Yet, the consumption-smoothing benefits of UI must be balanced against its potential to increase non-employment durations. Given its importance to optimal UI design, a large literature has focused on estimating the non-employment effects of UI. Several papers, primarily focused on younger workers in their 30s, 40s, and early 50s, have found that UI extensions have quantitatively meaningful effects on the non-employment durations of individuals who become unemployed – the intensive margin — (Card et al., 2007; Centeno and Novo, 2009; Schmieder et al., 2012; Lalive et al., 2015), while not affecting the inflow rates into unemployment — the extensive margin. At the same time, several papers argue that inflow effects can be sizable (e.g. Hartung et al., 2022; Jessen et al., 2023), especially for older workers closer to retirement (Winter-Ebmer, 2003; Jaeger et al., 2017; Kyryä and Wilke, 2007; Lalive, 2008; Tuit and van Ours, 2010; Baguelin and Remillon, 2014; Inderbitzin et al., 2016). The non-employment effects of UI may further depend on other institutional details including welfare and, particularly for older workers, retirement policies. As a result, policymakers still face considerable uncertainty as to the total effect of UI extensions, particularly for older workers.

In this paper, we study the labor supply effects of UI extensions for older workers in Germany using the social security data from 1975 to 2017. Over this time period, German unemployment rates of workers in their late 50s saw a dramatic and unparalleled rise, peaking at over 15% in the 90s, followed by an equally striking fall. Additionally, numerous reforms to both Germany’s UI and retirement system altered the payoffs to entering UI at different age thresholds and the search incentives of the unemployed. Workers in their 50s responded sharply to these policy changes on both the intensive and the extensive margin. We observe and quantify the *intensive margin* effect of UI extensions at 8 different age cutoffs that discretely extend UI for workers in their 40s and 50s using regression discontinuity designs. Our evidence suggests that the intensive margin effect is at least as large for workers in their early and late 50s as it is for workers in their 40s.

At the same time, we document sizeable *extensive margin* effects of UI. There is sharp bunching of UI inflows at precisely the age that allows workers to claim their pension right after UI expiration. The age at which workers can enter unemployment and subsequently receive a pension without any uninsured period can be considered a kink in

a lifetime budget set relating income to exit age. The bunching mass of inflows is large. Furthermore, UI inflows respond as expected to a series of UI extensions and pension rule changes.

While the empirical evidence clearly shows that workers responded to potential UI benefit durations on both margins, it is difficult to quantify the total non-employment effect of UI extensions and the reduced form evidence does not provide an obvious way to obtain a counterfactual. In order to estimate the total effect of UI on labor supply and generate plausible counterfactuals, we specify and estimate a life-cycle model of labor supply that explicitly captures transitions between employment, unemployment with job search, and exiting the labor force. Our model is similar to a basic labor supply model of retirement decisions but with two key extensions. First, we incorporate endogenous job loss into the model to explicitly allow for a role of firms. Second, we model unemployment in more detail than past life cycle models. While previous research with life cycle models typically allows for one or two states of unemployment with no dynamics, we model unemployment as a fully dynamic process that enables us to capture the duration of UI benefits and the response to their exhaustion in a natural way.<sup>1</sup> This also has the added benefit that our parameter estimates for the job search part can be compared with previous estimates of job search models (e.g. [Paserman, 2008](#); [DellaVigna et al., 2017, 2022](#)). We estimate our model using a method of moments estimator and use the resulting best-fit parameters to decompose the total non-employment effect of counterfactual UI extensions into its extensive and intensive margin components.

Germany provides a particularly interesting context for studying UI extensions for older workers since there has been a tremendous policy variation over the past decades. In the early 1980s, UI's maximum potential benefit duration (PBD) was capped at 12 months regardless of age. Throughout the 1980s, maximum PBDs increased dramatically for older workers, reaching up to 32 months of UI benefits for the most senior group. Between 1999 and 2007, Germany reversed track. Maximum PBDs were reduced for older workers, and Germany began the process of eliminating early retirement at age 60 following unemployment. This increase (and later decrease) in UI generosity is matched by a sharp increase (decrease) in the unemployment rate among older workers. Figure

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<sup>1</sup>Other structural life cycle papers typically assume workers receive UI forever or model UI as a Markov process with a fixed transition probability to exhaustion ([Haan and Prowse, 2010](#); [García-Pérez and Sánchez-Martín, 2015](#)).

1 shows that the unemployment rate for workers age 55 to 59 sharply diverged in the early 90s from the other age groups and rose to more than 15 percent by 1997, about twice as high as for all the other age groups. This is in stark contrast to the United States, for example, where the different age groups large move together. Previous authors, such as [Buchholz et al. \(2013\)](#), have attributed this to a variety of policy changes aimed at reducing the labor supply of older workers, but have not attempted to provide quantitative estimates of the different channels or to isolate the impact of UI.

While Germany provides a compelling setting for studying the effects of UI on workers close to retirement, it also offers several challenges. The main complication is that in addition to UI, many other policies have changed over the past decades, affecting inflows into UI and unemployment durations. Some of these changes are about regular and early retirement rules and are relatively easy to understand, but there are also many rules based on collective labor agreements (CLAs) on the sectoral level or even specific to individual firms. Such CLAs may themselves take policy induced age discontinuities into account, for example, by encouraging workers to exit firms at those age thresholds with severance packages. In this case, one can view CLAs as a mechanism of how age discontinuities lead to extensive margin responses. On the other hand, CLAs may also lead to bunching at age thresholds that are not directly related to retirement or UI institutions.

Our setting also raises interesting methodological issues. While several papers have estimated regression discontinuity designs in the presence of manipulation of the forcing variable ( see for e.g.: [Card and Giuliano \(2014\)](#); [Gerard et al. \(2015\)](#); [Barreca et al. \(2016\)](#); [Hoxby and Bulman \(2016\)](#)), this manipulation has typically been treated as a nuisance, with researchers attempting to avoid bias using techniques like excluding observations close to the threshold (donut-hole regressions).<sup>2</sup> However, whether and when to enter UI is itself a meaningful outcome, and in practice, individuals (together with firms) can influence this decision. When UI is used as a pathway to retirement, it essentially constitutes a labor supply decision with respect to a budget set defined by wage rates, the UI system, and retirement rules. The UI system creates kinks in this budget set and individuals choosing to enter UI as a step towards retirement should bunch at these kink points. We could thus use bunching techniques to back out labor supply elasticities for these workers based on the amount of bunching around such kinks ([Saez, 2010](#); [Kleven, 2016](#)). These estimates, however, would be based on a simple static life-cycle model that

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<sup>2</sup>[Citino et al. \(2022\)](#) is an interesting exception, studying manipulation around UI cutoffs for its own sake.

ignores the possible interactions of responding along the intensive and extensive margin and is difficult to reconcile with inflows into unemployment that are not driven by voluntary quits. Furthermore, these kinds of static bunching estimators are sensitive to ad hoc restrictions about the counterfactual distribution (Blomquist and Newey, 2017).<sup>3</sup> Our structural model helps overcome these challenges.

While bunching provides evidence of extensive margin decisions, it complicates the identification of intensive margin effects using RDs. Ideally, we would use the discrete changes in potential benefit duration at the age thresholds to estimate intensive margin responses. Yet, extensive margin responses at or around these thresholds directly violate the RD assumption that there is no manipulation of the running variable, and individuals on both sides of the cutoff are therefore comparable. To obtain plausible estimates of intensive margin responses, we focus on responses at slightly younger age thresholds (e.g. age 52) where bunching is less of an issue. Additionally, we use donut-hole regressions to exclude the range where most of the bunching occurs, which is most credible when bunching is not too extreme, and there does not appear to be an overall shift in the density outside of a sharp window around the threshold. Finally, we perform standard robustness checks, including to various series of individual-level controls that could help absorb any remaining selection effects.

Finally, we view our setting as particularly apt for a structural approach. First, our setting provides clear economic incentives and interactions between incentives that a fairly standard model can capture. Second, we have clean policy variation and empirical moments (e.g. RD estimates and bunching in UI inflows) to identify the model's key parameters, disciplining our estimation. Third, several reforms allow us to test our model's out-of-sample performance. And fourth, there is a clear value added to having a model for counterfactual and out-of-sample analyses. The model makes it straightforward to predict how intensive and extensive margin responses determine responses to any given policy reform and each channel's contribution. It also allows us to quantify how much of the changes in retirement age over the past decades in Germany can be explained by the reduction of UI generosity for older workers over this period.

Our paper is related to an extensive literature on retirement decisions. Several method-

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<sup>3</sup>Note that not all bunching around UI age discontinuities is necessarily related to early retirement. Firms may also postpone layoffs or workers postpone claiming UI benefits until they reach the threshold. This is likely to be most important at ages further away from the retirement age, such as the age threshold at age 54 in the 1990s or at age 55 in the 2000s.

ologically related papers have analyzed bunching in retirement age to derive labor supply elasticities; for example, [Brown \(2013\)](#) looks at bunching at the regular retirement age for teachers and [Manoli and Weber \(2016\)](#) analyze permanent exits from the labor force around tenure thresholds in Austria that lead to discrete increases in severance payments. Unlike these papers, we study entries into UI, rather than exits from the labor force.

A handful of papers examine the effects of UI extensions on older workers (e.g. [Kyyrä and Ollikainen \(2008\)](#); [Bennmarker et al. \(2013\)](#)). Among these, [Riphahn and Schrader \(2020\)](#) and [Dlugosz et al. \(2014\)](#) show that a 2006 reform that shortened UI benefits for older German workers increased employment. A smaller literature explicitly examines the interactions of the UI system with retirement decisions. For example, [Kyyrä and Pesola \(2020\)](#) show that postponing eligibility by two years for a retirement-via-UI pathway in Finland increases employment by 7 months. Similarly, [Kyyrä and Wilke \(2007\)](#) show that increasing the age threshold of early retirement via UI benefits from 53 to 57 in Finland significantly reduced unemployment durations. [Lalive \(2008\)](#) analyzes the effect of UI extensions for older workers around a discontinuity at age 50 in the Austrian UI system, as well as at a border discontinuity, and finds relatively large disincentive effects, especially for women. Using partially the same variation as Lalive, [Inderbitzin et al. \(2016\)](#) show that much of this was due to early retirement responses. [Hairault et al. \(2010\)](#) provide evidence based on French survey data that job search behavior of the unemployed depends on the distance to retirement age. [Michelacci and Ruffo \(2015\)](#) use CPS data to show that the disincentive effect of UI benefit level changes increases with age.<sup>4</sup> Several papers analyze the interaction between various retirement rules and labor supply in Germany (see [Giesecke and Kind \(2013\)](#); [Boersch-Supan et al. \(2004\)](#); [Boersch-Supan and Hendrik \(2011\)](#), among others). We focus on quantifying the overall effect of UI extensions on labor supply for older workers, accounting for both extensive and well-documented (e.g. [Card et al., 2007](#); [Schmieder et al., 2012](#)), intensive margin behavior.<sup>5</sup>

Finally, our work suggests that German firms play a role in regulating how worker inflows into UI respond to UI extensions. [Jaeger et al. \(2017\)](#) study job destruction following improvement in workers' outside options using variation in UIB in Austria, finding that

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<sup>4</sup>In contrast, [Coile and Levine \(2007\)](#) find that UI generosity has little impact on retirement in the U.S.

<sup>5</sup>While our focus is to quantify the overall effect of UI extensions rather than discussing optimal policy, our analysis can be viewed as an important input into welfare computations. For papers on the optimal design of UI for older workers see, for example: [Hairault et al. \(2012\)](#); [Michelacci and Ruffo \(2015\)](#); [Inderbitzin et al. \(2016\)](#).

low surplus jobs are destroyed. A few studies have estimated the sensitivity of layoffs of older workers to monetary incentives, with some finding minor sensitivity (Behaghel et al., 2008; Johnston, 2017) but not others (Schnalzenberger and Winter-Ebmer, 2009). While we cannot separately identify the role of firms from that of workers, we present several pieces of suggestive evidence consistent with a non-negligible role for firms.

This paper proceeds in five steps. First, Section 2 describes the core features of the German UI and retirement institutions and discusses our data. In Section 3, we present reduced-form evidence of both intensive and extensive margin responses. We document bunching in UI inflows at the bridge-to-retirement kink and estimate intensive margin effects using RDs at all age cutoffs possible. In Section 4, we develop a full life cycle model of labor supply, job search, and retirement decisions. We estimate this model in Section 5 using a method-of-moments estimator and perform counterfactual policy simulations in Section 6. Section 7 concludes.

## 2 Institutional Background and Data

### 2.1 Unemployment Insurance

The German unemployment insurance system provides income replacement to eligible workers who lose their job. Before 1985, eligible workers were entitled to at most 12 months of benefits. Net replacement rates for UI are 67-68% for an individual with children and 60-63% for an individual without children and remained relatively stable over our study period (1980–present). Beginning in 1985, numerous reforms changed the maximum UI potential benefit duration (PBD) in a manner that tied the maximum PBD to recipients' exact age at the beginning of their UI spell.<sup>6</sup>

Reforms in 1985 and 1987 increased maximum PBDs for workers age 42 and older. The most generous PBD — up to 32 months — became available to workers aged 54 and up following the 1987 reform. Reforms in 1999 and 2006 gradually decreased the generosity of the system. In 1999, age thresholds were increased, and then, beginning in 2006, maximum PBD was reduced from 32 to 18 months for workers above age 55, while everyone else could only receive 12 months. There was a modest reversal of this trend in 2008 when PBD for workers above age 50 was extended again to between 15 and 24

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<sup>6</sup>See Hunt (1995); Fitzenberger and Wilke (2010) for an analysis and discussion of these reforms.

months (depending on age).

Appendix Figure F.1 plots maximum PBD by age for older workers in each different institutional regime.<sup>7</sup> Appendix Table G.1 provides details about each reform. These policy changes provide highly useful empirical variation, both at the age thresholds, and by changing incentives on when to enter unemployment if using unemployment as a bridge-to-retirement, as we elaborate on in the next section.

Individuals who exhausted UI benefits before 2005 and whose net liquid wealth fell below a certain threshold were eligible for unemployment assistance (UA). In principle, UA replacement rates were between 50% and 57% (in the presence of dependent children) but lower in practice due to deductions like spousal income (see Schmieder et al. (2012) for a discussion). From 2005 on, UA was replaced by unemployment insurance benefits 2 (UIB II), an entirely means-tested program. Both UA and UIB II are unlimited in duration but especially due to the means-testing a very imperfect substitute for UI for older workers.

## 2.2 Pension System and Early Retirement Via Unemployment

Germany has a pay-as-you-go public pension system with high effective replacement rates. Participation is mandatory, with the exception of civil servants and the self-employed, who are not covered by our data. Pension benefits depend on workers' earnings, years of contributions, an adjustment factor, and the type of pension claimed. In 2017, pension benefits averaged approximately 50% of earnings in the year prior to retirement (Deutsche Rentenversicherung (2017)).

For most of our sample period, the statutory retirement age (SRA) for a regular old age pension remained at 65, with the only prerequisite being 5 years of contributions. Beginning with the 1947 birth cohorts in 2012, the statutory retirement age was gradually raised, reaching age 67 for cohorts born after 1964. Early retirement was possible under several alternate pathways, each with its own eligibility conditions, a normal retirement age (NRA) —the age at which unpenalized pension payments can begin— and an early retirement age (ERA) — the earliest age at which pension payments can begin. For example, the long-term insured pathway, which required 35 years of contributions, had an ERA

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<sup>7</sup>We omit the short 1985 regime in the interest of brevity and because it appears that some individuals who entered UI in 1985 retroactively benefited from the UI extensions in later years. We only plot changes in maximum PBD from age 48 to 62 in Figure F.1 to focus on the changes in PBD at older ages.



of 63 throughout our study period. Most relevantly, the pension due to unemployment pathway (UI pathway) allowed for retirement following an unemployment spell.<sup>8</sup>

The UI pathway provided eligible workers with an option to retire early at the age of 60.<sup>9</sup> The eligibility requirements for this pathway were: 1) at least 15 years of contributions, at least 8 of which must have occurred in the past 10 years, and 2) being unemployed for at least one year after the age of 58 and a half. The generosity of UI benefits, combined with lenient job search requirements for older workers, made old-age pensions due to unemployment attractive. After the late 1980s, unemployed individuals aged 58 and older were exempt from actively looking for a job or other obligations.<sup>10</sup> Entering UI voluntarily is feasible in Germany and at most lightly penalized.<sup>11</sup>

This system incentivizes workers considering early retirement to time their entry into UI around the age that allows them to transition directly from UI to pensions, without any uncovered period. Put differently, the possibility of using UI as a bridge-to-retirement introduces a kink in a lifetime budget constraint relating lifetime income to the year of exit into UI.<sup>12</sup> This kink occurs at the bridge-to-retirement age:  $ERA - P$ , with  $P$  being the maximum PBD. Individuals retiring before the bridge age are forced to spend time relying on other income sources, such as a spouse or unemployment assistance (UA/UIB 2) before their pension, whereas individuals who leave at or after  $ERA - P$  can take the full UI duration and transition directly into pension. This reduces the value of an extra year of work after the kink, decreasing the slope of the budget constraint. In general, the

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<sup>8</sup>The full list of alternative pathways to retirement can be found in Appendix Table G.2 with associated discussion in Appendix Section C.1. These pathways are old-age pensions for long-term insured, old-age pensions for women, old-age pensions due to unemployment (and, later, part-time work) and old-age pensions for severely disabled persons (Boersch-Supan and Wilke, 2005)). We note that while early retirement due to disability is quantitatively important, Riphahn (1997) argues that in practice this is not a close substitute to retirement via unemployment and that retirement due to disability is in fact usually associated with a health shock.

<sup>9</sup>For the first three selected cohorts (1924, 1929 and 1935) we will focus on, the unpenalized NRA and ERA via the UI pathway was age 60. Persons satisfying the requirements could retire at 60 with no penalty, missing out only on the marginal benefit gains from a few additional years of pension contributions. For later cohorts, the NRA and ERA increase.

<sup>10</sup>This so-called "58er-Regelung" was formally introduced at the end of 1985 and in place until the end of 2007.

<sup>11</sup>A worker may be sanctioned if she quits a job voluntarily. These sanctions take the form of losing the first few weeks of benefits and vary from a 4-12 week penalty over the study period. Sanctions are not always applied and are insufficient to offset the appeal of using UI as a pathway into retirement.

<sup>12</sup>Appendix Figure F.3 plots the evolution of stylized lifetime budget constraints for select cohorts experiencing different UI and pension regimes. Appendix section C.2 contains detailed descriptions of how these budget sets are constructed.

size of the kink is exacerbated by the generosity of the UI system, the replacement gap between UI and UA/UIB 2, and how generously time on UI is counted towards pension contributions (in practice, unemployment counts as an 80% contribution year calculated on pre-unemployment wages). We show that UI entries react to the location and size of the kink in Section 3.

The NRA and ERA via the UI pathway remained at 60 until a 1992 reform. Cohorts born between January 1937 and December 1941 saw their NRA increase in steps by birth month from 60 to 65. While they could continue to retire at the ERA of 60, they now faced an actuarial adjustment in the form of a 0.3% permanent pension reduction per each month they retired in advance of the NRA. Cohorts born after January 1946 saw their ERA increase in steps by birth month from 60 to 63, ending with cohorts born in December 1948. This meant that these cohorts could no longer claim their pensions at age 60, even with a penalty. The ERA remained at age 63 for cohorts born between 1949 and 1951. The entire UI pathway was eliminated for cohorts born on or after January 1st 1952.

### **2.3 Firms, Unions and Works Councils**

Firms' incentives play an important role in workers' early exit from the labor force over our time period. After labor shortages in the 1960s and 1970s and extremely low unemployment rates ( $\sim 1\%$ ), the German labor market worsened sharply after the 1973 oil crisis and even more so during the 1982 recession. Shrinking labor demand led to fast-rising unemployment. Facing employment protection laws and powerful unions and work councils, firms and employer organizations sought to downsize employment through voluntary means by negotiating collective labor agreements (CLAs) and 'social plans' with their workforce. These agreements typically offered severance packages to older workers to voluntarily quit the firm and were often tied to a specific age threshold. These severance packages effectively constituted a way to buy workers out, and represented a form of a mutually agreed-upon ending to the employment relationship. Appendix C.3 provides some more details.

Whether or not a worker would be willing to accept a severance package would depend on the worker's outside option. In a labor market with high unemployment rates, like that in the 80s and 90s, exiting a job in one's late 50s often meant accepting never to find work again, making the availability of unemployment benefits a crucial factor. Firms

and labor unions who negotiated were aware of the institutional setting and would take the structure of UI benefits into account when negotiating workforce reductions and exit packages as part of CLAs. Indeed, [Trampusch \(2005a\)](#) states that as early as the 1970s, “employees agreed to voluntary redundancy (that is they agreed to become unemployed at age 59) and began to draw unemployment pension after the lapse of unemployment benefits... Enterprises made this option attractive by topping up unemployment benefits with redundancy payments... Social plans providing for early exit spread quickly during the employment crisis of the 1970s and 1980s... work councils were more than happy to facilitate the exit of older workers under the generous terms offered by the social security system. In fact they often found themselves under considerable pressure from older workers who wanted to retire under the existing provisions.”

These practices only gained steam in the 1980s and 90s as unemployment spiked, UI benefits were expanded to a maximum of 32 months, and CLAs with severance pay provisions proliferated. CLAs delineating retirement packages were often implemented at the sectoral level but could be specific to individual firms. The details of these CLAs, including the earliest exit age and the corresponding severance package, varied (see [Trampusch, 2005a, 2009](#)), but tended to take age discontinuities induced by the UI and public pension system into account. [Trampusch \(2005a\)](#) writes, “a side effect of the [law allowing older workers to draw unemployment benefits for a maximum of 32 months] was effectively to turn the previous ‘59 rule’ into a ‘57 rule’, as early retirement became even more attractive to firms. Now firms could retire employees at age 57. Workers could receive unemployment benefit [for] a period of thirty-two months, and then take advantage of the pension due to unemployment at age 60.” In cases where firms encourage workers to exit at those age thresholds with severance packages, one can view CLAs as a mechanism of how age discontinuities lead to extensive margin responses. Of course, other factors could also influence the precise details of CLAs and associated age limits, potentially leading to bunching in UI inflows at age thresholds not directly related to retirement or UI institutions.

CLAs using other forms of early retirement emerged as well and applied often to employees at age 55, see [Appendix C.3](#) for more detail.

## 2.4 Data

We use German Social Security data, the Integrated Employment Biographies (IEB) from the Institute for Employment Research. This data provides detailed information about employment start and end dates, earnings, unemployment insurance spells and various demographic characteristics for the years 1975 to 2017.

**Sample Selection** We use the labor market history of selected birth years to track individual labor market dynamics when approaching retirement age. While we ultimately use data from all birth cohorts from 1924–1964, for presentation purposes we focus on 6 cohorts that (a) represent periods of different UI generosity at older ages and (b) are not directly affected by a UI reform close to retirement: 1924, 1929, 1935, 1941, 1945, 1950, and 1952.<sup>13</sup> We primarily focus on West German men. We do not observe employment histories for East Germany prior to reunification. We focus on men because men and women faced different retirement rules. Specifically, women had their own retirement pathway that altered their incentives to enter UI compared to men (with women facing generally more muted incentives). We present the full suite of reduced form and structural results for women in the Appendix.

We select individuals with a stable employment history at age 50. Specifically, we select individuals who are employed on their 50th birthday and have worked continuously over the previous three years without any UI receipt. We only count periods of social security reliable employment, thereby excluding for example individuals who have only worked in marginal employment, or other non-standard employment relationships. The employment history restriction increases the likelihood that these individuals are eligible for the maximum possible UI PBD, which can require up to 6 years worked out of the previous seven years. In addition, we exclude some industries known for having special retirement policies or CLAs linked to age 55. Namely, we exclude mining and steel construction industries. For cohorts born in or after 1937, when CLAs expanded, we also exclude several additional industries, listed in Appendix A, with likely CLAs linked to early retirement at age 55.

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<sup>13</sup>The cohort-specific institutional features are summarized in table 1. We will discuss these features in the context of the empirical results in the next section.

**States and Transitions for a Monthly Balanced Panel** We generate a monthly balanced panel of each birth cohort that tracks an individual’s labor market status since age 50.<sup>14</sup> We center the data around the cohort- and individual-specific bridge to retirement age, so that the first month after the bridge to retirement age starts with the exact date an individual faces a bridge to retirement. For all months, we assign individuals to one of five exclusive labor market states. Individuals can be employed (E), which includes all social security reliable employment, or in registered unemployment (UI), which consists of all periods of UI receipt. In addition, individuals can be outside of these observed employment and unemployment states.<sup>15</sup> Here we distinguish between non-observed unemployment (Nu), which entails up to 3-month interruptions between E and U, and temporary withdrawal from the labor force (Nt), which includes temporary employment interruption as well as interruptions between E and UI lasting longer than three months. Finally, individuals can withdraw permanently from the labor force (Np), denoted by an exit from E or U that is not followed by any other E or UI spell. We construct all possible transitions between states where a transition is defined by comparing the current and previous state of an individual.

To plot UI inflows by age and to generate the moments used in structural estimation we condense these five states into three: Employment (E), Unemployment (UI or Nu), and Non-Employed (Nt or Np).<sup>16</sup>

**Regression Discontinuity Sample** We construct a separate inflow sample into UI receipt to study the intensive margin responses to PBD extensions via a regression discontinuity design. Our sample construction largely follows [Schmieder et al. \(2012\)](#), with the main difference that we also include older ages and exclude mining and steel sector for consistency reasons. The sample is very similar to the cohort data except that we require individuals to have a work history such that they would qualify for the maximum PBD on the more generous side of the age discontinuity. [Appendix B](#) discusses this sample in more detail.

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<sup>14</sup>We also generate a complementary quarterly panel that we use in the structural estimation.

<sup>15</sup>This includes individuals out of the labor force, in genuinely unobserved states such as retirement but also marginal employment or second-tier unemployment assistance that could be observed in the data but is not part of the E or UI definition.

<sup>16</sup>If workers are sanctioned at the beginning of UI entry, they appear as Nu in the data and the relevant transition from work to unemployment occurs at the E to Nu transition.

### 3 Reduced Form Evidence

This section documents how older workers respond to UI PBD and retirement policy changes. Section 3.1 shows that UI inflows spike at the bridge-to-retirement age. Section 3.2 presents regression discontinuity (RD) estimates of the effects of PBD extensions for older workers. Together, these UI inflows and corresponding bunching masses and our RD estimates provide the moments that underlie the structural estimation in Section 5.

#### 3.1 Graphical Evidence of Extensive Margin (UI Entry) Responses

First, we document the behavior of older individuals entering UI over three decades. We present evidence of sizable extensive margin UI responses at the bridge-to-retirement kink and show that UI inflows react to UI and retirement policy changes. Specifically, we document a spike in UI inflows at each bridge-to-retirement age: at 59 when the ERA was 60, and maximum PBD was 12 months, at 58 when maximum PBD was extended to 24 months, and at age 57 and 4 months when maximum PBD was extended to 32 months. As the NRA increases (increasing the pension penalty associated with exiting at the ERA), this bunching is reduced, and eventually, as the ERA increases, it dissipates.

We also see evidence of bunching at other thresholds, not all of which correspond to kinks or notches in our stylized budget sets. For example, beginning with the 1929 cohort, we see bunching into UI entries at age 55. While some of this could be round-number bunching or bunching at reference points, much of this is likely driven by specific collective labor agreements at the firm or sectoral level that specified retirement packages and ages. Indeed, this type of bunching is almost entirely absent in the years leading up to and including 1982, consistent with the timing of the first major CLAs specifying retirement ages (see [Trampusch et al., 2010](#)). The importance of these CLAs fades throughout the late 90s and early 2000s. Generally, the bunching at the kink into retirement exceeds bunching at these alternative thresholds. Nevertheless, the data points to an active role for firms, together with workers, in governing responses to UI extensions. Regardless of the source, it will be clear that changes in UI durations generate extensive margin responses.

Figure 2 shows the number of individuals entering UI by age for six select cohorts in our sample, each chosen to represent a different institutional regime (see Table 1). We opt to display these annual cohort-level graphs to keep retirement rules constant within-figure. When constructing cohort-by-cohort figures, the state of the economy is not fixed

at one point in time, so we also plot the prevailing West German unemployment rate at the time for reference. Furthermore, since UI rules changed over time (and not by cohort), UI entrants at different ages in the same cohort can have different PBDs (see Appendix Table G.1).<sup>17</sup> Graphs of UI entrants by calendar year offer different trade-offs but ultimately yield a similar picture and are available upon request. Appendix Figure F.7 complements Figure 2 by plotting mean non-employment duration (until age 63) by age for each cohort. We now discuss each cohort in turn.

**1924 Cohort** Figure 2 Panel (a) shows UI inflows for the 1924 cohort. Note that UI entries prior to age 59 rise with the unemployment rate (the dashed line). When this cohort was younger than age 61, their PBD was 12 months.<sup>18</sup> Cohorts born before 1937, including this cohort, could retire early and without penalties at age 60 following a year of unemployment insurance. Since PBD was 12 months for this cohort, individuals could enter UI at age 59 and subsequently retire 12 months later without gaps. This ‘bridge-to-retirement’ pathway is indicated by the red and blue shaded areas under the figure.

We observe clear bunching in UI entries at age 59, precisely the age at which individuals can transition into retirement immediately following UI expiration. Almost 4000 individuals (more than 3% of a cohort of 128,000 workers), enter UI in the exact month they turn 59, with elevated inflows in the subsequent months as well. There is no comparable bunching elsewhere. Appendix Figure F.7 panel (a) plots the average non-employment duration (until age 63) for the individuals in Figure 2 Panel (a). Nonemployment durations at age 59 are very close to the maximum of 48 months (that is from age 59 to age 63, where we censor the durations), supporting the idea that the vast majority of entrants are using UI as a bridge to retirement. Together, this is clear evidence of sizable, extensive margin responses to UI policy. This view is reinforced below, where we examine UI entries for later cohorts facing longer PBDs and hence kinks at different, earlier ages.

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<sup>17</sup>From the perspective of a single cohort, UI can change for two reasons. It can change at age cutoffs (represented by the dashed red lines in Figure 2) which can be anticipated years in advance. Alternatively, UI can change above a certain age in a cohort due to a policy change which would not necessarily be known before its implementation.

<sup>18</sup>On January 1st, 1985, max PBD was extended to 18 months. This means that when a person born on December 31st, 1924, turns 60 and a day, they would be eligible for 18 months of PBD. By age 61, everyone in the 1924 cohort would have been eligible for 18 months of PBD. This ‘entire-cohort eligibility’ point is indicated by the change in the lower, grey-shaded bars, which also show the later UI reforms.

**1929 Cohort** Figure 2 Panel (b) shows UI entries for the 1929 cohort. This cohort faces the same retirement institutions as the 1924 cohort but has longer PBDs in their late 50s. Specifically, those who enter UI at age 58 have 24 months of PBD. This shifts the ‘bridge-to-retirement’ age to 58, and indeed, we see clear bunching at age 58. Note that the UI retirement pathway also requires being unemployed for at least 12 months, implying there still is a small kink at age 59, and indeed, we continue to note some excess mass at 59.

This figure also clearly shows bunching in UI entries at other non-kink points, particularly at ages 55 and 57. These likely represent collective bargaining agreements to release or buy out workers once they turn 55 or 57. This also hints that the bunching at the bridge-to-retirement age is driven by joint decisions between firms and workers. Panel (b) of Appendix Figure F.7, which plots average non-employment duration, again suggests that almost all UI entrants at age 58 use UI as a bridge to retirement.

**1935 Cohort** The 1935 cohort continues to face the same retirement institutions as the prior cohorts but is entitled to even more generous UI. Workers entering UI at or after age 54 had a PBD of 32 months. Accordingly, Figure 2 Panel (c) shows that UI entries exhibit substantial bunching at precisely age 57 and 4 months (32 months before the early retirement age of 60). We continue to see some excess bunching at age 59 (given the UI pathway’s eligibility requirement of 12 months of UI) as well as at some other non-kink points. Panel (c) of Appendix Figure F.7 confirms that people entering at the bridge-to-retirement age remain non-employed for close to the maximum duration.

**1945 Cohort** The 1945 cohort faces less generous retirement rules. This cohort could still retire at the ERA of age 60 following a year of unemployment, but doing so meant accepting an 18% permanent pension reduction since the NRA was 65. The PBD remained at 32 months for workers above age 54. In Figure 2 Panel (d), we continue to see bunching at age 57 and 4 months, but the bunching mass is substantially smaller than it was for the 1935 cohort, consistent with the large penalty for retiring early. Moreover, in Appendix Figure F.7 Panel (d) we now see that average non-employment durations drop substantially at age 57 and 4 months relative to what they were for the 1935 cohort at the same age. This suggests that some workers are returning to work instead of retiring at the penalized ERA.



**1950 Cohort** The 1950 cohort faced both reduced PBD at later ages and stricter retirement laws. Individuals born in 1950 could no longer retire early via unemployment at 60, but instead, at the earliest, could draw pensions at age 63. They had to wait until age 65 to draw pensions without penalties (7.2% for retiring at 63). Figure 2 Panel (e) shows some bunching at 61, consistent with an early retirement age of 63 and the two years of PBD. Importantly, now that the bridge-to-retirement age is no longer at 60, the distribution of entries is now relatively smooth at ages 57-59.

**1952 Cohort** This cohort is no longer allowed to retire early via unemployment. However, individuals eligible for the old-age pension for the long-term insured, could still retire at age 63. Since many in our sample are likely eligible for the long term insured pathway, this cohort is not *effectively* that different from the 1950 cohort. Indeed, the distribution of UI entries continues to look relatively smooth prior to 61, tracking the official unemployment rate, and we continue to see some bunching at age 61.

We also note some bunching at age 58 (dashed red line), where PBDs are extended discontinuously. The 1952 cohort would have known about the age 58 PBD cutoff extending the PBD from 18 months to 24 months starting in 2008 (i.e., when they turn 56). We discuss UI entry responses to these discontinuous increases in PBD as a result of the various PBD age cutoffs further in Section 3.2.

Overall, we observe clear bunching into UI at the bridge-to-retirement age. The bunching mass responds to UI extensions. We also saw bunching at other kink points in the distribution, at the age 59 kink due to the requirement that UI spells be at least one year long prior to claiming retirement-via-UI, and on occasion at age cutoffs where PBDs are extended discontinuously. Finally, we also saw bunching at non-kink points related to CLAs, suggesting that the employer side plays an important role. While we cannot easily identify the extent to which responses come from workers or firms (or their representatives on the sector level), it is clear that a full accounting of the effects of UI extensions on non-employment needs to consider these extensive margin responses. Given that PBD extensions shift UI entries earlier (and many of these remain permanently non-employed), the non-employment effects of PBD extensions for older workers could be substantially larger than those for younger workers.

### 3.2 Regression Discontinuity Estimates of the Effects of PBD Extensions

In addition to changing UI inflows, PBD extensions also affect non-employment durations *conditional on entering UI*. These ‘intensive margin’ effects could vary with age and proximity to retirement. As in [Schmieder et al. \(2012\)](#), we exploit the numerous age cut-offs at which PBD increases discontinuously (see [Figure F.1](#)) in an RD design to estimate intensive-margin non-employment effects of UI extensions.<sup>19</sup> How these effects vary with age is interesting in its own right, but they also provide valuable reduced-form moments that discipline our structural estimation.

Starting in 1987, there are 12 age cutoffs across 4 distinct periods at which we can potentially estimate the non-employment effect of UI extensions using RDs (see [Appendix Table G.1](#)). These estimates require the standard RD assumptions, including no sorting into UI around age cutoffs. As we saw above, this is not always clearly satisfied at older ages. As a result and as discussed further below, we only report estimates for the 8 cut-offs below age 55 for which density violations appear minimal. [Appendix B](#) discusses the sample and cutoff selection in more detail.

At each age cutoff, we estimate the following RD specification:

$$y_{ia} = \delta \mathbf{1}(a_i \geq A) \Delta PBD + f(a) + X_i \beta + \varepsilon_{ia} \quad (1)$$

$y_{ia}$  is the non-employment duration (capped at 36) for individual  $i$  of age  $a$ ,  $a_i$  is the age at time of UI entry (measured on the daily level) and  $\mathbf{1}(a_i \geq A)$  is a dummy variable indicating that an individual is above the age threshold  $A$ , where benefits are extended discontinuously by  $\Delta PBD$  months. In this specification,  $\delta$  measures the effect of a one-month increase in PBD. We specify  $f(a)$  as a linear function while allowing different slopes on both sides of the cutoff.  $X_i$  is a vector of additional controls. We use a rectangular kernel and cluster standard errors on the day level. We set the bandwidth to two years but restrict it to one year on the right side of the 49 and 54 age cutoffs during the 1987-1999 period due to the presence of other discontinuities at 50 and 55.

[Figure F.21 a\)](#) — and [Appendix Table G.4](#) — shows RD estimates of the jump in the density at the age threshold. Consistent with ([Schmieder et al., 2012](#)), the UI entries and other pre-determined outcomes are smooth around the younger age cutoffs. In contrast,

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<sup>19</sup>While [Schmieder et al. \(2012\)](#) only analyzed age discontinuities up until age 49 and [Schmieder and Trenkle \(2015\)](#) at age 50, our contribution is to investigate discontinuities affecting workers in their early 50s.

and consistent with Section 3, sorting at the cutoff is a concern at the oldest age cutoffs. Consequently, we do not report RD estimates for the age 55 or higher cutoffs. Moreover, to minimize any potential bias due to sorting at the younger cutoffs, we exclude 2 months on each side of the cutoff – the donut hole – in all our regressions. Self-contained Appendix B contains additional details as well as validity and robustness checks.

Figure 4 provides two example figures of our RD estimates, plotting mean non-employment duration (capped at 36 months) by age around the age 54 cutoff for the 1987 - 1994 period and around the 52 cutoff for the 1999-2006 period. Figure F.21 b) plots the 8 RD estimates for different age cutoffs with and without controls. These estimates are also reported in Table 2. Each dot in the figures corresponds to a marginal effect of one additional month of potential UI duration estimated at an age cutoff. The estimates average 0.09, suggesting that for each month of additional UI, affected workers spend around three more days in non-employment.<sup>20</sup> Estimates are relatively insensitive to controls. We do not have sufficient power to detect any clear variation by age, though we obtain the largest point estimates at the older ages. Importantly, we will use the 0.128 estimate at the age 52 cutoff between 1999 and 2006 as a target moment in our structural estimation.

## 4 Dynamic Labor Supply Model

In this section, we use the reduced form moments to estimate a life cycle model of labor supply, job search, and retirement decisions utilizing a method of moments estimator. Our setting is well suited to a structural approach for several reasons. First, the setting provides clear economic incentives and interactions between incentives that can be captured in a fairly standard model. Second, we have clean policy variations and empirical moments to identify the model's key parameters and discipline the estimation approach. Third, several reforms allow us to test our model's out-of-sample performance. And fourth, there is a clear value added to having a model for counterfactual and out-of-sample analysis and quantifying the economic importance of different channels. Our model also allows us to quantify how much of the changes in the unemployment rates of older workers over the past decades in Germany can be explained by changes in UI generosity and retirement institutions over this period.

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<sup>20</sup>Note that the point estimates are slightly smaller than in Schmieder et al. (2012), which is mostly due to our sample of only men. Appendix Table G.3 shows larger effects for women.

## 4.1 Model Set Up

The model is designed to capture work and retirement decisions over the lifecycle and includes unemployment and job search dynamics. In contrast to previous research with life cycle models that typically allow for a single or sometimes two unemployment states with no dynamics, we model unemployment as a fully dynamic process. In particular, this approach enables us to capture the duration of UI benefits and labor supply responses to changes in the structure of UI in a natural way.<sup>21</sup> This has the added benefit that our parameter estimates for the job search part can be compared with previous estimates of job search models (e.g., [Paserman, 2008](#); [DellaVigna et al., 2017, 2022](#)).

**States and Value Functions.** Workers can be in one of three states: employed ( $E$ ), unemployed ( $U$ ), or out of the labor force ( $O$ ). We assume that once a worker drops out of the labor force, she will not return; hence  $O$  is an absorbing state. We call a worker non-employed  $N$  if the worker is either unemployed or out of the labor force.

We assume that workers produce output  $p_t$  in each period, where  $p_t$  is i.i.d. according to some distribution  $F(p)$ . A critical state variable in our model is the total unemployment duration of a worker  $d^U$ . In practice, we will estimate our model starting at age 50, so that  $d^U$  will be the duration in unemployment since then. To keep the state space manageable, we also assume that workers initially are eligible to the maximum benefit duration but do not reaccumulate benefit eligibility if they are reemployed after losing a job. Under this assumption  $d^U$  is sufficient to both calculate remaining UI benefit durations for each individual as well as the pension of an individual if the person retires. We can therefore write the value functions as functions of  $p_t$  and  $d^U$ .  $d^U$  is deterministic, while  $p_t$  is uncertain.<sup>22</sup>

Workers have a utility function  $u(\cdot)$ , are paid  $w_t(\cdot)$ , and experience disutility from working ( $\eta$ ). The value of employment is:

$$V_t^E(p_t, d^U) = u(w_t(p_t, d^U)) - \eta + \beta E_{p_{t+1}} [\max \{V_{t+1}^E(p_{t+1}, d^U), V_{t+1}^N(d^U)\}] \quad (2)$$

<sup>21</sup>Other structural life cycle papers ([Haan and Prowse, 2010](#); [García-Pérez and Sánchez-Martín, 2015](#); [Michelacci and Ruffo, 2015](#)) typically assume workers receive UI forever or model UI as a Markov process with a fixed transition probability to exhaustion.

<sup>22</sup>A full accounting of the benefit eligibility in the presence of multiple unemployment spells would require to separately keep track of  $d^U$  as well as the remaining benefit duration in each unemployment spell and employment duration in each employment spell. This quickly becomes computationally very challenging due to the curse of dimensionality. As long as repeated unemployment spells with long in-between employment spells are rare, which they are in practice, our approach is only a very minor simplification that vastly reduces computational complexity.

For tractability, we will assume that workers have all the bargaining power and firms make zero profits, so that  $w_t = p_t$  in all periods.<sup>23</sup> Workers will separate from their job whenever the expected value of future non-employment exceeds that of employment. This could occur for several reasons: workers could receive a low productivity draw ( $p_t$ ) such that the employment relationship is no longer better than the worker's outside option. Alternatively, outside options could improve, such as an increase in UI or retirement benefits, which can push up  $V_t^N(d^U)$  for workers close to the retirement age and increase the rate of job separations. We also allow for exogenous job destruction at the rate  $\Lambda_t$ . To operationalize this, we assume that workers face a (large) negative productivity shock ( $-L$ ) with probability  $\Lambda_t$ . Otherwise, they draw a productivity level  $p_t$  from a lognormal distribution. These distributional assumptions enable us to derive closed form solutions to all eventual transitions generated by the model.

When workers enter unemployment they engage in costly job search and receive payments  $B(d^U)$ . If the individual still has UI benefits remaining ( $d^U < P$ ), she will receive UI benefits ( $B(d^U) = b$ ). If not, the individual receives  $y^o$  ( $B(d^U) = y^o$ ), which can be interpreted as unemployment assistance. An unemployed individual searches for a job and chooses an optimal level of search effort  $s$  which is normalized to the probability of finding a job. Generating search effort comes at a cost  $\psi(s)$  which is increasing and convex. Finally, whether or not an individual receives a job offer, she can decide to retire at the end of the period. If she remains unemployed  $d^U$  increases by one period. The value of unemployment is thus:

$$V_t^U(d^U) = u(B(d^U)) + \max_s \{ \beta s E_{p_{t+1}} \max [V_{t+1}^E(p_{t+1}, d^U + 1), V_{t+1}^N(p_{t+1}, d^U + 1)] + \beta(1-s) E_{p_{t+1}} V_{t+1}^N(d^U + 1) - \psi_t(s) \} \quad (3)$$

For increasing and convex  $\psi(s)$  at an interior solution, optimal search effort will be given by  $s^* = \psi'^{-1} (\beta E \max [V_{t+1}^E(p_{t+1}, d^U + 1), V_{t+1}^N(d^U + 1)] - \beta V_{t+1}^N(d^U + 1))$ .

At any point, a worker can choose to transition to being out of the labor force  $O$ , which is an absorbing state. The value of  $O$  depends primarily on the value of one's pension  $y_t^p$  as determined by prevailing retirement institutions.  $y_t^p$  will depend on work history ( $d^U$ ) and age at which the worker retires. Specifically, for a worker who lives until  $T^{Last}$  and is

<sup>23</sup>Alternatively one could assume Nash bargaining over the surplus, but in that case there is now closed form solution for the expected value of employment and solving the model becomes computationally challenging. Since we are trying to match wages, this simplification strikes us as a worthwhile trade-off.

eligible to receive pension at  $T^{ERA}$ , the value function for being out of the labor force is:

$$V_t^O(d^U) = \begin{cases} \sum_{k=t}^{T^{ERA}} \beta^{k-t} u(y^o) + \sum_{k=T^{ERA}}^{T^{Last}} \beta^{k-t} u(y_t^p) & t \leq T^{ERA} \\ \sum_{k=t}^{T^{Last}} \beta^{k-t} u(y_t^p) & t > T^{ERA} \end{cases} \quad (4)$$

The value of the pension depends on the relevant, cohort-specific retirement institutions in addition to the individuals work history ( $d^U$ ). Individuals accrue pension benefits while they work or are on UI benefits (at 80%), but not otherwise. People retire at the ERA but receive a penalty if they retire before the NRA, starting with the 1937 cohort. We assume all individuals in our sample are eligible for the long-term insured retirement pathway and the retirement via UI pathway as long as they have one year of unemployment history ( $d^U$ ). We allow individuals to choose the best retirement option available. In Appendix Section E.5, we outline in detail how we calculate  $V_t^O$  for each cohort.

Finally, the value of non-employment is defined as:

$$V_t^N(d^U) = \max(V_t^U(d^U), V_t^O(d^U)) \quad (5)$$

**Heterogeneity in the disutility of work.** Under our distributional and functional form assumptions (detailed in Appendix Section D.3.), the preceding model generates closed-form solutions for all transitions between states (e.g.  $E$  to  $U$ ) and can be used to calculate the expected non-employment duration for a given value of  $\eta$ . We allow for heterogeneity (beyond randomness from the productivity distribution  $F(p)$ ), by modelling different types of workers with varying levels of disutility of work  $\eta$ . We assume that individual workers draw their  $\eta$  from a cohort-specific distribution and integrate transitions and non-employment durations over the entire distribution. Specifically, we will assume that  $\eta$  is normally distributed with mean  $\bar{\eta}_{cohort}$  and a fixed standard deviation  $\eta_{sd}$  across cohorts. We implement this in practice by simulating the model for 25 different values of  $\eta$  and use Simpson's rule to approximate the full integral over the  $\eta$  distribution whenever we calculate cohort-level transitions and non-employment durations.

## 4.2 Assumptions and Estimation

Here we lay out the functional forms and distributional assumptions underlying our baseline model. Productivity  $p_t$  will be drawn from a mixture distribution in which

workers have  $\Lambda_t$  probability of facing a (large) negative productivity shock ( $-L$ ) that destroys the job with certainty. Meanwhile, with probability  $1 - \Lambda_t$ , workers draw a productivity level  $p_t$  from a lognormal distribution. This allows for exogenous job destruction at the rate  $\Lambda_t$ . Formally,  $p_t$  is drawn from a mixture distribution defined by  $f(\ln(p_t)) = \Lambda_t f^L(\ln(p_t)) + (1 - \Lambda_t) f_{p,\sigma_p}^N(\ln(p_t))$  where  $f^L(\ln(p_t)) = 1$  if  $\ln(p_t) = -L$  and  $f^L(\ln(p_t)) = 0$  otherwise and  $f_{p,\sigma_p}^N$  is a normal PDF with mean  $p$  and standard deviation  $\sigma_p$ . This allows for closed form solutions to all eventual transitions generated by the model. For sufficiently large  $L$  the CDF of the mixture variable is effectively  $F(\ln(p_t)) = \Lambda_t(1) + (1 - \Lambda_t) F_{p,\sigma_p}^N(\ln(p_t))$  where  $F_{p,\sigma_p}^N$  is the normal CDF with mean  $p$  and standard deviation  $\sigma_p$ .<sup>24</sup> In practice, we will allow the exogenous job destruction rate  $\Lambda_t$  to vary with the national male unemployment rate (UR). Specifically  $\Lambda_t$  will be a logistic function  $\Lambda_t = \frac{1}{1+e^{-(\lambda_1+\lambda_2\bar{U}R_t+\lambda_3\Delta UR_t)}}$  with parameters  $\lambda_1$  to  $\lambda_3$  allowing  $\Lambda_t$  to vary with the level and year-on-year change in the national male unemployment rate. We assume workers have log utility  $u(\cdot) = \ln(\cdot)$ . Firms make zero profits and hence pay the worker  $w_t = p_t$  in all periods. Workers draw disutility  $\eta$  from a normal distribution ( $\eta \sim N(\eta_{mean,cohort}, \eta_{sd})$ ). The search cost function is based on [Della Vigna et al. \(2022\)](#) with some added flexibility. Specifically we assume:

$$\psi_t = k_0 + k_1 \mathbf{1}(dU = 0) + e^{k_2 \times dU} \times k_3 \frac{s^{1+\gamma}}{1+\gamma} \quad (6)$$

Where  $k_0$  is a fixed cost of being in unemployment,  $k_1$  a fixed cost of entering unemployment the first time,  $k_2$  allows search to become more costly over the unemployment spell, while  $k_3$  and  $\gamma$  govern the slope and curvature of the job search function.

We estimate the model structurally, using a minimum distance estimator to match our key empirical reduced form moments. Denote as  $\xi$  the parameters of the structural model. Furthermore, let  $m(\xi)$  be the vector of moments predicted by the model as a function of the parameters  $\xi$ , and by  $\hat{m}$  the vector of observed moments. The estimator chooses the parameters  $\hat{\xi}$  that minimize the distance  $(m(\hat{\xi}) - \hat{m})' W (m(\hat{\xi}) - \hat{m})$  where  $W$  is a weighting matrix.

As moments we focus on 3 cohorts: 1929, 1935 and 1950, where we match the quarterly

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<sup>24</sup>This definition applies for the relevant sample space of the lognormal part of the distribution (which is assumed positive), and it assumes that the CDF of the degenerated random variable is equal to 1 for (almost) every value of that sample space.

E to U flows and average non-employment durations (until age 63). Furthermore, we use the RD estimate for  $dD/dP$  for men at the age 52 cutoff of 0.128 (Table 2) to inform the intensive margin effect of UI for the 1950 cohort.

Our weighting matrix is block diagonal and uses a full covariance/variance matrix for all  $E$  to  $U$  transitions based on 200 simulations using the empirical data, and a diagonal variance matrix for non-employment durations and  $\frac{\partial N_{onemp}}{\partial P}$  based on the standard errors obtained when estimating these in the data. For the intensive margin RD moment, we use a larger weight (100x) since this is a causal estimate that we have significant confidence in given the research in this paper and many other well-identified estimates from the literature and we want to make sure our fitted model generates realistic predictions for intensive margin responses.<sup>25</sup>

As a second step, we refit our model to all other cohorts. We estimate a single parameter per cohort, which is the mean of that cohort's  $\eta$  distribution ( $\eta_{mean,cohort}$ ). In this estimation exercise, our target moments are transitions from  $E$  to  $U$  and non-employment durations. Since we have already estimated this parameter within our in-sample cohorts, refitting does not change the model parameters for our in-sample cohorts, but allows different cohorts to have different outside options / workforce attachment that are not otherwise captured by retirement and UI institutions.

We estimate the following parameters: The standard deviation of the productivity distribution ( $\sigma_p$ ); three parameters that allow the exogenous job destruction rate  $\Lambda_t$  to vary with the level and year-on-year change in the national male unemployment rate ( $\lambda_1 - \lambda_3$ ); five parameters in the search cost function ( $k_0 - k_3$ , and  $\gamma$ ); and four parameters governing the  $\eta$  distribution:  $\bar{\eta}_{1929}$ ,  $\bar{\eta}_{1935}$ ,  $\bar{\eta}_{1950}$ , and  $\eta_{sd}$  (which does not vary by cohort). The institutional parameters used in the model are outlined in Table 1.

The model is written in Python, using the package Numba to obtain fast numerical code via pre-compilation. We minimize the objective function using the optimization package **estimagic** (Gabler, 2022) to search for global minima using a multi-start algorithm paired with two local minimizers: Derivative-Free Optimizer for Least-Squares Minimization (DFO-LS) (Cartis et al., 2018) and POUNDERS (Wild, 2015). See Appendix E.3 for more details.

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<sup>25</sup>This upweighting is in the same spirit as Armstrong and Kolesár (2021) and DellaVigna et al. (2022).



## 5 Estimation Results

Figure 5 gauges our estimated model's fit by comparing simulated  $E$  to  $U$  transitions and simulated non-employment duration to their empirical counterparts for the three cohorts matched in the estimation (1929, 1935 and 1950). Overall, our model captures the key empirical patterns of interest. It predicts UI inflow bunching at the bridge to retirement age and generally gets the size of the bunching mass right. It captures overall  $E$  to  $U$  transition trends and it matches older workers' actual mean non-employment duration. The model also matches other relevant data features, such as the dip in non-employment duration for the 1950 cohort between ages 56 and 58 when PBD decreased. However, while the model fits the key patterns of interest well, it does not perfectly fit all the empirical moments' features. For instance, the model systematically under-fits UI inflow spikes at ages prior to the bridge retirement age (e.g. 55 and 57 for the 1929 cohort). As discussed in Section 3 in reference to Figure 2, these spikes are most likely due to collective labor agreements linked to specific ages but not to any corresponding kink in these individual's budget sets. Consequently, nothing in our model can (nor should) generate bunching at these points. While the model does well at predicting non-employment duration for workers close to the bridge-retirement, it has difficulty matching non-employment duration at younger ages, over-fitting non-employment duration for the 1929 cohort and under-fitting them for the 1950 cohort.

In addition to matching  $E$  to  $U$  transition and non-employment duration moments, our model also targets our RD estimate of  $\frac{\partial Nonemp}{\partial P}$  at age 52 for the 1952 cohort (0.128) as an unweighted moment. The model fits this RD moment very well (0.126) indicating that younger workers non-employment responses to UI extensions in our model will be close to what we would predict using reduced form RD evidence.

Appendix Table G.10 summarizes the overall SSE as well as its breakdown across all three cohorts and types of matched moments. SSEs are relatively similar across cohorts, with the highest SSE for the 1935 cohort. SSEs from  $E$  to  $U$  transitions are typically larger than those from nonemployment durations. Note that nonemployment durations at younger ages tend to be measured with a bit more noise in the empirical data, and hence are implicitly given less weight than at older ages. Consistent with the model fitting RD moments well, SSEs from  $\frac{\partial Nonemp}{\partial P}$  are negligible.

Table G.11 Column (1) shows our model's estimated parameters and corresponding

standard errors. Standard errors tend to be small, suggesting that parameters are locally identified. While our parameters are generally not directly comparable to estimates in other settings, our search cost function shares some features with those in DellaVigna et al. (2017, 2022). We estimate the curvature of the search cost function  $\gamma$  (i.e. the inverse of the elasticity of search effort with respect to the net value of employment) to be 0.851, which is comparable to the single type  $\delta$  discounting reference-dependent model estimate in DellaVigna et al. (2017) (0.81) as well as to the composite curvature in DellaVigna et al. (2022) estimated on German data. The slope of the search cost function (226) lies between that of the high cost searcher in a standard 3 type model and the 1 type reference dependent model in DellaVigna et al. (2017). The estimated duration dependence is larger in our setting, implying higher search costs later on in an unemployment spell, perhaps in part because we focus on older workers closer to retirement.

In order to simulate our model for out-of-sample cohorts we require estimates of  $\bar{\eta}_{cohort}$ , i.e. the cohort-specific average disutility of work. As discussed in Section 4, for all out-of-sample cohorts between 1924 and 1963, we estimate a cohort-specific  $\bar{\eta}$  by refitting the model to match that cohort's non-employment duration and transitions, holding all other parameters constant. Appendix Figure E.35 plots estimated  $\bar{\eta}$  across all cohorts, revealing a relatively continuous pattern, with birth cohorts around 1935 having the highest disutility of work. The trends in  $\bar{\eta}$  across early cohorts mirror the changes in the national unemployment between the mid 80s and early 2000s (approximately when these workers turned 60). This is consistent with  $\bar{\eta}$  helping our model capture changes in the outside options of workers that are not otherwise well captured by the model's fixed productivity distribution or job destruction rate.

Figure 6 shows how well the model performs out of sample for select cohorts. We focus on the remaining three cohorts in Figure 2: the 1924, 1945, and 1952 cohorts, which faced different UI and retirement institutions. Despite using parameters estimated from other cohorts, our model performs well in fitting the broad empirical patterns of interest, matching overall UI inflows, the spike in UI inflows at the bridge-to-retirement age, and nonemployment duration relatively well. However, the model still struggles to capture spikes in inflows prior the bridge to retirement and underfits nonemployment duration at younger ages for the older cohorts. Table G.10 shows that SSEs are comparable across both in sample and out of sample cohorts.

Figure 6 also performs a counterfactual exercise that illustrates how the model works.

We simulate a counterfactual in which the PBD is one year longer for all individuals. Using the 1945 cohort as an example (panels c and d), we can see how this extension affects UI entries and non-employment duration at different ages. For those whose inflows are unaffected by this extension, for example younger workers who experience an exogenous job loss, the effect should be similar to the standard  $\frac{\partial N_{onemp}}{\partial P}$  effect estimated in the RDs. Using the 0.128 estimate at age 52, we might expect average nonemployment duration to increase by 1.5 months around age 52 (and this is indeed what we see in panel (d)). For those closer to retirement age, the PBD extension moves the bridge-to-retirement left by one year, causing some (but not necessarily all) to enter UI up to one year earlier. Since these individuals who exit remain non-employed until retirement, this creates a massive increase in non-employment duration at age 56 and 4 months (as compared to 57 and 4 months initially). At older ages, the vast majority of UI entries stay non-employed until retirement anyway, so intensive margin effect of PBD extensions will matter little. Table G.10 Panel B shows simulated  $\frac{\partial N_{onemp}}{\partial P}$  at different ages holding disutility of work constant, and reveals exactly what we expect.  $\frac{\partial N_{onemp}}{\partial P}$  is close to 0.128 initially, and perhaps increasing somewhat with age (a pattern also seen in Table 2, albeit noisily). At ages closer to the bridge to retirement age,  $\frac{\partial N_{onemp}}{\partial P}$  spikes upwards, since, in the extreme case, a 1 month extension can induce everyone to just leave 1 month earlier and have 1 month longer non-employment duration. At the oldest ages (prior to 1950 and 1952 when the earliest possible retirement age was much later)  $\frac{\partial N_{onemp}}{\partial P}$  is 0, since everyone who enters UI at these ages stays non-employed until age 63 regardless of  $P$ . Overall, this counterfactual illustrates the mechanics of our model and how it allows for a range of responses to policy changes across the age distribution.

The key objective of our model is to quantify the role various institutional changes played in shaping the striking increase and decrease of the unemployment rate for workers close to retirement, as depicted in Figure 1. To this end, we simulate our model for all birth cohorts from 1924 to 1963 and obtain the resulting  $E$  to  $U$  transitions and non-employment durations. We then use these transitions and non-employment durations to predict the share of workers who are unemployed for each cohort  $\times$  year cell.<sup>26</sup> Consequently, at any given point in calendar time (e.g. calendar year) we can aggregate

<sup>26</sup>To simplify this procedure and to make it directly comparable with what we can easily export from the admin data, we do this calculation assuming a constant hazard of exiting unemployment, rather than allowing for the full duration dependence. By applying this approach uniformly to both the model simulations and empirical moments, we ensure that the two unemployment rates are directly comparable.

predicted unemployment shares for any given age range. We focus on ages 52-55 and 56-59.<sup>27</sup> We perform this exercise both using our model's simulated  $E$  to  $U$  transitions and non-employment duration, as well as separately using the empirical transitions and non-employment duration.

Figure 7 panel (a) shows the empirical and simulated unemployment rates (as defined above) separately for each age group. The empirical unemployment rates we construct roughly follow the OECD unemployment rates reported in Figure 1. Our model fits the empirical pattern remarkably well. Notice that this exercise also serves as a joint test of fit across all cohorts' non-employment duration and transitions. At younger ages we fit the empirical pattern very closely. At the older ages we tend to under-fit the empirical unemployment rate by up to 2 percentage points. This is especially clear in the later years where we tend to systematically under-estimate non-employment duration, and in some of the earliest years where we under-fit the bunching mass at the bridge to retirement. Nevertheless, given that we fit a relatively parsimonious model to 40 cohorts of data, holding all but one parameter constant, the model captures the key patterns in both the empirical and OECD data very well. Specifically, the model captures the striking 10pp. rise in the unemployment rate of workers aged 56-59 between 1983 and 1994 and its contrast with the much smaller rise in the unemployment rate of younger workers over the same period. It also captures the equally striking decline in the unemployment rate of older workers between 1994 and the mid-2000s, over a time period when the unemployment rate of younger workers barely changed.

We can now explore how counterfactual scenarios affect not just the cohort specific moments, but how they change these overall unemployment rates. Panel (b) of Figure 7 revisits the exercise from Figure 6 of increasing PBD by one year for everyone. Consistent with the changes we saw for the select cohorts in Figure 6, we find that extending PBD by one year for everyone has a limited effect on the unemployment rate of those aged 52-55. The PBD extension has close to no effect on these workers' inflows into UI, but has the standard effect of lengthening non-employment durations conditional on entry. As a result, simulated unemployment rates increase, but only by a modest amount (around 0.3pp in 1994, see Table 3). In stark contrast, this change increases the unemployment rate of older workers by close to 2pp in 1994 (see Table 3), as many now enter UI a full year

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<sup>27</sup>Since everyone in the empirical data is employed at age 50, we prefer starting at age 52 to allow some time for unemployment spells to begin.

earlier at the bridge-to-retirement. While this serves to illustrate the mechanics of our model and is an important result in and of itself, we now turn to a series of more specific policy simulations that aim to both explain the rapid rise and fall of old age unemployment in Germany over the 1990s and 2000s and to illustrate how the non-employment effects of UI extensions depend on and interact with retirement institutions.

## 6 Policy Simulations

We are interested both in explaining how UI and retirement policy changes shaped the historical evolution of UI inflows and non-employment durations as well as in uncovering broader lessons about how the non-employment effects of UI extensions depend on features of other, non-UI, institutions. First, we assess the extent to which UI and retirement policy changes caused the massive rise and later decline of unemployment rates among workers 55 and older in the mid 1990s. While time varying economic conditions clearly mattered, PBD extensions contributed significantly to rising unemployment. Stricter retirement policies contributed to the eventual decline in older workers' unemployment rates. Second, we are interested in the interaction between the UI and pension system. We ask how the non-employment effect of UI extensions for older workers taking pension institutions as given differs when pension institutions change.

### 6.1 Counterfactual Policies

Figures 8 and 9 conduct a variety of counterfactual policy simulations to answer these questions. First, we investigate how the rise in unemployment among older workers would have been had maximum PBD remained at the 1984 level of 12 months, rather than increasing to 24 and eventually 32 months. Panels a) and b) of Figure 8 show, in the red dash-dotted line, what the 1935 cohort's UI inflows and non-employment duration would have looked like under the counterfactual scenario. We find that keeping PBD fixed at 12 would have massively reduced non-employment duration for workers in their late 50s, as the bridge-to-retirement age would have remained at age 59. Figure 9 panel a) shows how keeping PBD fixed at 12 affects the overall unemployment rate of younger and older workers from all cohorts. We find, at the peak in 1994, unemployment rates of workers aged 56-59 would have been 5.1pp lower (see Table 3). In other words, the increases in PBD explain 5.1pp of the 9.7pp (or 53%) increase in the unemployment rate from 1983

to 1994. In contrast, the effects of PBD extensions on younger and older ages are much more muted, though for different reasons. Table 3 shows that, had PBD remained at 12, the unemployment rate of workers aged 52-55 would have been 0.3pp lower in 1994, and the unemployment rate of workers aged 60-62 would have been 0.2pp lower in 1994. For younger ages the PBD change did not affect inflows, so the change in the unemployment rate is close to what we would have expected from RD estimates of  $\frac{\partial Nonemp}{\partial P}$ . In contrast, workers who entered UI in their 60s already remained non-employed until retirement, leaving a change in inflows as the only margin of adjustment. While inflows increase somewhat at these later ages (as in Figure 9 panel (a)), entering UI so close to retirement is relatively unappealing. Overall, while other factors including changes in the broader economic environment clearly mattered, Germany's PBD increases played a large role in increasing the unemployment rate of workers in their late 50s in the early 1990s by shifting the bridge-to-retirement leftwards.

In Figure 9 panel b), we consider an alternative policy simulation that leaves PBD to evolve as it did in real life but instead imagines that the retirement via UI pathway never existed, making age 63 the earliest possible retirement age available for all birth cohorts. It is of course still possible to bridge into retirement at age 63 less maximum PBD, for example 60 and 4 months for the 1935 cohort when max PBD was 32 months, but this would primarily affect UI inflows of workers 60 and up. In Figure 8 panel a), the green dashed line shows how the 1935 cohort would have behaved had the UI pathway been closed. While there is still a lot of bunching at 60 and 4 months, this policy would have greatly reduced the non-employment duration of workers aged 60 and below. Consequently, Figure 9 panel b), which combines model simulations from all birth cohorts, shows that closing the retirement-via-UI pathway would have had a dramatic impact on the unemployment rates of workers aged 56-59 prior to 2006.<sup>28</sup> Had the retirement-via-UI pathway with an ERA of 60 not been available to workers in pre-1946 birth cohorts, older workers' unemployment rates would have been more comparable to those of younger workers, despite Germany's large UI reforms. Older workers unemployment rates would still have increased faster than those of younger workers during the PBD extension years (consistent with higher  $\frac{\partial Nonemp}{\partial P}$  and potentially a long left tail to the bunching around the bridge

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<sup>28</sup>The convergence in the unemployment rate after 2006 stems from the fact that the ERA via the UI pathway increased from age 60 to 63 between the 1946 (aged 60 in 2006) and 1948 birth cohorts, and was formally closed starting with the 1952 cohort.

to retirement), but these differences would have been far less dramatic. As such, retirement institutions clearly shape the effects of UI extensions on workers at various ages.

If maximum PBD changes helped explain much of the increase in the unemployment rate of older workers, what explained its recent decline? We consider a range of potential policy explanations. In 1994 institutions were near their most generous. Workers aged 58 in 1994 (1936 cohort) had a maximum PBD of 32 months and could retire via-UI at age 60 without penalty. Thereafter, PBDs eventually decrease, pension penalties for retiring at age 60 start to kick in, and the earliest possible age for retirement via UI increases. In order to understand how each of these changes might have mattered in isolation, Figure 9 panel c), shows how each separate component of these reforms would have affected unemployment rates (Figure 8 shows how these policies would have affected the 1952 cohort). First, the dashed blue line shows that had all institutions remained fixed at their (generous) 1994 levels the unemployment rate would have only declined by 7.9pp between 1994 and 2014 (due to non-policy or economic reasons) instead of declining by 11.9pp (the solid, dark blue line). Thus, the retirement and UI policy changes account for 4pp (or 34%) of the observed decline between 1994 and 2014 (see also Table 3). The dotted yellow line shows what would have happened had only PBD changed, but not retirement institutions. The 2006 reform that reduced PBD would have reduced the unemployment of older workers by 0.9pp relative to holding all institutions fixed at their 1994 levels. The dashed green line shows what would have happened had only the penalty for retiring via UI at 60 been implemented, but not the PBD nor retirement age changes. The penalty alone accounts for about 1.3pp of the decline relative to holding 1994 institutions fixed. As such, the penalty has a similar bite to changing PBD. Finally, the purple line shows that simply increasing the earliest possible age for retirement via UI (which affected birth cohorts after 1945) would have had a large 3.7pp effect on unemployment rates. This is comparable to the 4pp effect of changing all institutions. As can be seen in Figure 8, increasing the ERA UI age basically eliminates bunching in inflows at ages below 60.

## 6.2 Robustness

We probe the robustness of our conclusions regarding the various policy counterfactuals. Table 4 re-estimates our model under 5 alternative modeling choices and repeats our policy simulations for each of these alternate models. Columns (2)-(4) consider alternate

search cost functions. Column (2) uses a linear instead of exponential specification for duration dependence ( $k_2$ ), column (3) shuts down duration dependence entirely, and column (4) shuts down the fixed cost of UI entry ( $k_1 = 0$ ). Column (5) re-estimates the entire model with a single, as opposed to cohort-specific, mean for the disutility of work ( $\bar{\eta}$ ). This means that the entire model is only ever fit to our three main cohorts and there is no refitting whatsoever across all the other cohorts. Column (6) estimates the discount factor  $\beta$  as opposed to taking it as given. While overall SSE unsurprisingly drops without a fixed cost of entering UI and without cohort specific  $\bar{\eta}$ , our key policy takeaways remain broadly stable. PBD changes continue to explain a large portion of the rise in the unemployment of older workers from 1983-1984. All UI and retirement institutional changes explain a sizable portion of the overall reduction in the unemployment of older workers between 1994 and 2014, with each individual component of these policy changes explaining relatively similar shares as in our baseline. The constant  $\bar{\eta}$  model attributes even greater importance to PBD changes than our baseline.

### 6.3 Discussion

These policy counterfactuals leave us with several takeaways. First, ignoring pension institutions and just focusing on the effects of PBD changes, we note that the non-employment effects of UI extensions for older workers are historically much larger than what we might have naively predicted by applying RD estimates from younger workers to older workers (e.g. [Schmieder et al. \(2012\)](#)). PBD extensions explain over 50% of the increase in the unemployment rates of older workers between 1983 and 1994. Had retirement institutions stayed constant at their 1994 levels, the 2006 PBD declines would also have meaningfully reduced the unemployment rate of older workers by 1pp or more.

However, our work also emphasizes that thinking about the non-employment effect of UI extensions independently from retirement institutions may not always be ideal. If retirement institutions were such that retirement were not possible until the mid 60s, the effects of  $\frac{\partial Nonemp}{\partial P}$  on workers in their 50s would have been fundamentally different. While UI extensions always have the potential to alter both non-employment duration conditional on being unemployed and inflows into UI, the importance of these channels varies to a large and quantitatively meaningful extent based on pension institutions. For example, our results speak to a recent debate ([Hartung et al., 2022](#); [Jessen et al., 2023](#), e.g.)



on how important inflow responses to UI are to benefit changes, by highlighting that these responses likely depend on other (non-UI) institutions. Our model predicts strong inflow responses near retirement and much smaller separation effects of PBD changes at younger ages.

While modeling how programs interact is necessarily more complex, it can help us think about how generalizable reduced form estimates can be. Our model also gives policy makers more tools to achieve their goals. For example, had policy makers wanted to contain the unemployment rate of older workers in the early 90s they could have done so either by not extending PBD, or by removing the retirement-via UI pathway.

## 7 Conclusion

In this paper we document the effects of UI benefit extensions for workers approaching retirement age. We show that extensive margin responses, that is UI-induced inflows into non-employment, play an important role, and operate in addition to the standard intensive margin UI responses for younger workers that most of the previous literature has focused on. The combination of intensive and extensive margin responses, as well as voluntary and involuntary inflows into UI, complicates the application of standard non-parametric estimators such as RD designs and bunching estimators, but we argue the discontinuities, kinks, and notches induced by the UI and retirement institutions can still be used to learn about labor supply responses.

We specify and estimate a life-cycle labor supply model that explicitly accounts for transitions between employment, unemployment, and retirement and how they are affected by labor demand as well as the structure of UI benefits and parameters of the old age pension system. We estimate this model using a minimum distance estimator to fit critical empirical moments of the German labor market for several birth cohorts. Additionally, we explicitly match our model to our reduced form RD estimates. Simulations of our model show that we can match the key patterns observed in the data. We use our model to understand the total non-employment effects of UI extensions for older workers and how they contributed to the remarkable rise and subsequent fall in unemployment among workers in their late 50s in Germany in the 90s and 00s. We show that, in part as a result of the prevailing retirement institutions, unemployment insurance extensions played a large role in the early spike, and a much larger role than you would have pre-

dicted if using estimates from younger workers. UI policy and even more so retirement policy changes contributed to much of the subsequent decline.

Last, we simulate what the non-employment effects of UI extensions for both older and younger workers might have been under different institutional environments, including different retirement ages and penalties, providing a window into how UI effects interact with other non-UI institutions. We find that the effects of UI extensions on age-specific unemployment rates varies considerably with non-UI institutional details, in part helping to explain why estimates of the non-employment effects of UI (as well as UI inflow or separation effects) differ across ages and contexts.

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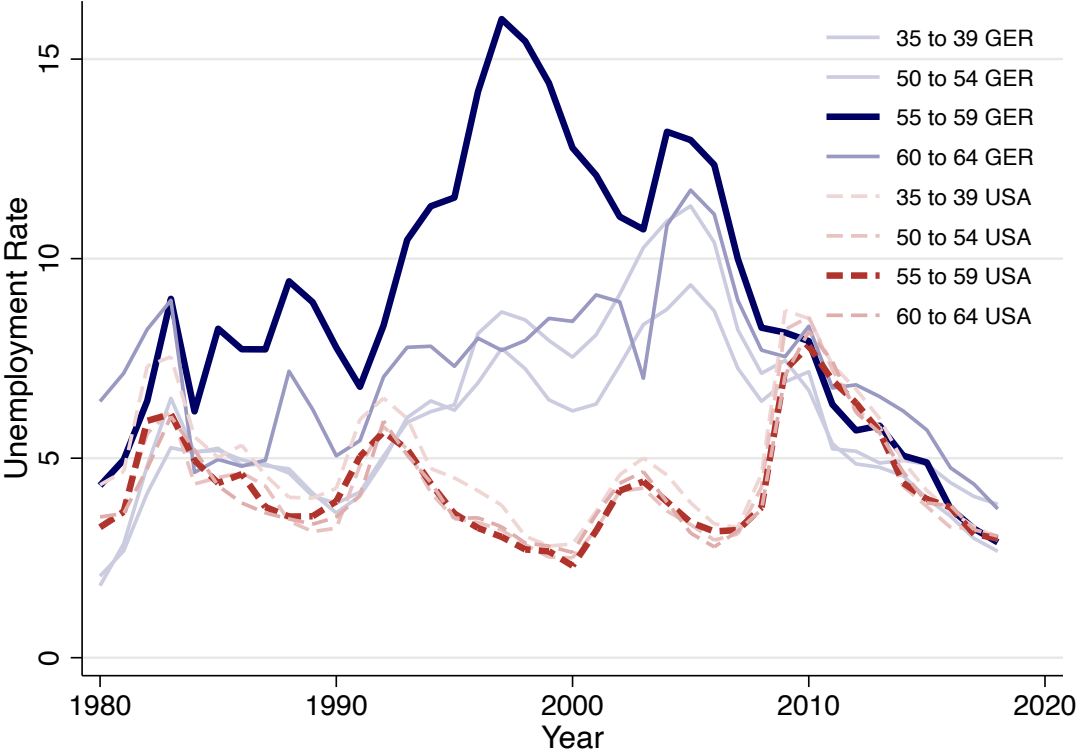
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# Figures

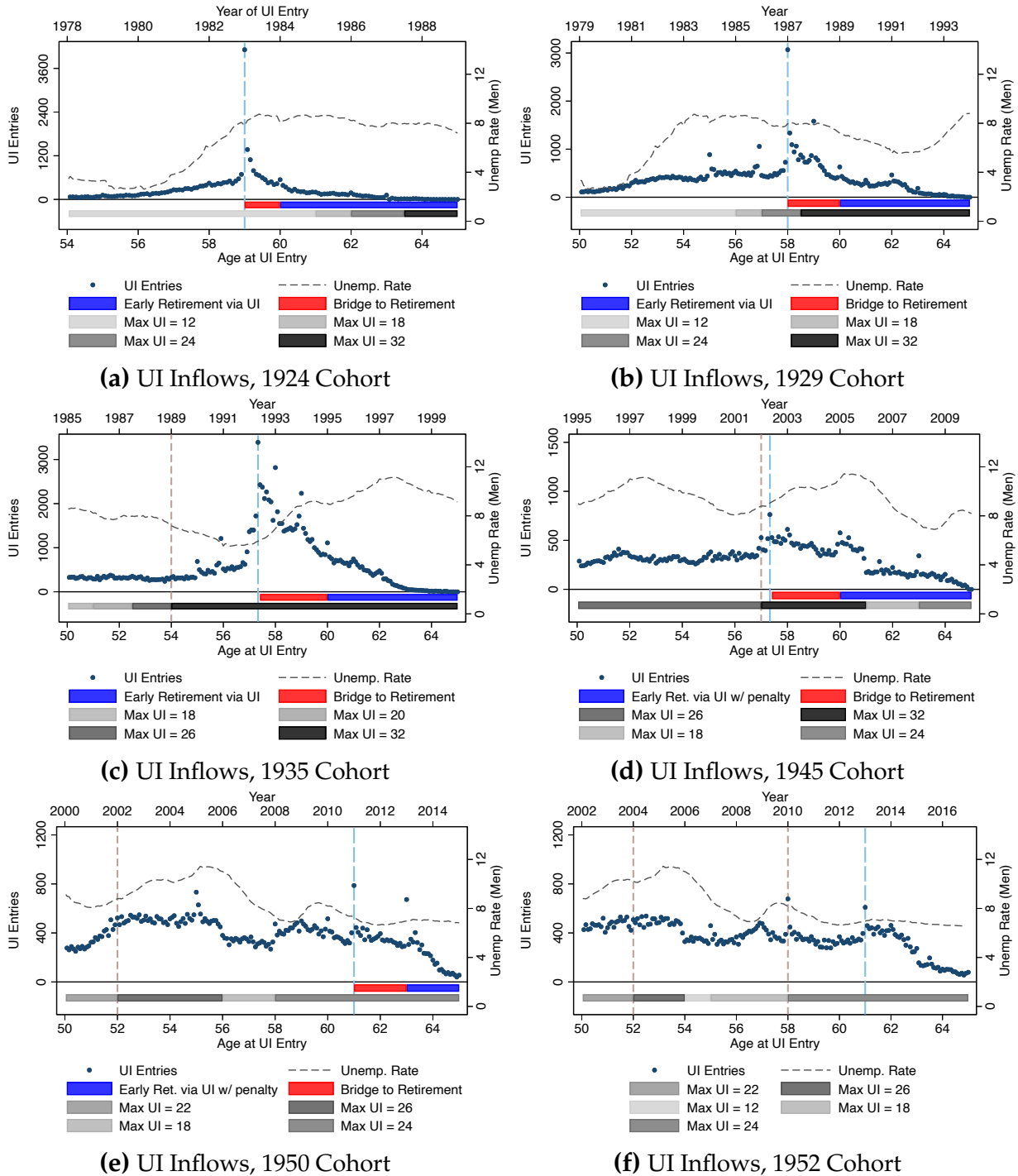
Figure 1: Male Unemployment Rates by Age Group: West Germany and U.S.A



Notes: This figure shows the male unemployment rate for select age groups in West Germany and the USA from 1980 until 2018, using data from the OECD.

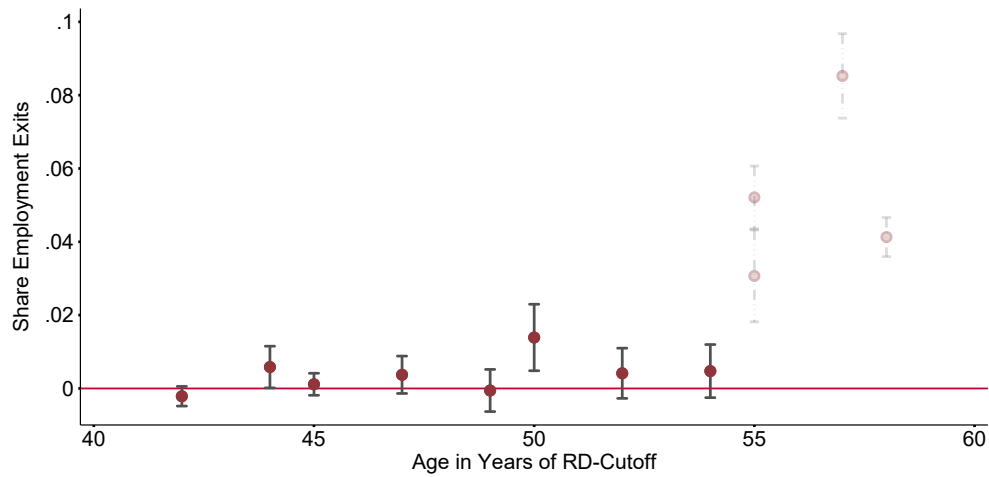


**Figure 2: UI Inflows by Age for Different Cohorts in Germany, Men**

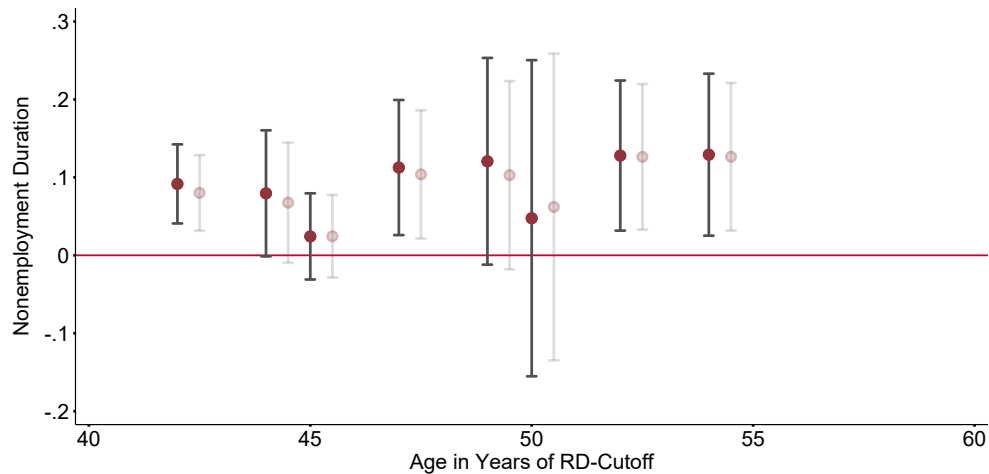


**Notes:** These figures plot the number of UI inflows per month (transitions from employment to unemployment) by age for different cohorts of West German Men in our sample (left axis). It also plots the male, seasonally adjusted unemployment rate as a dashed gray line (right axis). The red bar under the figure indicates the period over which an individual could receive UI before drawing pension (the blue bar under the figure) if he entered UI at the bridge-to-retirement age, indicated by the vertical dashed blue line. The different shades of grey represent different maximum PBD eligibility for UI, which can change because of an existing age-cutoff (the red dashed line) or because of an overall UI policy change enacted in that year.

**Figure 3: RD Results: One-month PBD Extension on Non-Employment, Men**



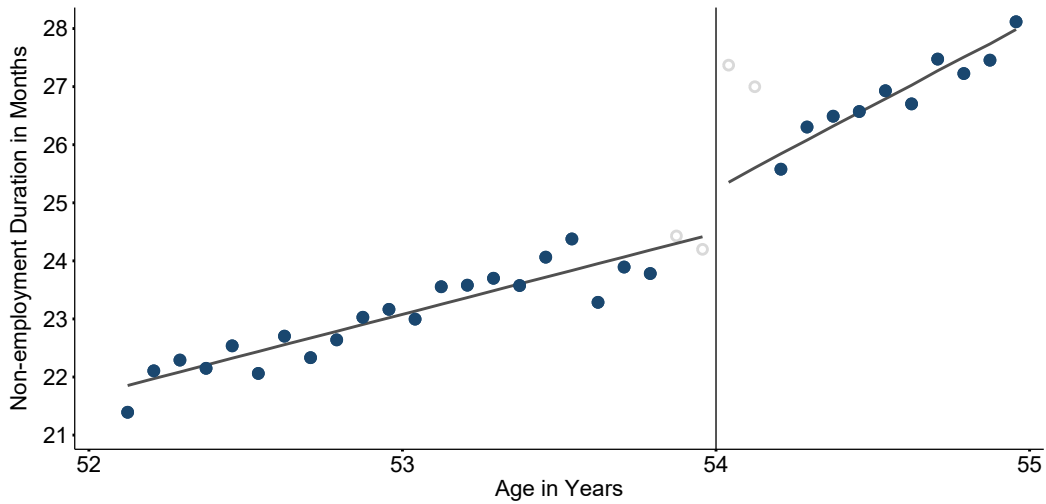
**(a) Density Estimates**



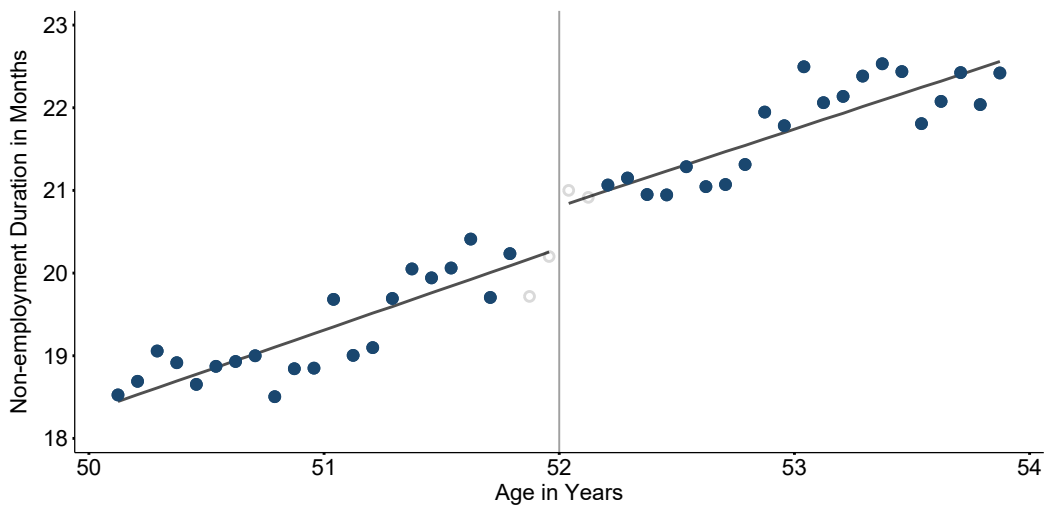
**(b) Donut-Hole RD Results: Non-Emp. Duration, Men with & without controls**

**Notes:** These figures contain Regression Discontinuity estimates of the effect of UI potential benefit durations at each age cut-off beginning July 1987. See Table 2 for the estimates. We pool all years under the same UI regime. We employ a local polynomial regression with a uniform kernel and cluster standard errors at the daily level. 95% CI are plotted. All results are divided by the number of months PBD was extended. The bandwidth is 2 years except for the '87-'99 age 49 and 54 cutoffs where it is 1 year on the right due to other discontinuities. We exclude 2 months on each side of the cutoff – the donut hole – to partially address sorting. Figure (a) contrasts estimates without (solid) and with (transparent) controls. Controls include: pre-unemployment wage, gender, nationality (non-german), experience, wage/occupation/firm-tenure and education in years. Age Cutoffs of 55 years and older are excluded due shifts in the density (panel b). Sample Restrictions: West German Men With full eligibility, excluding mining and steel construction.

**Figure 4:** Sample RD Estimates of the effect of PBD extensions on Non-Emp. Duration



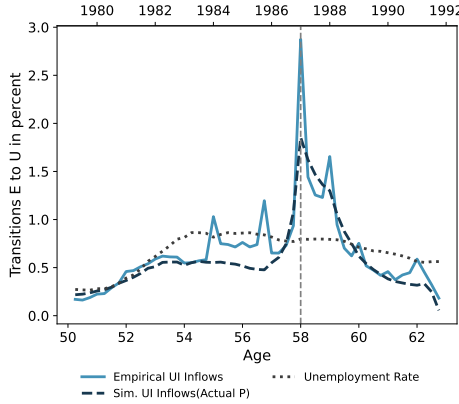
**(a)** Mean Non-Emp. Duration, Jul 1987 - Feb 1994, cut-off: age 54,  $\Delta$  PBD = 6



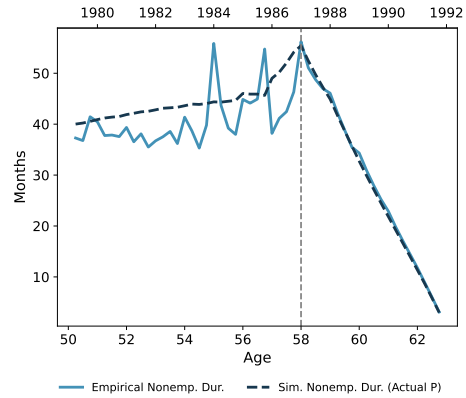
**(b)** Mean Non-Emp. Duration, Mar 1999- Jan 2005, cut-off: age 52,  $\Delta$  PBD = 4

**Notes:** These example RD figures show how mean non-employment duration changes at two sample age-cutoffs that extend potential unemployment benefit duration. Subfigure (a) shows the effect of a 6 month maximum PBD extension (from 26 to 32 months) at the age 54 cutoff in Jul 1987- Feb 1994, while subfigure (b) shows the effect of a 4 month maximum PBD extension (from 22 to 26 months) at the age 52 cutoff in Mar 1999-Jan 2005. We estimate separate, local linear regressions on each side of the cutoff using a uniform kernel (the solid line). The bandwidth is 2 years on each side of the cutoff except in subfigure (a), where it is 1 year to the right of the cutoff due to an additional discontinuity at age 55. We also omit 2 months on each side of the cutoff — the donut hole — to partially address sorting. Estimates at all the age cutoffs in our data, including the above cutoffs, can be found in Table 2 and visualized in Figure F.21.

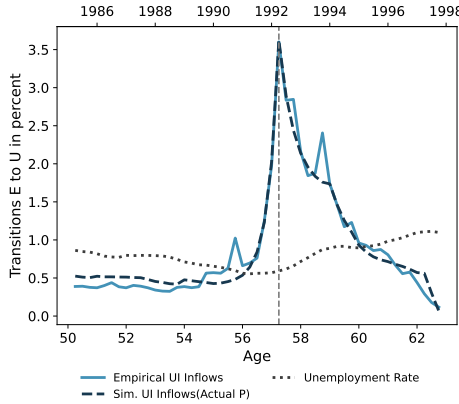
**Figure 5: In-Sample Fit of Life-Cycle Model for Transitions from Employment to UI and Non-Employment Durations (capped at age 63)**



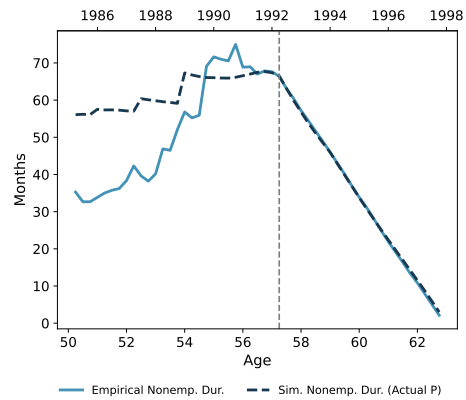
**(a) Transitions from E to U, 1929**



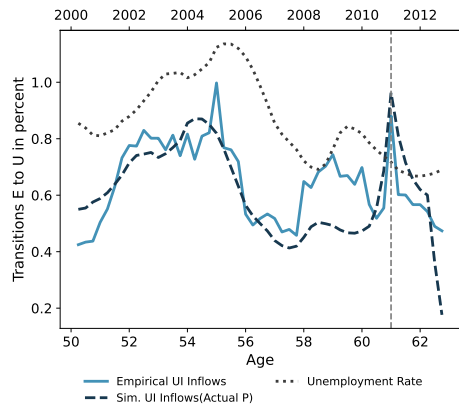
**(b) Non Employment Duration, 1929**



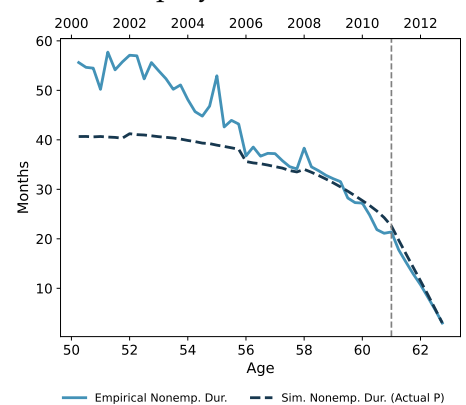
**(c) Transitions from E to U, 1935**



**(d) Non Employment Duration, 1935**



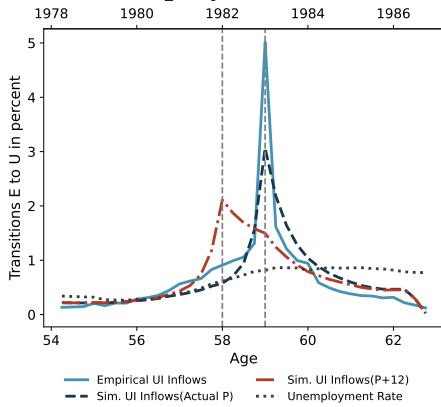
**(e) Transitions from E to U, 1950**



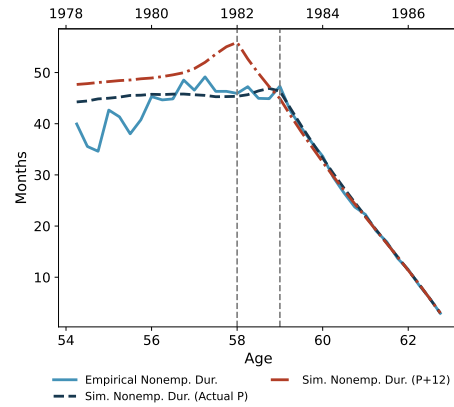
**(f) Non Employment Duration, 1950**

**Notes:** These figures compare our model-generated moments to their corresponding empirical moments for in-sample cohorts (1929, 1935, 1950), aggregated to the quarterly level. Figure (a) compares the transitions from employment to unemployment in 1929 whereas Figure (b) compares non-employment durations in 1929. Figures (c) and (d) show the same comparisons for the 1935 cohorts, and Figures (e) and (f) for the 1950 cohort. Non-employment duration is capped at age 63, which explains the linear decline leading up to age 63.

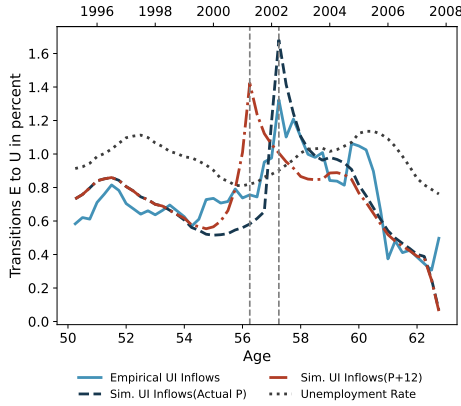
**Figure 6:** Out-of-Sample Fit of Life-Cycle Model for Transitions from Employment to UI and Non-Employment Durations, Baseline Model and Counterfactual 1:  $P + 12$



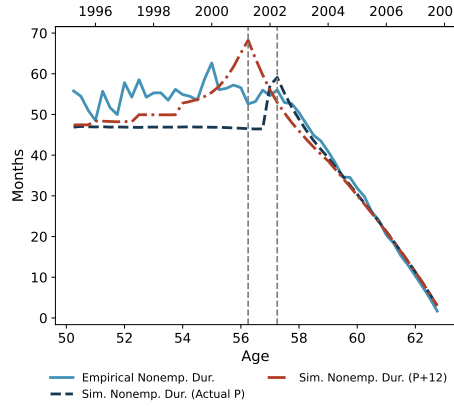
(a) Transitions from E to U, 1924



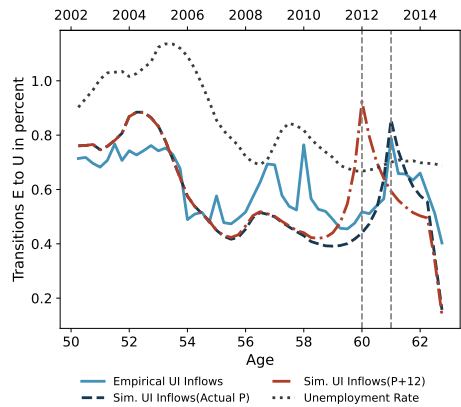
(b) Non Employment Duration, 1924



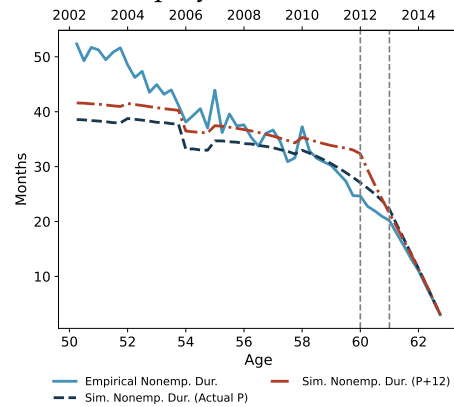
(c) Transitions from E to U, 1945



(d) Non Employment Duration, 1945



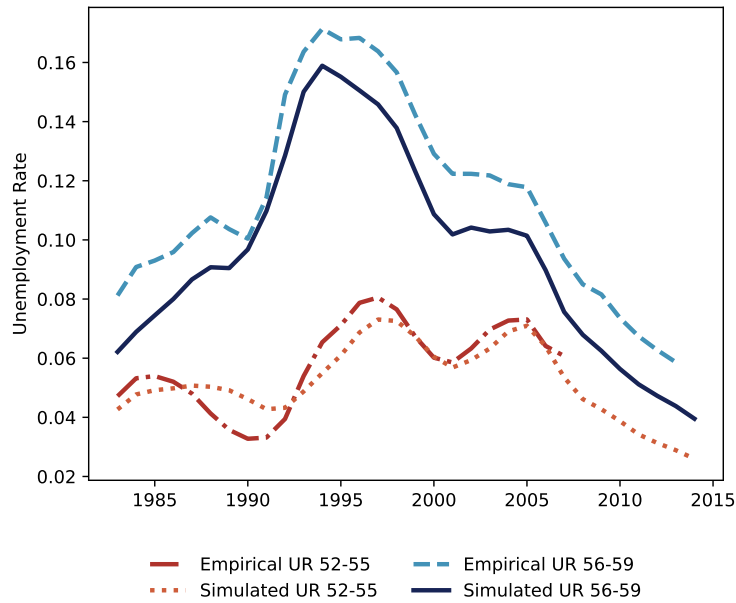
(e) Transitions from E to U, 1952



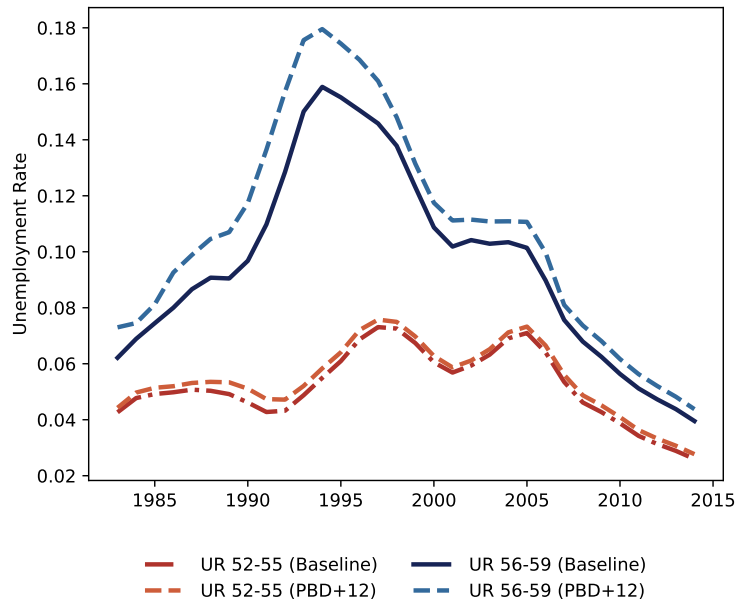
(f) Non Employment Duration, 1952

**Notes:** These figures compare our model-generated moments to their corresponding empirical moments for select out-of-sample cohorts (1924, 1945, 1952), aggregated to the quarterly level. Model-generated moments include the baseline specification and a counterfactual model where we increase potential benefit duration of UI by 12 months across all ages. Figure (a) compares the transitions from employment to unemployment in 1924 whereas Figure (b) compares non-employment durations in 1924. Figures (c) and (d) show the same comparisons for the 1945 cohort, and Figures (e) and (f) for the 1952 cohort.

**Figure 7: Empirical and Simulated Unemployment Rate by Age Group**



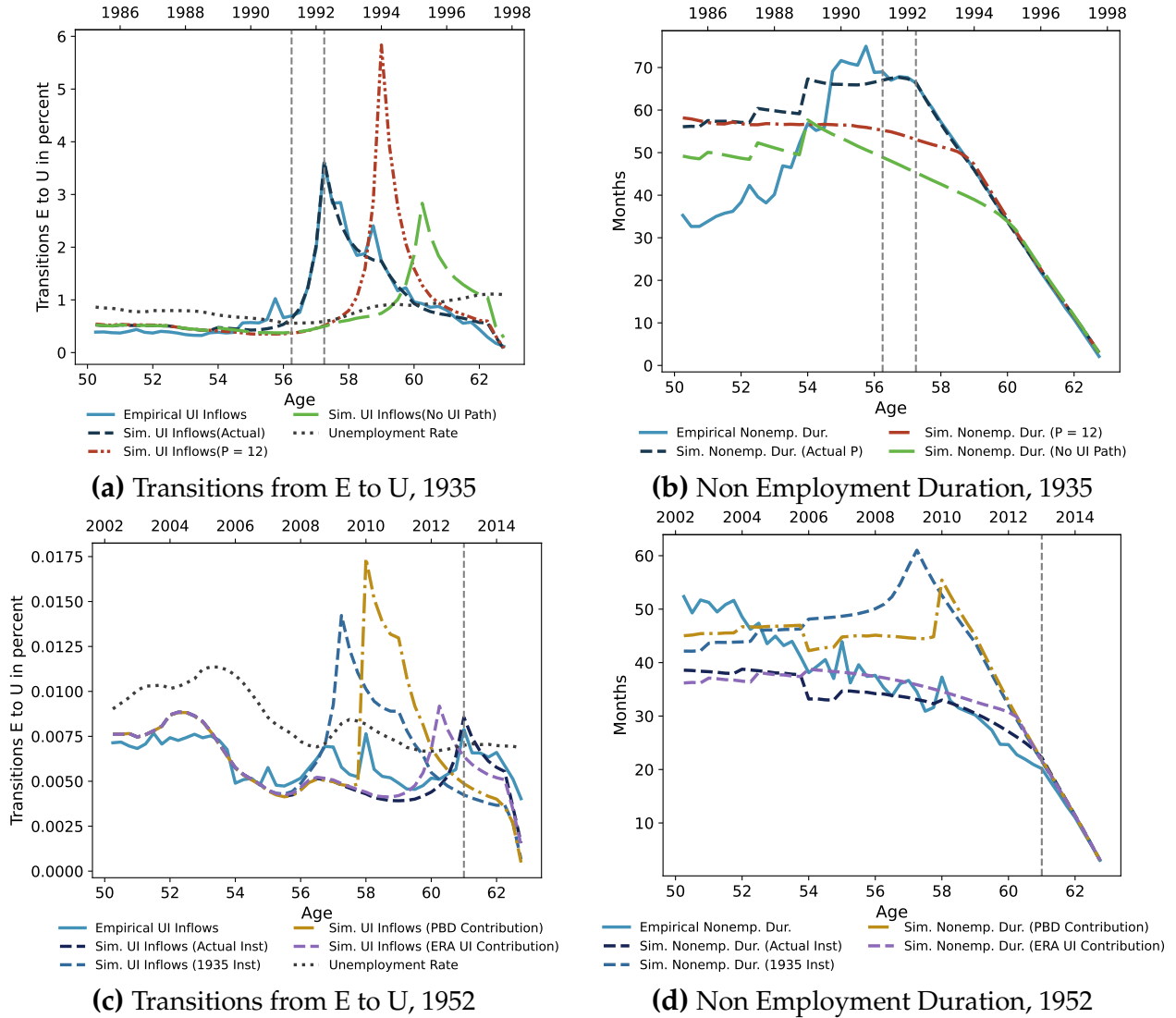
**(a) Empirical and Simulated Unemployment Rate**



**(b) Extending UI PBD by 12 months**

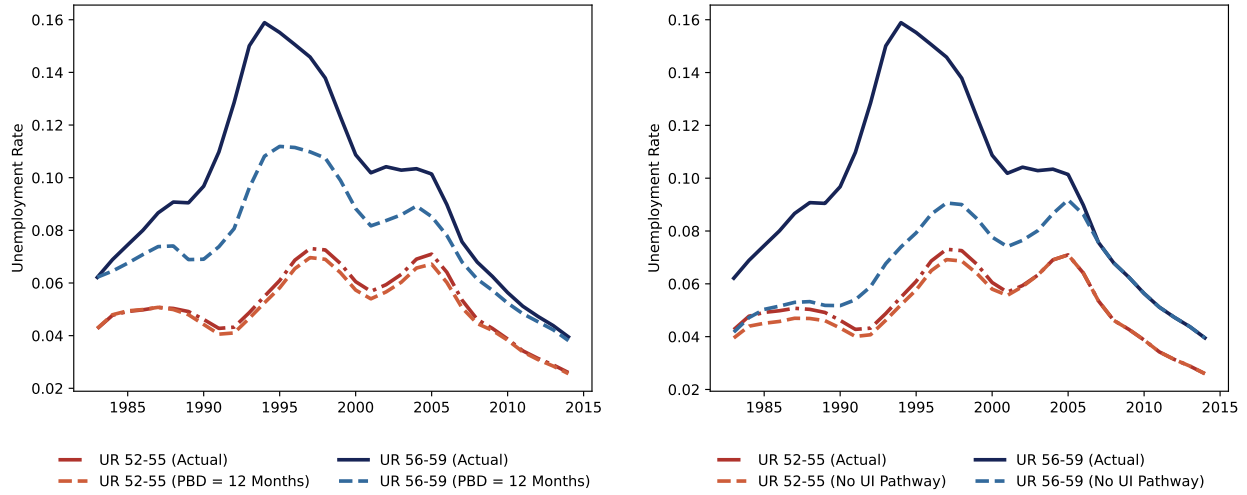
**Notes:** Panel (a) shows the empirical and simulated unemployment rate from the model for two age groups; 50-54 years old and 55-59 years old. Panel (b) shows the structural unemployment rate under the actual institutions (corresponding to the dashed line in panel (a) ) and when the potential benefit duration (PBD) is increased by 12 months.

**Figure 8: Model Simulations for Counterfactual Policies**



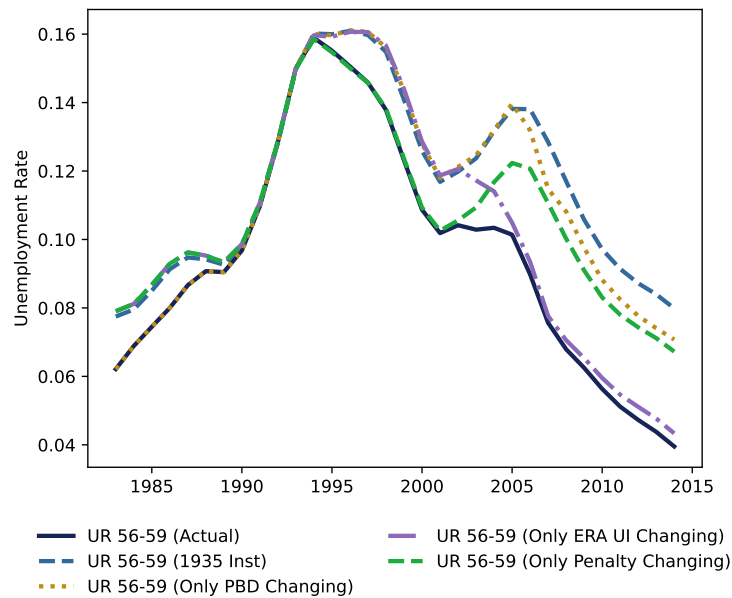
**Notes:** These figures compare our model-generated moments to their corresponding empirical moments for select out-of-sample cohorts (1945, 1952), aggregated to the quarterly level. Model-generated moments include the baseline specification, a counterfactual model where we set  $P$  to the values that were valid in 1924, and a counterfactual model where we set UI and retirement institutions (retirement ages and pathways, replacement rates, penalties and discounts) to the 1924 values. Figure (a) compares the transitions from employment to unemployment in 1945 whereas Figure (b) compares non-employment durations in 1945. Figures (c) and (d) show the same comparisons for the 1952 cohort.

**Figure 9: Simulated Unemployment Rates under Alternative Policy Regimes**



**(a) PBD fixed at 12 months**

**(b) No UI Pathway**



**(c) The Influence of Policy Changes after 1994**

**Notes:** Panel (a) shows the predicted unemployment rate structurally calculated from the model across calendar years for the baseline model, for the counterfactual model that sets  $P$  to the values that were valid in 1924, and for the counterfactual model that sets UI and retirement institutions (retirement ages and pathways, replacement rates, penalties and discounts) to the 1924 values. This is presented for two age groups: age 50-54 and age 55-59.



## Tables

**Table 1: Institutional Parameters for the Key Cohorts**

Men	1924	1929	1935	1945	1950	1952
Statutory retirement age	65	65	65	65	65+4/12	65+6/12
ERA (earliest possible) for long-term insured*	63	63	63	63	63	63
NRA (no penalty) for long-term insured	63	63	63	65	65+4/12	65+6/12
Penalty for retire at ERA for long-term insured	0	0	0	0.072	0.084	0.09
ERA (earliest possible) via UI	60	60	60	60	63	-
NRA (no penalty) via UI	60	60	60	65	65	-
UI Bridge Age	59	58	57+1/3	57+1/3	61	61**
PBD at ERA via UI bridge age	12m	24m	32m	32m	24m	24m**
UI replacement rates on net wages at UI bridge age	0.63	0.63	0.63	0.60	0.60	0.60
Conversion rate to UI replacement rate on gross wages	0.65	0.65	0.65	0.65	0.65	0.65
Pension replacement rates per year of contribution on gross wages	0.0104	0.0104	0.0100	0.0099	0.0095	0.0094
Pension contribution years at age 55 cond. on being	32.5	32.5	32.8	31.8	31.6	31.1
N employed at age 50	65,172	94,790	111,730	73,113	99,260	100,635
Penalty for retire at ERA via UI	0	0	0	0.18	0.072	-

Source: Sozialgesetzbuch (SGB) Sechstes Buch (VI) and see Appendix Section B.2 and D.1 for more details. \* Individuals were eligible for the long-term insured pathway after 35 years of retirement contributions. \*\* The old-age pension for unemployment pathway is abolished for cohorts born in 1952 and after. Therefore, the bridge age via UI here refers to the age at which individual take the full UI and transition into the old-age pension for long-term insured if they are eligible for this pathway.

**Table 2: Intensive Margin Effects of UI Extension on Nonemployment Duration**

		No Controls	Controls
<b>Period Jul 1987 - Feb 1999</b>			
Age 42, P: (12-18), $\Delta P: 6$	$\frac{dy}{dP}$	0.092 [0.026]**	0.080 [0.025]**
N		173,313	173,313
Mean Dep. Var		16.049	16.049
Age 44, P: (18-22), $\Delta P: 4$	$\frac{dy}{dP}$	0.079 [0.041]+	0.068 [0.039]+
N		170,270	170,270
Mean Dep. Var		17.046	17.046
Age 49, P: (22-26), $\Delta P: 4$	$\frac{dy}{dP}$	0.121 [0.068]+	0.103 [0.062]
N		107,255	107,255
Mean Dep. Var		18.568	18.568
Age 54, P: (26-32), $\Delta P: 6$	$\frac{dy}{dP}$	0.129 [0.053]*	0.126 [0.048]**
N		66,720	66,720
Mean Dep. Var		24.331	24.331
<b>Period Mar 1999 - Jan 2006</b>			
Age 45, P: (12-18), $\Delta P: 6$	$\frac{dy}{dP}$	0.024 [0.028]	0.024 [0.027]
N		156,927	156,927
Mean Dep. Var		15.637	15.637
Age 47, P: (18-22), $\Delta P: 4$	$\frac{dy}{dP}$	0.113 [0.044]*	0.104 [0.042]*
N		148,285	148,285
Mean Dep. Var		16.794	16.794
Age 52, P: (22-26), $\Delta P: 4$	$\frac{dy}{dP}$	0.128 [0.049]**	0.126 [0.048]**
N		113,128	113,128
Mean Dep. Var		20.546	20.546
<b>Period Jan 2008 - Dec 2010</b>			
Age 50, P: (12-15), $\Delta P: 3$	$\frac{dy}{dP}$	0.048 [0.103]	0.062 [0.100]
N		57,116	57,116
Mean Dep. Var		18.539	18.539

This table shows rd-estimates of UI extensions at various cutoffs on nonemployment duration in months (capped at 36 months). Estimates are obtained using local polynomial regressions controlling linearly for age (allowing for different slopes on each side of cutoff), using a uniform kernel and a bandwidth of 2 years on each side of the cutoff, except for age cutoff 49 and 54 who have only a bandwidth of one year on the right due to other discontinuities. Standard errors (in brackets) clustered on day level ( $\dagger P < .1$ ,  $*$   $P < .05$ ,  $** P < .01$ ).

**Table 3: Policy Simulations - Key Predictions of Model**

	(1)	(2)	(3)
	Age 52-55	Age 56-59	Age 60-62
<b>Unemployment Rate</b>			
1983, Actual Inst.	4.3%	6.2%	10.4%
1994, Actual Inst.	5.5%	15.9%	13.3%
1994, PBD=PBD+12	5.8%	18.0%	13.3%
1994, PBD=12	5.2%	10.8%	13.1%
1994, No UI Path	5.2%	7.4%	8.8%
2014, Actual Inst.	2.6%	4.0%	5.1%
<b>Change in UR from 1983 to 1994</b>			
Overall change	1.2 pp	9.7 pp	2.8 pp
Change due to other reasons.	1.0 pp	4.6 pp	2.7 pp
Change due to PBD change	0.2 pp	5.1 pp	0.1 pp
<b>Change in UR from 1994 to 2014</b>			
Overall change	-2.9 pp	-11.9 pp	-8.2 pp
Change due to other reasons.	-2.5 pp	-7.9 pp	-3.9 pp
Change due to all inst	-0.4 pp	-4.0 pp	-4.3 pp
Change due to PBD change	-0.1 pp	-0.9 pp	0.5 pp
Change due to UI ERA change	-0.3 pp	-3.7 pp	-3.5 pp
Change due to penalty	0.0 pp	-1.3 pp	-2.0 pp

Notes: The table shows model simulations for different counterfactual policies.

**Table 4: The Role of UI Institutions for the Unemployment Rate - Model Predictions**

	(1)	(2)	(3)	(4)	(5)	(6)
	Baseline	Linear Time Trend in Cost	No Trend in Cost	No Fixed Cost of UI Entry	Constant $\bar{\eta}$	Estimate Discount Factor
<b>Model Fit</b>						
SSE	20679.1	20878.5	22973.2	40171.4	30243.8	20639.4
dD/dP	0.129	0.131	0.135	0.125	0.130	0.130
<b>Unemployment Rate (Age 56-59)</b>						
1983, Actual Inst.	6.2%	6.1%	6.0%	5.9%	5.8%	6.2%
1994, Actual Inst.	15.9%	16.0%	15.6%	13.1%	13.4%	15.8%
1994, PBD=PBD+12	18.0%	18.1%	17.8%	14.2%	18.8%	17.9%
1994, PBD=12	10.8%	10.9%	10.5%	9.9%	7.3%	10.7%
1994, No UI Path	7.4%	7.3%	7.1%	7.3%	6.4%	7.4%
2014, Actual Inst.	4.0%	3.9%	3.8%	3.9%	4.6%	3.9%
<b>Change in UR (Age 56-59) from 1983 to 1994</b>						
Overall change	9.7 pp	9.8 pp	9.6 pp	7.1 pp	7.6 pp	9.7 pp
Change due to other reasons.	4.6 pp	4.7 pp	4.4 pp	4.0 pp	1.4 pp	4.6 pp
Change due to PBD change	5.1 pp	5.1 pp	5.1 pp	3.2 pp	6.1 pp	5.1 pp
<b>Change in UR (Age 56-59) from 1994 to 2014</b>						
Overall change	-11.9 pp	-12.1 pp	-11.7 pp	-9.2 pp	-8.8 pp	-11.9 pp
Change due to other reasons.	-7.9 pp	-8.1 pp	-8.3 pp	-7.0 pp	-1.9 pp	-7.8 pp
Change due to all inst	-4.0 pp	-4.0 pp	-3.5 pp	-2.2 pp	-6.9 pp	-4.1 pp
Change due to PBD change	-0.9 pp	-0.9 pp	-0.9 pp	-0.5 pp	-2.8 pp	-1.0 pp
Change due to UI ERA change	-3.7 pp	-3.6 pp	-3.1 pp	-1.8 pp	-6.4 pp	-3.7 pp
Change due to penalty	-1.3 pp	-1.3 pp	-1.1 pp	-0.6 pp	-3.7 pp	-1.2 pp

Notes: The table shows key results for alternative estimates of the model. Column (1) replicates the baseline model for comparison. Column (2) estimates the model using a linear as opposed to exponential time trend in the cost of job search. Column (3) estimates the model assuming no time trend in the cost of job search. Column (4) estimates the model assuming that there is no fixed cost of entering UI. Column (5) imposes a constant mean of the disutility of work  $\bar{\eta}$  across all cohorts (in-sample and out-of-sample). Column (6) estimates the discount factor  $\beta$ .

# Online Appendix

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## A Data Appendix for Cohort Data

**Sample Selection** We use the labor market history of selected birth-years to track individual labor market dynamics when approaching retirement age. Each birth year is called a cohort which we construct separately for men and women. For display purposes, we highlight cohorts that (a) represent periods of different UI generosity at older ages and (b) are not directly affected by a UI reform close to retirement. We use the birth-year cohorts 1924, 1929, 1935, 1945, 1950, 1952 and 1952. The cohort-specific institutional features are summarized in tables G.1 and G.2. For each of these cohorts we select all individuals with a stable employment history at their 50th birthday. Specifically, we select individuals that are in social security reliable employment at their 50th birthday and have at this point worked in social security reliable employment continuously over the previous three years without any UI receipt during this period. In addition, we exclude some industries that are known for having special early retirement practices. Namely we exclude mining and steel construction. For cohorts 1937 and later we exclude additional industries that have excess exits from employment at age 55 in the 1941 cohort based on visual inspection. These likely have CLAs that specify an early retirement agreement at age 55. In particular we exclude the following three digit industry codes based on the 2008 industry classification: 291 (manufacturing of cars), 201 (production of base chemicals), 351 (electricity supply), 701 (business administration), 234 (production of other porcelain and ceramics), 642 (holdings), 212 (production of other pharmaceuticals), 204 (production of cleaning- and toilet products), 192 (petroleum refinement) and 262 (production of data processing devices).

**States and Transitions for a Monthly Balanced Panel** We generate a monthly balanced sample of each birth cohort that tracks an individual's labor market status since age 50.<sup>29</sup> We center the data around the cohort- and individual-specific bridge to retirement age, so that the the first month after the bridge to retirement age starts with the exact date an individual faces a bridge to retirement. For all months, we assign individuals to one of five exclusive labor market states. Individuals can be employed (E), which includes all social security reliable employment, or in registered unemployment (UI), which consists of all periods of UI receipt. In addition, individuals can be outside of the observed E and

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<sup>29</sup>We also generate a complementary quarterly panel that we use in the structural estimation.

UI states.<sup>30</sup> We distinguish between non-observed unemployment (Nu), which entails up to 3-month interruptions between E and U, and temporary withdrawal from the labor force (Nt), which includes temporary employment interruption as well as interruptions between E and UI lasting longer than three months. Finally, individuals can withdraw permanently from the labor force (Np), denoted by an exit from E or UI that is not followed by any other E or UI spell. If individuals are in multiple states in a given months – due to the transition date being in the middle of the month – we select one state with the rule that UI is preferred over Nu which is preferred over E, which is preferred over Nt and Np. If an individual has, for example, an employment spell (E) in the first half of a month and an Nu spell in the second half of the month, he is assigned Nu for the month. We construct all possible transitions between states where a transition is defined by comparing the current and previous state of an individual. For simplicity, we later condense these five states into three: Employment (E), Unemployment (UI or Nu), and Non-Employed (Nt or Np). The main reason for combining Nu and UI, is that if workers are sanctioned at the beginning of an UI entry, they would appear as Nu in the data and the relevant transition from work to unemployment occurs at the E to Nu transition.

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<sup>30</sup>This includes other states such as marginal employment or second-tier unemployment assistance that could sometimes be observed in the data as well as states that are genuinely never observed in the data, such as retirement.



## B Additional Details and Results for the RD Specification

This section describes the sample used for the RD analysis, validity tests, the main findings, and additional robustness checks.

### B.1 Data and Sample Construction

We construct an inflow sample into UI receipt based on the IEB, largely following [Schmieder et al. \(2012\)](#), with two main differences: First, we also include older individuals. Second, to be consistent with our cohort data we also exclude individuals that were employed in mining or steel construction prior to job loss.

We select West German individuals that, based on their pre-UI history, are eligible for the maximum (age and cohort-specific) potential benefit duration (PBD), as summarized in [G.1](#). In particular, we restrict to individuals that worked at least 12 months in a social security reliable job for the previous 3 years and also worked 52 months within the last 7 years with no intermittent UI spell in the previous 48 months. We further restrict to cases of UI take-up within 28 days after job separation. Our main sample restricts to male individuals but we provide complementary evidence for females and a combined sample.

As [G.1](#) illustrates, the German UI system has had periods of different age-specific PBD. We select all age cutoffs below age 55 from the 1987 period onwards.<sup>31</sup> This leaves us with 8 age cutoffs from 3 periods. For the cutoffs that seem to exhibit density violations — the age cutoffs 54 and 52 — we further exclude years from the end of the period where the violation is most severe. For the 54 age cutoff we exclude the last 5 years (07/1995 - 03/1999) of the period 07/1987-03/1999), for the 52 age cutoff, we exclude the last year (04/2005-01/2006) in period 03/1999-01/2006.

**Outcomes** Our main outcome is non-employment duration, measured as the duration in months between the start of UI receipt and the start of the next job. We topcode values above 36 to reduce the influence of outliers. In addition, we use several predetermined variables for balance checks and/or as control variables. In particular, we use the daily Pre UI wage, a dummy for foreign nationality, the years of education, years of Firm-, industry- and Occupation- specific tenure as well as the time in months between job loss

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<sup>31</sup>We discard some earlier periods because of their short duration and some open questions regarding the implementation, especially unclear evidence for a first stage

and UI claim.

**Main Specifications** For each cutoff, we estimate a separate RD specification. The main specification employs a two-year bandwidth on each side of the cutoff with the exception of the 49 and 54 age cutoff where it is only one year on the right due to other policy discontinuities above one year. Because of sorting, especially at some of the older cutoffs, we exclude 2 months just to the left and right of each cutoff. We control for linear trend in the running variable which is allowed to differ on each side of the cutoff. We estimate the model via OLS, clustering standard errors on the age (in days) level. We also provide a range of robustness checks and alternative specifications discussed in the next section.

## B.2 Description of Findings

**Validity Checks** Before turning to the main findings, we conduct balance and density checks. Figures [F.23](#) (males), [F.27](#) (females) and [F.31](#) (both) explore the smoothness of the density around the cutoffs, plotting the number of UI entries by age separately around each cutoff. There is some evidence for sorting directly around the cutoffs, i.e. a missing mass directly left to the cutoff and an excess mass right to the cutoff. This sorting appears somewhat stronger for older workers and females. Importantly though, the sorting is mostly restricted to the +/- 2 months on each side of the cutoff which are hence excluded in the main specification. There appears to be no or at most small evidence of a density shift. To further quantify the presence (or absence) of a shift in a density, Column (1) of Appendix Tables [G.4](#) (males), [G.5](#) (females) and [G.6](#) (both), report estimates of the marginal increase in the number of UI entries which is rescaled around the sample mean for each of the cutoff to make the estimates more comparable between periods and cutoffs. For males, most estimates are precisely estimated and very close to zero. The strongest exception is the 50 cutoff in the most recent period, where the estimated increase in the density is about 1.5% relative to the mean. For females, the shift in density is somewhat larger, at the age cutoff 50 the estimated increase is 2.1% relative to the mean. We also examine whether pre-determined variables are balanced across the cutoffs in columns (2) - (7) of Appendix Tables [G.4](#), [G.5](#) and [G.6](#). In particular we check for balance in the daily Pre UI wage, a dummy for foreign nationality, the years of education, years of firm-, industry- and Occupation- specific tenure as well as the time in months between job-loss and UI claim. Most estimates are insignificant and close to zero, with the estimates

precise enough to rule out economically meaningful sorting along most of the variables considered. The one notable exception is a positive effect on pre-UI wages at the 54 age cutoff for both males and females and the 52 age cutoff for females.

**Main Findings** Estimates of the effect of a one month increase in PBD on nonemployment duration are reported in Table G.3. Column (1) shows the main results for males without controls and column (2) shows it with controls. Most estimates are in a similar ballpark as those in Schmieder et al. (2012), with estimated effect sizes for older workers tending to be slightly (though not statistically significantly) larger. For example, the baseline estimate at the age 42 cutoff in Period 07/1987-02/1999 implies an increase in non-employment duration of .092 months for an additional month of PBD (se.=0.026), whereas the estimated effect at age 54 is 0.129 months (se.=0.053). Adding controls barely moves the coefficients. If anything, the effect sizes tend to get a little smaller, though the differences are not statistically significant. Columns (3) and (4) report the corresponding estimates for females. Females tend to be somewhat more responsive to UI extensions (as already documented in Schmieder et al. (2012)) and the age gradient also appears slightly larger. To take the same cutoffs as before, the baseline estimate for the age cutoff 42 in Period 07/1987-02/1999 implies an increase in non-employment duration by .124 months for an additional month of PBD (se.=0.025), whereas the estimated effect at age 54 is 0.203 (se.=0.040). The results are again robust to the inclusion of the additional controls. Finally, Columns (5) and (6) show results for the pooled (men and women) sample. As expected, these lie between the estimates for males and those for females and are more precisely estimated.

Figures F.25 (males), F.29 (females) and F.33 (combined) plot mean non-employment duration as a function of age so that our RD estimates can be inspected visually. The linear specification used on each side of the cutoff appears to be a reasonable approximation for the underlying conditional expectation.

**Additional Robustness** We complement our findings with a number of robustness checks. These are reported in Tables G.7 (males), G.8 (females) and G.9 (both). In particular, we examine the robustness to the inclusion of more granular controls including detailed industry and regional controls (Column (2)), extending the excluded area around the cutoff to 3 months (Column (3)), reducing the BW to one year (Column (4)), and using a rectan-

gular kernel of the local polynomial regression instead of a uniform of the OLS baseline specifications (Column (5)). Overall, our findings are relatively robust: most estimates are similar, or at least in the same ballpark, as the baseline estimates, though sometimes less precisely estimated.

## C Additional Details on Institution

### C.1 Pension Institutions and Pension Reforms in Germany

Over our sample period, there have been several pension reforms which alter the incentives to claim pension early and possible pathways into retirement. Appendix Table G.2 summarizes the reforms for all of the different pathways over our study period. It lists the six main pathways: Standard old-age pension, old-age pensions for the long-term insured, old-age pensions due to unemployment (and part-time work), old-age pensions for women, old-age pensions for disabled workers, old-age pension for especially long-term insured. These pathways make retiring before the regular retirement age 65 possible for certain groups of workers. Each pathway has its own eligibility conditions, normal retirement age (NRA) and early retirement age (ERA). In the following, we provide more details on the pathways, the pension reforms and associated retirement ages.

*Standard old-age pension* Workers can claim the standard old-age pension (SGB VI §235) at age 65 throughout our sample period. The eligibility condition is at least 5 years of contributions. For cohorts 1947 to 1964, this age will gradually increase by one month for each year of birth from age 65 to 67. This change will be implemented starting in 2012 and completed phase in in 2030 (See SGB VI §235(2)).

*Old-age pension for long-term insured* The long-term insured pathway allows workers with at least 35 years of contributions to claim pension as early as age 63 (SGB VI §236). The NRA without penalty for early claim is 63 until cohort 1936. It is increased gradually at monthly steps from 63 to 65 for cohorts 1937 to 1938 and remains at 65 until cohort 1948. Afterwards, the NRA increases to 65 and 3 months for cohort 1949 and will increase at the same pace as the SRA for cohorts 1950 to 1964 and reaches age 67 in year 2030. The ERA remains at age 63. Workers eligible for this pathway can always claim at age 63, however they face an actuarial adjustment in the form of a 0.3% pension reduction per each month they retired in advance of the NRA.

*Old-age pension due to unemployment or part-time work* Cohorts born before 1952 can claim pensions earlier via this pathway (SGB VI §237). The eligibility requirements for the UI pathway were: 1) at least 15 years of contributions, at least 8 of which must have occurred in the past 10 years, and 2) being unemployed for at least 1 year after the age of 58 and a half, or in old-age part-time work. The part-time work is granted by the partial retirement law (Altersteilzeitgesetz), which provided a maximum public subsidy for up

to five years if older workers switch from full-time to part-time work. This program was enacted in the mid-1990s and was suspended in 2009. The ERA is 60 for cohorts younger than 1946 and starts to gradually increase at monthly steps from 60 to 63 from cohort 1946 to 1948 and remains at age 63 until it is abolished for cohorts younger than 1951 (SGB VI appendix 19). The NRA without any early claim penalties is 60 until cohort 1936 and starts to increase gradually from 60 to 65 during cohorts 1937 and 1941, and remains at age 65 until being abolished.

*Old-age pension for women* Women with at least 15 years of contributions, at which at least 10 years of which must have occurred after age 40. The ERA remains at 60 throughout the sample period till being abolished for cohorts younger than 1951. The NRA is 60 until cohort 1939, and start to increase gradually to 65 for during cohorts 1940 to 1944 (SGB VI appendix 20) and remains at 65 until being abolished.

*Old-age pension for disabled workers* Workers have lost their earnings capacity can claim the old-age pension for disabled workers. This pathway is also referred to as invalidity pathway. The eligibility condition is at least 35 years of contribution and having lost of at least 50% of their earnings capacity. The ERA is 60 throughout the sample period and is scheduled to gradually increase to age 62 from 1952 to 1963. The NRA is 60 for workers born between 1920 and 1940, and is raised gradually by 1 month for each month of birth from 60 to 63 from cohort 1941 to 1943, and remains at 63 until cohort 1951 (SGB VI appendix 22). It is then scheduled to gradually increase to age 63 to 65 during cohorts 1952 to 1963.

*Old-age pension for especially long-term insured* The 2014 pension reform introduced the so-called old-age pension for especially long-term insured. Since July 2014, this special pathway allows workers with at least 45 contributory years to draw a pension without deductions as early as age 63. Because this pathway is not available during our sample period, and the first cohort effective can use this pathway is cohort 1951. From the birth cohort 1953 onwards, the NRA increases by two months for each birth cohort and will once again be 65 for persons born in 1964

The last pathway for workers to leave the labor force is via disability insurance. The disability insurance is available for workers with at least 5 years of contributions of which at least 3 out 5 before claiming. The claiming of disability insurance is independent of age. Workers who are officially recognized as having low earnings capacity, which entails permanently not being able to work more than 3 hours per day in any job, can claim

disability insurance.

## C.2 Budget Sets

We assume individuals earn a constant (after tax) wage  $w$  and at retirement receive total pension payments  $y^R(E)$  and UI payments  $y^{UI}(E)$ , where  $E$  is age at exiting employment. Thus, the total years worked is  $S = E - s$ , where  $s$  indicate years of schooling.

This yields a budget constraint of the form

$$C = w(E - s) + y^{UI}(E) + y^R(E)$$

Here we detail how we compute the budget set.  $\rho$  is the replacement rate per year of pension contribution on net wage.

In other words, each year of work with wage of  $w$  will increase pension benefits  $y^R(E)$  by  $\rho w$ . Each year spent on UI increases pension benefits  $y^R(E)$  by  $0.8 \times \rho w$ . We assume individuals take their full UI duration upon exit and then rely on UA till they retire at age  $T^R$ . For illustration purpose, here we assume UA provides zero income. In the simulation, we assume UA yields 50 per month ( $y^o$ ) and workers spend  $T^R - E - P$  on UA.

The budget constraint is thus given by:

$$C = w(E - s) + \underbrace{bD + 0.8 \times \rho w D \times [T - \max\{T^R, E - s + T^u\}]}_{y^{UI}(E)} + \underbrace{\rho w(E - s) \times [T - \max\{T^R, E - s + T^u\}]}_{y^R(E)}$$

Where  $D$  is UI duration,  $T^u$  is unemployment duration,  $P$  is maximum potential UI duration,  $b$  is UI benefit level. By definition,  $T^u = D \geq P$ . The stylized budget sets in Appendix Figure F.3 assume that a worker always retire at the earliest possible retirement age ( $T^R = ERA$ ).

Therefore,

$$C = Y = \begin{cases} w(E - s) + bP + \rho w \times (E - s + 0.8P) \times [T - T^R] & \text{if } E < T^R - P \\ w(E - s) + b(T^R - E) + \rho w \times (E - s + 0.8(T^R - E)) \times [T - T^R] & \text{if } E \geq T^R - P \end{cases}$$

$$\frac{dY}{dE} = \begin{cases} w + \rho w \times [T - T^R] & \text{if } E < T^R - P \\ w - b + \rho w(1 - 0.8) \times [T - T^R] & \text{if } E \geq T^R - P \end{cases}$$

In the case of a change in the maximum potential UI duration  $P$  over the life cycle (e.g., changes from  $P_1$  to  $P_2$  at age  $T^{RD}$ ). The  $P$  just before  $ERA$  defines the bridge age

$(ERA - P_2)$ . Then the budget sets is the following:

$$Y = \begin{cases} w(E - s) + bP_1 + \rho w \times (E - s + 0.8P_1) \times [T - ERA] & \text{if } E < T^{RD} \\ w(E - s) + bP_2 + \rho w \times (E - s + 0.8P_2) \times [T - ERA] & \text{if } T^{RD} \leq E < ERA - P_2 \\ w(E - s) + b(ERA - E) + \rho w \times (E - s + 0.8(ERA - E)) \times [T - ERA] & \text{if } E \geq ERA - P_2 \end{cases}$$

When there exists a financial penalty to claim pension at  $ERA$ , we adjust the  $y^R(E)$  by multiplying  $(1 - (NRA - ERA) * 3.6\%)$ .

Let's take the 1924 cohort as an example (where  $P = 1$  and  $T^R = 60$ ). Therefore, the budget set is

$$C = Y = \begin{cases} w(E - s) + bP + \rho w \times (E - s + 0.8P) \times [T - 60] & \text{if } E < 60 - P \\ w(E - s) + b(60 - E) + \rho w \times (E - s + 0.8 * (60 - E)) \times [T - 60] & \text{if } E \geq 60 - P \end{cases}$$

The baseline budget sets by cohort are constructed for the sample of married couple without dependent children. Given that in our sample, around 80% are married and around 15% have dependent children, it is representative to construct the life time budget constrain for married couple without children. We use the following parameters:  $s = 20$ ,  $T = T_{last} = 78$  and  $a = 0.8$ . We use the same institutional parameters as described in Appendix section E.4.

In Appendix Figure F.3 Panels (a)-(c), representing the 1924, 1929, and 1935 cohort respectively, the NRA and ERA for retirement via unemployment were age 60, but maximum PBD varied. In panel (d), representing the 1945 cohort, the ERA remained at 60 but the un-penalized NRA was increased to around 64, with slight variation by month of birth. This amounted to a financial penalty for retiring at age 60 of approximately 18% of gross lifetime pension benefits. In Panel (e), representing the 1950 cohort, the ERA was increased to 63 and the NRA was 65.18. The penalty for retiring at age 63 via unemployment was 7.2%. In panel (f), representing the 1952 cohort, the pathway into retirement via unemployment was abolished, leaving the earliest possible retirement age as 63 for long-term insured workers with over 35 years of qualified contributions. The penalty for retiring at age 63 via the long-term insured pathway was 9%.

### C.3 UI as a Bridge to Retirement and Other Ways to Retire Early

**Evolution of the bridge over time** The use of UI as a bridge to retirement dates back to the Weimar Republic. The "59 rule" originated in the economic crisis of 1929-1930, allowing white-collar workers to retire at age 60 after receiving UI for one year. After WW-



II, the rule was extended to blue-collar workers in 1957 (Trampusch, 2005a; Trampusch et al., 2010). The popularity of UI as a bridge to retirement increased in the early 1980s. After the 1982 recession, using UI as a bridge to retirement became a popular way to manage layoffs (Trampusch et al., 2010). The increase of PBD in several steps from 12 to 32 months in 1987 for workers above 54 (see table G.1) increased the attractiveness of this pathway and shifted the earliest age where one could use the UI pathway from 59 down to 57 and 4 months. In addition, the so-called "58-rule" came into effect end of 1985 which allowed workers to stay on UI without any job search obligations (Bundesgesetzblatt, 1985), providing additional incentives to use UI as a bridge to retirement (Schneider and Stuhler, 2007). Starting in 1997, the reduction in the generosity and phase-out of the early retirement system after UI made the UI pathway less attractive again (see section C.1). In addition, the UI reform of 2006 cut back PBD for workers 55 and older from (up to) 32 months to a maximum of 18 months and was increased again slightly to 24 months in 2010 (see table G.1). The 58-rule was abolished for new UI entries from 2007 onwards (Schneider and Stuhler, 2007), further decreasing the attractiveness of UI as a bridge to retirement. In the environment since 2010, UI can still be used as a bridge to retirement, though at later ages and to less generous terms.

**Public perceptions** The norm of using UI as a bridge to retirement changed over time. Describing the situation before the oil crisis of 1973, (Trampusch, 2005a, p. 206) writes *"The operation of early retirement (...) made it popular with a wide and diverse constituency. (...) The policy was widely seen as a particularly humane solution to structural adjustment..."*. With the increased usage of the bridge, this changed over time. The news magazine "Der Spiegel" described the situation in 1995 (Der Spiegel, 1995), when UI receipt for the affected age group (55-59) was at its historical high: The article — titled *"Sliding into retirement"* (German: Gleitend in die Rente, own translation) — emphasizes that using the bridge to retirement puts high pressure on the social security system making the current practice unsustainable, while also displaying some sympathy for retiring early. The labor minister is cited as warning representatives of the Employer Organizations and Unions of *"misusing the retirement system"* who were at that time still making heavy use of the early retirement options via UI. The leader of the metal union (IG-Metal) at that time is quoted in defense of the UI pathway.

The tone of a news article from 2017 again by the Spiegel — now titled *"double dip-*

*ping*” (German: Doppelt Kassieren, own translation) — has considerably shifted against the usage of the bridge (Fröhlingsdorf, 2017). The article describes and denounces the practice of using UI as a bridge to retirement at a large private bank and a leader of the service union (Verdi) is calling out this practice.

**Usage in practice and the role of different stakeholders** In Germany, older workers with long tenure benefit from strong layoff protections in Germany (see [EPL Database \(2015\)](#) for more details). Consequently, separations from older workers prior to retirement age often occur with the workers’ explicit consent to the terms and conditions of the separation (see (Fröhlingsdorf, 2017) for a concrete example). This can occur on an individual layoff-event level, but commonly involves different pillars of Germany’s industrial relations system, including Works Councils and managers on the establishment level as well as Unions and Employer Organizations on the sectoral level (see Jäger et al. (2022) for a review of these institutions and Trampusch (2005a); Trampusch et al. (2010) for their role in using the UI bridge as a separation policy). In the post-1982 period, when usage of the UI bridge picked up, sector-level collective bargaining agreements (CBAs) that defined the conditions of early-retirement practices became prevalent (Trampusch et al., 2010). Social plans often accompanied these agreements — agreements between works councils and the establishment management on how to manage separations— that further established the usage of these rules (Trampusch, 2005a). Fröhlich et al. (2013) describes the practice of different pathways into early retirement in the early 2010ths in six different industries, including a portrait of one concrete firm in each sector. In two out of the six sectors (chemical industry and private banking), the portrayed firm has been using UI as a bridge to retirement in the recent past (Fröhlich et al., 2013, p. 339-340, p. 475-476). In both cases, the bridge to retirement models involved an explicit or implicit agreement between management and the works council and generous severance payments to top up UI benefits. These policies guaranteed a fixed replacement rate of the previous net wage (between 70% and 90%) and the coverage of all social security and tax contributions for the period between layoff and earliest possible retirement, under the assumption that workers took-up and exhausted completely the UI benefits. In the case of the portrayed bank, the policy explicitly offered workers to assist in claiming UI benefits. For the same sector, (Fröhlingsdorf, 2017) reports high demand of the UI bridge among workers at a large firm, and a take-up rate of 96% among those workers the policy has been offered to.

In this firm, the management decides whom to offer the policy on a case by case basis.

[Knuth and Kalina \(2002\)](#) document that a high usage of the bidge in the manufacturing sector, among high income workers and in large ( $\geq 500$  employees) establishments.

**Alternative Pathways** The government also supported CLAs on early retirement in other forms, such as subsidizing employers' costs of buying-out older workers through the so-called partial retirement law (Altersteilzeitgesetz). This partial retirement law (Altersteilzeitgesetz) was enacted in mid-1990s and was suspended in 2009. Most CLAs on early retirement based on this law were not renewed. It was realized by halving older workers' working time (either via part-time work or early retirement). The employer paid 50% of the previous full-time income and the state government provided the remaining 50% to the employers, but only under the condition that the vacancy was replaced by an unemployed person or a freshly trained apprentice. In addition, the government supported this early retirement option by topping up the pension contribution of the workers who entered early retirement. This partial retirement law provided a maximum public subsidy for up to five years. Combined with the ERA being at age 60, this requirement meant that the CLA early retirement option applied most directly to employees age 55 and older ([Trampusch, 2005b](#)). Age 55, and to a lesser extent, age 56, was a common cutoff used in CLAs.

## D Model Details

This appendix sets up and solves our labor supply model.

### D.1 Model Set Up

**States.** Workers can be in one of three states: Employed ( $E$ ), Unemployed ( $U$ ), or out of the labor force ( $O$ ). We assume that once a worker drops out of the labor force he or she will not return, hence  $O$  is an absorbing state. We call a worker Non-Employed  $N$  if the worker is either unemployed or out of the labor force.

We assume that workers produce output  $p_t$  in each period, where  $p_t$  is i.i.d. according to some distribution  $F(p)$ . Another important state variable in our model is the total unemployment duration of a worker  $d^U$ . In practice we will estimate our model starting at age 50, so that  $d^U$  will be the duration in unemployment since then. To keep the state space manageable, we also assume that workers initially are eligible to the maximum benefit duration but do not reaccumulate benefit eligibility if they are reemployed after losing a job. Under this assumption  $d^U$  is sufficient to both calculate remaining UI benefit durations for each individual as well as the pension of an individual if the person retires. A full accounting of the benefit eligibility in the presence of multiple unemployment spells would require to separately keep track of  $d^U$  as well as the remaining benefit duration in each unemployment spell and employment duration in each employment spell. This quickly becomes computationally very challenging due to the curse of dimensionality. As long as repeated unemployment spells with long in-between employment spells are rare, which they are in practice, our approach is only a very minor simplification that vastly reduces the computational complexity. We can therefore write the value functions for the firm and worker as functions of  $p_t$  and  $d^U$ , where  $d^U$  is deterministic, while  $p_t$  is uncertain.

**Value Function For Employment.** Workers have a utility function  $u(\cdot)$ , are paid  $w_t(\cdot)$ , and experience disutility from working ( $\eta$ ), which will be drawn from a cohort specific distribution. The Value Function for Employment is:

$$V_t^E(p_t, d^U) = u(w_t(p_t, d^U)) - \eta + \beta E_{p_{t+1}} [\max \{V_{t+1}^E(p_{t+1}, d^U), V_{t+1}^N(d^U)\}] \quad (\text{C.1})$$

Workers will separate from their job whenever the expected value of future non-employment exceeds that of employment. This could occur for several reasons: workers

could receive a low productivity draw ( $p_t$ ) such that the employment relationship is no longer better than the worker's outside option. Alternatively, outside options could improve. For example, an increase in retirement benefits will push up  $V_t^N(d^U)$  for workers close to the retirement age and can increase the rate of jobs ending.

**Value Function For Unemployment.** When workers leave to unemployment they engage in costly job search and receive payments  $B(d^U)$ . If the individual still has Unemployment Insurance benefits remaining ( $d^U < P$ ), he or she will receive UI benefits ( $B(d^U) = b$ ). If not, the individual receives  $y^o$ , which can be interpreted as unemployment assistance. An unemployed individual searches for a job and chooses an optimal level of search effort  $s$  which is normalized to the probability of finding a job. Generating search effort comes at a cost  $\psi(s)$  which is increasing and convex. Finally, whether or not an individual receives a job offer she can decide to retire at the end of the period. If she remains unemployed  $d^U$  increases by one period. The Value Function for Unemployment is thus:

$$V_t^U(d^U) = u(B(d^U)) + \max_s \{ \beta s E_{p_{t+1}} \max [V_{t+1}^E(p_{t+1}, d^U + 1), V_{t+1}^N(p_{t+1}, d^U + 1)] + \beta(1-s) E_{p_{t+1}} V_{t+1}^N(d^U + 1) - \psi_t(s) \} \quad (\text{C.2})$$

Individuals choose search effort so that the marginal return to search equals the marginal cost up to the constraint that  $s \leq 1$ . For an interior solution, the first order condition for the optimal level of search effort  $s^*$  is:

$$\psi'(s^*) = \beta E \max [V_{t+1}^E(p_{t+1}, d^U + 1), V_{t+1}^N(d^U + 1)] - \beta V_{t+1}^N(d^U + 1)$$

Since we assume that  $\psi(\cdot)$  is increasing and convex, optimal search effort at an interior solution is:

$$s^* = \psi'^{-1} (\beta E \max [V_{t+1}^E(p_{t+1}, d^U + 1), V_{t+1}^N(d^U + 1)] - \beta V_{t+1}^N(d^U + 1)) \quad (\text{C.3})$$

**Value Function For Out of the Labor Force.** At any point, a worker can choose to transition to being out of the labor force  $O$ , which is an absorbing state. The value of  $O$  depends primarily on the value of one's pension  $y_t^p$  as determined by prevailing retirement institutions.  $y_t^p$  will depend on work history ( $d^U$ ) and age at which the worker retires. Specifically, for a worker who lives until  $T^{Last}$  and is eligible to receive pension at  $T^{ERA}$ ,

the value function for being out of the labor force is:

$$V_t^O(d^U) = \begin{cases} \sum_{k=t}^{T^{ERA}} \beta^{k-t} u(y^o) + \sum_{k=T^{ERA}}^{T^{Last}} \beta^{k-t} u(y_t^p) & t \leq T^{ERA} \\ \sum_{k=t}^{T^{Last}} \beta^{k-t} u(y_t^p) & t > T^{ERA} \end{cases} \quad (\text{C.4})$$

The value of the pension depends on the relevant, cohort-specific retirement institutions in addition to the individuals work history ( $d^U$ ). Individuals accrue pension benefits while working and while on UI benefits (at 80%), but not otherwise. Persons retiring at the earliest allowable retirement age (ERA) but before the normal retirement age (NRA) begin receiving a penalty starting with the 1937 cohort. We assume all individuals in our sample are eligible for the long-term insured retirement pathway and eligible for the retirement via UI pathway as long as they have 1 year of unemployment history ( $d^U$ ). We allow individuals to choose the best retirement option available. In Section E.5 below, we outline in detail how we calculate  $V_t^O$  for each cohort.

**Value Function For Non-Employment.** Finally the value of non-employment is defined as  $V_t^N(d^U) = \max(V_t^U(d^U), V_t^O(d^U))$ .

## D.2 Heterogeneity in the Disutility of Work

We introduce an additional layer of heterogeneity (beyond the productivity distribution  $F(p)$ ), by integrating the preceding model over a distribution of disutility of work types ( $\eta$ -types).

Under our distributional and functional form assumptions (laid out in detail in Section C.3.) the preceding model generates closed form solutions for all transitions between states (e.g.  $E$  to  $U$ ) and can be used to calculate expected non-employment durations for a given value of  $\eta$ . We will assume individual workers draw their  $\eta$  from a cohort-specific, distribution and integrate transitions and non-employment durations over the entire distribution. Specifically, we will assume that  $\eta$  is normally distributed with mean  $\eta_{mean, cohort}$  and standard deviation  $\eta_{sd}$  (which is fixed across cohorts). We implement this in practice by simulating the model for 50 different values of  $\eta$  and use Simpson's rule to approximate the full integral over the  $\eta$  distribution whenever we calculate cohort-level transitions and non-employment durations.

### D.3 Distributional and Functional Form Assumptions

Here we lay out the functional forms and distributional assumptions underlying our baseline model.

Productivity  $p_t$  will be drawn from a mixture distribution in which workers have  $\Lambda_t$  probability of facing a (large) negative productivity shock ( $-L$ ) that destroys the job with certainty. Meanwhile, with probability  $1 - \Lambda_t$ , workers draw a productivity level  $p_t$  from a lognormal distribution. This allows for exogenous job destruction at the rate  $\Lambda_t$ . Formally,  $p_t$  is drawn from a mixture distribution defined by  $f(\ln(p_t)) = \Lambda_t f^L(\ln(p_t)) + (1 - \Lambda_t) f_{p,\sigma_p}^N(\ln(p_t))$  where  $f_{p,\sigma_p}^N$  is the normal PDF and  $f^L(\ln(p_t)) = 1$  if  $\ln(p_t) = -L$  and  $f^L(\ln(p_t)) = 0$  otherwise. This allows for closed form solutions to all eventual transitions generated by the model. For sufficiently large  $L$  the functional form for the CDF of the mixture variable is  $F(\ln(p_t)) = \Lambda_t(1) + (1 - \Lambda_t) F_{p,\sigma}^N(\ln(p_t))$  where  $F_{p,\sigma}^N$  is the normal CDF. Additionally, we will allow the exogenous job destruction rate  $\Lambda_t$  to vary with the national male unemployment rate (u.r.). Specifically  $\Lambda_t$  will be a logistic function  $\Lambda_t = \frac{1}{1 + e^{-(\lambda_1 + \lambda_2 u.r._t + \lambda_3 \Delta u.r._t)}}$  with parameters  $\lambda_1$  to  $\lambda_3$  allowing  $\Lambda_t$  to vary with the level and year-on-year change in the national male unemployment rate.

We assume workers have log utility  $u(\cdot) = \ln(\cdot)$ . Firms make zero profits and hence pay the worker  $w_t = p_t$  in all periods. Workers draw disutility  $\eta$  from a normal distribution ( $\eta \sim N(\eta_{mean,cohort}, \eta_{sd})$ ).

The search cost function is based on [Della Vigna et al. \(2022\)](#) with some added flexibility. Specifically we assume:

$$\psi_t = k_0 + k_1 \mathbf{1}(dU = 0) + e^{k_2 \times dU} \times k_3 \frac{s^{1+\gamma}}{1 + \gamma} \quad (\text{C.5})$$

Where  $k_0$  is a fixed cost of being in unemployment,  $k_1$  a fixed cost of entering unemployment the first time,  $k_2$  allows search to become more costly later on in unemployment spells, while  $k_3$  and  $\gamma$  govern the slope and curvature of the job search function.

### D.4 Closed Form Solutions For Each Value Function

**Value Function For Employment.** Let  $\omega_{t,d^U}$  be the ‘reservation productivity’ such that  $V_t^E(\omega_{t,d^U}, d^U) = V_t^N(d^U)$ . Further, let  $\bar{\omega}_{t,d^U} \equiv \frac{\ln(\omega_{t,d^U}) - p}{\sigma_p}$ .

Since  $V_t^E(p_t, d^U) = \ln(p_t) - \eta + \beta E_{p_{t+1}} [\max \{V_{t+1}^E(p_{t+1}, d^U), V_{t+1}^N(d^U)\}]$ , plugging in

$\omega_{t,d^U}$  for  $p_t$  and rearranging  $V_t^E(\omega_{t,d^U}, d^U) - V_t^N(d^U) = 0$  gives:

$$\ln(\omega_{t,d^U}) = \eta - \beta E_{p_{t+1}} [\max \{V_{t+1}^E(p_{t+1}, d^U), V_{t+1}^N(d^U)\}] + V_t^N(d^U) \quad (\text{C.6})$$

Given the distribution of  $p_t$ :

$$\begin{aligned} E_{p_{t+1}} [\max \{V_{t+1}^E(p_{t+1}, d^U), V_{t+1}^N(d^U)\}] &= [\Lambda_{t+1} + (1 - \Lambda_{t+1})\Phi(\bar{\omega}_{t+1,d^U})] V_{t+1}^N(d^U) \\ &+ [1 - \Lambda_{t+1} - (1 - \Lambda_{t+1})\Phi(\bar{\omega}_{t+1,d^U})] E \left[ V_{t+1}^E(p_{t+1}, d^U) \mid \frac{\ln(p_{t+1}) - p}{\sigma_p} \geq \omega_{t+1,d^U} \right] \end{aligned}$$

Note that the conditional expectation at the end of this equation is “as if” is normally distributed, for the relevant sample space of productivity values. Using the fact that  $E(X|Z < \bar{\omega}_{t+1}) = p - \sigma_p \frac{\phi(\bar{\omega}_{t+1})}{\Phi(\bar{\omega}_{t+1})}$  and  $E(X|Z \geq \bar{\omega}_{t+1}) = p + \sigma_p \frac{\phi(\bar{\omega}_{t+1})}{1 - \Phi(\bar{\omega}_{t+1})}$  for a random variable  $Z \sim N(0, 1)$  and for  $X = \sigma Z + \mu \sim N(\mu, \sigma)$ , we obtain:

$$\begin{aligned} E \left[ V_{t+1}^E(p_{t+1}, d^U) \mid \frac{\ln(p_{t+1}) - p}{\sigma_p} \geq \omega_{t+1,d^U} \right] &= p - \eta \\ &+ \beta E_{p_{t+2}} [\max \{V_{t+2}^E(p_{t+2}, d^U), V_{t+2}^N(d^U)\}] + \sigma_p \frac{\phi(\bar{\omega}_{t+1}(d^U))}{1 - \Phi(\bar{\omega}_{t+1}(d^U))} \end{aligned}$$

And hence

$$\begin{aligned} E_{p_{t+1}} [\max \{V_{t+1}^E(p_{t+1}, d^U), V_{t+1}^N(d^U)\}] &= [\Lambda_{t+1} + (1 - \Lambda_{t+1})\Phi(\bar{\omega}_{t+1,d^U})] V_{t+1}^N(d^U) \\ &+ [1 - \Lambda_{t+1} - (1 - \Lambda_{t+1})\Phi(\bar{\omega}_{t+1,d^U})] \\ &\times \left\{ p - \eta + \beta E_{p_{t+2}} [\max \{V_{t+2}^E(p_{t+2}, d^U), V_{t+2}^N(d^U)\}] \right. \\ &\left. + \sigma_p \frac{\phi(\bar{\omega}_{t+1}(d^U))}{1 - \Phi(\bar{\omega}_{t+1}(d^U))} \right\} \end{aligned}$$

Similarly,

$$\begin{aligned} E_{p_{t+2}} [\max \{V_{t+2}^E(p_{t+2}, d^U), V_{t+2}^N(d^U)\}] &= [\Lambda_{t+2} + (1 - \Lambda_{t+2})\Phi(\bar{\omega}_{t+2,d^U})] V_{t+2}^N(d^U) \\ &+ [1 - \Lambda_{t+2} - (1 - \Lambda_{t+2})\Phi(\bar{\omega}_{t+2,d^U})] \\ &\times \left\{ p - \eta + \beta E_{p_{t+3}} [\max \{V_{t+3}^E(p_{t+3}, d^U), V_{t+3}^N(d^U)\}] \right. \\ &\left. + \sigma_p \frac{\phi(\bar{\omega}_{t+2}(d^U))}{1 - \Phi(\bar{\omega}_{t+2}(d^U))} \right\} \end{aligned}$$

And so forth, until the final period  $T^{Last}$



$$E_{p_{TLast}} \left[ \max \left\{ V_{TLast}^E(p_{TLast}, d^U), V_{TLast}^N(d^U) \right\} \right] = V_{TLast}^N(d^U) = V_{TLast}^O(d^U)$$

Hence, the value of employment in any given period can be determined using backward induction. For convenience, we define  $\Omega_{t,d^U} \equiv E \max [V_t^E(p_t, d^U), V_t^N(d^U)]$ . This allows us to express  $V_t^E(p_t, d^U) = u(w_t(p_t, d^U)) - \eta + \beta \Omega_{t+1,d^U}$ . Altogether, these results and Equation C.6 imply:  $\bar{\omega}_{t,d^U} \equiv \frac{\ln(\omega_{t,d^U}) - p}{\sigma_p} = \frac{\eta - \beta \Omega_{t+1,d^U} + V_t^N(d^U) - p}{\sigma_p}$ .

**Value Function For Unemployment.** Given the above, we can rewrite the value of unemployment as a function of

$$V_t^U(d^U) = u(B(d^U)) + \max_s \left\{ \beta V_{t+1}^N(d^U + 1) + \beta s (\Omega_{t+1,d^U+1} - V_{t+1}^N(d^U + 1)) - \psi_t(s) \right\}$$

and

$$s^* = \psi'^{-1} (\beta \Omega_{t+1,d^U+1} - \beta V_{t+1}^N(d^U + 1))$$

**Transitions.** Individuals can be in any of the following  $N_s$  states: employed with  $d^U = 0$  to  $d^U = T$ , unemployed with  $d^U = 0$  to  $d^U = T$ , or out of the labor force. Let  $\mathbf{h}_t \equiv (h_{t,E,d^U=0}, \dots, h_{t,E,d^U=T}, h_{t,U,d^U=0}, \dots, h_{t,U,d^U=T}, h_{t,O})$  be the vector describing the number of individuals across states at each time period. Let the  $m_{t,i,j}$  be the probability of an individual transitioning from state  $i$  at time  $t$  to state  $j$  at time  $t+1$ . Let  $\mathbf{M}_t$  be the transition matrix across states where  $m_{t,i,j}$  is the element of the  $i^{th}$  row and  $j^{th}$  column.

The transition matrix describes the evolution of the number of individuals across states:

$$\mathbf{h}_{t+1} = \mathbf{h}_t \mathbf{M}_t$$

Define  $\zeta_{d^U} \equiv \Lambda_{t+1} + (1 - \Lambda_{t+1})\Phi(\bar{\omega}_{t+1,d^U})$  and  $\zeta_{d^U+1} \equiv \Lambda_{t+1} + (1 - \Lambda_{t+1})\Phi(\bar{\omega}_{t+1,d^U+1})$

The transition matrix  $\mathbf{M}_t$  is given by:

	Employed $d^U$	Employed $d^U + 1$	Unemployed $d^U$	Unemployed $d^U + 1$	OLF
...					
Employed $d^U$	$1 - \zeta_{d^U}$	0	$\zeta_{d^U} \mathbf{1} \left( \begin{array}{l} V_{t+1}^U(d^U) \\ \geq \\ V_{t+1}^O(d^U) \end{array} \right)$	0	$\zeta_{d^U} \mathbf{1} \left( \begin{array}{l} V_{t+1}^O(d^U) \\ > \\ V_{t+1}^U(d^U) \end{array} \right)$
...					
Unemployed $d^U$	0	$s[1 - \zeta_{d^U+1}]$	0	$\left\{ (1-s) + s(\zeta_{d^U+1}) \right\} \times \mathbf{1} \left( \begin{array}{l} V_{t+1}^U(d^U+1) \\ \geq \\ V_{t+1}^O(d^U+1) \end{array} \right)$	$\left\{ s\zeta_{d^U+1} + (1-s) \right\} \times \mathbf{1} \left( \begin{array}{l} V_{t+1}^O(d^U+1) \\ > \\ V_{t+1}^U(d^U+1) \end{array} \right)$
...					
OLF	0	0	0	0	1

As an example a transition from employed with  $d^U \rightarrow$  unemployed with  $d^U$  occurs

with  $prob[V_{t+1}^E(p_{t+1}, d^U) < V_{t+1}^N(d^U)]\mathbf{1}(V_{t+1}^U(d^U) \geq V_{t+1}^O(d^U))$ . This can be simplified to:

$$\begin{aligned}
&= prob[\ln(p_{t+1}) < V_{t+1}^N(d^U) + \eta - \beta \Omega_{t+2, d^U}]\mathbf{1}(V_{t+1}^U(d^U) \geq V_{t+1}^O(d^U)) \\
&= F(V_{t+1}^N(d^U) + \eta - \beta \Omega_{t+2, d^U})\mathbf{1}(V_{t+1}^U(d^U) \geq V_{t+1}^O(d^U)) \\
&\text{Recall } \bar{\omega}_{t+1, d^U} = \frac{V_{t+1}^N(d^U) + \eta - \beta \Omega_{t+2, d^U} - p}{\sigma_p}, \text{ hence:} \\
&= [\lambda_{t+1} + (1 - \lambda_{t+1})\Phi(\bar{\omega}_{t+1, d^U})]\mathbf{1}(V_{t+1}^U(d^U) \geq V_{t+1}^O(d^U)) \\
&= \zeta_{d^U} \mathbf{1}(V_{t+1}^U(d^U) \geq V_{t+1}^O(d^U))
\end{aligned}$$

**Model Output: Aggregate Transition Probabilities and Non-Employment Durations.** We first simulate the model for 50 different realizations of the distribution of disutility of work. For each of them, we calculate simulated moments such as transitions between employment statuses and non-employment durations. For transitions, we sum across the elements of the transition matrix that correspond to each moment. For non-employment durations, we employ a backwards induction procedure that assumes that all workers are not employed by the last period, and then it considers the probability of entering non-employment recursively. This approach allows us to generate the expected value for non-employment duration for new entrants into UI ( $d^U = 0$ ) for every period.

After calculating these moments, we aggregate all realizations by integrating over the distribution of  $\eta$  using Simpson's rule.

## E Estimation Details

### E.1 Estimation Procedure

**In-Sample Cohorts.** We estimate the model structurally, using a minimum distance estimator to match the empirical reduced form moments from Section 3. Denote as  $\xi$  the parameters of the structural model. Furthermore, let  $m(\xi)$  be the vector of moments predicted by the model as a function of the parameters  $\xi$ , and by  $\hat{m}$  the vector of observed moments. We estimate the model using 3 cohorts: 1929, 1935, and 1950 on quarterly data. The moments  $m(\xi)$  we use for matching are i) the monthly transition probabilities of workers from  $E$  to  $U$  between age 50 and 63, ii) the non-employment durations (calculated from job exit until age 63), and iii)  $\frac{\partial Nonemp}{\partial P}$  at age 52 = 0.128, only for the 1950 cohort (from Table 2).<sup>32</sup>

<sup>32</sup>While we observe UI receipt, we cannot distinguish unemployment from OLF after UI benefits are exhausted. For this reason we simply distinguish between non-employment and employment, which we

The estimator chooses the parameters  $\hat{\xi}$  that minimize the distance:

$$(m(\xi) - \hat{m})' W (m(\xi) - \hat{m}) \tag{C.1}$$

Where  $W$  is a weighting matrix. We simulate all transitions using the empirical data to construct the full covariance matrix.

For the intensive margin RD moments, we use a larger weight ( $\times 100$ ) since this is a causal estimate that we have significant confidence in given the research in this paper and many other well identified estimates from the literature and we want to make sure our fitted model generates realistic predictions for intensive margin responses. We omit the first and last quarter from the estimation.

**Out-of-Sample Cohorts.** In the second step of the model we refit our model to all other cohorts by estimating a single parameter per cohort - the mean of that cohort's  $\eta$  distribution ( $\eta_{\{mean, cohort\}}$ ). For this estimation exercise, our target moments are transitions from  $E$  to  $U$  and non-employment durations. Since this parameter was already estimated within our in-sample cohorts, refitting does not change the model parameters for our in-sample cohorts, but allows different cohorts to have different outside options / workforce attachment that is not otherwise captured by retirement and UI institutions. We also employ a minimum distance estimator using the same specifications previously described.

## E.2 Estimated Parameters

We estimate the following parameters: standard deviation of the distribution of productivity  $\sigma_p$ ; parameters of exogenous job loss shock  $\lambda_1 - \lambda_3$ ; search cost function parameters  $k_0 - k_3$  and  $\gamma$ ; and parameters for the cohort-specific distribution of disutility of work  $\eta_{mean,1929}$ ,  $\eta_{mean,1935}$ ,  $\eta_{mean,1950}$ , and  $\eta_{sd}$ .

## E.3 Numerical Optimization

The model is simulated in Python. We carefully optimized our code using the Python package Numba to pre-compile the code which greatly speeds up computation times. We then estimate the model by numerically minimizing the objective function (C.1). For this we rely on the optimization package **estimagic** (see [Gabler \(2022\)](#)), which provides an

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can easily generate from the model predictions by pooling the unemployed and OLF states.

elegant way to search for global minima using a multi-start algorithm, that can be distributed over many computing cores and nodes and allows for easily switching between alternative local optimizers. For our problem, we found that two derivative free least squares optimizers work well: Derivative-Free Optimizer for Least-Squares Minimization (DFO-LS) (Cartis et al., 2018) and POUNDERS (Wild, 2015). A noteworthy practical point is that these least-squares optimizers perform vastly better than a wide range of black box optimizers that we tried (such as newtonian, quasi-newtonian, trust-region, and genetic algorithms).

Our algorithm is the following: We use 18 compute nodes with 28 cores each. We then draw 280 random starting values on each node using latin hypercube sampling (to guarantee good coverage of the parameter space). On each node we then pick the 28 best starting values (lowest SSE) and run a local minimizer (in half the cases DFO-LS in the other half POUNDERS) on them with a walltime of 10 hours. The total compute time is thus  $18 \cdot 28 \cdot 10 = 5040$  hours. We can assess convergence by comparing the best solutions from each of the 18 nodes. They are fairly close to each other, both in terms of SSE and the parameter estimates, suggesting that we reliably find a global minimum or at least a point very close to the global minimum.

#### E.4 Institutional Parameters and Other Parameters

We set  $T^{Last} = 78$ ,  $y^o = 50$ , and  $\beta = 0.95$ .

*Average Wages/Productivity:* The mean of the  $p$  distribution is set at 3000 euro (in 2010 euro) as the gross monthly average wage. This is in line with average gross wages for those aged 50-60 with a UI spell (3,282 across all 6 select cohorts). We use a constant conversion rate between gross and net wages of 0.65. (In the model, we need to specify the UI replacement rates on gross wages, defined as the ratio of monthly (net) UI benefits relative to monthly pre-unemployment gross-wages. For cohorts 1935 and later, we take all individuals in the cohort with a UI spell in the IEB-data aged 50-60 and compare their actual UI benefits to their gross income. For each cohort, we obtain an average gross replacement rate of 0.39, implying a constant conversion rate from net UI replacement rates to gross UI replacement rates of 0.65. We assume this conversion rate also applied to prior cohorts.)

*UI replacement rates:* UI reforms in the past decades also changed the UI replacement rates. The replacement rates on net wages stay at 63% for an individual without children

and 67 % for an individual with children till end of 1993. Starting January 1994, the replacement rates reduced to 60% and 67%, respectively. Since most of population will no longer have eligible children, we use the 63% and 60% rates. We list the UI replacement rates on net wages for each cohort when they are at the UI bridge age.

*Pension replacement rate:*  $\rho$  represents the pension replacement rate on gross wages per one additional year of employment. We calculate the values for an average earner born in the key cohorts based on the pension benefit formula in Germany. For each cohort, we take the value of  $\rho$  in the years when they are between 60 and 63 years old. The several pension reforms in the past decades have changed the pension benefit formula. Before 1992, the pension benefit size is determined by four factors: the relative earnings of the insured, the aggregate annual pension value, the number of insurance years, and an adjustment factor (Steigerungssatz), which was set at 1.5 for old-age pensions. For an average earner with 45 years of contribution, the gross annual pension benefit is annual pension value  $\times 45 \times 1.5$ . Therefore, the pension replacement rate on gross wage is (annual pension value  $\times 45 \times 1.5$ )/average annual income. The pension replacement rate on gross wages per one additional year of employment is calculated from the monthly pension benefits net of health care and long-term care contribution (ssc) : (annual pension value  $\times 1.5$ )(1-ssc)/average annual income. After 1992, the monthly pension benefit amount is obtained by multiplying the personal pension base by the monthly pension value (PV). The personal pension base is the sum of the earnings points (EPs) accumulated over the entire working history. For example, an average wage earner with 45 contribution years will accumulate 45 EPs. At the time of retirement, this personal pension base is scaled up by the pension value at the time of retirement, which is determined aggregately by factors such as the average wage of all insured, the contribution rate, and demographic changes. For example, one EP was equivalent to 29.21 euro per month in 2015. Therefore, the pension replacement rate on gross wage earnings is (45  $\times$  PV  $\times$  12)/average annual income. The pension replacement rate on gross wage an additional year of contribution net of health care and long-term care contribution(ssc) is (PV  $\times$  12)(1-ssc)/average annual income.

We obtain the values of pension values, average annual income of all insured and the health care and long-term care contribution rates from year 1980 to 2016 from the German pension statistics office and social code book VI. The pension values are from **Zahlen und Tabellen vom 1.1. bis 30.6.2020**. The average annual income of all insured is from Appendices 1 and 2 of the social code book VI. The average social security contribution

rats are from the [German pension insurance annual report 2019](#). We set the income tax rate on pension benefit to zero for two reasons. First, for individuals who retire before 2005, pension income is tax-free<sup>33</sup>. Second, for individual who retire after 2005, only 50 percent of the gross pension benefit was recognized as taxable income. However, annual income up to a statutory threshold is exempt from income tax, independent of income sources. This is EUR 9 000 per single person in 2018 and EUR 7356 in 2005. The taxable part of the pension benefits is typically lower than this threshold for an average earner. For example, the annual pension benefits of an average earner with 40 years of contribution who retires in 2005 is around EUR 12,500. Half of this amount is below the taxable income threshold. Therefore, it is reasonable to set the income tax for pension benefits to zero.

*Years of contribution made before age 55.* We obtain the average years of contribution at age 54 by using the scientific use file of the Insurance Account Sample (Versicherungskontenstichprobe, SUFVSKT) of the German Federal Pension Register. Each wave of SUFVSKT contains 5% random sample of individuals with an active public pension insurance account in Germany, who were between the ages of 30 and 67 at the time of data collection. Each wave also contains the earnings biographies from age 14 onwards, at a monthly frequency. For cohorts from 1935 to 1946, we calculate the average years of employment at age 54 for West Germans employed at age 50 using the wave SUFVSKT2002. We obtain the values for cohorts from 1947 to 1952 by using the waves SUFVSKT2010 and SUFVSKT2018. However, we cannot observe cohorts older than in 1935 because the earliest SUFVSKT available wave is 2002. Cohorts born before 1935 are older than 67 in 2002. Therefore, they are not in the dataset. To obtain reasonable values of employment years before age 54 for these older cohorts, we use the average values for cohorts from 1935 to 1940 as a proxy for the older cohorts' years of contribution made before age 55.

*Discounted pension accrual rates while on UI and UA* The time spent on unemployment insurance also increase pension benefits, because the UI agency contributes to the pension scheme on behalf of the unemployed. During the periods of claiming UI, contributions

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<sup>33</sup>The proportion of the income subject to tax varies with the year of retirement at which the individual first started drawing the pension. Pensions starting before 2005 are tax-free. For pensions beginning in 2005, 50 percent of the gross pension benefit was recognized as taxable income. This portion remains fixed for the pensioners retire in 2005 in the subsequent years. Until 2020 the taxable part of the pension will increase by 2 percentage points per year and from 2020 until 2040 by one percentage point per year. In 2015, 70\% of the pension income is taxable. The statutory health and long-term care insurance contributions are exempt from the taxable income. For more details about the schedule, please check the [German statutory pension insurance website](#).

are paid on the basis of 80% of previous gross earnings (SGBVI §166 Paragraph 1 No. 2)). Therefore, one additional year of time spent on UI increases the future pension benefits by  $\rho \times 80\%$ . During the periods of claiming unemployment insurance benefits 2 (UIB II), which is means-tested and paid at a lower rate, and unemployment assistance (UA), the unemployment insurance provides no financial contributions to the pension scheme. Therefore, has no impact on future pension benefits. The discount rate is set to zero (OECD: pension at a glance).

Table 1 lists the values of parameters used in the model for six select cohorts, each chosen to represent a different institutional regime. We first list the statutory retirement age via regular old-age pension. Then for both the long-term insured pension pathway and the pension via UI pathway, we list the earliest available retirement age (ERA), the age at which you can collect pension without penalties (NRA), and the accrual adjustment penalty for retiring at the ERA. We also highlight the UI bridge age, which is (ERA via UI-P), with P being the maximum UI PBD. Individuals who leave at the UI bridge age can take the full UI duration and transition directly into pensions. We provide more information on pension reforms and retirement pathways in Section C.

## E.5 Retirement Details: How we calculate the Value of Out Of The Labor Force

To calculate the value of being out of the labor force (OLF), we proceed by first calculating the income from pension that depends on contribution years (from employment, unemployment and welfare), working years, duration of unemployment  $d^U$ , reference income for retirement, pension replacement rates, potential UI duration and pension contribution discount associated to UI (or unemployment assistance). Then, we generate an age-specific path of OLF income which comprises home production before retirement and pension income (after early retirement penalties) after retirement. This income stream depends on institutional values such as early retirement ages and which pathway is used by the worker to retire (UI or long-term-insured).

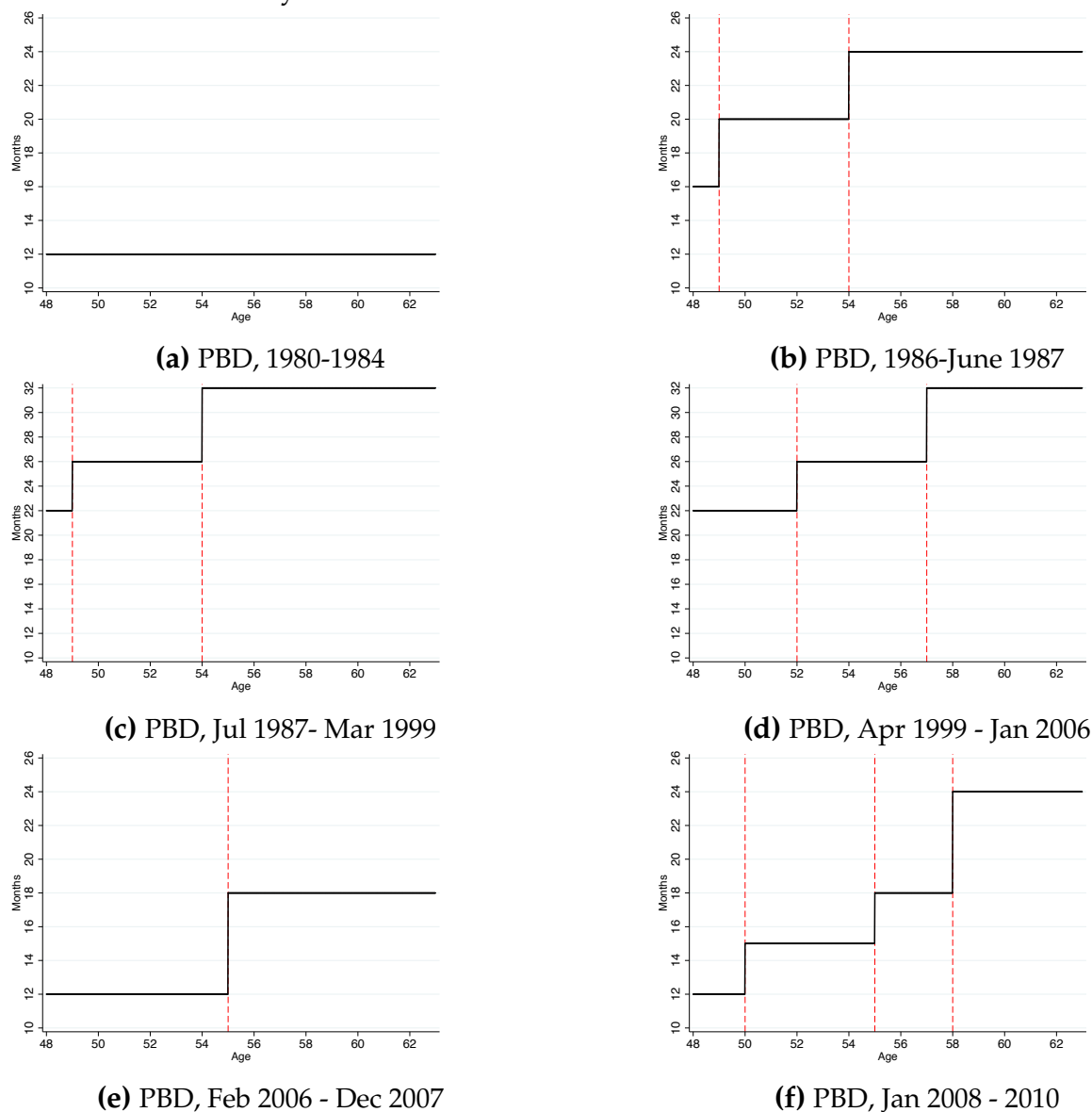
In a final step, we calculate the value of OLF for the two potential retirement pathways (UI or long-term-insured). Here we follow the definition of this expression presented in Equation C.4 and calculate the discounted value. Having computed the value of OLF for each retirement pathway, the procedure takes into account the availability of them for workers, which is cohort-specific. If the UI pathway is not available, then the value of OLF is the one of the long-term-insurance pathway. If both are available, then the

maximum value between the two options will be the value of OLF.



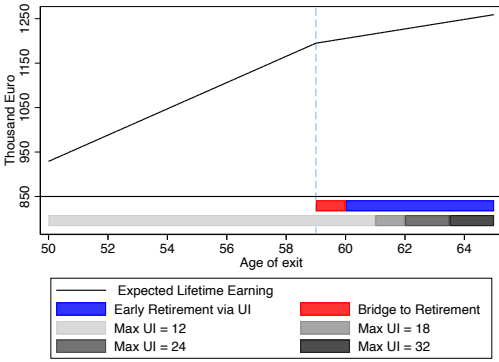
## F Appendix Figures

**Figure F.1:** Maximum Potential UI Benefit Durations (PBDs) by Age for Different Time Periods in Germany

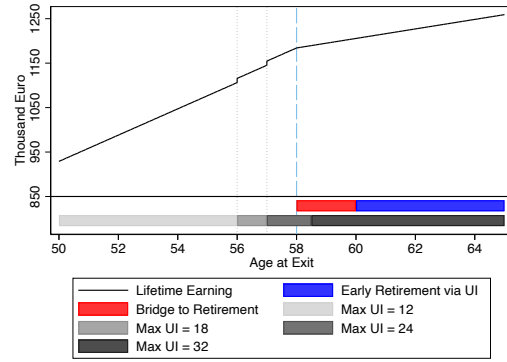


**Notes:** The figure shows maximum potential unemployment insurance (UI) benefit durations vary with age and over time in Germany from 1980 to 2010. We drop the brief 1985 regime in the interest of brevity. Each figure corresponds a different UI regime. Appendix Table G.1 contains more detailed information on each institutional regime, including eligibility requirements and benefit levels. The vertical red dash-dotted lines mark the age cutoffs for increases in potential UI durations at different ages.

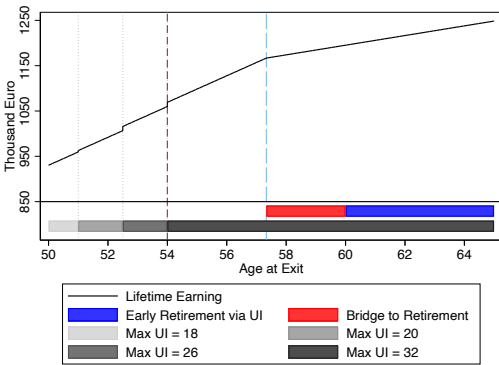
**Figure F.3: Stylized Budget Sets for Different Cohorts in Germany, Men**



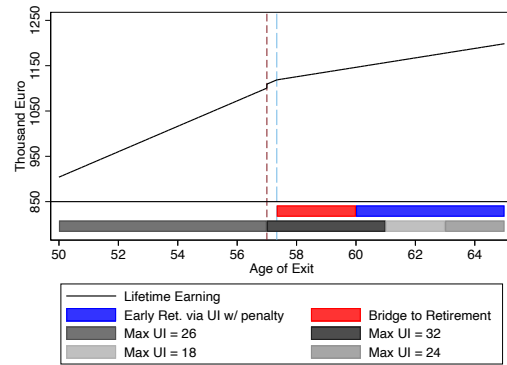
**(a) Lifetime Income, 1924 Cohort**



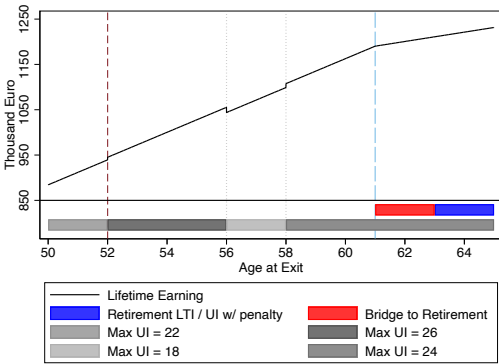
**(b) Lifetime Income, 1929 Cohort**



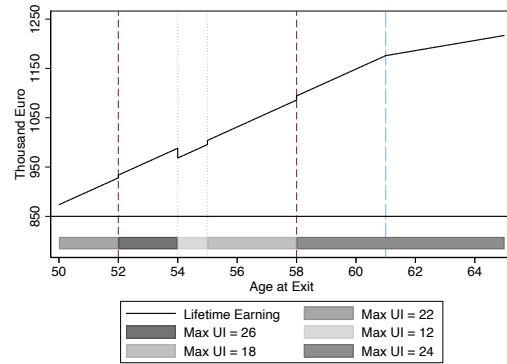
**(c) Lifetime Income, 1935 Cohort**



**(d) Lifetime Income, 1945 Cohort**



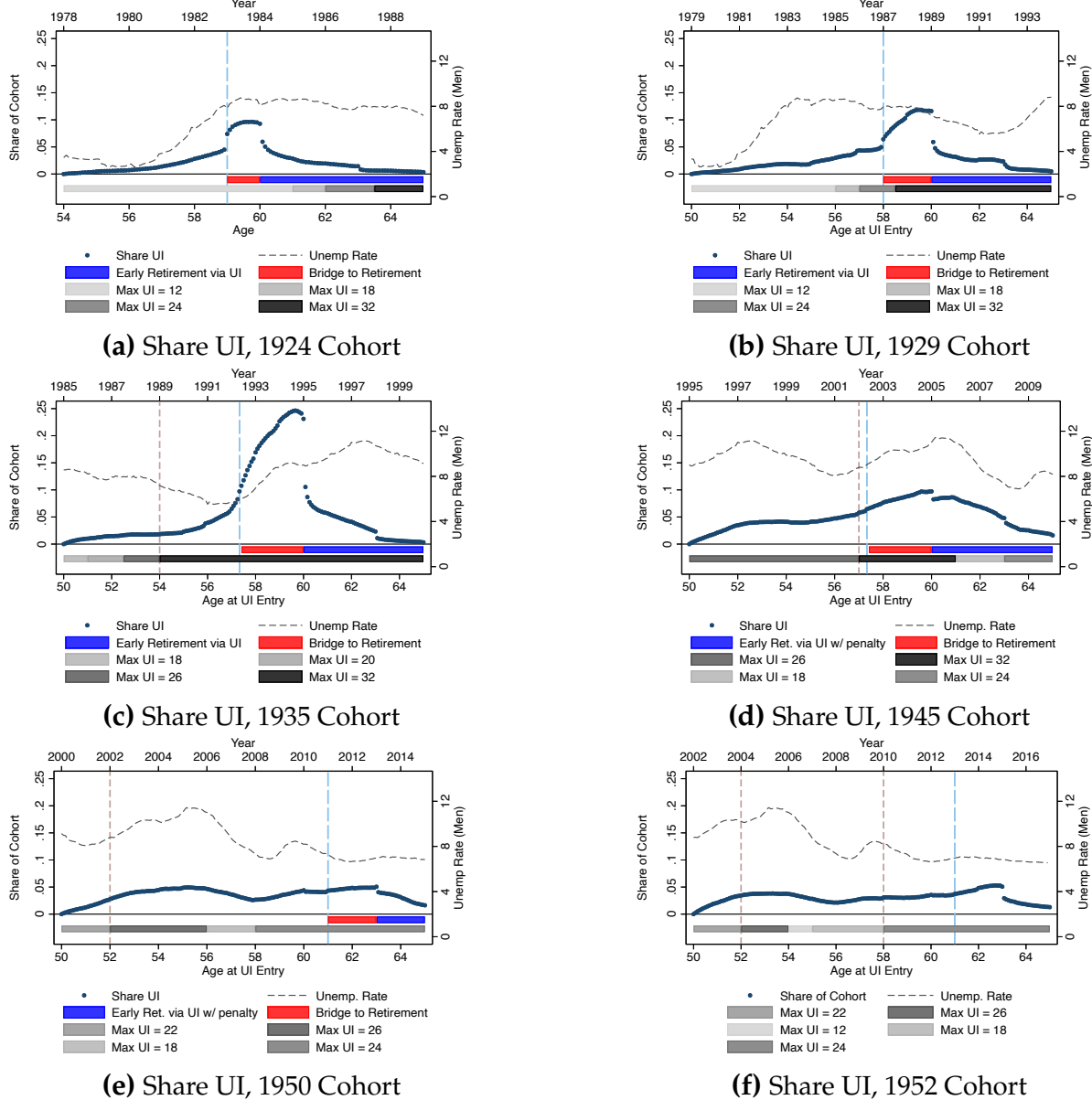
**(e) Lifetime Income, 1950 Cohort**



**(f) Lifetime Income, 1952 Cohort**

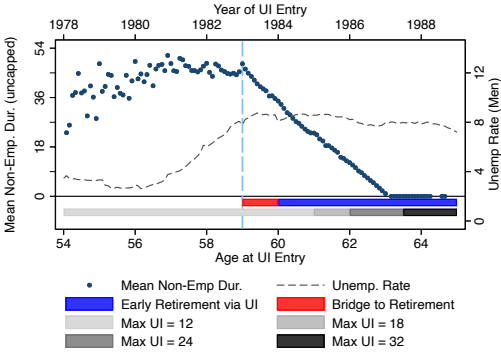
**Notes:** These figures plot stylized lifetime budget sets by age for different cohorts of West German Men in our sample. The red bar under the figure indicates the period over which an individual could receive UI before drawing pension (the blue bar under the figure) if he entered UI at the bridge-to-retirement age (the blue dashed line). The different shades of grey represent different maximum PBD eligibility for UI, which can change because of an existing age-cutoff (the red dashed line) or because of an overall UI policy change enacted in that year (the gray dotted line).

**Figure F.5: Share UI by Age for Different Cohorts in Germany, Men**

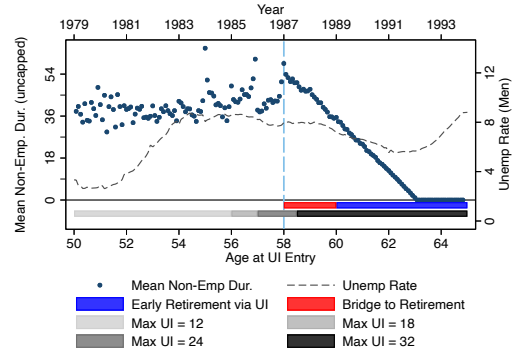


**Notes:** These figures the share of the cohort in UI by age for different cohorts of West German Men in our sample (left axis). It also plots the male, seasonally adjusted unemployment rate as a dashed gray line (right axis). The red bar under the figure indicates the period over which an individual could receive UI before drawing pension (the blue bar under the figure) if he entered UI at the bridge-to-retirement age, indicated by the vertical dashed blue line. The different shades of grey represent different maximum PBD eligibility for UI, which can change because of an existing age-cutoff (the red dashed line) or because of an overall UI policy change enacted in that year.

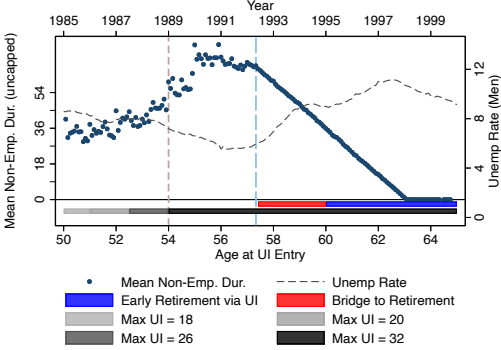
**Figure F.7: Mean Non-Emp. Duration by Age for Different Cohorts in Germany, Men**



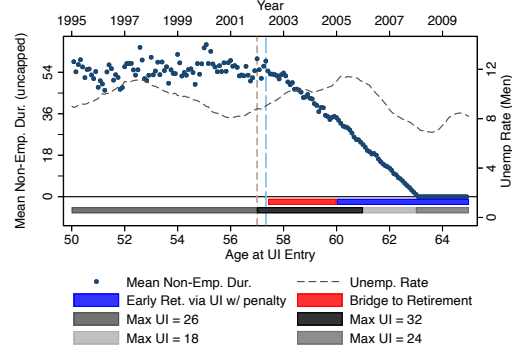
**(a) Mean Non-Emp. Duration, 1924 Cohort**



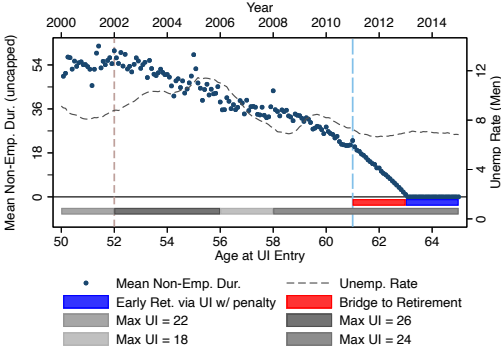
**(b) Mean Non-Emp. Duration, 1929 Cohort**



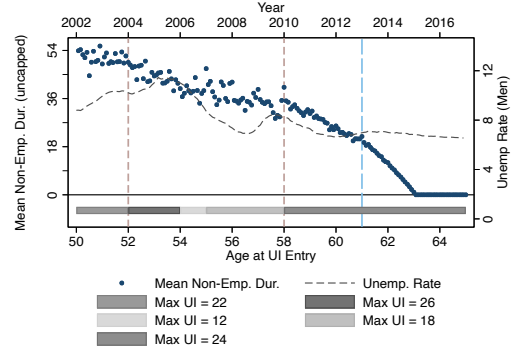
**(c) Mean Non-Emp. Duration, 1935 Cohort**



**(d) Mean Non-Emp. Duration, 1945 Cohort**



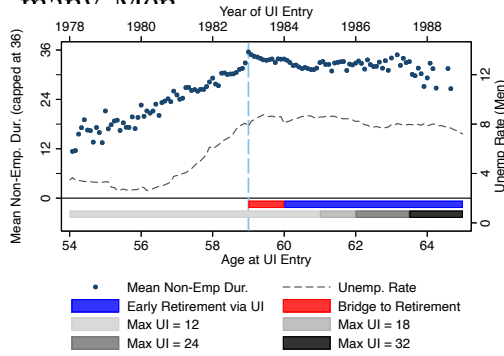
**(e) Mean Non-Emp. Duration, 1950 Cohort**



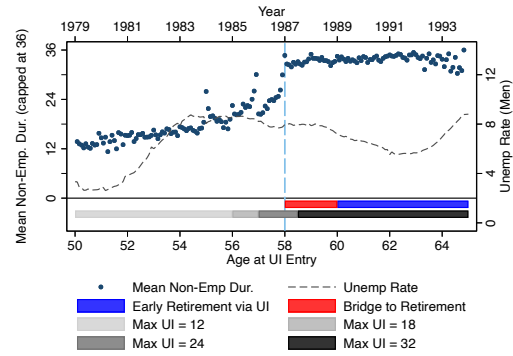
**(f) Mean Non-Emp. Duration, 1952 Cohort**

**Notes:** These figures plot mean non-employment duration (up to age 63) for different cohorts of West German Men in our sample entering unemployment at the given age (left axis). It also plots the male, seasonally adjusted unemployment rate as a dashed gray line (right axis). The red bar under the figure indicates the period over which an individual could receive UI before drawing pension (the blue bar under the figure) if he entered UI at the bridge-to-retirement age, indicated by the vertical dashed blue line. The different shades of grey represent different maximum PBD eligibility for UI, which can change because of an existing age-cutoff (the red dashed line) or because of an overall UI policy change enacted in that year.

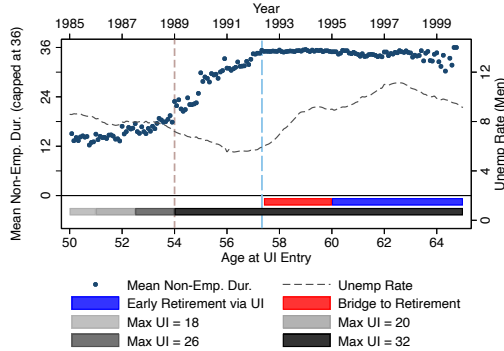
**Figure F.9: Mean Capped Non-Emp. Duration by Age for Different Cohorts in Germany Men**



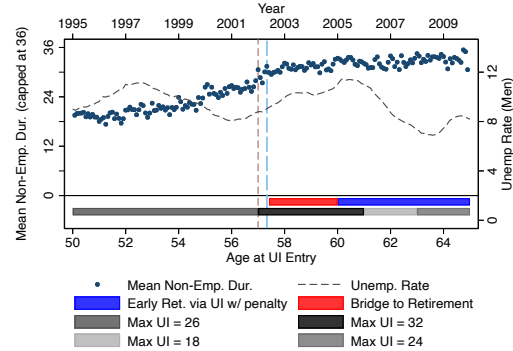
**(a) Mean Non-Emp. Duration, 1924 Cohort**



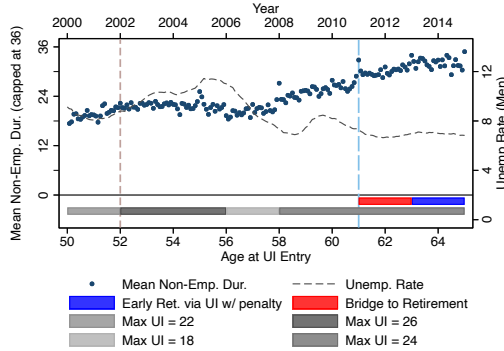
**(b) Mean Non-Emp. Duration, 1929 Cohort**



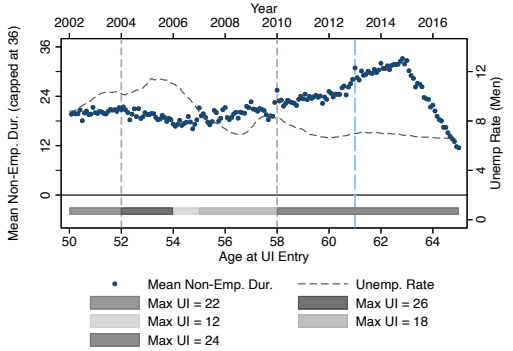
**(c) Mean Non-Emp. Duration, 1935 Cohort**



**(d) Mean Non-Emp. Duration, 1945 Cohort**



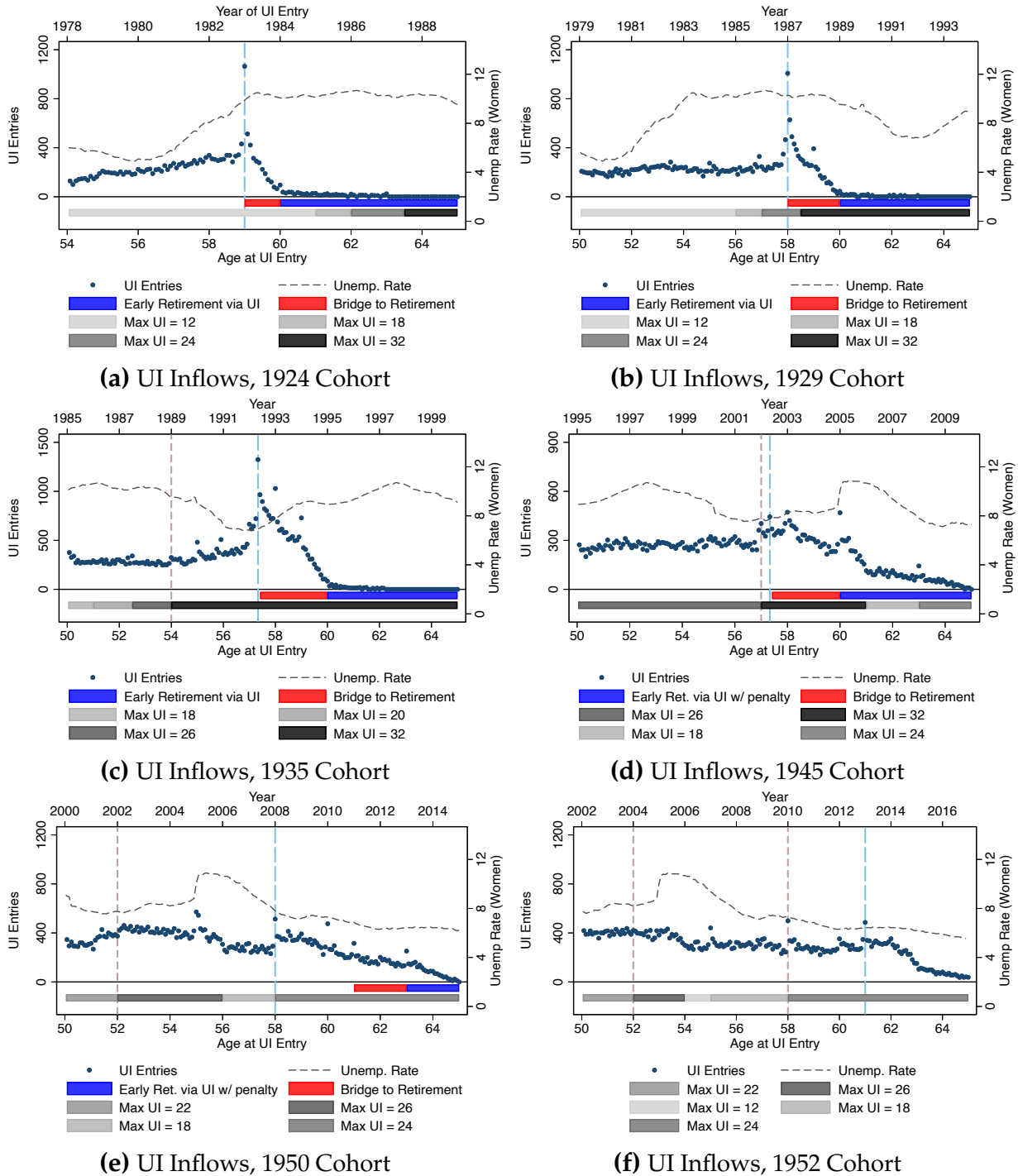
**(e) Mean Non-Emp. Duration, 1950 Cohort**



**(f) Mean Non-Emp. Duration, 1952 Cohort**

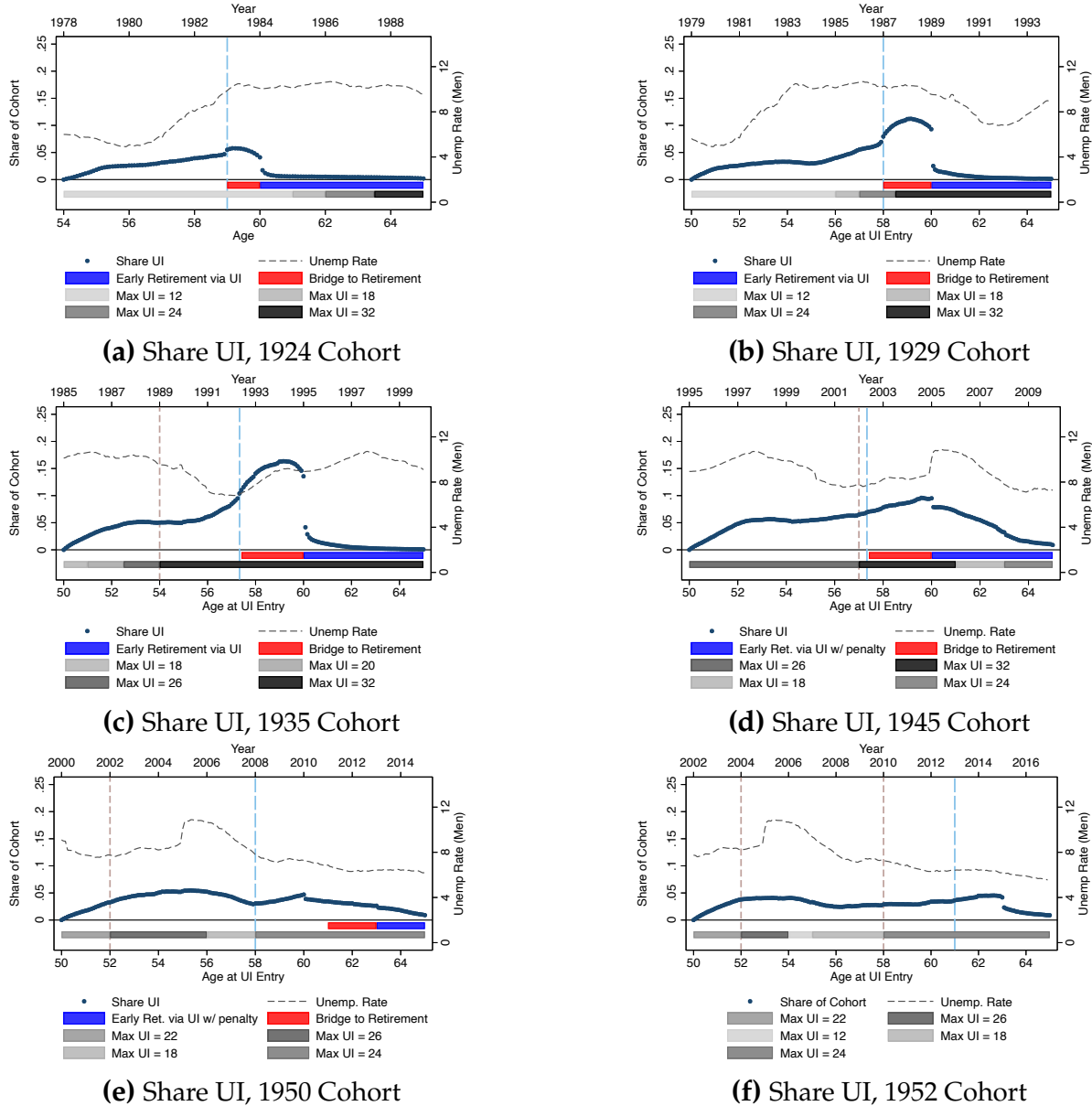
**Notes:** These figures plot mean non-employment duration (capped at 36 months) for different cohorts of West German Men in our sample entering unemployment at the given age (left axis). It also plots the male, seasonally adjusted unemployment rate as a dashed gray line (right axis). The red bar under the figure indicates the period over which an individual could receive UI before drawing pension (the blue bar under the figure) if he entered UI at the bridge-to-retirement age, indicated by the vertical dashed blue line. The different shades of grey represent different maximum PBD eligibility for UI, which can change because of an existing age-cutoff (the red dashed line) or because of an overall UI policy change enacted in that year.

**Figure F.11: UI Inflows by Age for Different Cohorts in Germany, Women**



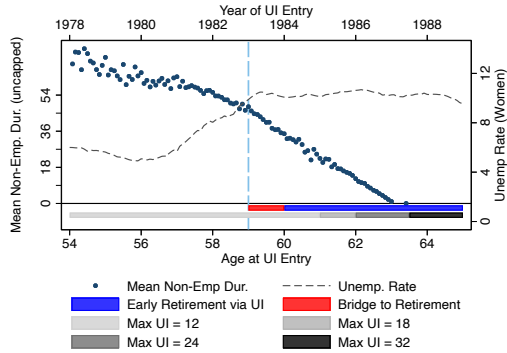
**Notes:** These figures plot UI inflows (transitions from employment to unemployment) by age for different cohorts of West German Women in our sample (left axis). It also plots the female, seasonally adjusted unemployment rate as a dashed gray line (right axis). The red bar under the figure indicates the period over which an individual could receive UI before drawing pension (the blue bar under the figure) if he entered UI at the bridge-to-retirement age, indicated by the vertical dashed blue line. The different shades of grey represent different maximum PBD eligibility for UI, which can change because of an existing age-cutoff (the red dashed line) or because of an overall UI policy change enacted in that year.

**Figure F.13: Share UI by Age for Different Cohorts in Germany, Women**

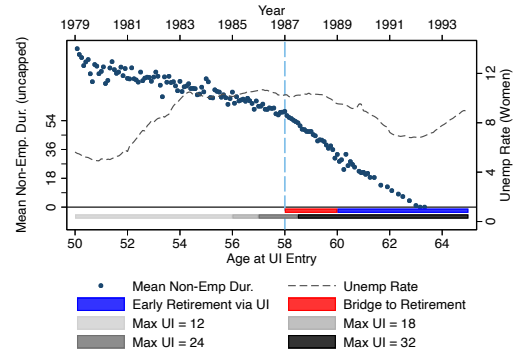


**Notes:** These figures show the share of the cohort in UI by age for different cohorts of West German Women in our sample (left axis). It also plots the female, seasonally adjusted unemployment rate as a dashed gray line (right axis). The red bar under the figure indicates the period over which an individual could receive UI before drawing pension (the blue bar under the figure) if he entered UI at the bridge-to-retirement age, indicated by the vertical dashed blue line. The different shades of grey represent different maximum PBD eligibility for UI, which can change because of an existing age-cutoff (the red dashed line) or because of an overall UI policy change enacted in that year.

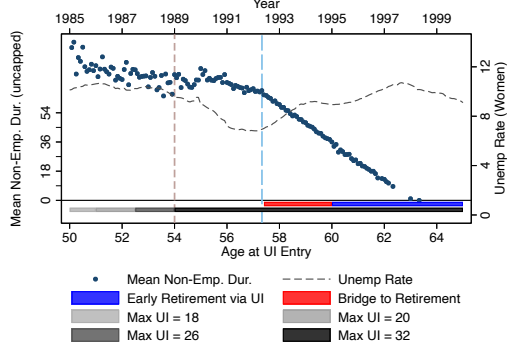
**Figure F.15: Mean Non-Emp. Duration by Age for Different Cohorts in Germany, Women**



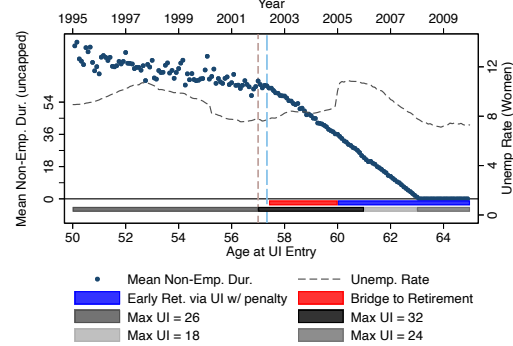
**(a) Mean Non-Emp. Duration, 1924 Cohort**



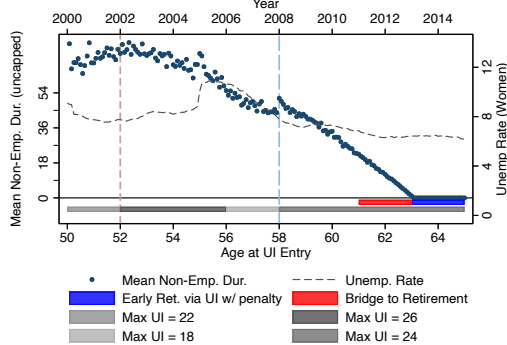
**(b) Mean Non-Emp. Duration, 1929 Cohort**



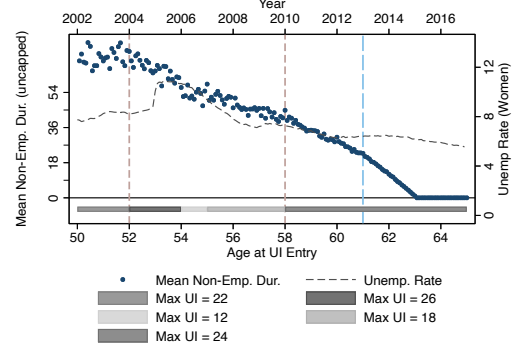
**(c) Mean Non-Emp. Duration, 1935 Cohort**



**(d) Mean Non-Emp. Duration, 1945 Cohort**



**(e) Mean Non-Emp. Duration, 1950 Cohort**

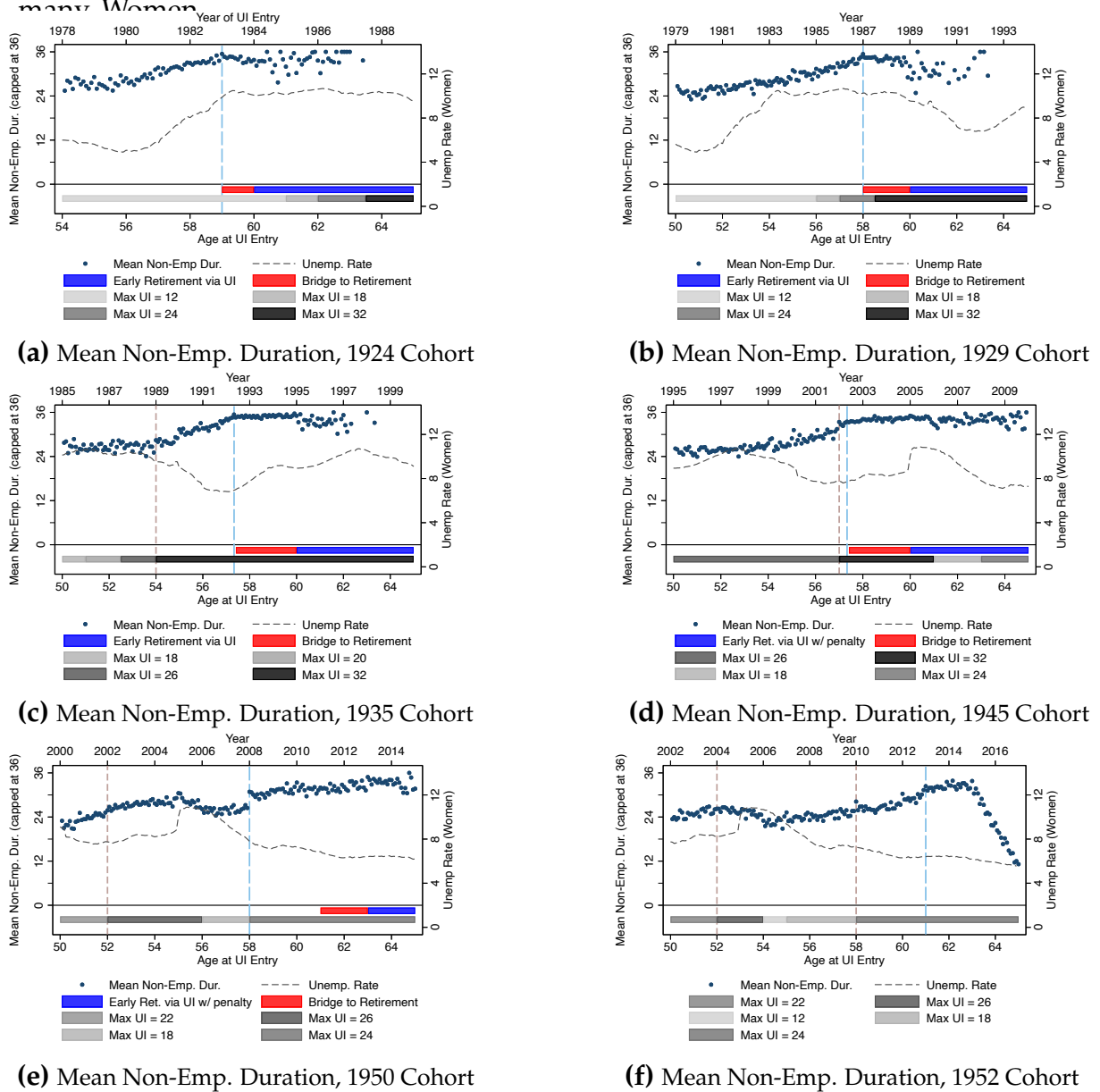


**(f) Mean Non-Emp. Duration, 1952 Cohort**

**Notes:** These figures plot mean non-employment duration (up to age 63) for different cohorts of West German Women in our sample entering unemployment at the given age (left axis). It also plots the female, seasonally adjusted unemployment rate as a dashed gray line (right axis). The red bar under the figure indicates the period over which an individual could receive UI before drawing pension (the blue bar under the figure) if he entered UI at the bridge-to-retirement age, indicated by the vertical dashed blue line. The different shades of grey represent different maximum PBD eligibility for UI, which can change because of an existing age-cutoff (the red dashed line) or because of an overall UI policy change enacted in that year.

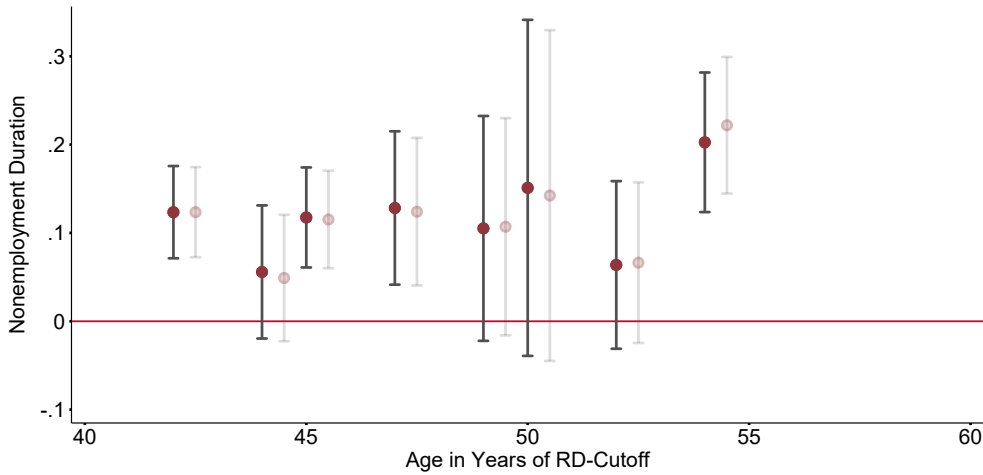


**Figure F.17: Mean Capped Non-Emp. Duration by Age for Different Cohorts in Germany**

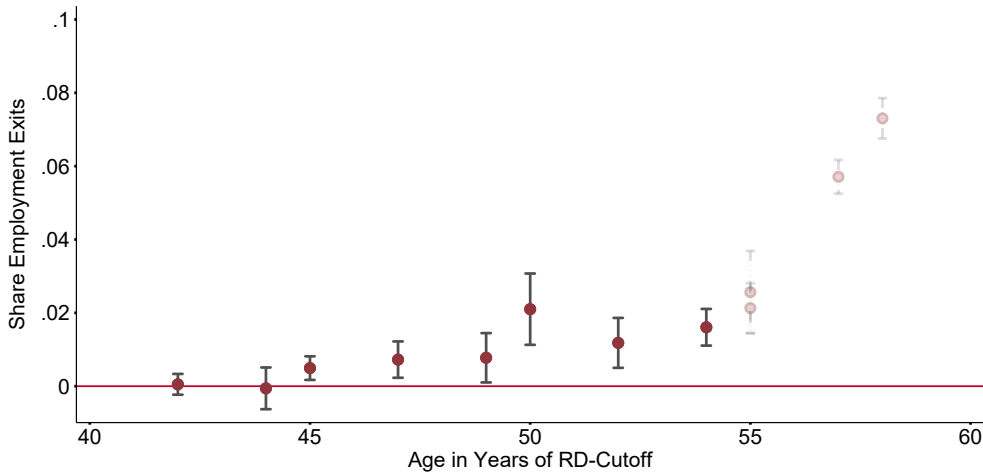


**Notes:** These figures plot mean non-employment duration (capped at 36 months) for different cohorts of West German Women in our sample entering unemployment at the given age (left axis). It also plots the female, seasonally adjusted unemployment rate as a dashed gray line (right axis). The red bar under the figure indicates the period over which an individual could receive UI before drawing pension (the blue bar under the figure) if he entered UI at the bridge-to-retirement age, indicated by the vertical dashed blue line. The different shades of grey represent different maximum PBD eligibility for UI, which can change because of an existing age-cutoff (the red dashed line) or because of an overall UI policy change enacted in that year.

**Figure F.19: RD Results: One-month PBD Extension on Non-Employment, Women**



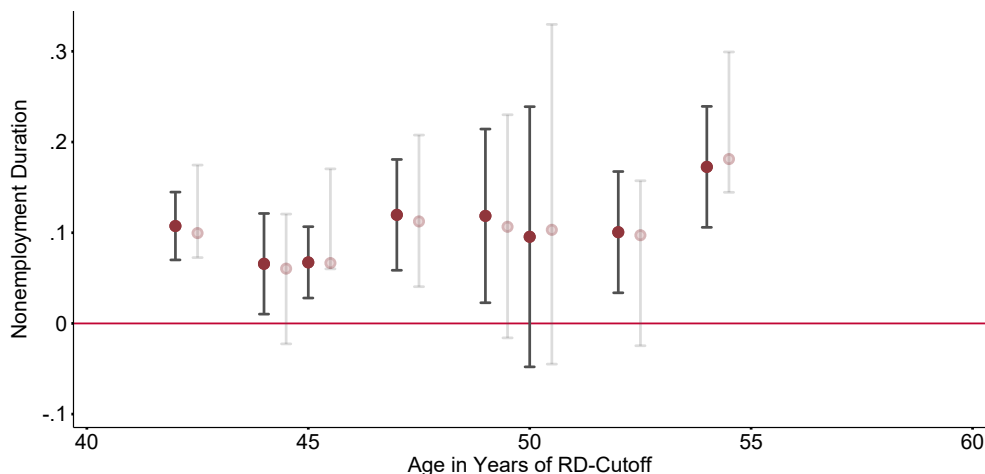
**(a) Donut-Hole RD Results: Non-Emp. Duration, Men with & without controls**



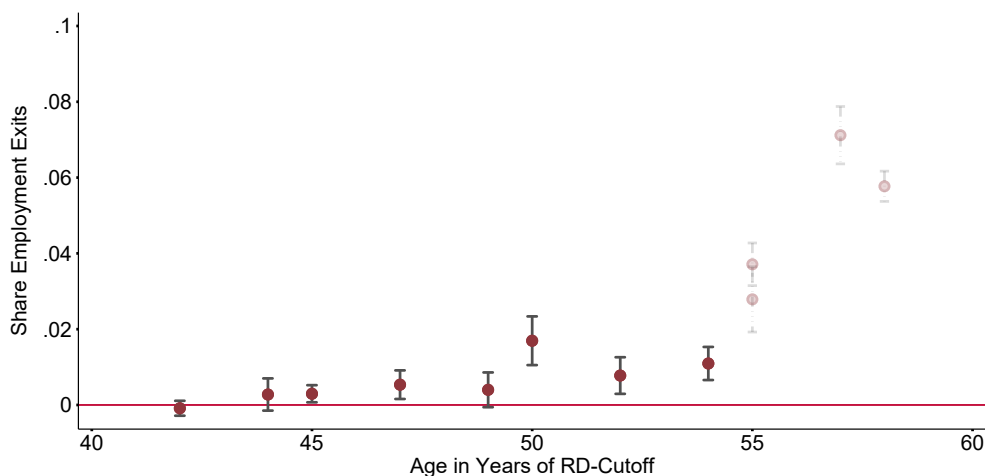
**(b) Density Estimates**

**Notes:** These figures contain Regression Discontinuity estimates of the effect of UI potential benefit durations at each age cut-off beginning July 1987. See Table G.8 for the estimates. We pool all years under the same UI regime. We employ a local polynomial regression with a uniform kernel and cluster standard errors at the daily level. 95% CI are plotted. All results are divided by the number of months PBD was extended. The bandwidth is 2 years except for the '87-'99 age 49 and 54 cutoffs where it is 1 year on the right due to other discontinuities. We exclude 2 months on each side of the cutoff – the donut hole – to partially address sorting. Figure (a) contrasts estimates without (solid) and with (transparent) controls. Controls include: pre-unemployment wage, gender, nationality (non-german), experience, wage/occupation/firm-tenure and education in years. Age Cutoffs of 55 years and older are excluded due shifts in the density (panel b). Sample Restrictions: West German Men With full eligibility, excluding mining and steel construction.

**Figure F.21:** RD Results: One-month PBD Extension on Non-Employment, Men and Women



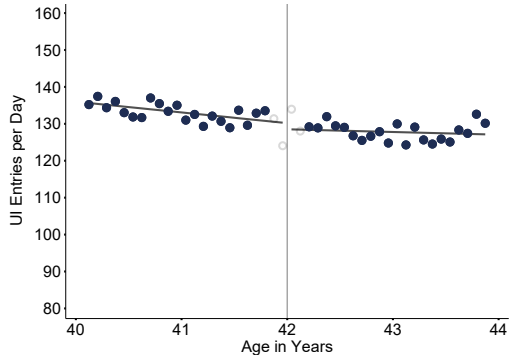
**(a)** Donut-Hole RD Results: Non-Emp. Duration, Men with & without controls



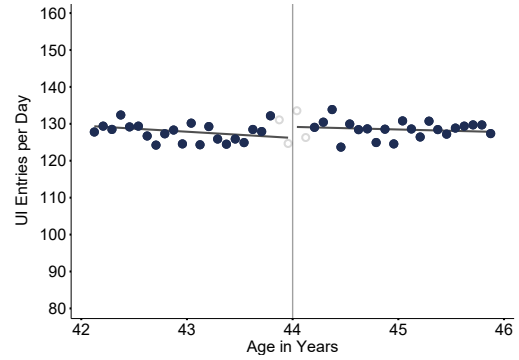
**(b)** Density Estimates

**Notes:** These figures contain Regression Discontinuity estimates of the effect of UI potential benefit durations at each age cut-off beginning July 1987. See Table G.9 for the estimates. We pool all years under the same UI regime. We employ a local polynomial regression with a uniform kernel and cluster standard errors at the daily level. 95% CI are plotted. All results are divided by the number of months PBD was extended. The bandwidth is 2 years except for the '87-'99 age 49 and 54 cutoffs where it is 1 year on the right due to other discontinuities. We exclude 2 months on each side of the cutoff – the donut hole – to partially address sorting. Figure (a) contrasts estimates without (solid) and with (transparent) controls. Controls include: pre-unemployment wage, gender, nationality (non-german), experience, wage/occupation/firm-tenure and education in years. Age Cutoffs of 55 years and older are excluded due shifts in the density (panel b). Sample Restrictions: West German Men With full eligibility, excluding mining and steel construction.

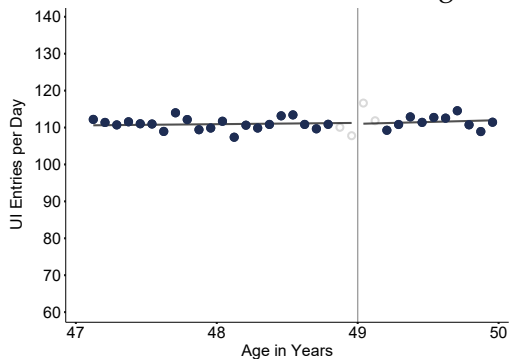
**Figure F.23: RD-Estimates Density, Men**



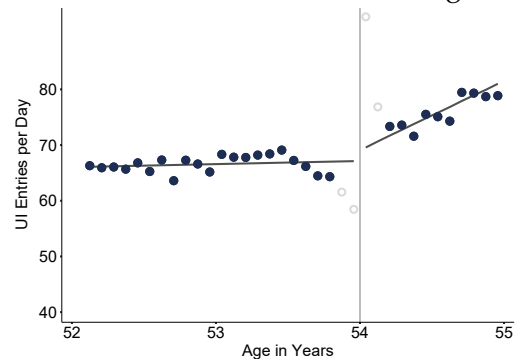
**(a)** Period 07/1987-03/1999, Age 42



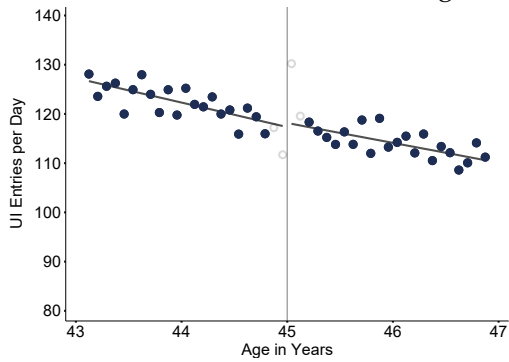
**(b)** Period 07/1987-03/1999, Age 44



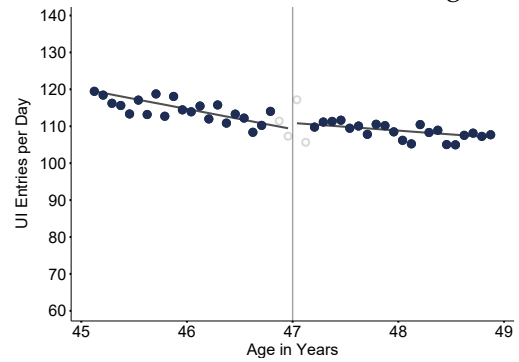
**(c)** Period 07/1987-03/1999, Age 49



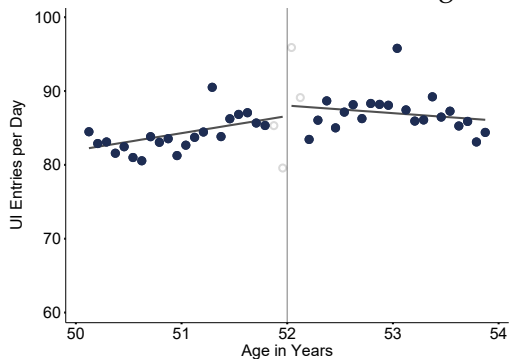
**(d)** Period 07/1987-03/1999, Age 54



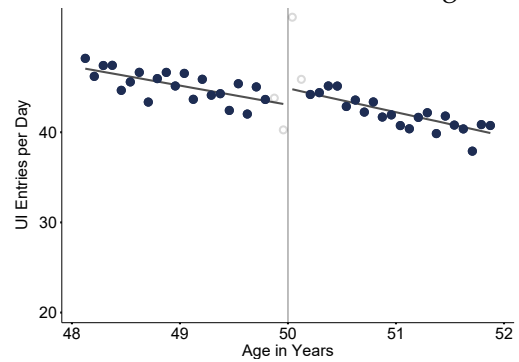
**(e)** Period 04/1999-01/2006, Age 45



**(f)** Period 04/1999-01/2006, Age 47



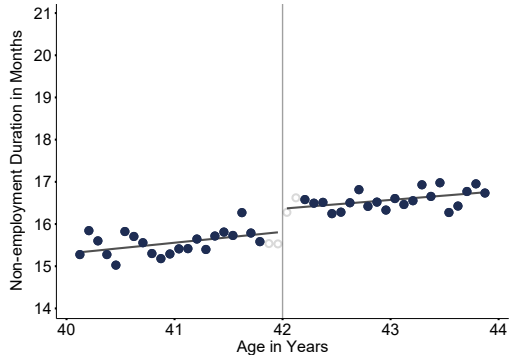
**(g)** Period 04/1999-01/2006, Age 52



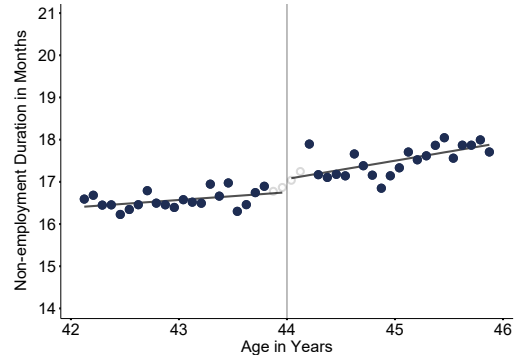
**(h)** Period 01/2008-12/2010, Age 50

**Notes:** This figure shows the average number of UI entries per ageday. Each dot shows this mean over a one-month window. Transparent dots close to the cutoff mark the leave-out region and gray lines show the fit of the corresponding RD estimates.

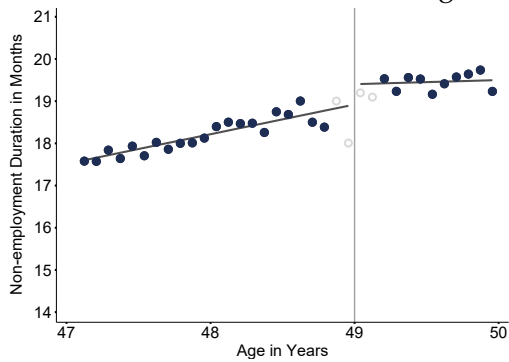
**Figure F.25: RD-Estimates Nonemployment Duration, Men**



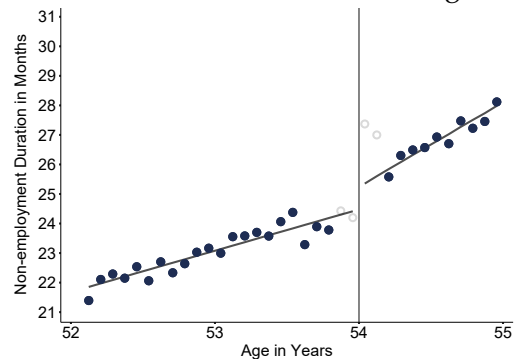
**(a)** Period 07/1987-03/1999, Age 42



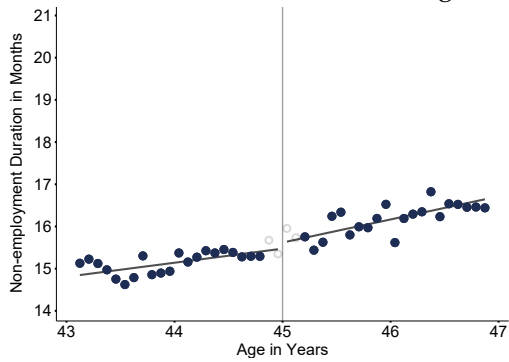
**(b)** Period 07/1987-03/1999, Age 44



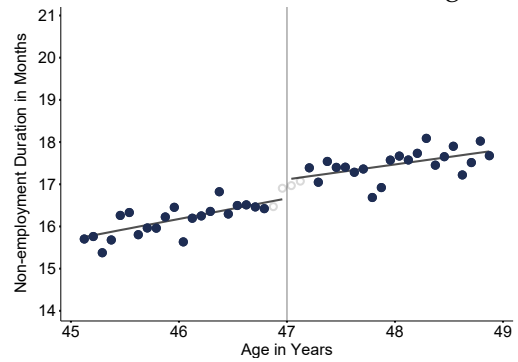
**(c)** Period 07/1987-03/1999, Age 49



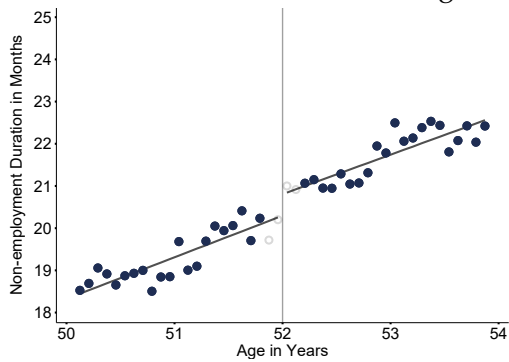
**(d)** Period 07/1987-03/1999, Age 54



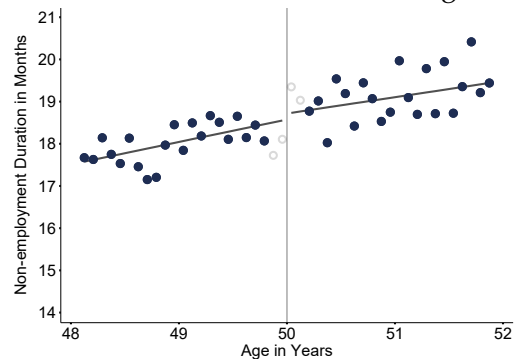
**(e)** Period 04/1999-01/2006, Age 45



**(f)** Period 04/1999-01/2006, Age 47



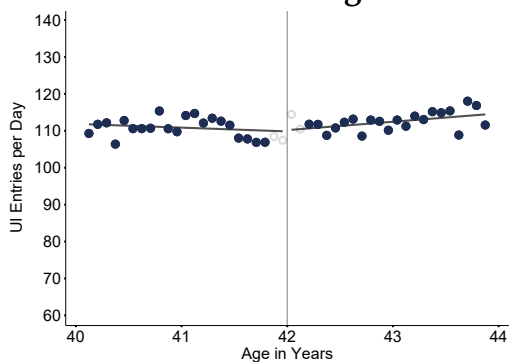
**(g)** Period 04/1999-01/2006, Age 52



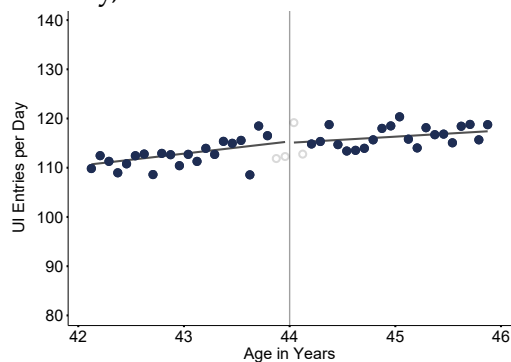
**(h)** Period 01/2008-12/2010, Age 50

**Notes:** This figure shows the average non employment duration around the different age cutoffs. Each dot shows this average over a one-month window. Transparent dots close to the cutoff mark the leave-out region and gray lines show the fit of the corresponding RD estimates.

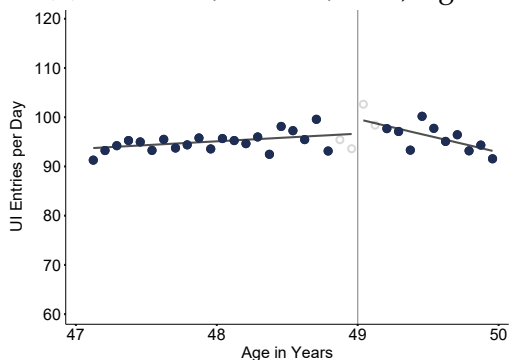
**Figure F.27: RD-Estimates Density, Women**



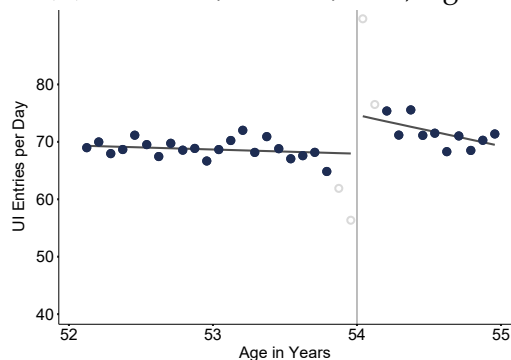
**(a)** Period 07/1987-03/1999, Age 42



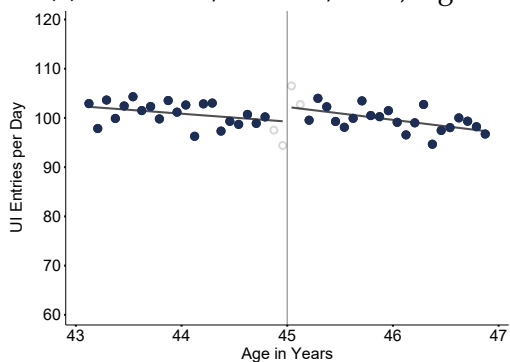
**(b)** Period 07/1987-03/1999, Age 44



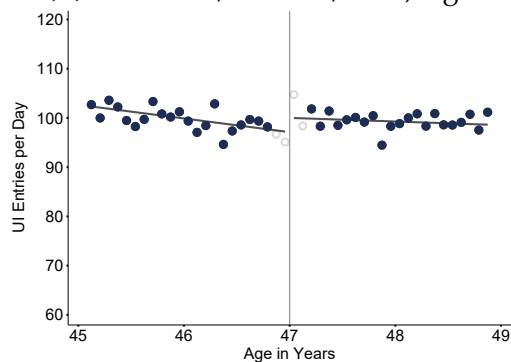
**(c)** Period 07/1987-03/1999, Age 49



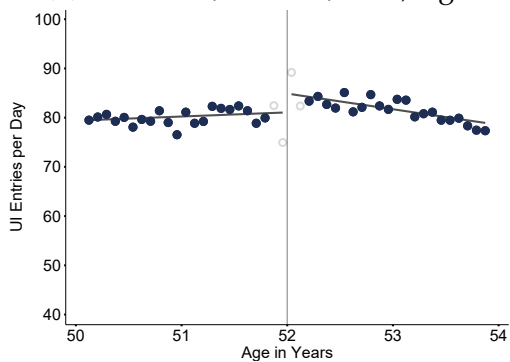
**(d)** Period 07/1987-03/1999, Age 54



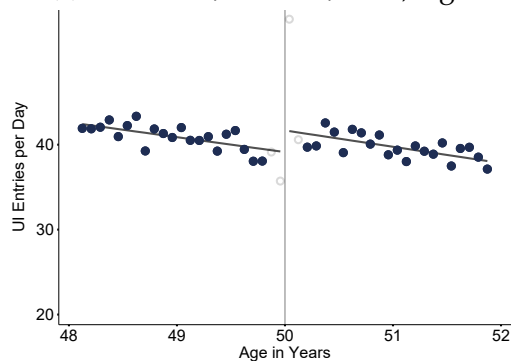
**(e)** Period 04/1999-01/2006, Age 45



**(f)** Period 04/1999-01/2006, Age 47



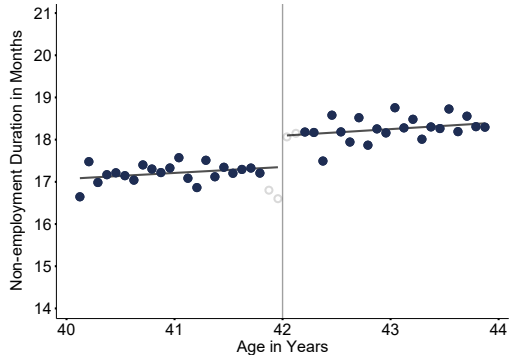
**(g)** Period 04/1999-01/2006, Age 52



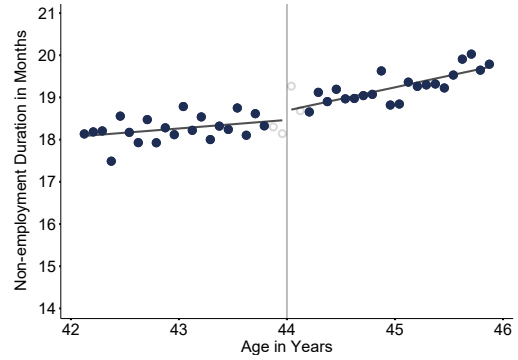
**(h)** Period 01/2008-12/2010, Age 50

**Notes:** This figure shows the average number of UI entries per ageday. Each dot shows this mean over a one-month window. Transparent dots close to the cutoff mark the leave-out region and gray lines show the fit of the corresponding RD estimates.

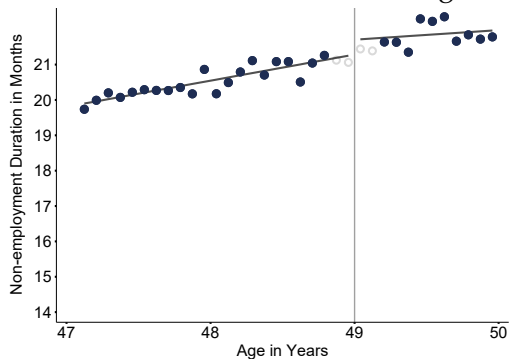
**Figure F.29: RD-Estimates Nonemployment Duration, Women**



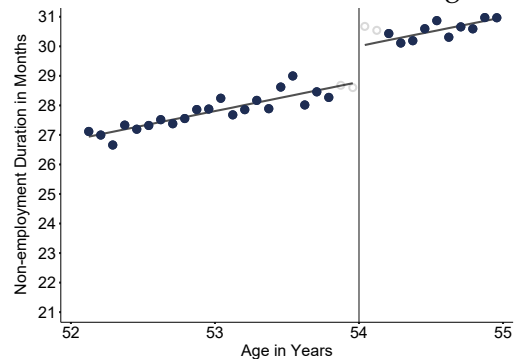
**(a)** Period 07/1987-03/1999, Age 42



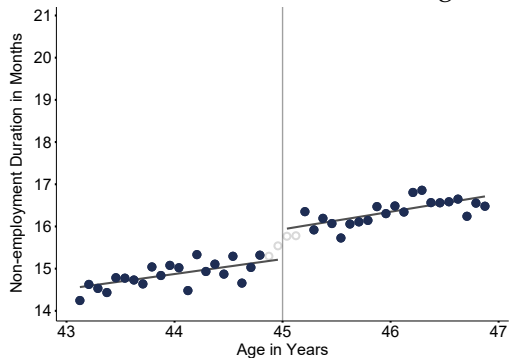
**(b)** Period 07/1987-03/1999, Age 44



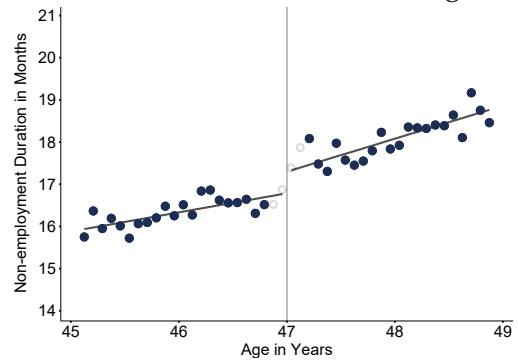
**(c)** Period 07/1987-03/1999, Age 49



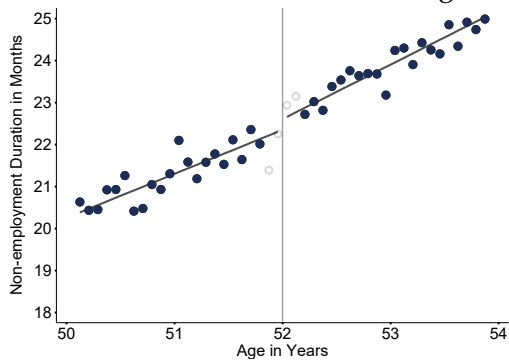
**(d)** Period 07/1987-03/1999, Age 54



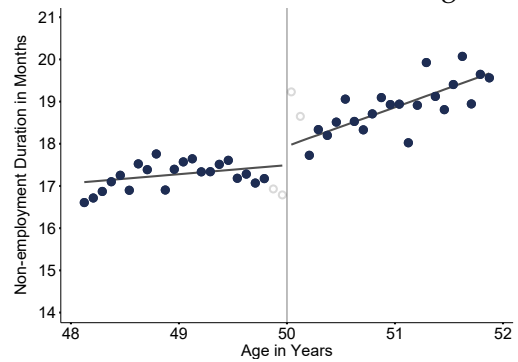
**(e)** Period 04/1999-01/2006, Age 45



**(f)** Period 04/1999-01/2006, Age 47



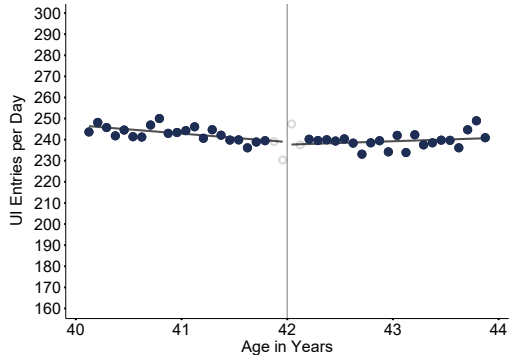
**(g)** Period 04/1999-01/2006, Age 52



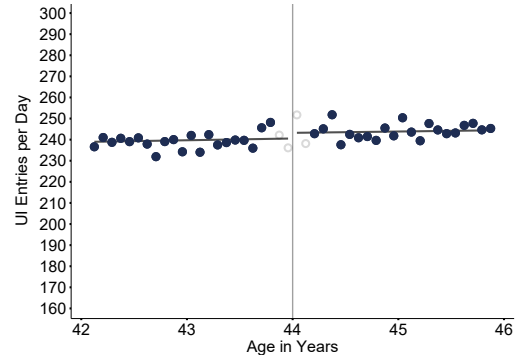
**(h)** Period 01/2008-12/2010, Age 50

**Notes:** This figure shows the average non-employment duration around the different age cutoffs. Each dot shows this average over a one-month window. Translucent dots close to the cutoff mark the leave-out region and gray lines show the fit of the corresponding RD estimates.

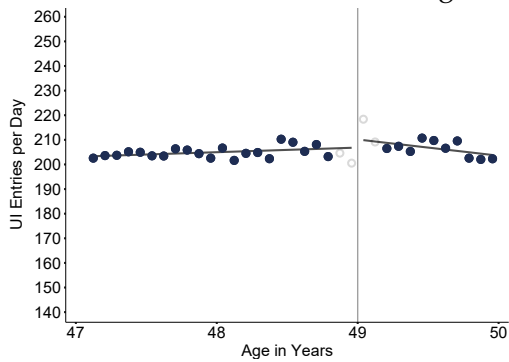
**Figure F.31: RD-Estimates Density, Men and Women**



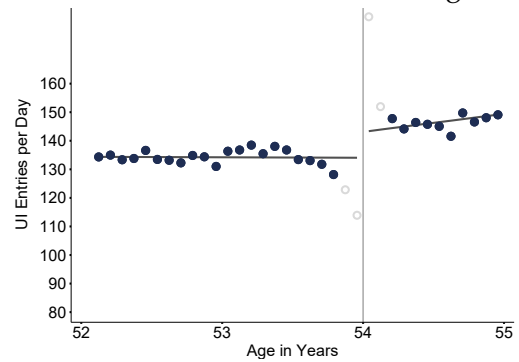
**(a)** Period 07/1987-03/1999, Age 42



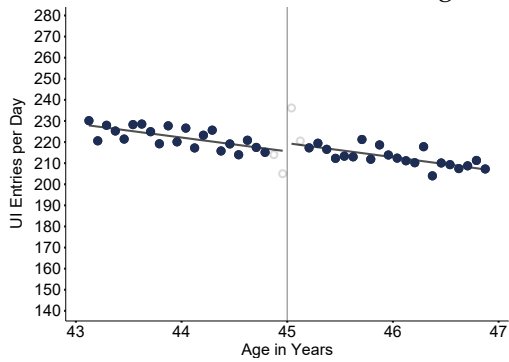
**(b)** Period 07/1987-03/1999, Age 44



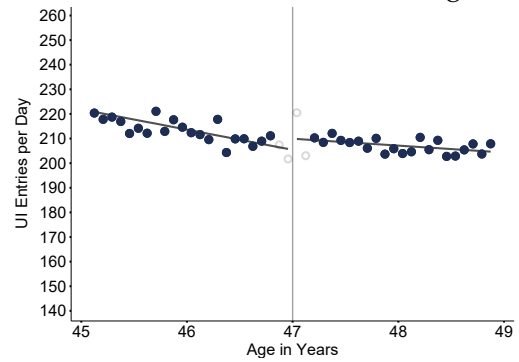
**(c)** Period 07/1987-03/1999, Age 49



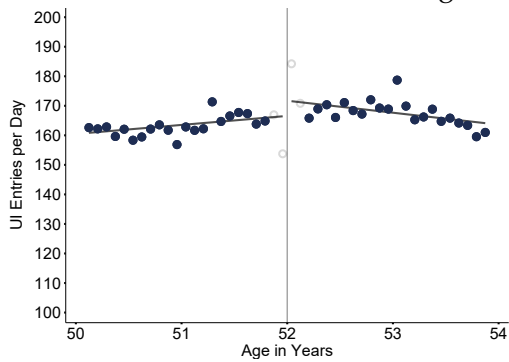
**(d)** Period 07/1987-03/1999, Age 54



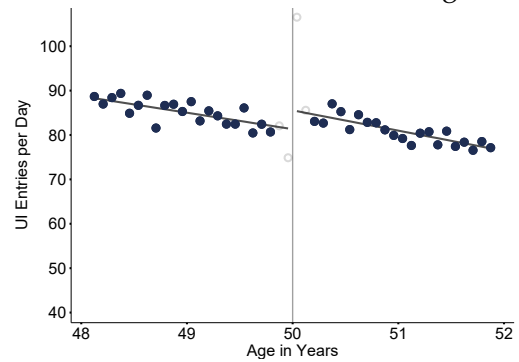
**(e)** Period 04/1999-01/2006, Age 45



**(f)** Period 04/1999-01/2006, Age 47



**(g)** Period 04/1999-01/2006, Age 52

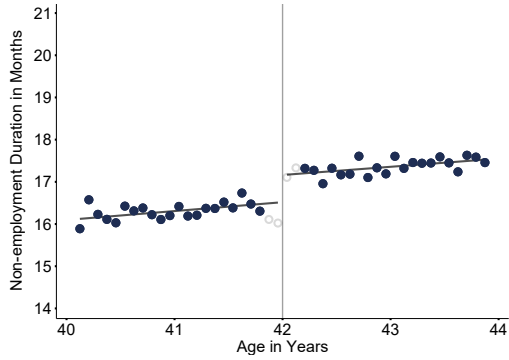


**(h)** Period 01/2008-12/2010, Age 50

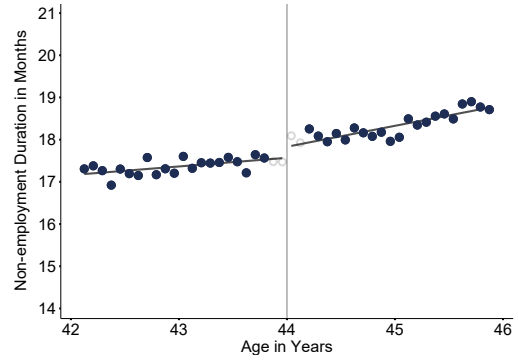
**Notes:** This figure shows the average number of UI entries per ageday. Each dot shows this mean over a one-month window. Transparent dots close to the cutoff mark the leave-out region and gray lines show the fit of the corresponding RD estimates.



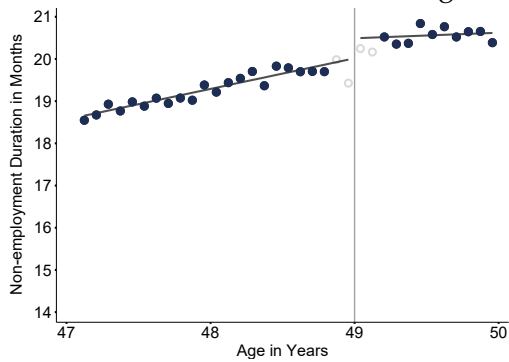
**Figure F.33: RD-Estimates Nonemployment Duration, Women**



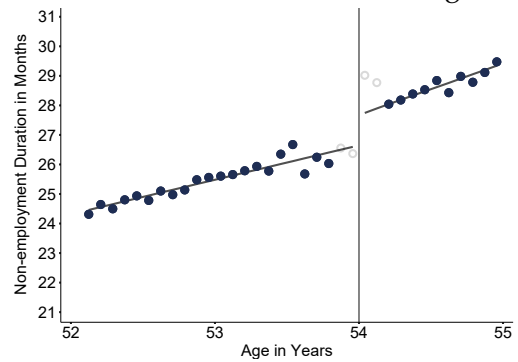
**(a)** Period 07/1987-03/1999, Age 42



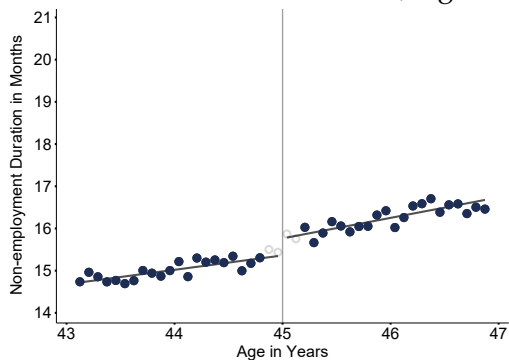
**(b)** Period 07/1987-03/1999, Age 44



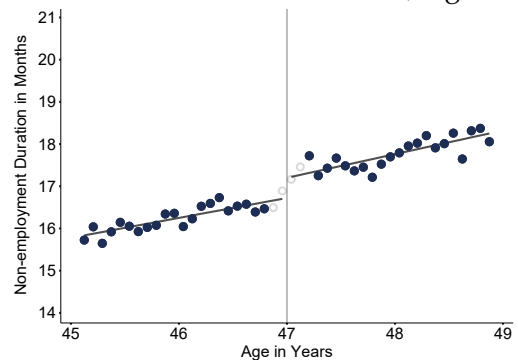
**(c)** Period 07/1987-03/1999, Age 49



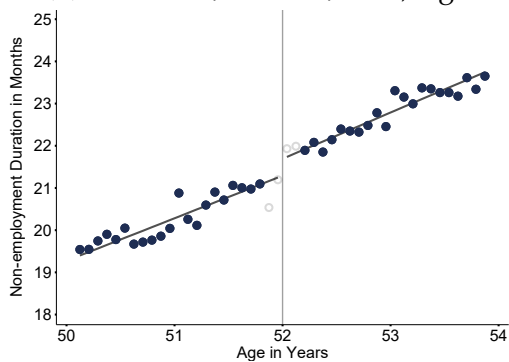
**(d)** Period 07/1987-03/1999, Age 54



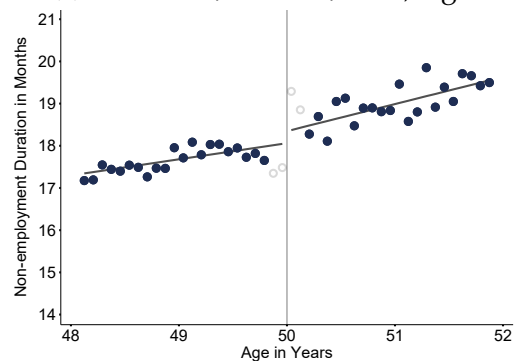
**(e)** Period 04/1999-01/2006, Age 45



**(f)** Period 04/1999-01/2006, Age 47



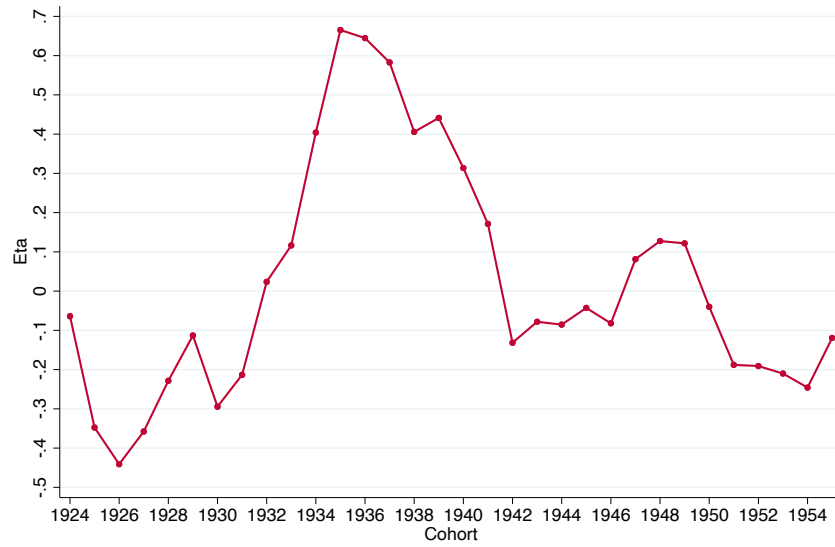
**(g)** Period 04/1999-01/2006, Age 52



**(h)** Period 01/2008-12/2010, Age 50

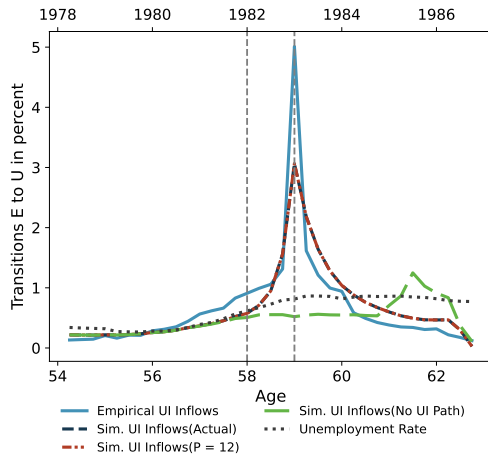
**Notes:** This figure shows the average non-employment duration around the different age cutoffs. Each dot shows this average over a one-month window. Transparent dots close to the cutoff mark the leave-out region and gray lines show the fit of the corresponding RD estimates.

**Figure F.35:** Cohort-specific estimates of mean disutility of work ( $\bar{\eta}$ )

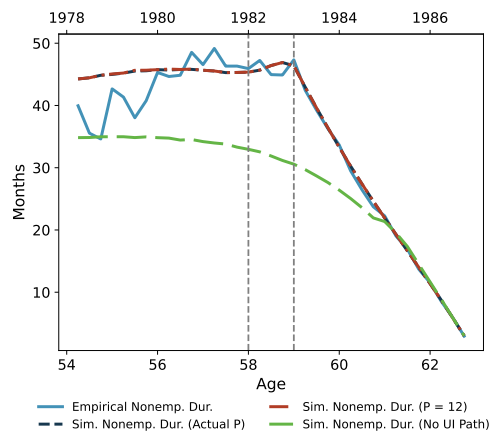


**Notes:** This figure plots our model's cohort-specific estimates of the mean disutility of work ( $\bar{\eta}$ ). For the three in-sample cohorts, this is estimated directly along with all other parameters. For the out-of-sample cohorts this single parameter is estimated (taking all others as given) to fit  $E$  to  $U$  transitions and nonemployment durations.

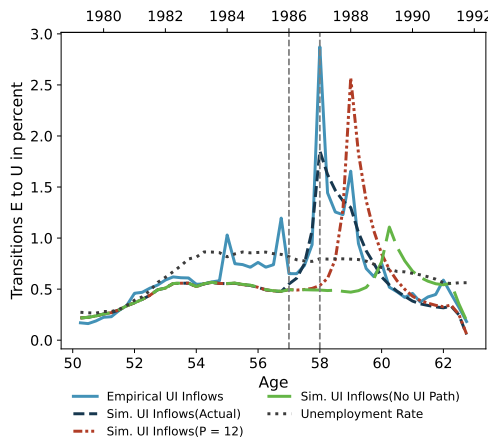
**Figure F.36: Counterfactual Policy Simulations for Main Cohorts (Actual Policy, PBD=12 Months and No UI Path)**



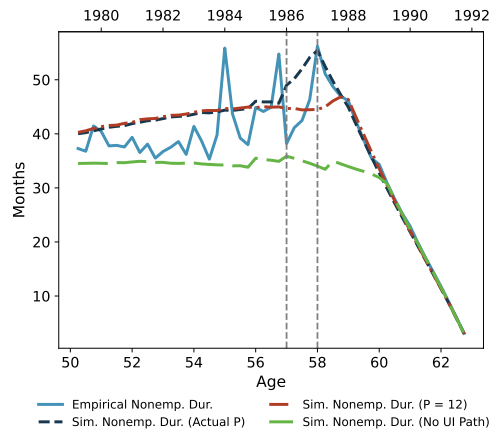
**(a) Unemp. Inflows - Cohort: 1924**



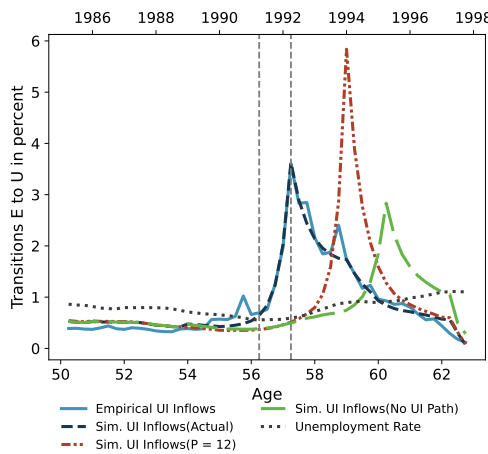
**(b) Nonemp. Durations - Cohort: 1924**



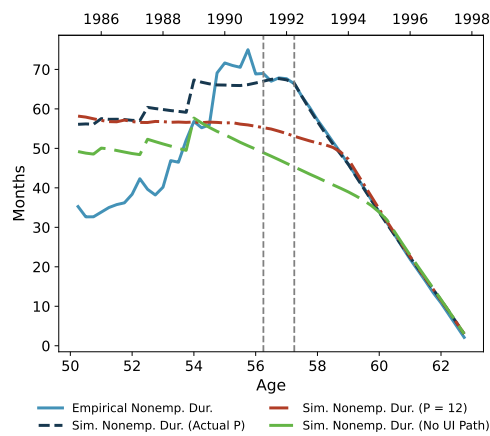
**(c) Unemp. Inflows - Cohort: 1929**



**(d) Nonemp. Durations - Cohort: 1929**

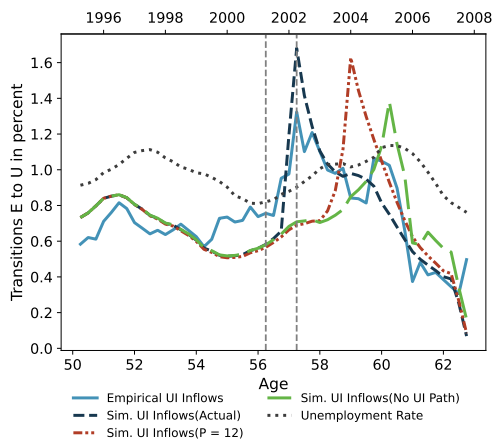


**(e) Unemp. Inflows - Cohort: 1935**



**(f) Nonemp. Durations - Cohort: 1935**

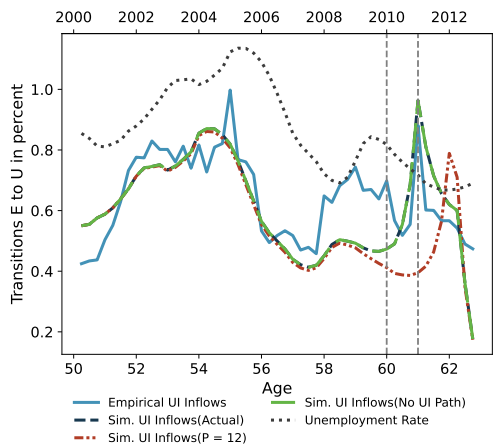
**Figure E.38: Counterfactual Policy Simulations for Main Cohorts (Actual Policy, PBD=12 Months and No UI Path, continued)**



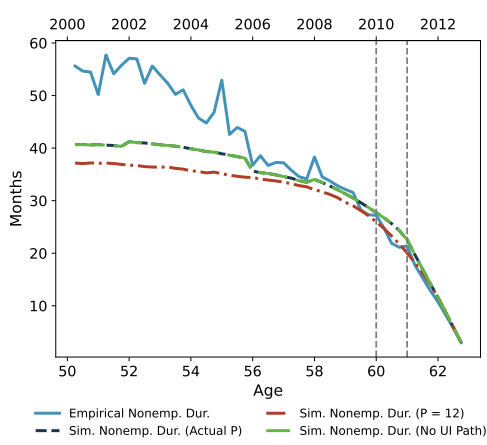
**(a) Unemp. Inflows - Cohort: 1945**



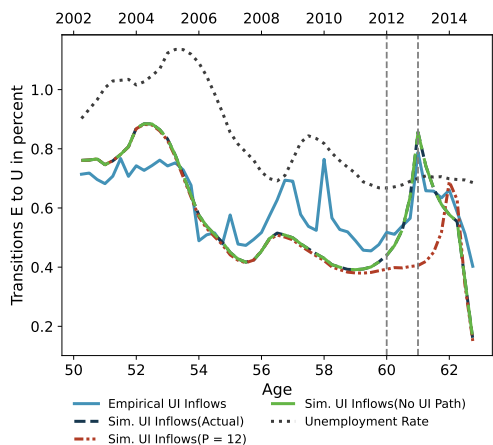
**(b) Nonemp. Durations - Cohort: 1945**



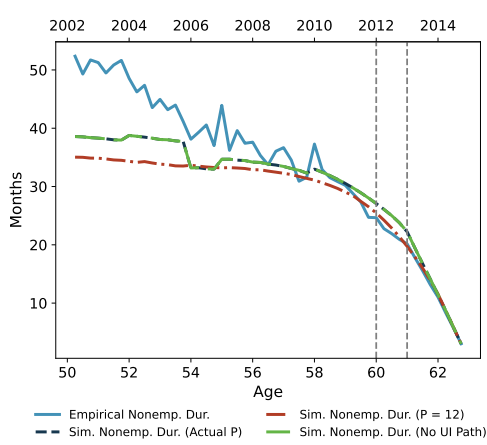
**(c) Unemp. Inflows - Cohort: 1950**



**(d) Nonemp. Durations - Cohort: 1950**

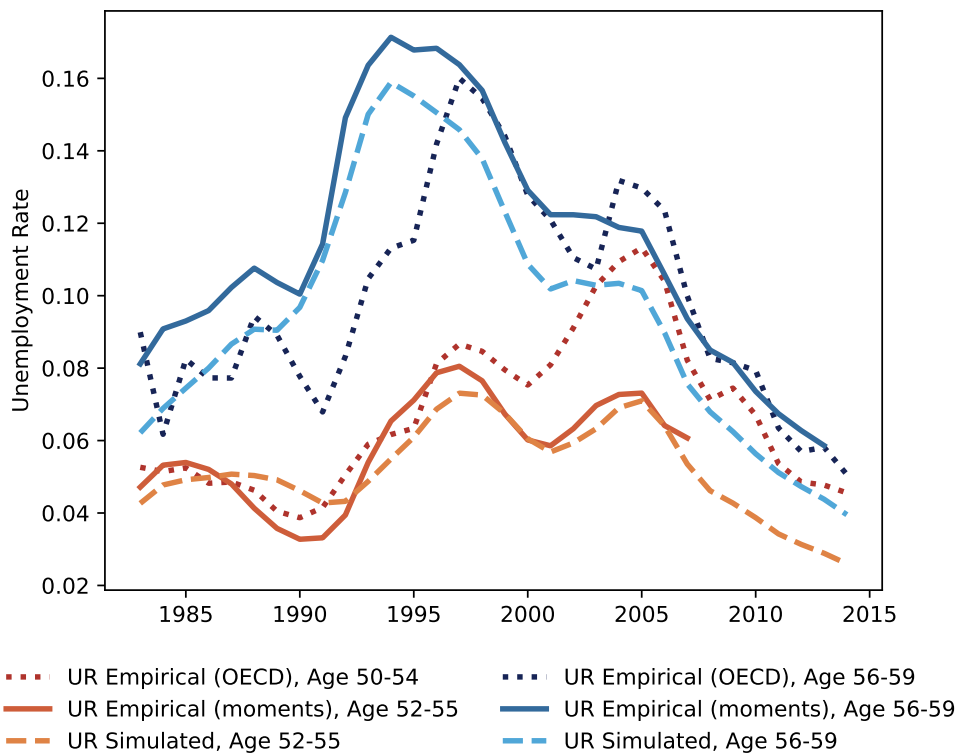


**(e) Unemp. Inflows - Cohort: 1952**



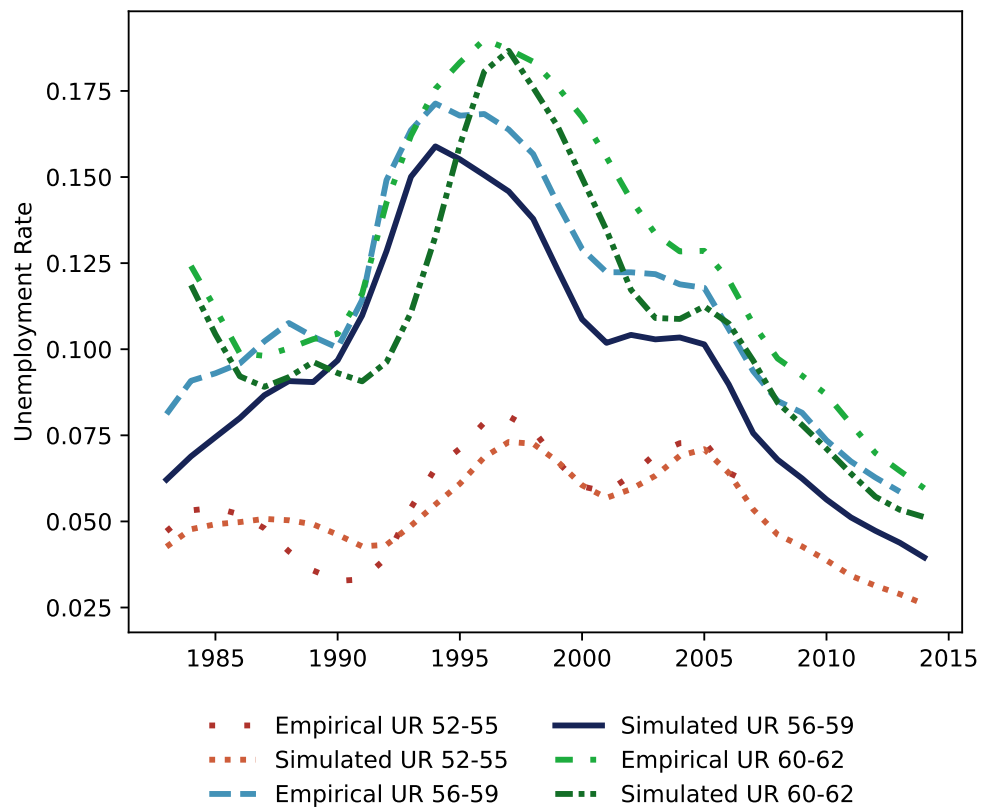
**(f) Nonemp. Durations - Cohort: 1952**

**Figure F.40:** Unemployment Rates by Age Groups: Official OECD Unemployment Rates, Moment Based and Model Simulations



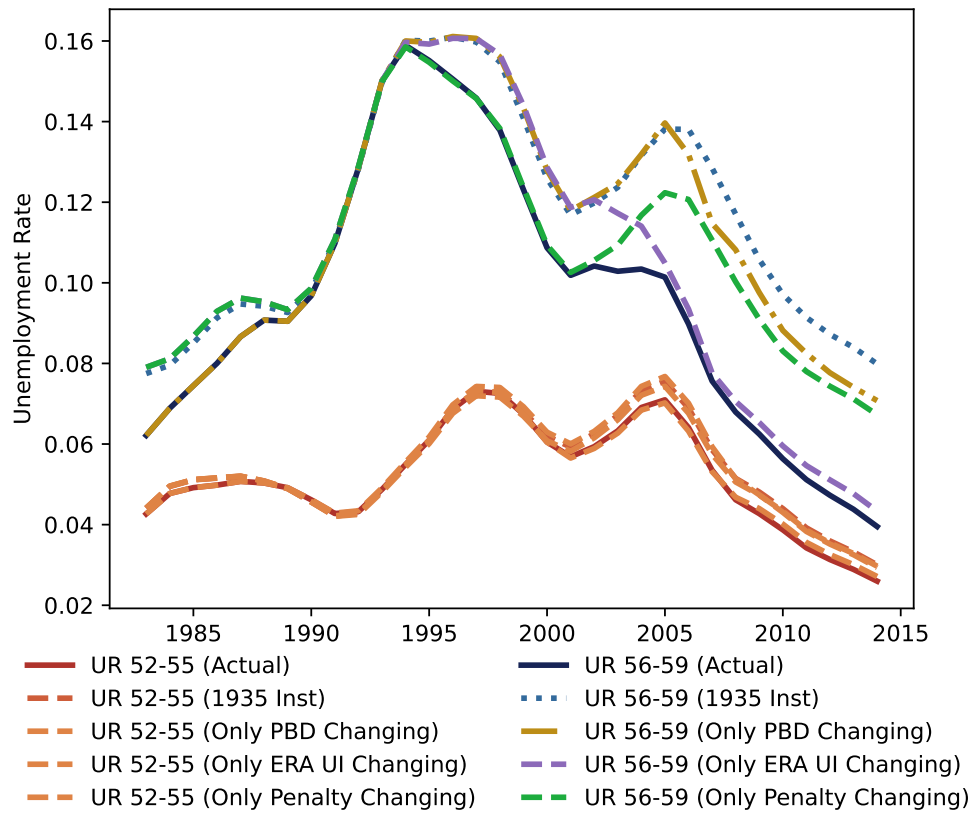
**Notes:** This figure shows the unemployment rate by age in West Germany. It contrasts the OECD unemployment rates (see Figure 1 in main paper), with the moment based unemployment rates from our sample and the simulated unemployment rates from the baseline model

**Figure F.41:** Empirical and Simulated Unemployment Rates for 3 Age Groups



**Notes:** This figure shows the unemployment rate by age groups.

**Figure F.42:** Simulated Unemployment Rates under Alternative Policy Regimes after 1994

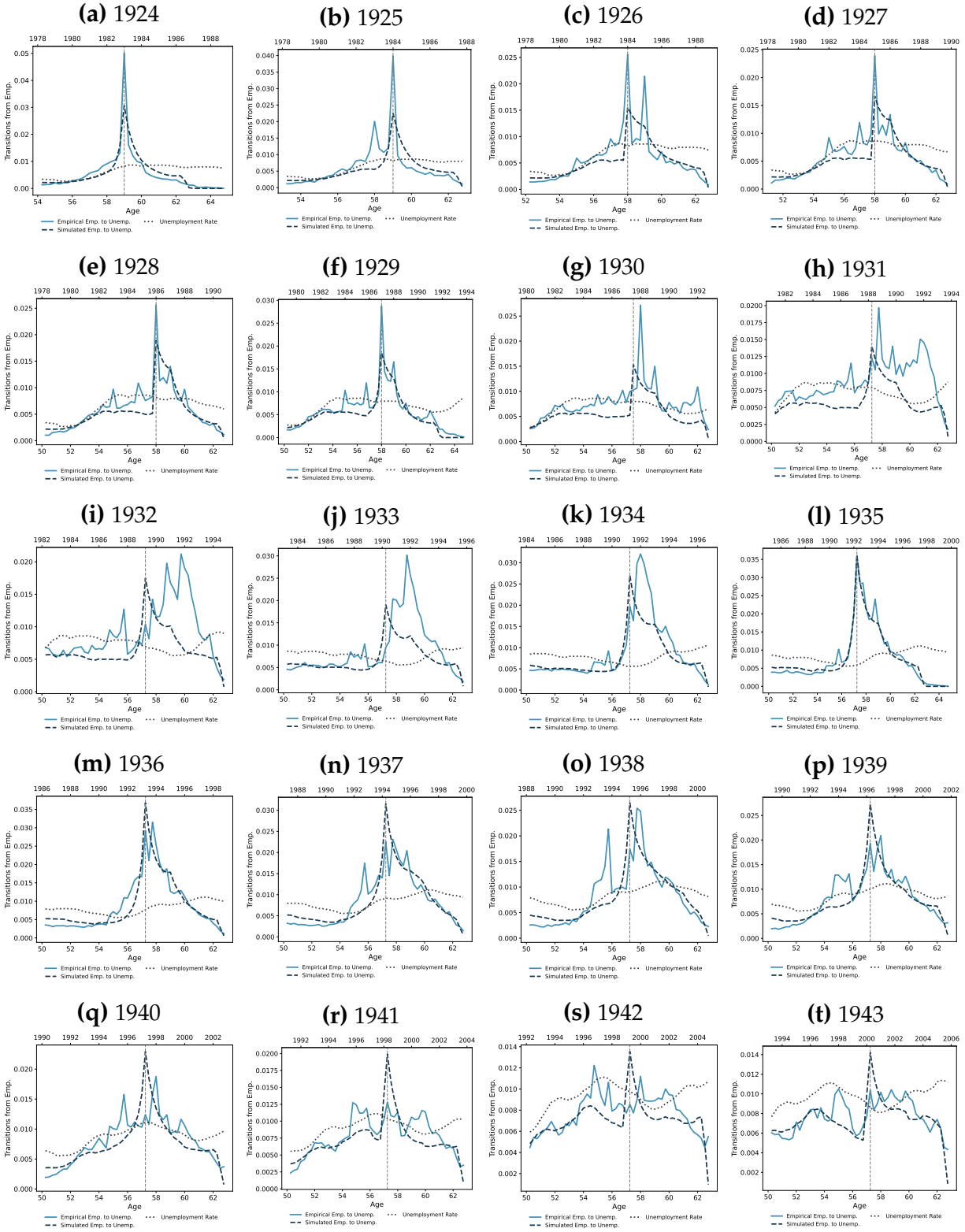


**Notes:** This figure corresponds to Figure 9 in the main paper but includes the Age 52 to 55 age group.

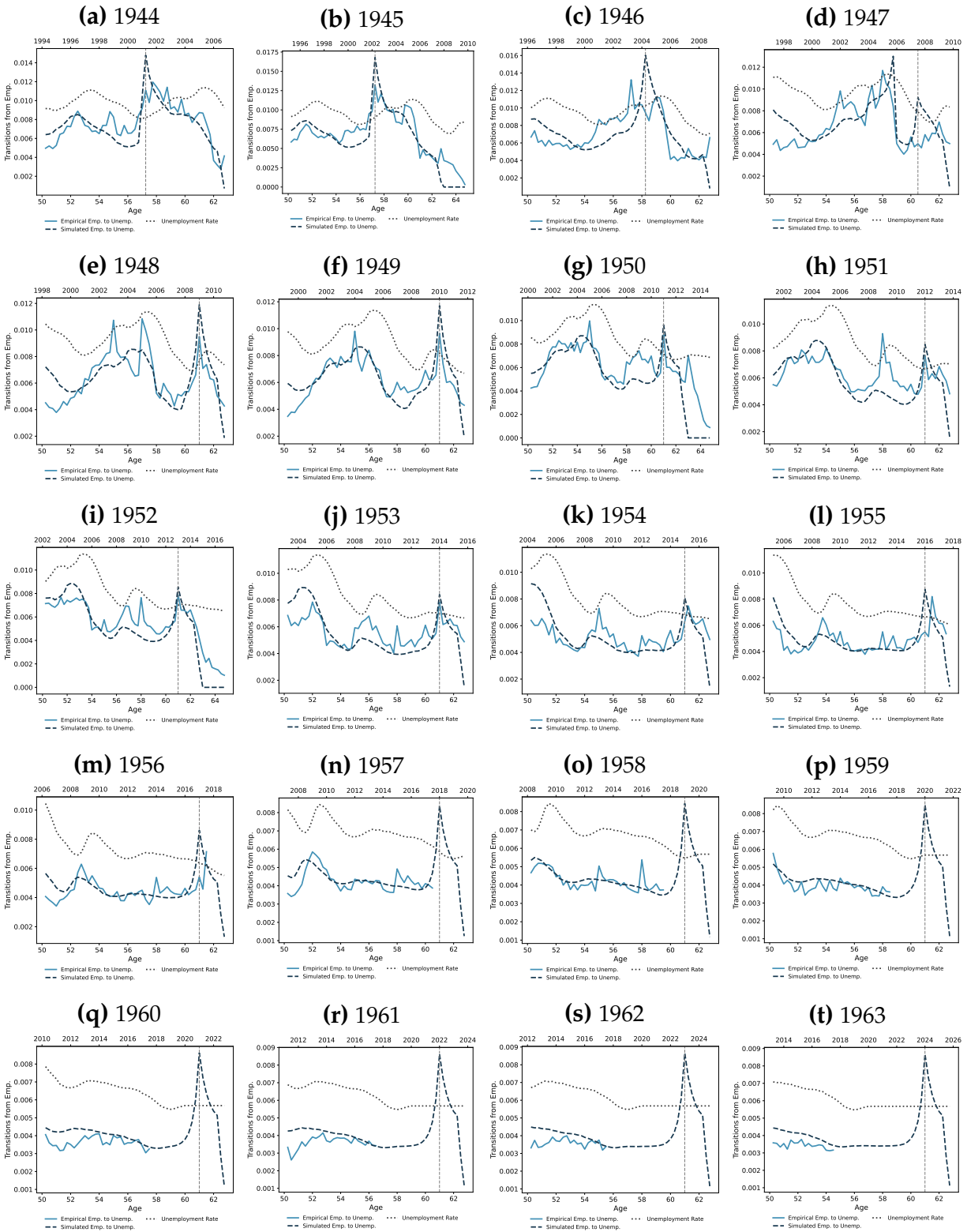




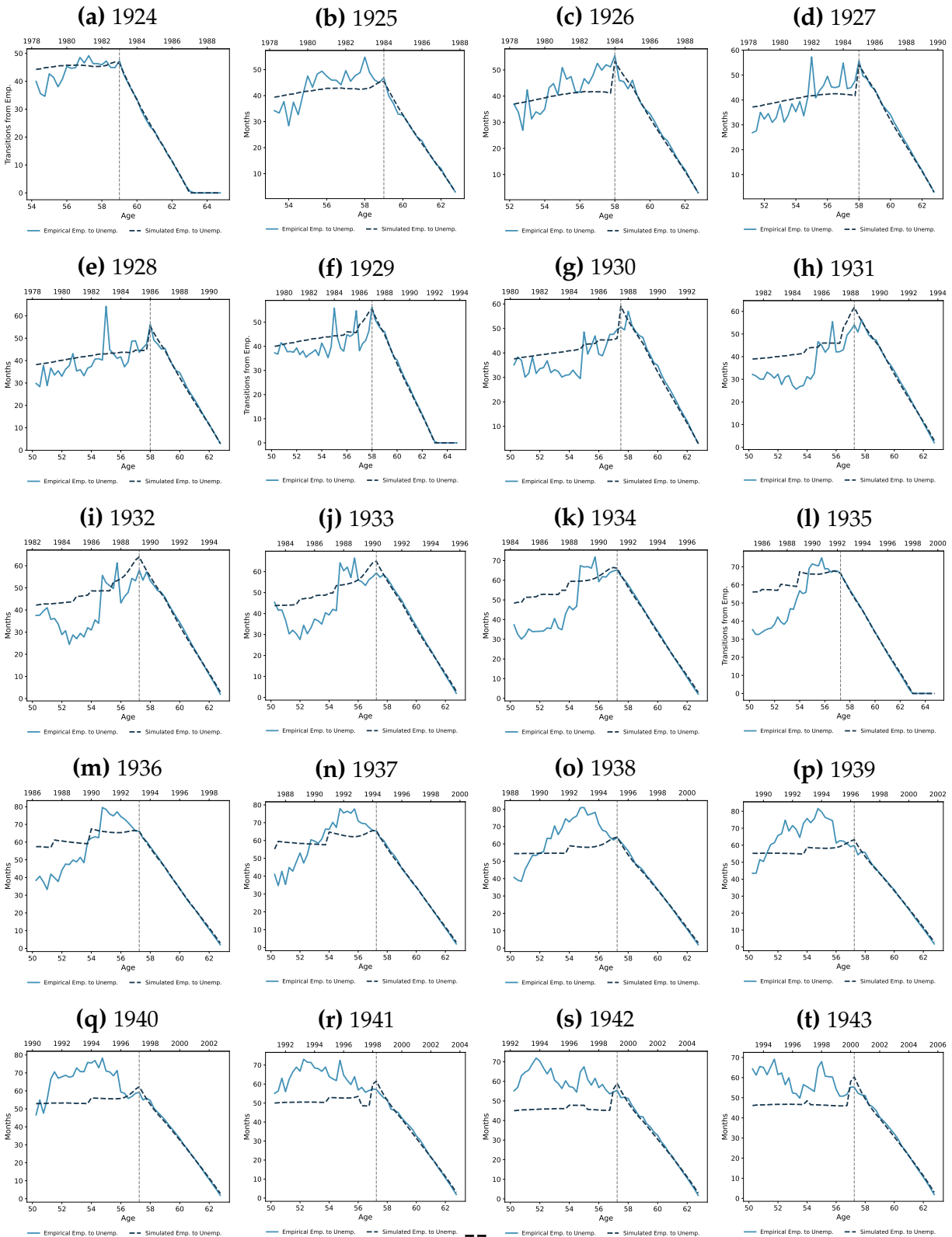
**Figure F.43: Empirical and Simulated UI Inflows for all Cohorts (Baseline Model)**



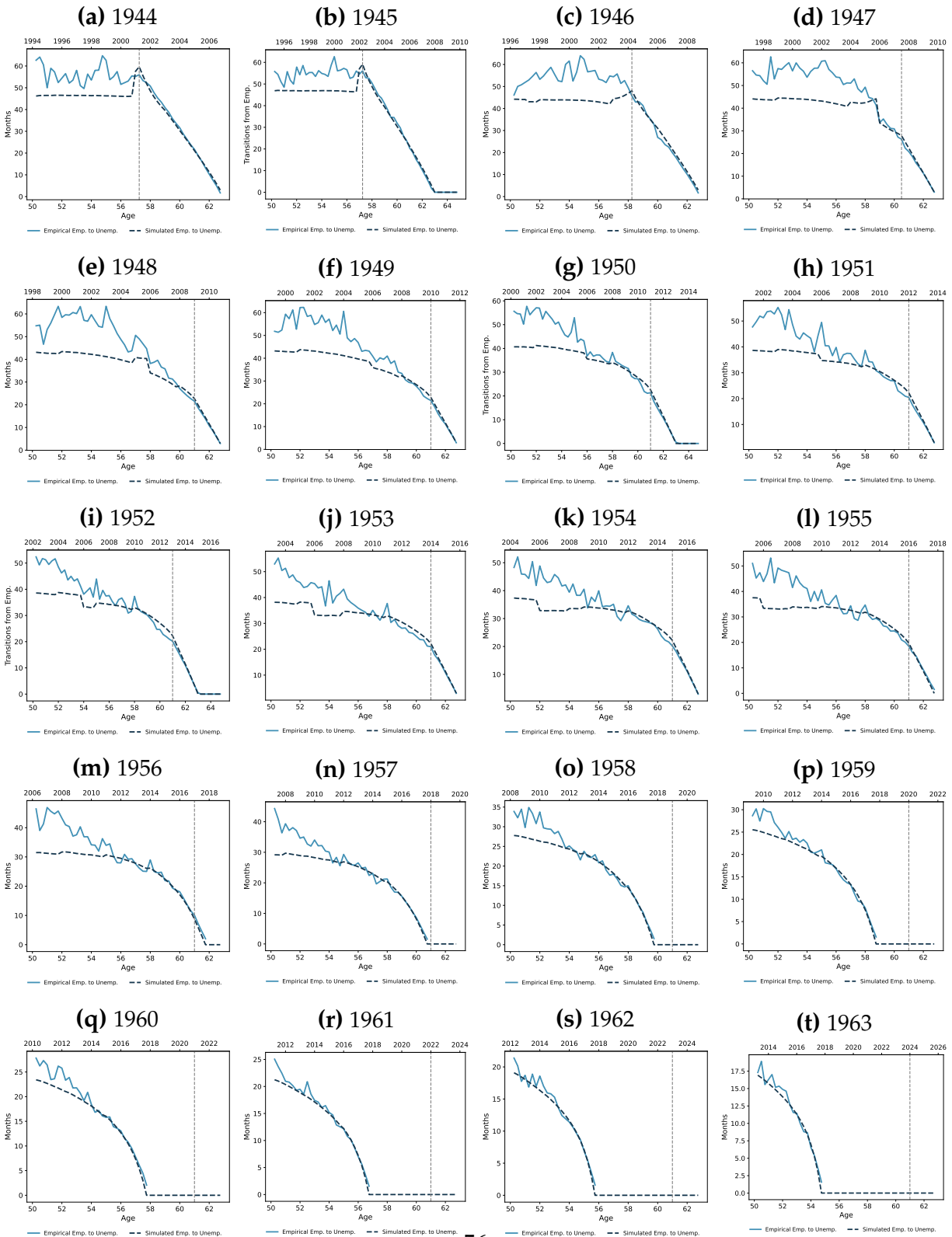
**Figure F.44: E to UI transitions**



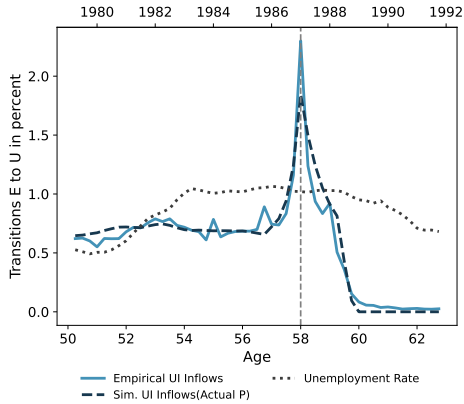
**Figure F.46: Empirical and Simulated Nonemployment Durations for all Cohorts (Baseline Model)**



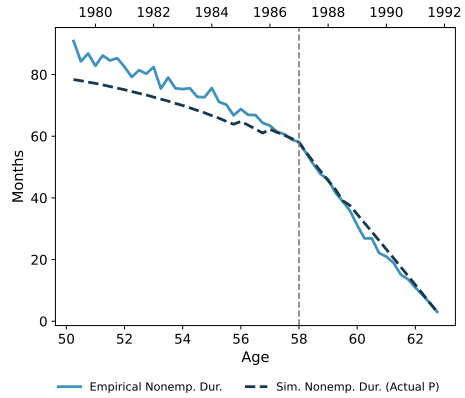
**Figure F.47:** Empirical and Simulated Nonemployment Durations for all Cohorts (Baseline Model), continued



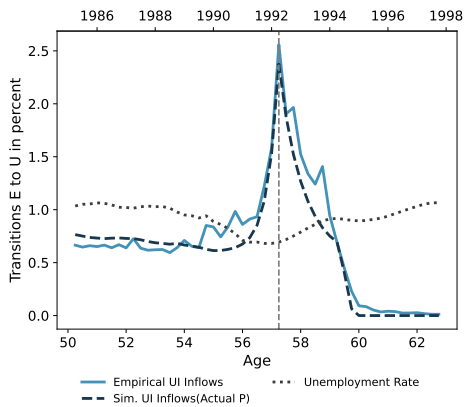
**Figure F.49: In-Sample Fit of Life-Cycle Model - Women**



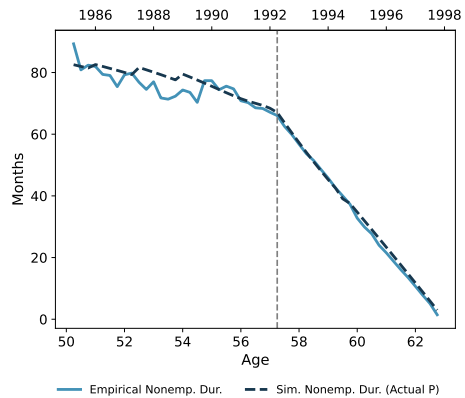
**(a) Transitions from E to U, 1929**



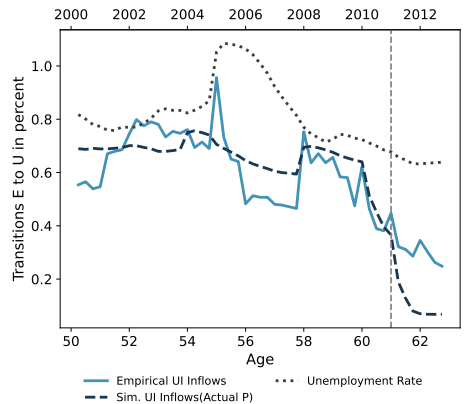
**(b) Non Employment Duration, 1929**



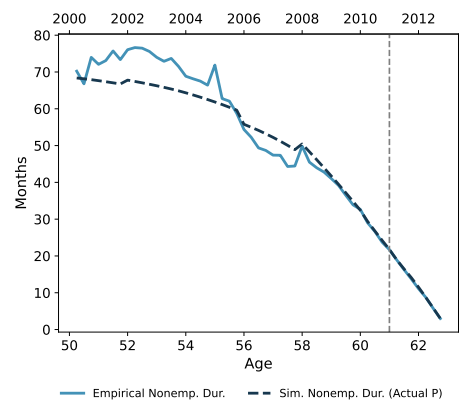
**(c) Transitions from E to U, 1935**



**(d) Non Employment Duration, 1935**



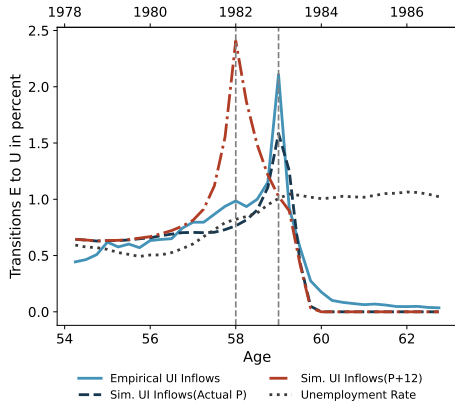
**(e) Transitions from E to U, 1950**



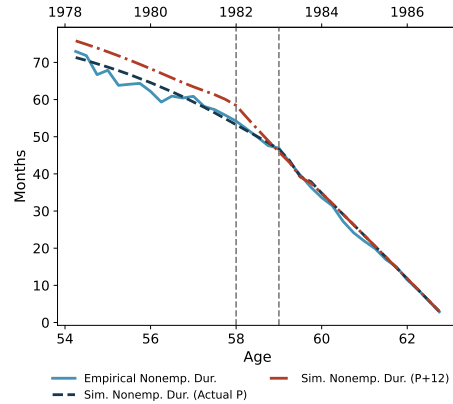
**(f) Non Employment Duration, 1950**

**Notes:** These figures compare our model-generated moments to their corresponding empirical moments for in-sample cohorts (1929, 1935, 1950), aggregated to the quarterly level.

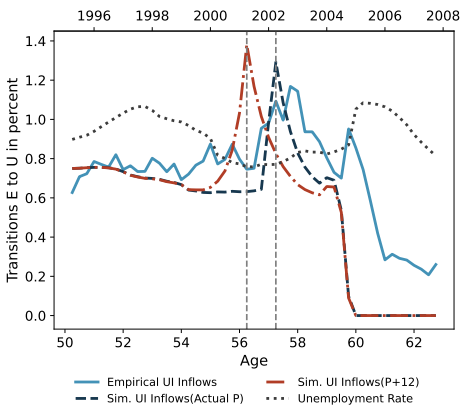
**Figure F.51: Out-of-Sample Fit of Life-Cycle Model - Women**



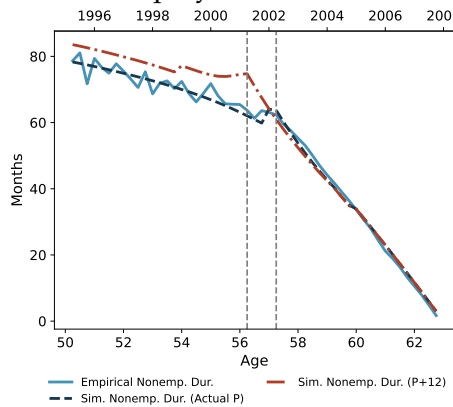
**(a) Transitions from E to U, 1924**



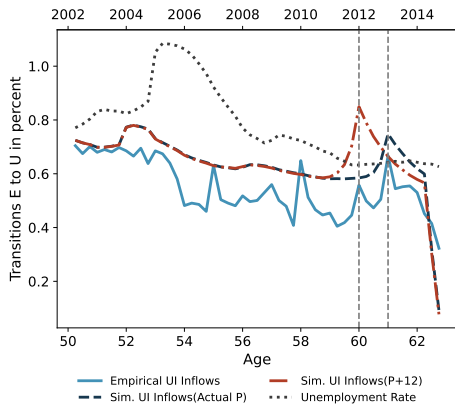
**(b) Non Employment Duration, 1924**



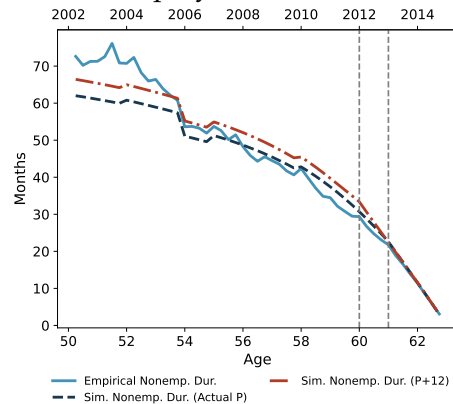
**(c) Transitions from E to U, 1945**



**(d) Non Employment Duration, 1945**



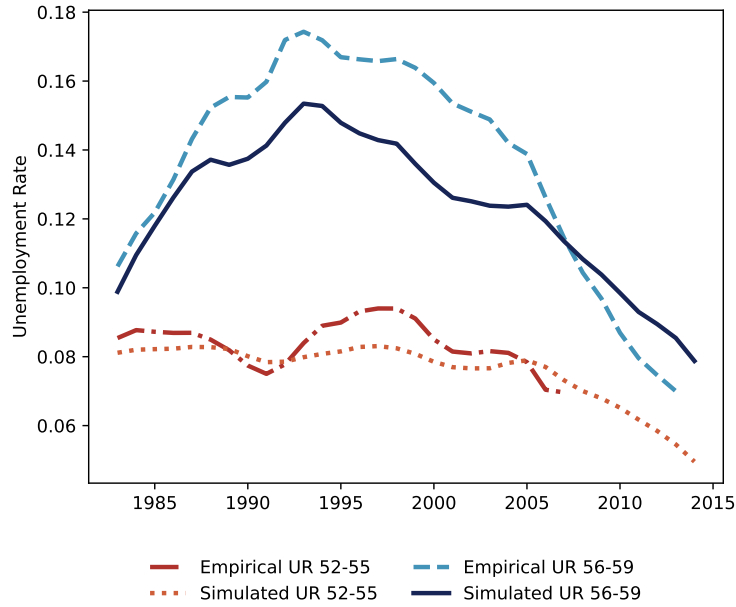
**(e) Transitions from E to U, 1952**



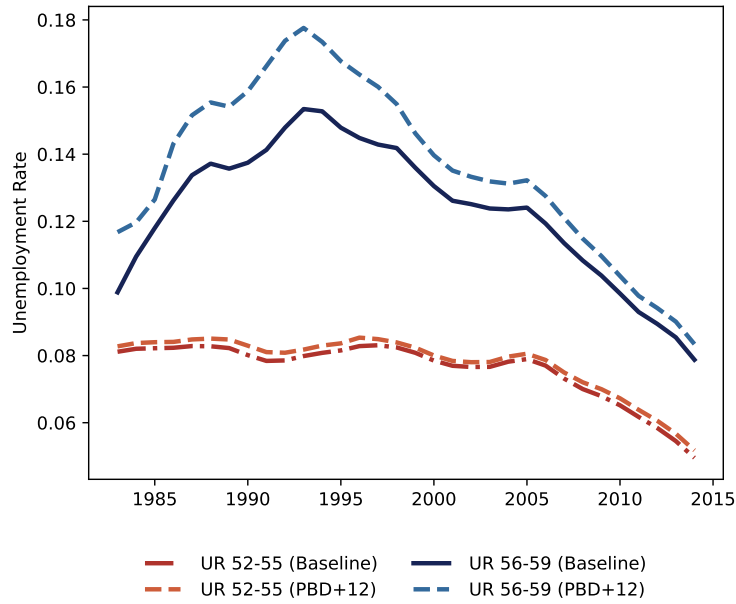
**(f) Non Employment Duration, 1952**

**Notes:** These figures compare our model-generated moments to their corresponding empirical moments for select out-of-sample cohorts (1924, 1945, 1952), aggregated to the quarterly level. Model-generated moments include the baseline specification and a counterfactual model where we increase potential benefit duration of UI by 12 months across all ages. Figure (a) compares the transitions from employment to unemployment in 1924 whereas Figure (b) compares non-employment durations in 1924. Figures (c) and (d) show the same comparisons for the 1945 cohort, and Figures (e) and (f) for the 1952 cohort.

**Figure F.53: Empirical and Simulated Unemployment Rate - Women**



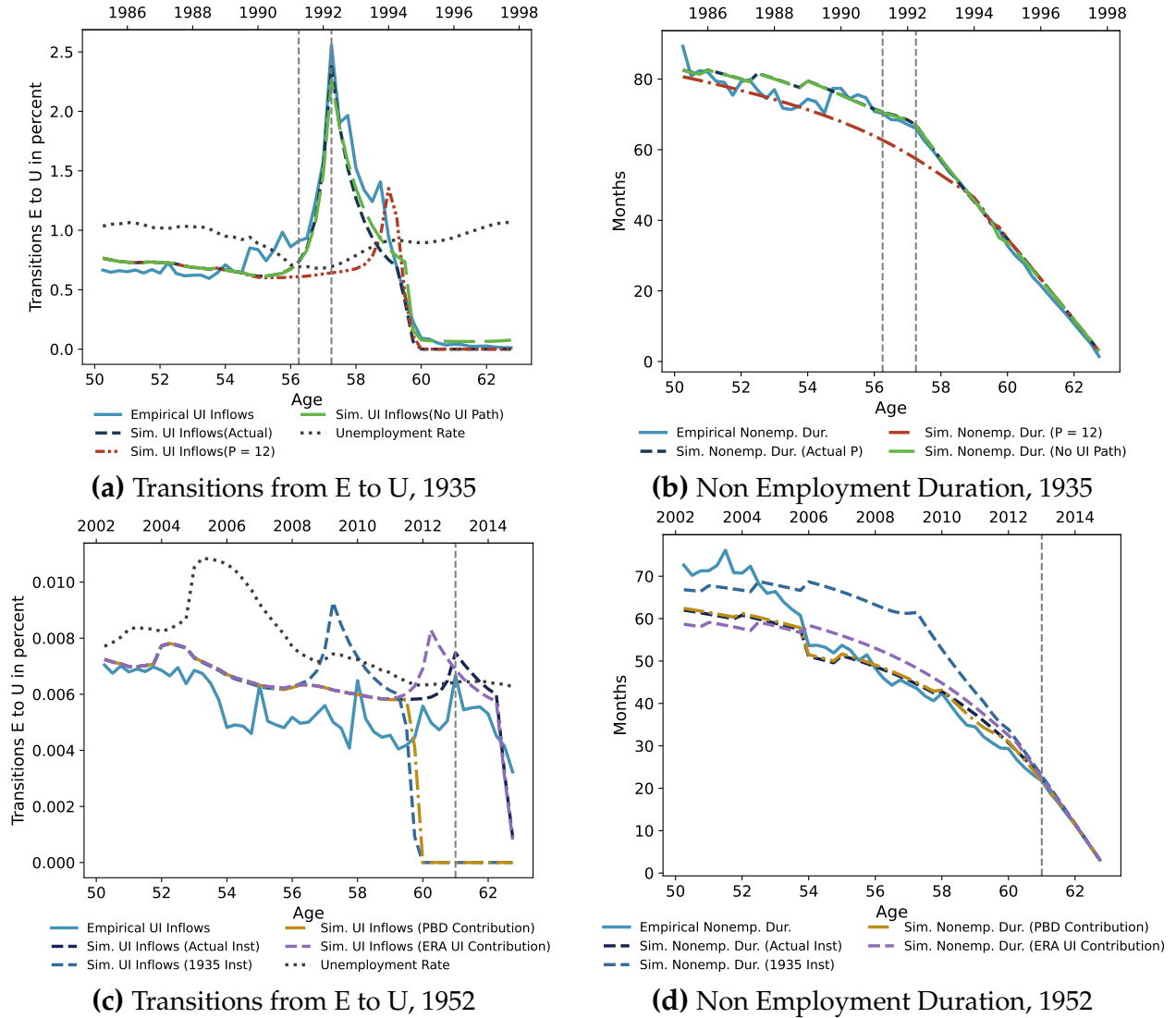
**(a) Empirical and Simulated Unemployment Rate**



**(b) Extending UI PBD by 12 months**

**Notes:** Panel (a) shows the empirical and simulated unemployment rate from the model for two age groups; 50-54 years old and 55-59 years old. Panel (b) shows the structural unemployment rate under the actual institutions (corresponding to the dashed line in panel (a)) and when the potential benefit duration (PBD) is increased by 12 months.

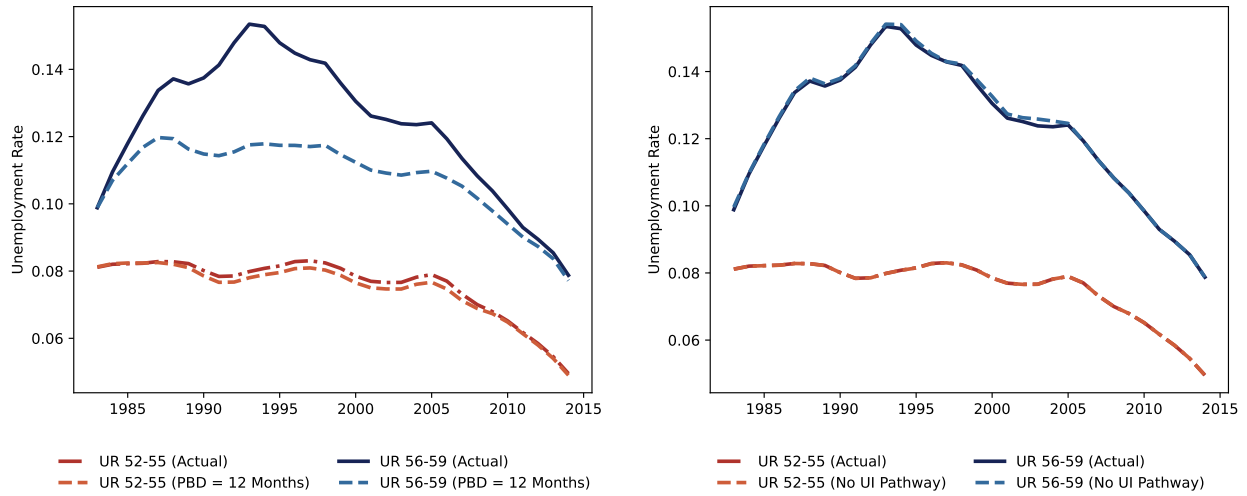
**Figure F.55: Model Simulations for Counterfactual Policies - Women**



**Notes:** These figures compare our model-generated moments to their corresponding empirical moments for select out-of-sample cohorts (1945, 1952), aggregated to the quarterly level. Model-generated moments include the baseline specification, a counterfactual model where we set P to the values that were valid in 1924, and a counterfactual model where we set UI and retirement institutions (retirement ages and pathways, replacement rates, penalties and discounts) to the 1924 values. Figure (a) compares the transitions from employment to unemployment in 1945 whereas Figure (b) compares non-employment durations in 1945. Figures (c) and (d) show the same comparisons for the 1952 cohort.

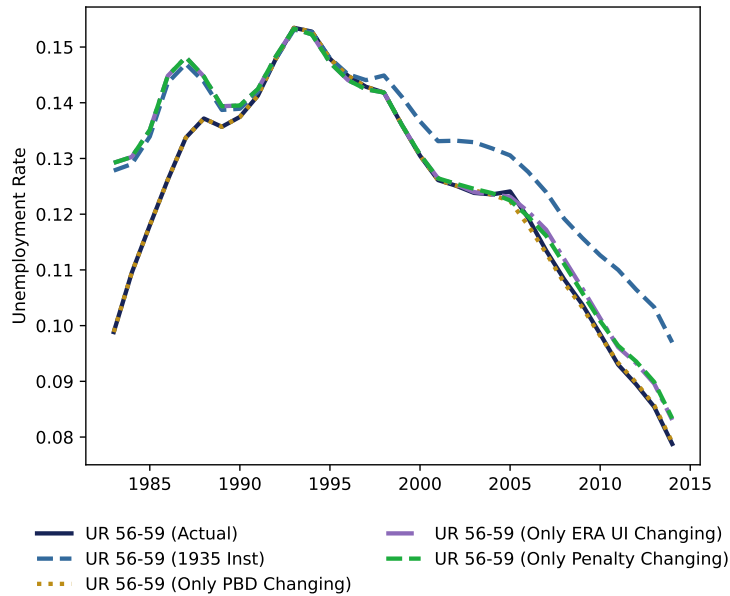


**Figure F.57: Simulated Unemployment Rates under Alternative Policy Regime - Women**



**(a) PBD fixed at 12 months**

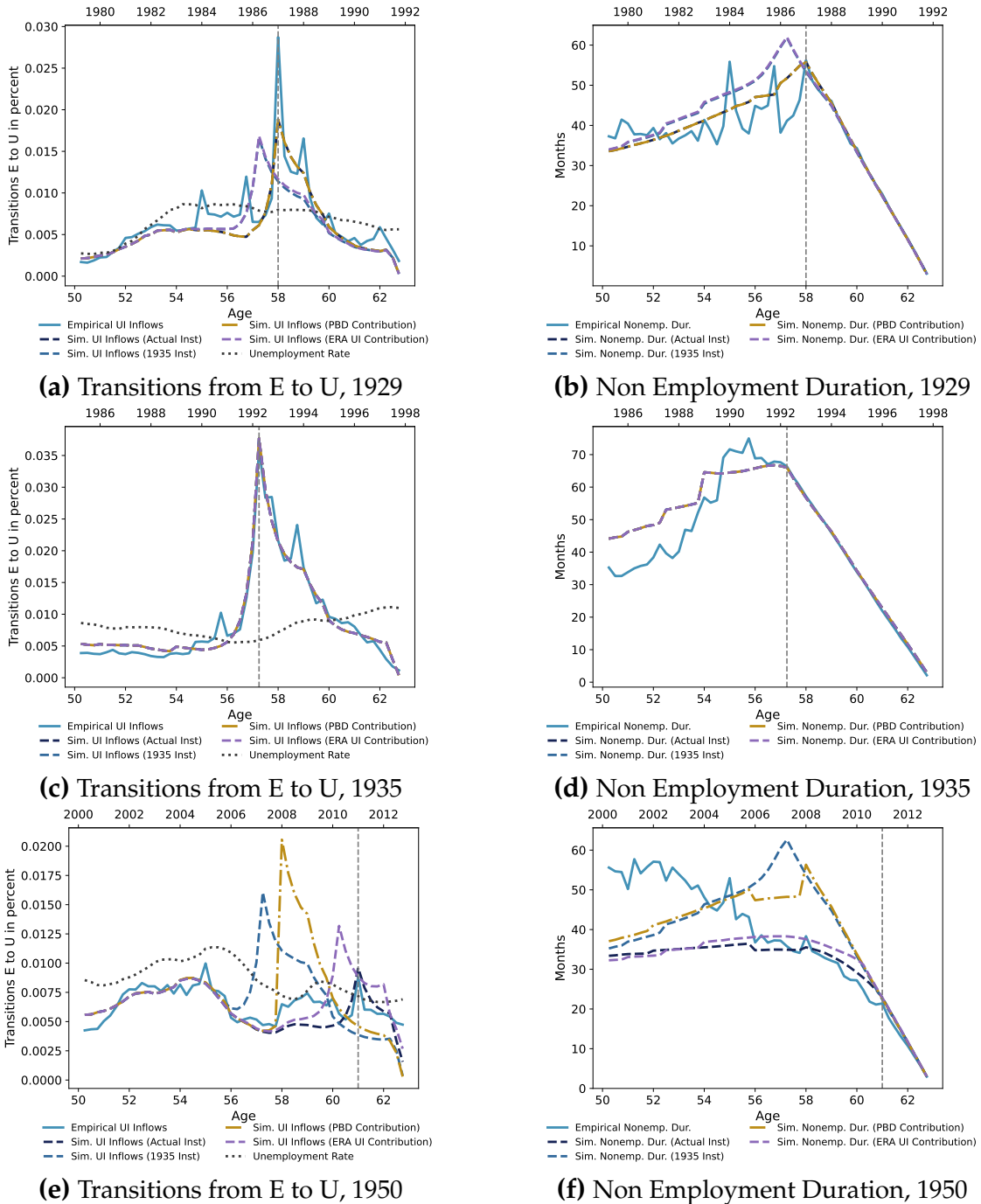
**(b) No UI Pathway**



**(c) The Influence of Policy Changes after 1994**

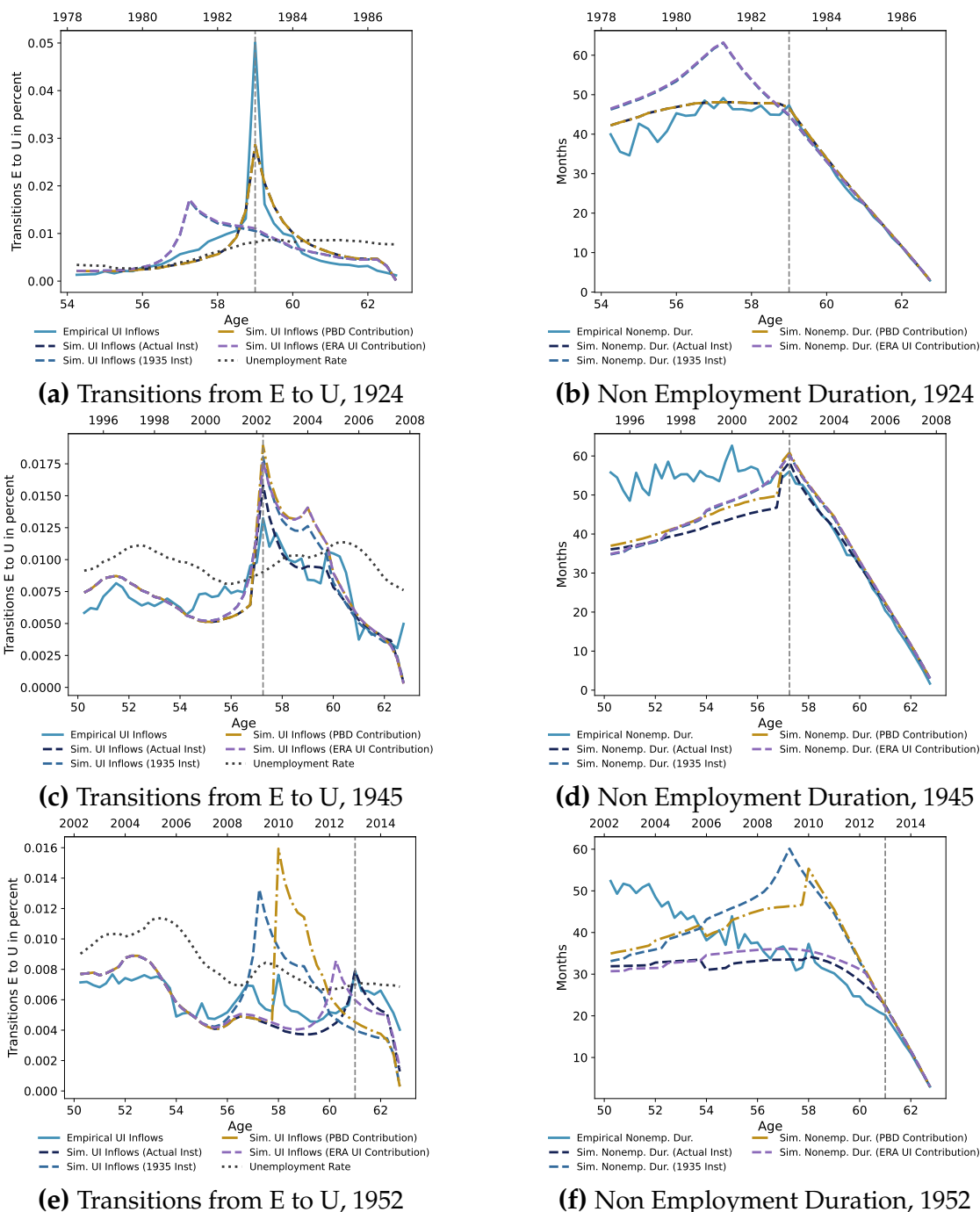
**Notes:** Panel (a) shows the predicted unemployment rate structurally calculated from the model across calendar years for the baseline model, for the counterfactual model that sets P to the values that were valid in 1924, and for the counterfactual model that sets UI and retirement institutions (retirement ages and pathways, replacement rates, penalties and discounts) to the 1924 values. This is presented for two age groups: age 50-54 and age 55-59.

**Figure F.59: Robustness of Structural Model - Model Fit and Counterfactuals for Model without Time Trend - Men**



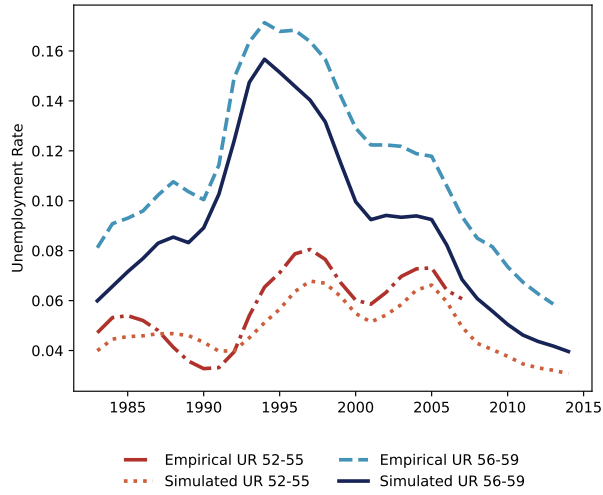
**Notes:** These figures compare our model-generated moments to their corresponding empirical moments for the in-sample cohorts (1929, 1935, 1950), aggregated to the quarterly level. Model-generated moments include the baseline specification and a counterfactual model where we increase potential benefit duration of UI by 12 months across all ages. Figure (a) compares the transitions from employment to unemployment in 1929 whereas Figure (b) compares non-employment durations in 1929. Figures (c) and (d) show the same comparisons for the 1935 cohort, and Figures (e) and (f) for the 1950 cohort.

**Figure F.61: Robustness of Structural Model - Model Fit and Counterfactuals for Model without Time Trend - Men**

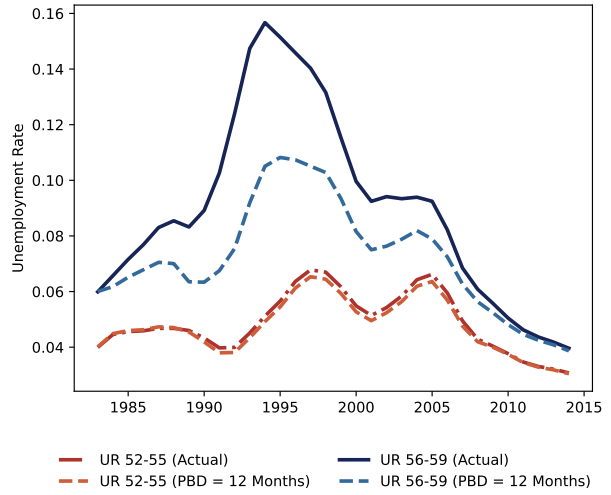


**Notes:** These figures compare our model-generated moments to their corresponding empirical moments for select out-of-sample cohorts (1924, 1945, 1952), aggregated to the quarterly level. Model-generated moments include the baseline specification and a counterfactual model where we increase potential benefit duration of UI by 12 months across all ages. Figure (a) compares the transitions from employment to unemployment in 1924 whereas Figure (b) compares non-employment durations in 1924. Figures (c) and (d) show the same comparisons for the 1945 cohort, and Figures (e) and (f) for the 1952 cohort.

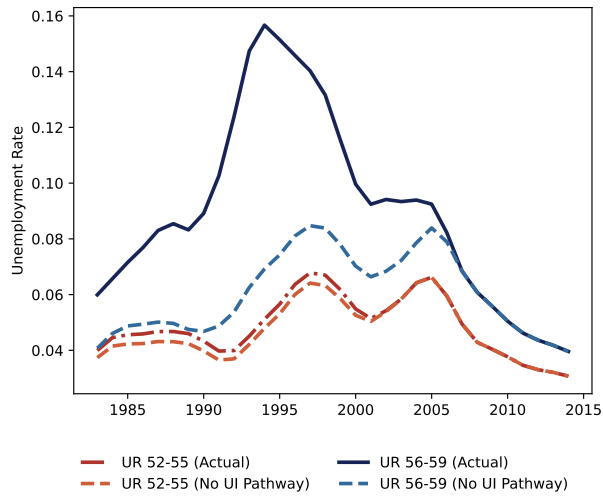
**Figure F.63: Robustness of Model Estimation - No Time Trend - Men**



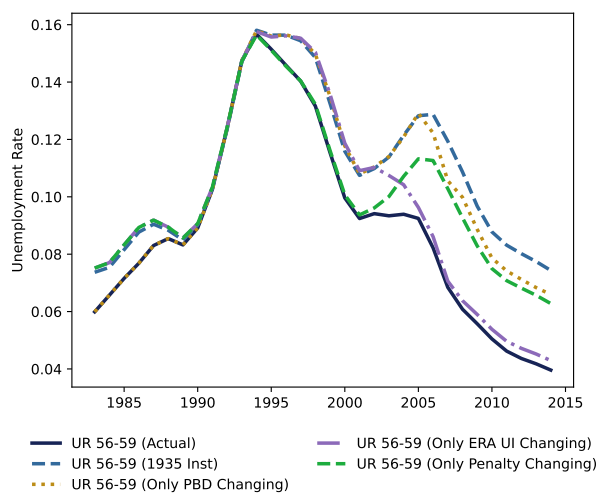
**(a) Empirical and Simulated Unemp. Rate**



**(b) PBD fixed at 12 months**



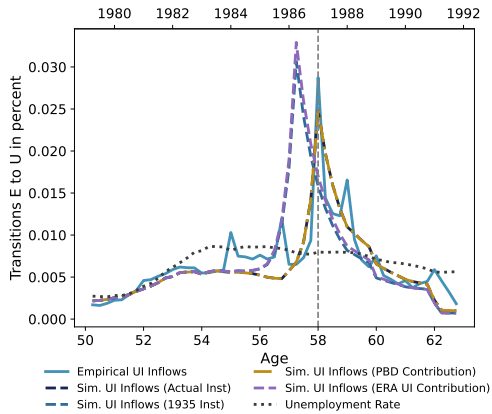
**(c) No UI Pathway**



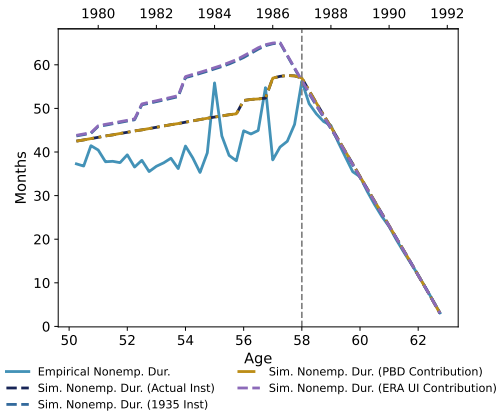
**(d) The Influence of Policy Changes after 1994**

**Notes:** Panel (a) shows the empirical and simulated unemployment rate from the model for two age groups; 50-54 years old and 55-59 years old. Panel (b) shows the structural unemployment rate under the actual institutions (corresponding to the dashed line in panel (a) ) and when the potential benefit duration (PBD) is increased by 12 months.

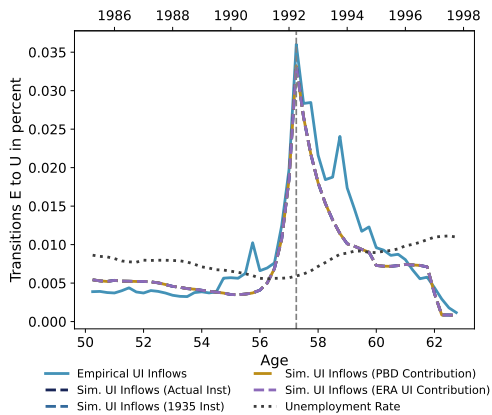
**Figure F.65: Robustness of Structural Model - Model Fit and Counterfactuals for Model with Constant  $\bar{\eta}$  - Men**



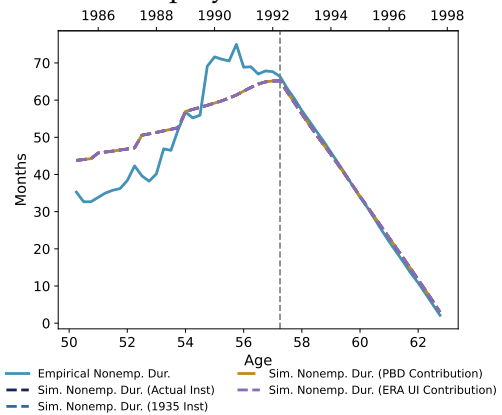
**(a) Transitions from E to U, 1929**



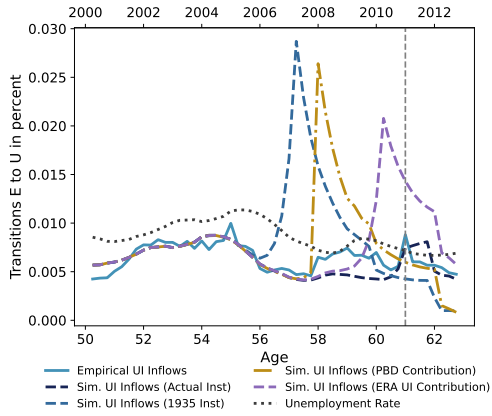
**(b) Non Employment Duration, 1929**



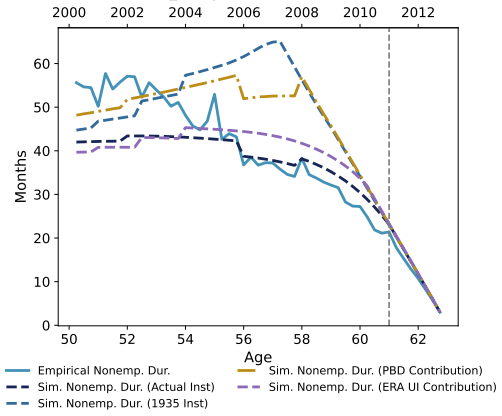
**(c) Transitions from E to U, 1935**



**(d) Non Employment Duration, 1935**



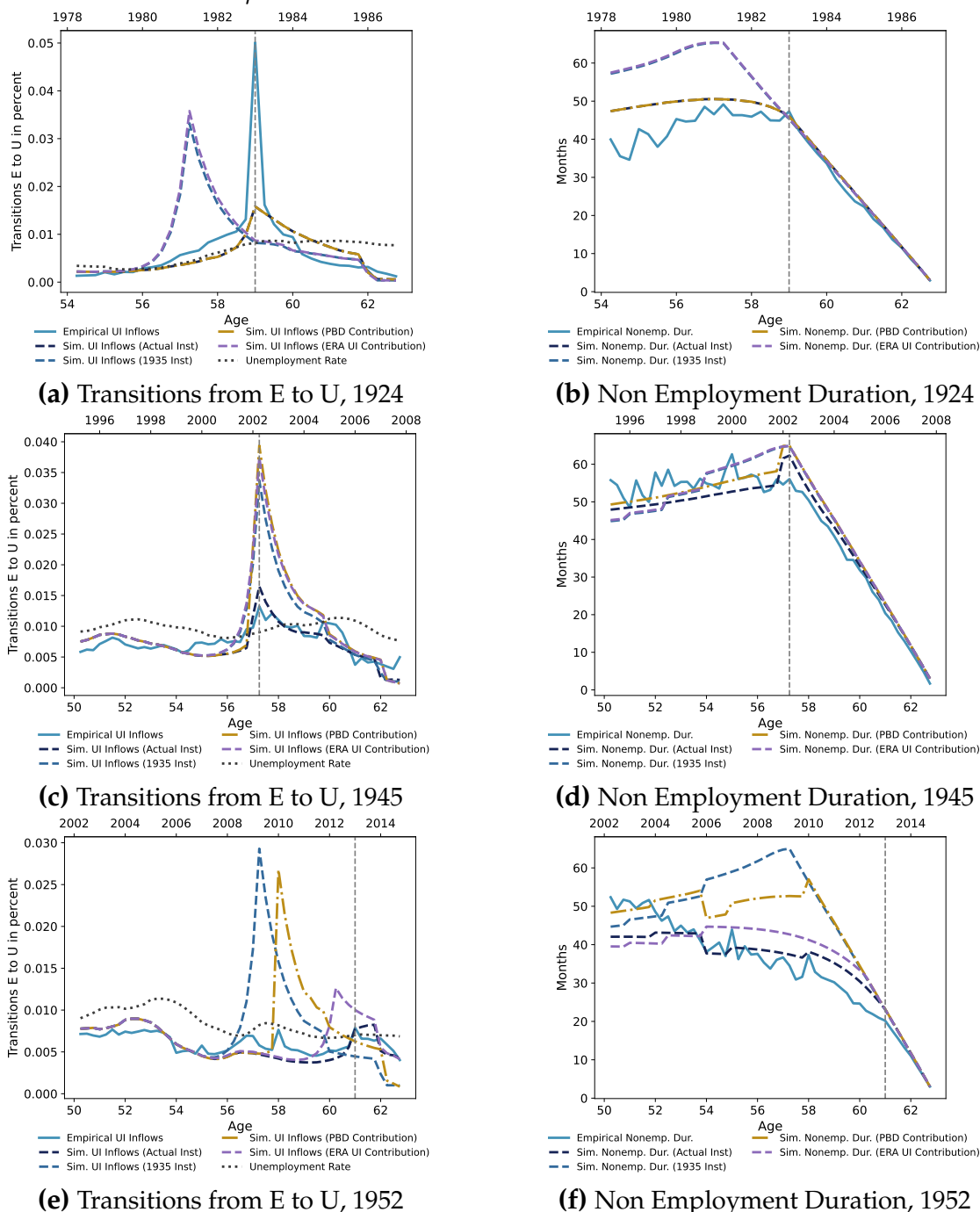
**(e) Transitions from E to U, 1950**



**(f) Non Employment Duration, 1950**

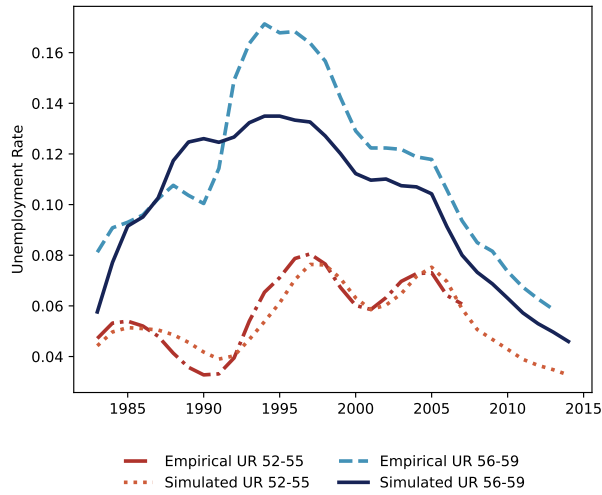
**Notes:** These figures compare our model-generated moments to their corresponding empirical moments for select out-of-sample cohorts (1924, 1945, 1952), aggregated to the quarterly level. Model-generated moments include the baseline specification and a counterfactual model where we increase potential benefit duration of UI by 12 months across all ages. Figure (a) compares the transitions from employment to unemployment in 1924 whereas Figure (b) compares non-employment durations in 1924. Figures (c) and (d) show the same comparisons for the 1945 cohort, and Figures (e) and (f) for the 1952 cohort.

**Figure F.67: Robustness of Structural Model - Model Fit and Counterfactuals for Model with Constant  $\bar{\eta}$  - Men**

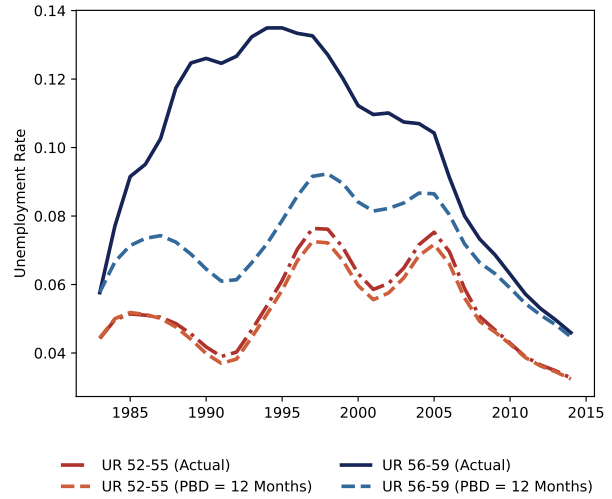


**Notes:** These figures compare our model-generated moments to their corresponding empirical moments for select out-of-sample cohorts (1924, 1945, 1952), aggregated to the quarterly level. Model-generated moments include the baseline specification and a counterfactual model where we increase potential benefit duration of UI by 12 months across all ages. Figure (a) compares the transitions from employment to unemployment in 1924 whereas Figure (b) compares non-employment durations in 1924. Figures (c) and (d) show the same comparisons for the 1945 cohort, and Figures (e) and (f) for the 1952 cohort.

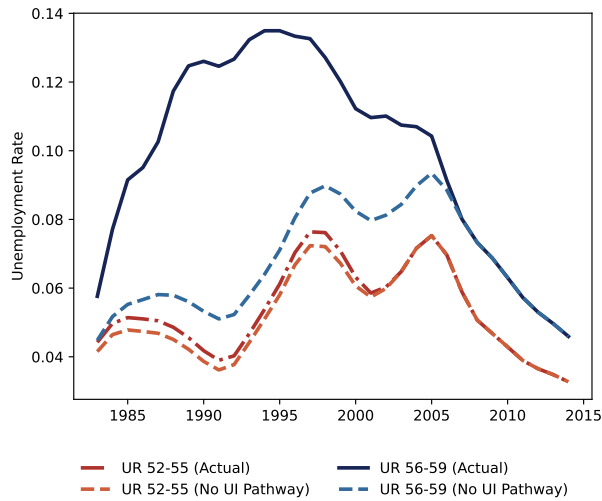
**Figure F.69: Robustness of Model Estimation - Constant  $\bar{\eta}$  - Men**



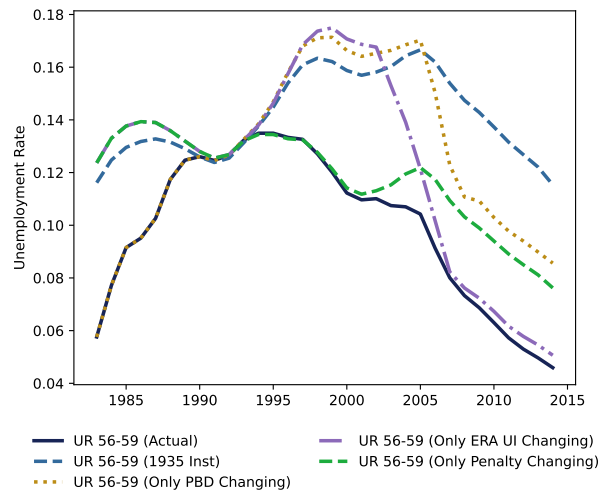
**(a) Empirical and Simulated Unemp. Rate**



**(b) PBD fixed at 12 months**



**(c) No UI Pathway**



**(d) The Influence of Policy Changes after 1994**

**Notes:** Panel (a) shows the empirical and simulated unemployment rate from the model for two age groups; 50-54 years old and 55-59 years old. Panel (b) shows the structural unemployment rate under the actual institutions (corresponding to the dashed line in panel (a) ) and when the potential benefit duration (PBD) is increased by 12 months.

## G Appendix Tables

**Table G.1:** Potential Unemployment Insurance Benefit (UIB) Durations as a Function of Age and Months Worked in Previous 7 Years.

Months Worked in prev. X years	January 1983- December 1984	January 1985- December 1985	January 1986- June 1987	July 1987- March 1997	April 1997* - January 2006	February 2006 - December 2007	January 2008 - Present
12	4	4	4	6	6	6	6
16	4	4	4	8	8	8	8
18	6	6	6	8	8	8	8
20	6	6	6	10	10	10	10
24	8	8	8	12	12	12	12
28	8	8	8	14 (>42)	14 (>45)	12	12
30	10	10	10	14 (>42)	14 (>45)	15 (>55)	15 (>50)
32	10	10	10	16 (>42)	16 (>45)	15 (>55)	15 (>50)
36	12	12	12	18 (>42)	18 (>45)	18 (>55)	18 (>55)
40	12	12	12	20 (>44)	20 (>47)	18 (>55)	18 (>55)
42	12	14 (>49)	14 (>44)	20 (>44)	20 (>47)	18 (>55)	18 (>55)
44	12	14 (>49)	14 (>44)	22 (>44)	22 (>47)	18 (>55)	18 (>55)
48	12	16 (>49)	16 (>44)	24 (>49)	24 (>52)	18 (>55)	24 (>58)
52	12	16 (>49)	16 (>44)	26 (>49)	26 (>52)	18 (>55)	24 (>58)
54	12	18 (>49)	18 (>49)	26 (>49)	26 (>52)	18 (>55)	24 (>58)
56	12	18 (>49)	18 (>49)	28 (>54)	28 (>57)	18 (>55)	24 (>58)
60	12	18 (>49)	20 (>49)	30 (>54)	30 (>57)	18 (>55)	24 (>58)
64	12	18 (>49)	20 (>49)	32 (>54)	32 (>57)	18 (>55)	24 (>58)
66	12	18 (>49)	22 (>54)	32 (>54)	32 (>57)	18 (>55)	24 (>58)
72	12	18 (>49)	24 (>54)	32 (>54)	32 (>57)	18 (>55)	24 (>58)
Rahmenfrist - Min emp dur. for new UI eligibility	12	12	12	12	12	12	12
X - Base Period for P>12	7	7	7	7	7	5	5
X - Base Period for P<12	4	4	4	3	3	2	2
<b>Replacement Rates on Net Wages in Percent:</b>							
UI (children)	68	68	68	67 <sup>‡</sup>	67	67	67
UI (no children)	63 <sup>†</sup>	63	63	60 <sup>‡</sup>	60	60	60
UA (children)	58	58	58	57 <sup>‡</sup>	57	UIB II	UIB II
UA (no children)	53 <sup>†</sup>	53	53	50 <sup>‡</sup>	50	UIB II	UIB II

Source: Hunt (1995), Bundesgesetzblatt (1983-2015) and Dlugosz et al (2013).

\*The reform in 1997 was phased in gradually: For workers who had worked for more than one year during the three years before April 1997, the old rules applied until March 1999 (See Arntz, Simon Lo, and Wilke 2007).

<sup>†</sup> UI and UA replacement rates were lowered starting in January 1984. Until December 1983, ALG was 68 percent and ALH 58 percent of the previous net wage, irrespective of whether the recipient had children.

<sup>‡</sup> UI and UA were lowered starting in January of 1994.



**Table G.2: Retirement age by retirement pathways from 1957 till now**

Pathways	Time of implementation	Affected cohorts	SRA		Reform
<b>Standard old-age pension</b> (Years of contribution: 5 <sup>34</sup> )	1957 - 2011	<1947 Jan	65	-	
	2012 - 2030 > 2031	1947 Jan- 1964 Jan ≥1964 Jan	65 to 67 67	-	2007 Reform
			NRA (no penalty)	ERA (earliest possible)	
<b>Old-age pension for long-term insured</b> (Years of contribution :35 )	1972 - 1999	1909 Jan - 1936 Dec	63	-	1972 Reform †
	2000 - 2003	1937 Jan - 1938 Dec	63 to 65	63	1992 Reform §
	2004 - 2010	1939 Jan - 1947 Dec	65	63	
	2011 - 2030	1949 Jan - 1964 Jan	65 to 67	63	2007 Reform *
<b>Old-age pension due to unemployment or part-time work</b> (at least 52 weeks unemployed after 58½, or 2 years part-time) (Years of contribution: 15(8 in last 10 yrs) )	1972 - 1996	< 1937 Jan	60	-	1972 Reform
	1997 - 2006	1937 Jan - 1941 Dec	60 to 65	60	1992/99 Reform
		1942 Jan - 1945 Dec	65	60	
	2006 - 2011	1946 Jan - 1948 Dec	65	60 to 63	1992 Reform
	2012 - 2016 > 2017.1	1949 Jan - 1951 Dec > 1952 Jan	65 Phased out	63 -	2007 Reform
<b>Old-age pension for women</b> (Years of contribution: 15 (10 after age 40))	1957 - 2000	<1940 Jan	60	-	
	2000 - 2009	1940 Jan - 1944 Dec	60 to 65	60	1992 Reform
	2010 - 2016	1945 Jan - 1951 Dec	65	60	
	> 2017.1	> 1952 Jan	Phased out	-	2007 Reform
<b>Old-age pension for disabled workers</b> (Years of contribution: 35) (Loss of at least 50 percent of earnings capability)	1972 - 1977	1911 - 1917	62	-	1972 Reform
	1978 - 1980	1918 Jan - 1919 Dec	62 to 60	-	1978 Reform
	1981- 2000	1920 Jan - 1940 Dec	60	-	
	2001 - 2006	1941 Jan - 1943 Dec	60 to 63	60	1992 Reform
	2007 - 2011	1944 Jan - 1951 Dec	63	60	
	2012 - 2025 > 2026	1952 Jan - 1963 Dec > 1964 Jan	63 to 65 65	60 to 62 62	2007 Reform
<b>Old-age pension for especially long-term insured</b> (qualifying period of 45 years)	2014-2016	1951- 1953	63	-	
	2016 - 2028	1953 Jan - 1963 Dec	63 to 65	-	2014 Reform
	> 2029.1	> 1964.1.1	65	-	
<b>Disability pension : independent of age</b>	<1985	5 years of contribution			
	> 1985	5 yrs with minimum 3 in last 5 yrs			1984 Reform

† The German public pension system distinguishes "old-age pensions" from "disability pensions": old-age pensions for workers aged 60 and older; and disability benefits for workers below age 60, which at the statutory retirement age are converted to old-age pensions at age 65.

‡ The 1972 reform: "flexible retirement" after age 63 with full benefits became possible for long-term insured; retirement at age 60 with full benefits became possible for women, the unemployed, and older disabled workers.

§ The 1992 reform introduced actuarial adjustment. Since then, we distinguish ERA and NRA. It also increased NRA to 65 for all pathways except for disabled workers. It increased ERA for the unemployed to 63 (See SGBVI appendix 19).

\* The 2007 reform increases SRA stepwise between 2012 and 2029 from 65 to 67 for both men and women (see SGB VI 235). For cohorts older born in 1952 and after, retirement pathway for women and the unemployed are phased out.

**Sources:** Sozialgesetzbuch (SGB) Sechstes Buch (VI), Börsch-Supan and Jürges (2012), Börsch-Supan and Wilke (2006), Giesecke and Kind (2013).

**Table G.3:** RD Estimations of the Effects of UI PBD Extensions on Nonemployment Duration for Men and Women

		Male		Female		Male and Female	
		Base	Controls	Base	Controls	Base	Controls
<b>Period Jul 1987 - Feb 1999</b>							
Age 42, P: (12-18), $\Delta$ P: 6	$\frac{dy}{dP}$	0.092	0.080	0.124	0.124	0.107	0.100
		[0.026]**	[0.025]**	[0.027]**	[0.026]**	[0.019]**	[0.018]**
N		173,313	173,313	148,220	148,220	321,533	321,533
Mean Dep. Var		16.049	16.049	17.736	17.736	16.827	16.827
Age 44, P: (18-22), $\Delta$ P: 4	$\frac{dy}{dP}$	0.079	0.068	0.056	0.049	0.066	0.060
		[0.041]+	[0.039]+	[0.038]	[0.037]	[0.028]*	[0.026]*
N		170,270	170,270	152,092	152,092	322,362	322,362
Mean Dep. Var		17.046	17.046	18.777	18.777	17.863	17.863
Age 49, P: (22-26), $\Delta$ P: 4	$\frac{dy}{dP}$	0.121	0.103	0.105	0.107	0.119	0.107
		[0.068]+	[0.062]	[0.065]	[0.063]+	[0.049]*	[0.046]*
N		107,255	107,255	91,736	91,736	198,991	198,991
Mean Dep. Var		18.568	18.568	20.920	20.920	19.652	19.652
Age 54, P: (26-32), $\Delta$ P: 6	$\frac{dy}{dP}$	0.129	0.126	0.203	0.222	0.173	0.181
		[0.053]*	[0.048]**	[0.040]**	[0.039]**	[0.034]**	[0.032]**
N		66,720	66,720	66,823	66,823	133,543	133,543
Mean Dep. Var		24.331	24.331	28.639	28.639	26.486	26.486
<b>Period Mar 1999 - Jan 2006</b>							
Age 45, P: (12-18), $\Delta$ P: 6	$\frac{dy}{dP}$	0.024	0.024	0.118	0.115	0.067	0.067
		[0.028]	[0.027]	[0.029]**	[0.028]**	[0.020]**	[0.020]**
N		156,927	156,927	132,763	132,763	289,690	289,690
Mean Dep. Var		15.637	15.637	15.605	15.605	15.622	15.622
Age 47, P: (18-22), $\Delta$ P: 4	$\frac{dy}{dP}$	0.113	0.104	0.128	0.124	0.120	0.112
		[0.044]*	[0.042]*	[0.044]**	[0.043]**	[0.031]**	[0.029]**
N		148,285	148,285	132,154	132,154	280,439	280,439
Mean Dep. Var		16.794	16.794	17.214	17.214	16.992	16.992
Age 52, P: (22-26), $\Delta$ P: 4	$\frac{dy}{dP}$	0.128	0.126	0.064	0.066	0.101	0.097
		[0.049]**	[0.048]**	[0.048]	[0.046]	[0.034]**	[0.033]**
N		113,128	113,128	106,936	106,936	220,064	220,064
Mean Dep. Var		20.546	20.546	22.619	22.619	21.553	21.553
<b>Period Feb 2006 - Dec2007</b>							
Age 50, P: (12-15), $\Delta$ P: 3	$\frac{dy}{dP}$	0.048	0.062	0.151	0.142	0.096	0.103
		[0.103]	[0.100]	[0.097]	[0.096]	[0.073]	[0.072]
N		57,116	57,116	52,647	52,647	109,763	109,763
Mean Dep. Var		18.539	18.539	18.077	18.077	18.317	18.317

This table shows rd-estimates of UI extensions at various cutoffs on nonemployment duration in months (capped at 36 months). Estimates are obtained using local polynomial regressions controlling linearly for age (allowing for different slopes on each side of cutoff), using a uniform kernel and a bandwidth of 2 years on each side of the cutoff, except for age cutoff 49 and 54 who have only a bandwidth of one year on the right due to other discontinuities. Standard errors (in brackets) clustered on ageday level ( $\dagger$   $P < .1$ , \*  $P < .05$ , \*\*  $P < .01$ ).

**Table G.4: Placebo Outcomes, Males**

		Fraction of UI entries per day	Pre UI Wage	Foreign Citizen	Years of Education	Occ. Tenure Last Job	Ind. Tenure Last Job	Times until UI Claim
<b>Period Jul 1987 - Feb 1999</b>								
Age 42, P: (12-18), Δ P: 6	$\frac{dy}{dP}$	-0.002	0.083	0.001	0.007	-0.000	0.011	0.000
		[0.001]	[0.069]	[0.001]*	[0.006]	[0.011]	[0.011]	[0.006]
N		173,313	173,313	173,313	173,313	173,313	173,313	173,313
Mean Dep. Var		1.000	80.712	0.134	12.911	9.955	8.921	1.517
Age 44, P: (18-22), Δ P: 4	$\frac{dy}{dP}$	0.006	0.027	0.000	0.012	-0.008	0.000	0.013
		[0.003]*	[0.107]	[0.001]	[0.010]	[0.018]	[0.019]	[0.009]
N		170,270	170,270	170,270	170,270	170,270	170,270	170,270
Mean Dep. Var		1.000	80.460	0.147	12.851	10.626	9.578	1.526
Age 49, P: (22-26), Δ P: 4	$\frac{dy}{dP}$	-0.001	-0.255	-0.000	-0.001	0.017	0.047	-0.008
		[0.003]	[0.165]	[0.002]	[0.016]	[0.027]	[0.028]	[0.009]
N		107,255	107,255	107,255	107,255	107,255	107,255	107,255
Mean Dep. Var		1.000	81.666	0.175	12.755	12.342	11.258	1.036
Age 54, P: (26-32), Δ P: 6	$\frac{dy}{dP}$	0.005	0.496	-0.002	-0.008	0.023	0.025	0.007
		[0.004]	[0.151]**	[0.001]	[0.010]	[0.018]	[0.020]	[0.006]
N		66,720	66,720	66,720	66,720	66,720	66,720	66,720
Mean Dep. Var		1.000	75.899	0.143	11.566	12.178	11.842	0.906
<b>Period Mar 1999 - Jan 2006</b>								
Age 45, P: (12-18), Δ P: 6	$\frac{dy}{dP}$	0.001	-0.036	0.000	-0.003	0.016	0.019	-0.007
		[0.002]	[0.079]	[0.001]	[0.007]	[0.014]	[0.014]	[0.006]
N		156,927	156,927	156,927	156,927	156,927	156,927	156,927
Mean Dep. Var		1.000	78.133	0.083	13.467	11.736	5.542	1.271
Age 47, P: (18-22), Δ P: 4	$\frac{dy}{dP}$	0.004	-0.129	0.001	0.019	-0.007	-0.010	-0.011
		[0.003]	[0.131]	[0.001]	[0.011]	[0.024]	[0.022]	[0.009]
N		148,285	148,285	148,285	148,285	148,285	148,285	148,285
Mean Dep. Var		1.000	77.292	0.082	13.424	12.750	5.957	1.287
Age 52, P: (22-26), Δ P: 4	$\frac{dy}{dP}$	0.004	-0.088	0.000	-0.012	0.055	0.045	-0.004
		[0.003]	[0.162]	[0.001]	[0.011]	[0.029]+	[0.031]	[0.010]
N		113,128	113,128	113,128	113,128	113,128	113,128	113,128
Mean Dep. Var		1.000	76.409	0.089	13.139	15.562	8.502	1.413
<b>Period Jan 2008 - Dec 2008</b>								
Age 50, P: (12-15), Δ P: 3	$\frac{dy}{dP}$	0.014	0.462	-0.000	0.013	0.029	0.007	-0.007
		[0.005]**	[0.286]	[0.002]	[0.020]	[0.059]	[0.009]	[0.010]
N		57,116	57,116	57,116	57,116	57,116	57,116	57,116
Mean Dep. Var		1.000	75.830	0.089	12.548	13.415	6.020	0.453

This table shows estimates of UI extensions at various cutoffs on different placebo outcomes. For details on the estimation specification see for example notes of table G.3. Standard errors (in brackets) clustered on ageday level († P<.1, \* P<.05, \*\* P<.01).

**Table G.5: Placebo Outcomes, Females**

		Fraction of UI entries per day	Pre UI Wage	Foreign Citizen	Years of Education	Occ. Tenure Last Job	Ind. Tenure Last Job	Times until UI Claim
<b>Period Jul 1987 - Feb 1999</b>								
Age 42, P: (12-18), Δ P: 6	$\frac{dy}{dP}$	0.001	0.120	0.000	0.002	0.019	0.013	0.003
		[0.001]	[0.061]*	[0.001]	[0.008]	[0.012]	[0.012]	[0.007]
N		148,220	148,220	148,220	148,220	148,220	148,220	148,220
Mean Dep. Var		1.000	52.560	0.122	12.756	7.801	6.850	1.371
Age 44, P: (18-22), Δ P: 4	$\frac{dy}{dP}$	-0.001	0.045	-0.001	0.002	0.001	0.013	-0.013
		[0.003]	[0.095]	[0.001]	[0.011]	[0.019]	[0.018]	[0.010]
N		152,092	152,092	152,092	152,092	152,092	152,092	152,092
Mean Dep. Var		1.000	52.242	0.123	12.817	7.798	6.921	1.358
Age 49, P: (22-26), Δ P: 4	$\frac{dy}{dP}$	0.008	-0.076	0.000	0.005	0.021	0.026	-0.004
		[0.003]*	[0.134]	[0.001]	[0.016]	[0.030]	[0.029]	[0.009]
N		91,736	91,736	91,736	91,736	91,736	91,736	91,736
Mean Dep. Var		1.000	53.000	0.104	12.821	8.617	7.865	0.866
Age 54, P: (26-32), Δ P: 6	$\frac{dy}{dP}$	0.016	0.452	-0.002	-0.009	0.015	-0.010	-0.007
		[0.003]**	[0.107]**	[0.001]**	[0.010]	[0.022]	[0.023]	[0.006]
N		66,823	66,823	66,823	66,823	66,823	66,823	66,823
Mean Dep. Var		1.000	50.236	0.059	11.662	8.369	8.157	0.770
<b>Period Mar 1999 - Jan 2006</b>								
Age 45, P: (12-18), Δ P: 6	$\frac{dy}{dP}$	0.005	0.003	0.000	-0.000	-0.002	0.009	-0.007
		[0.002]**	[0.070]	[0.001]	[0.007]	[0.015]	[0.012]	[0.007]
N		132,763	132,763	132,763	132,763	132,763	132,763	132,763
Mean Dep. Var		1.000	49.867	0.065	13.574	8.275	3.821	1.134
Age 47, P: (18-22), Δ P: 4	$\frac{dy}{dP}$	0.007	0.083	-0.000	0.023	0.010	-0.003	-0.004
		[0.003]**	[0.108]	[0.001]	[0.012]*	[0.026]	[0.019]	[0.010]
N		132,154	132,154	132,154	132,154	132,154	132,154	132,154
Mean Dep. Var		1.000	49.352	0.072	13.596	8.715	4.047	1.145
Age 52, P: (22-26), Δ P: 4	$\frac{dy}{dP}$	0.012	0.326	0.001	-0.007	0.066	0.048	0.013
		[0.003]**	[0.126]*	[0.001]	[0.013]	[0.029]*	[0.026]+	[0.010]
N		106,936	106,936	106,936	106,936	106,936	106,936	106,936
Mean Dep. Var		1.000	48.233	0.082	13.569	10.014	5.545	1.202
<b>Period Jan 2008 - Dec 2010</b>								
Age 50, P: (12-15), Δ P: 3	$\frac{dy}{dP}$	0.021	-0.187	-0.000	-0.020	-0.047	-0.041	0.008
		[0.005]**	[0.241]	[0.002]	[0.021]	[0.057]	[0.020]*	[0.011]
N		52,647	52,647	52,647	52,647	52,647	52,647	52,647
Mean Dep. Var		1.000	47.291	0.070	12.328	9.267	3.631	0.469

This table shows estimates of UI extensions at various cutoffs on different placebo outcomes. For details on the estimation specification see for example notes of table G.3. Standard errors (in brackets) clustered on agetday level († P<.1, \* P<.05, \*\* P<.01).

**Table G.6: Placebo Outcomes, Males + Females**

	Fraction of UI entries per day	Pre UI Wage	Foreign Citizen	Years of Education	Occ. Tenure Last Job	Ind. Tenure Last Job	Times until UI Claim
<b>Period Jul 1987 - Feb 1999</b>							
Age 42, P: (12-18), Δ P: 6	$\frac{dy}{dP}$	-0.001	0.079	0.001	0.004	0.007	0.010
		[0.001]	[0.051]	[0.001]+	[0.005]	[0.008]	[0.008]
N		321,533	321,533	321,533	321,533	321,533	321,533
Mean Dep. Var		1.000	67.735	0.128	12.839	8.962	7.966
Age 44, P: (18-22), Δ P: 4	$\frac{dy}{dP}$	0.003	0.077	-0.000	0.008	-0.000	0.010
		[0.002]	[0.079]	[0.001]	[0.008]	[0.013]	[0.013]
N		322,362	322,362	322,362	322,362	322,362	322,362
Mean Dep. Var		1.000	67.146	0.136	12.835	9.292	8.324
Age 49, P: (22-26), Δ P: 4	$\frac{dy}{dP}$	0.004	-0.233	-0.000	0.002	0.010	0.029
		[0.002]+	[0.120]+	[0.001]	[0.012]	[0.020]	[0.020]
N		198,991	198,991	198,991	198,991	198,991	198,991
Mean Dep. Var		1.000	68.451	0.142	12.786	10.625	9.694
Age 54, P: (26-32), Δ P: 6	$\frac{dy}{dP}$	0.011	0.409	-0.002	-0.008	0.010	-0.002
		[0.002]**	[0.101]**	[0.001]*	[0.008]	[0.016]	[0.017]
N		133,543	133,543	133,543	133,543	133,543	133,543
Mean Dep. Var		1.000	63.058	0.101	11.614	10.272	9.998
<b>Period Mar 1999 - Jan 2006</b>							
Age 45, P: (12-18), Δ P: 6	$\frac{dy}{dP}$	0.003	-0.049	0.000	-0.002	0.004	0.013
		[0.001]*	[0.055]	[0.000]	[0.005]	[0.010]	[0.009]
N		289,690	289,690	289,690	289,690	289,690	289,690
Mean Dep. Var		1.000	65.179	0.075	13.516	10.150	4.753
Age 47, P: (18-22), Δ P: 4	$\frac{dy}{dP}$	0.005	-0.050	0.000	0.021	-0.002	-0.008
		[0.002]**	[0.090]	[0.001]	[0.008]*	[0.018]	[0.015]
N		280,439	280,439	280,439	280,439	280,439	280,439
Mean Dep. Var		1.000	64.125	0.077	13.505	10.848	5.057
Age 52, P: (22-26), Δ P: 4	$\frac{dy}{dP}$	0.008	0.059	0.000	-0.009	0.049	0.040
		[0.002]**	[0.112]	[0.001]	[0.009]	[0.022]*	[0.021]+
N		220,064	220,064	220,064	220,064	220,064	220,064
Mean Dep. Var		1.000	62.717	0.086	13.348	12.866	7.065
<b>Period Jan 2008 - Dec 2010</b>							
Age 50, P: (12-15), Δ P: 3	$\frac{dy}{dP}$	0.017	0.119	-0.000	-0.003	-0.012	-0.019
		[0.003]**	[0.199]	[0.001]	[0.014]	[0.041]	[0.011]
N		109,763	109,763	109,763	109,763	109,763	109,763
Mean Dep. Var		1.000	62.142	0.080	12.443	11.426	4.874

This table shows estimates of UI extensions at various cutoffs on different placebo outcomes. For details on the estimation specification see for example notes of table G.3. Standard errors (in brackets) clustered on agetday level († P<.1, \* P<.05, \*\* P<.01).

**Table G.7: Robustness for RD-Estimates, Male**

	(1) baseline estimate	(2) more controls	(3) exclude 3 months	(4) bw 12 months	(5) kernel triangular
Period 3, Age 42					
RD-Estimate	0.0916*** [0.0259]	0.0679** [0.0249]	0.0741* [0.0289]	0.0734 [0.0448]	0.0854** [0.0294]
N	173313	173313	165203	78519	173313
Period 3, Age 44					
RD-Estimate	0.0795 [0.0412]	0.0522 [0.0378]	0.0507 [0.0444]	0.189** [0.0685]	0.0991* [0.0451]
N	170270	170270	162222	77334	170270
Period 3, Age 49					
RD-Estimate	0.137* [0.0589]	0.0650 [0.0518]	0.0854 [0.0681]	0.180** [0.0692]	0.139* [0.0589]
N	128050	128050	119883	80498	128050
Period 3, Age 54					
RD-Estimate	0.129* [0.0530]	0.0813 [0.0451]	0.150* [0.0584]	0.180** [0.0624]	0.147** [0.0518]
N	66720	66720	62507	43057	66720
Period 4, Age 45					
RD-Estimate	0.0242 [0.0282]	0.0225 [0.0261]	0.0201 [0.0300]	0.0116 [0.0465]	0.0153 [0.0305]
N	156927	156927	149712	71417	156927
Period 4, Age 47					
RD-Estimate	0.113* [0.0442]	0.0920* [0.0407]	0.0908 [0.0469]	0.139 [0.0729]	0.120* [0.0479]
N	148285	148285	141405	67315	148285
Period 4, Age 52					
RD-Estimate	0.128** [0.0491]	0.108* [0.0468]	0.128* [0.0550]	0.0547 [0.0855]	0.0637 [0.0561]
N	113128	113128	107910	51966	113128
Period 6, Age 50					
RD-Estimate	0.0476 [0.103]	0.0895 [0.0931]	0.0289 [0.108]	0.117 [0.166]	0.0150 [0.109]
N	57116	57116	54455	26172	57116

**Notes:** This table provides additional robustness estimates to the RD-estimates in table 2. Column (1) shows the baseline results. Column (2) adds to the baseline controls in a addition 1-digit industry controls, state-Fixed effects as well as calendar month and year FE. Column (3) excludes 3 instead of two months on each side of the cutoff, column (4) changes the bandwidth from 24 to 12 months and Column (5) uses a rectangular kernel. SE are clustered on the ageday level.

**Table G.8: Robustness for RD-Estimates, Female**

	(1) baseline estimate	(2) more controls	(3) exclude 3 months	(4) bw 12 months	(5) kernel triangular
Period 3, Age 42					
RD-Estimate	0.124*** [0.0266]	0.120*** [0.0264]	0.112*** [0.0306]	0.137** [0.0477]	0.123*** [0.0312]
N	148220	148220	141468	67098	148220
Period 3, Age 44					
RD-Estimate	0.0558 [0.0384]	0.0445 [0.0390]	0.0539 [0.0454]	0.131 [0.0702]	0.0766 [0.0462]
N	152092	152092	144991	69463	152092
Period 3, Age 49					
RD-Estimate	0.0649 [0.0589]	0.0697 [0.0540]	0.0646 [0.0685]	0.0367 [0.0694]	0.0576 [0.0591]
N	115576	115576	108182	72433	115576
Period 3, Age 54					
RD-Estimate	0.203*** [0.0403]	0.197*** [0.0394]	0.168*** [0.0489]	0.221*** [0.0515]	0.209*** [0.0425]
N	66823	66823	62537	42085	66823
Period 4, Age 45					
RD-Estimate	0.118*** [0.0289]	0.115*** [0.0273]	0.109*** [0.0312]	0.131** [0.0485]	0.118*** [0.0319]
N	132763	132763	126625	60612	132763
Period 4, Age 47					
RD-Estimate	0.128** [0.0443]	0.124** [0.0418]	0.0746 [0.0482]	0.282*** [0.0747]	0.167*** [0.0490]
N	132154	132154	126025	59650	132154
Period 4, Age 52					
RD-Estimate	0.0638 [0.0484]	0.0633 [0.0471]	0.0626 [0.0544]	0.149 [0.0845]	0.0729 [0.0555]
N	106936	106936	101891	49396	106936
Period 6, Age 50					
RD-Estimate	0.151 [0.0971]	0.157 [0.0975]	0.166 [0.111]	0.232 [0.174]	0.194 [0.114]
N	52647	52647	50282	24037	52647

**Notes:** This table provides additional robustness estimates to the RD-estimates in table 2. Column (1) shows the baseline results. Column (2) adds to the baseline controls in addition 1-digit industry controls, state-Fixed effects as well as calendar month and year FE. Column (3) excludes 3 instead of two months on each side of the cutoff, column (4) changes the bandwidth from 24 to 12 months and Column (5) uses a rectangular kernel. SE are clustered on the ageday level.

**Table G.9:** Robustness for RD-Estimates, Male+Female

	(1) baseline estimate	(2) more controls	(3) exclude 3 months	(4) bw 12 months	(5) kernel triangular
Period 3, Age 42					
RD-Estimate	0.107*** [0.0191]	0.0922*** [0.0182]	0.0918*** [0.0211]	0.107** [0.0327]	0.104*** [0.0214]
N	321533	321533	306671	145617	321533
Period 3, Age 44					
RD-Estimate	0.0657* [0.0283]	0.0514 [0.0273]	0.0489 [0.0318]	0.157** [0.0491]	0.0860** [0.0323]
N	322362	322362	307213	146797	322362
Period 3, Age 49					
RD-Estimate	0.105* [0.0421]	0.0758* [0.0375]	0.0762 [0.0484]	0.115* [0.0492]	0.102* [0.0418]
N	243626	243626	228065	152931	243626
Period 3, Age 54					
RD-Estimate	0.173*** [0.0340]	0.151*** [0.0302]	0.164*** [0.0386]	0.205*** [0.0410]	0.185*** [0.0340]
N	133543	133543	125044	85142	133543
Period 4, Age 45					
RD-Estimate	0.0673*** [0.0201]	0.0657*** [0.0189]	0.0611** [0.0217]	0.0670* [0.0336]	0.0625** [0.0220]
N	289690	289690	276337	132029	289690
Period 4, Age 47					
RD-Estimate	0.120*** [0.0312]	0.108*** [0.0293]	0.0827* [0.0337]	0.206*** [0.0522]	0.142*** [0.0343]
N	280439	280439	267430	126965	280439
Period 4, Age 52					
RD-Estimate	0.101** [0.0341]	0.0883** [0.0333]	0.0995* [0.0388]	0.110 [0.0603]	0.0755 [0.0396]
N	220064	220064	209801	101362	220064
Period 6, Age 50					
RD-Estimate	0.0955 [0.0732]	0.125 [0.0675]	0.0931 [0.0775]	0.168 [0.120]	0.0982 [0.0787]
N	109763	109763	104737	50209	109763

**Notes:** This table provides additional robustness estimates to the RD-estimates in table 2. Column (1) shows the baseline results. Column (2) adds to the baseline controls in a addition 1-digit industry controls, state-Fixed effects as well as calendar month and year FE. Column (3) excludes 3 instead of two months on each side of the cutoff, column (4) changes the bandwidth from 24 to 12 months and Column (5) uses a rectangular kernel. SE are clustered on the ageday level.



**Table G.10: Model Fit In-Sample and Out of Sample**

Panel A: Goodness of Fit (SSE)	Total In-Sample	In-Sample Cohorts			Out-of-Sample Cohorts		
		1929	1935	1950	1924	1945	1952
SSE	20676.1	6812.7	8658.5	5205.0	5552.5	7125.9	4140.3
SSE from E to UI	12647.3	5204.6	4595.8	2847.0	5145.8	2409.3	2574.2
SSE from Dnonemp (uncapped)	8013.8	1608.1	4062.7	2343.0	406.7	4716.6	1566.1
SSE from dDdP	15.0			15.0			
<b>Panel B: dD/dP (target=0.128; age 52 in 1950)</b>							
dDdP at age 50		0.1575	0.1757	0.1241		0.1282	0.1183
<b>dDdP at age 52</b>		0.1792	0.1685	0.1261		0.1384	0.1232
dDdP at age 55		0.2093	0.0807	0.1375	0.2065	0.1319	0.1751
dDdP at age 57		0.1011	0.0442	0.1856	0.1757	0.0817	0.1884
dDdP at age 59		0.0000	0.0000	0.1083	0.0000	0.0000	0.1163
<b>Panel C: Time out of Work</b>							
Time out of work (months), empirical		13.8074	23.1400	12.7511	9.2592	17.5114	10.8200
Time out of work (months), model prediction		12.6359	24.0896	10.4838	8.7094	16.0694	9.3335

Notes: Panel A presents measures of goodness of fit (SSEs) for all in sample and selected out of sample cohorts. Panel B shows the model's estimated  $\frac{dD}{dP}$  at different ages (the targeted empirical moment is 0.128 at age 52 in 1950). Panel C shows the expected time someone is in unemployment (up to age 63), where unemployment is defined as a nonemployment spell that starts with UI. This is not a directly targeted moment, but is constructed from the (targeted) non-employment duration and transition vector

**Table G.11: Parameter Estimates of Baseline Model and Alternative Models**

	(1)	(2)	(3)	(4)	(5)	(6)
	Baseline	Linear Time Trend in Cost $k_2$	No Trend in Cost	No Fixed Cost of UI Entry ( $k_1 = 0$ )	Constant $\bar{\eta}$	Estimate Discount Factor $\beta$
Std. dev. of productivity shock $\sigma$	3.333 (0.037)	3.381 (0.040)	3.391 (0.040)	1.346 (0.013)	5.293 (0.052)	3.221 (0.038)
Fixed cost of job search $k_0$	1.319 (0.009)	1.306 (0.009)	1.268 (0.010)	1.162 (0.006)	0.168 (0.007)	1.287 (0.011)
Cost of UI entry $k_1$	4.409 (0.046)	4.456 (0.119)	4.494 (0.125)		13.186 (0.153)	4.411 (0.048)
Time trend in search cost (exp. or linear) $k_2$	0.228 (0.010)	0.458 (0.023)		0.123 (0.004)	0.066 (0.002)	0.297 (0.014)
Slope parameter of search cost $k_3$	225.7 (6.0)	234.4 (6.9)	703.3 (4.9)	256.7 (7.5)	419.8 (5.1)	178.0 (6.0)
Elasticity of search cost $\gamma$	0.851 (0.007)	0.912 (0.007)	1.032 (0.002)	0.639 (0.009)	0.989 (0.007)	0.822 (0.007)
Discount factor $\beta$						0.937 (0.002)
<b>Parameters of job destruction rate</b>						
$\lambda_1$	-6.601 (0.014)	-6.657 (0.014)	-6.650 (0.014)	-6.353 (0.012)	-6.618 (0.013)	-6.603 (0.014)
$\lambda_2$	0.171 (0.002)	0.177 (0.002)	0.178 (0.002)	0.140 (0.001)	0.176 (0.002)	0.171 (0.002)
$\lambda_3$	0.152 (0.003)	0.149 (0.003)	0.148 (0.003)	0.199 (0.003)	0.144 (0.003)	0.148 (0.003)
<b>Disutility of work distribution (mean: <math>\bar{\eta}</math> and SD <math>\eta_{SD}</math>)</b>						
$\bar{\eta}_{1929}$	-0.113 (0.012)	-0.109 (0.016)	-0.150 (0.017)	-1.114 (0.016)	0.947 (0.010)	-0.076 (0.012)
$\bar{\eta}_{1935}$	0.665 (0.008)	0.675 (0.011)	0.663 (0.012)	-0.298 (0.011)		0.669 (0.008)
$\bar{\eta}_{1950}$	-0.040 (0.016)	-0.045 (0.024)	-0.090 (0.027)	-1.360 (0.022)		-0.001 (0.017)
$\eta_{SD}$	1.269 (0.009)	1.278 (0.010)	1.287 (0.010)	1.605 (0.009)	0.453 (0.007)	1.212 (0.011)
SSE	20679.1	20878.5	22171.8	40171.4	30133.9	20639.4

Notes: The table shows the parameter estimates for the baseline model (column 1) and the alternative specifications in the robustness table (columns 2 to 6). Column (2) estimates the model using a linear time trend in the cost of job search. Column (3) estimates the model assuming no time trend in the cost of job search. Column (4) estimates the model assuming that there is no fixed cost of entering UI. Column (5) imposes a constant mean of the disutility of work  $\bar{\eta}$  across all cohorts (in-sample and out-of-sample). Column (6) estimates the discount factor  $\beta$ .

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