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ABSTRACT

In 1996, Germany introduced the Altersteilzeit (ATZ) law, which encouraged longer working lives through partial retirement incentives. Using matched pension system and establishment survey data, we estimate changes in part-time employment and retirement after ATZ. We find the policy induced growth in part-time work for men and extended men's expected duration of employment by 1.8 years. As the policy evolved to include an abrupt retirement option, the worklife gain for men fell to 1.2 years. Among women, part-time employment grew less and employment duration changed little initially but later declined by 0.2 years when abrupt retirement became available.

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1. Introduction

Population aging has important economic consequences. From 1992 to 2002, the share of older workers in the U.S. labor force increased from 12% to 14% and is expected to reach 26% by 2022 (Toossi 2013). In European countries the situation is more critical because birth rates are among the lowest in the world, life expectancies are among the highest, and trends towards earlier retirement and longer life expectancies exacerbate the demographic transition ("Pensions at a Glance 2013: OECD and G20 Indicators" 2013). From 1965 to 1995, average retirement age for men fell by 4.4 years in Germany as compared to 1.9 years in the U.S. (Gendell 1998).

The aging workforce raises concerns about the solvency of public pension systems and creates a need to explore policy options that may extend working life. Finding cost effective ways to incentivize longer working lives among older workers is one way to ease current demographic pressures (Maestas and Zissimopoulos 2010).To encourage later transitions out of working life, some countries have created incentives for partial retirement with the aim of postponing full retirement. Recently, average effective retirement ages have risen in many European countries and partial retirement may have played an important role in enabling longer work lives (Comeau and Latulippe 2015). Yet, these policies may instead crowd out years that would have been spent in full time employment, without postponing retirement (Gustman and Steinmeier 2008). To date seven European countries have enacted partial retirement policies, but there are few rigorous empirical studies of their effects (Eurofound 2014).[1] In this paper we investigate Germany's partial retirement policy.

[1]Some European articles call these "progressive retirement policies" (Eurofound 2014). These are separate from partial pension policies, which allow workers who have reached pensionable age to continue working and receive a portion of their pension benefits if earnings remain below the "earnings test" threshold.

Studying German policies, as we do here, is especially important because Germany is "the first and biggest test" of the effects of population aging (Elliot and Kollewe 2011). Germany's population aged 15 to 64 is projected to fall 23 percent by 2050, compared to an overall population decline of 13 percent (Fuchs, Söhnlein, and Weber 2008). Germany's demographic challenges have been featured in the U.S. media because the U.S. is projected to face similar challenges in the future (Daley and Kulish 2013). In addition, as the largest economy in Europe, Germany's continued economic success is critical to Europe and the global economy.

We examine changes in part-time employment and retirement associated with incentives for partial retirement introduced in Germany through the 1996 Altersteilzeit (ATZ) policy. ATZ set compensation floors for partial retirees, aged 55 and older, and provided subsidies to employers if they replaced partial retirees' work hours by hiring unemployed workers or trainees. Our information comes from a particularly rich source of matched employer-employee administrative data: the Linked Employer Employee Data of the Institute for Employment Research (LIAB). The LIAB offers the unique advantage of matching survey data from a national stratified random sample of German establishments to social security records for *all* establishment employees covered by the social security system. We estimate changes in part-time employment and retirement hazard rates in a difference-in-differences framework using before and after policy variation and exploiting the age cutoff of 55.

The estimates suggest that the ATZ policy was initially successful, especially for men. It was associated with large increases in part-time employment among 55-61 year old males, with a peak increase of 20 percentage points at age 61. Since this growth largely occurred among persons who would have otherwise been retired, male worklives were extended by 1.8 years, and full-time employment by 0.8 years. In combination, these results indicate that the

policy significantly increased working time among 55 to 65 year old men. Conversely, there were no important changes in worklife duration among women. However, as the ATZ policy evolved, many men and women were able to use an increasingly expansive definition of partial retirement to achieve earlier abrupt departures from work while technically remaining employed, as described below. Once these opportunities became popular, the average worklife extension of males fell to a (still substantial) 1.2 years, but females worked 0.2 fewer years, and full-time 1.2 years less than before the ATZ policy was implemented. These disparate results point to the importance of careful policy design which focuses on the incentives inherent in specific aspects of the programs implemented.

2. The ATZ Policy

Early retirement was very common in Germany in the early 1990s. Between 1993 and 1995, approximately 25% of men left the labor force by age 56 between 1993 and 1995 (Borsch-Supan and Schnabel 1997). A common path for these retirements involved an abrupt transition from full-time work to retirement, supported through the unemployment insurance system, and then followed by the claiming of Old Age pensions. In the 1990s, Germany (as well as many other developed countries) addressed the unsustainable early retirement patterns by raising pensionable ages and reducing access to unemployment insurance. Germany also introduced incentives for gradual, later, transitions from working life to retirement through the ATZ policy.

ATZ had three goals. First, it was intended to promote gradual transitions between work and retirement. The second was to extend working lives by offering an alternative to abrupt (early) retirement. Third, it was intended to encourage the employment of unemployed workers and trainees as older persons retired. We examine the extent to which the ATZ achieved the first two of these objectives.

To accomplish these goals, the law set compensation and pension contribution floors for partial retirees, aged 55 and older, who reduced work hours by 50% over a 3 to 10 year period and had worked at least 1,080 days in the previous 5 years in jobs covered by the social security system (though not necessarily all with the same employer). Specifically, ATZ required partial retirees be paid at minimum 70% of prior (pre-partial retirement) earnings and pension benefits accrue at a minimum of 90% of the rate obtained under full-time work. Also, wage earnings in excess of 50% of prior earnings were exempt from income taxes. ATZ participants were eligible for full Old Age Pension benefits at age 60.[2] While this seems too early to promote extensions of working lives in the current German context, the modal retirement age in Germany when the ATZ was introduced was 58.

Finally, ATZ made federal subsidies available to help employers meet the new compensation floors. These subsidies were equivalent to 20% of former full-time wages and 40% of full-time pension contributions, but were only paid if employers replaced partial retirees' hours by hiring an unemployed worker or trainee. In practice, few employers applied for subsidies and anecdotal evidence suggests that employers offered ATZ opportunities without subsidization because it was a legal way to reduce workforce and manage demographic transition (Schmähl 2003).

The effects of ATZ were not immediate because the policy required employers and employees to establish agreements that outline the terms for partial retirement arrangements, usually as part of a collective agreement. Collective bargaining in Germany generally takes place regionally at the industry level and approximately 58% of the workforce is covered by collective agreements (Peter

[2] After an amendment passed in 2004, the pensionable age gradually increased to 65.

Ellguth and Kohaut 2015). In many industries, the pay and pension contributions negotiated exceeded the ATZ minimums.[3]

Six other European countries have laws similar to Germany's ATZ, and three others have institutionalized corresponding incentives through the collective bargaining system (Eurofound 2014). Existing studies suggest the effects of partial retirement policies on part-time employment vary from country to country. Some previous investigations of Germany's law found little or no effect on part-time work because the number of subsidies paid to employers was quite low (Trampusch 2005). Yet, other studies indicate the majority of partial retirements were not subsidized , and so are not captured by looking only at subsidy payments (Brussig, Knuth, and Wojtkowski 2009). Using German data , Wanger (2010) reports approximately 16% of all newly retired individuals were ATZ participants. Huber, Lechner, and Wunsch (2013) estimate workers ages 51 to 60 in firms that offered partial retirement opportunities spent an average of 6 to 9 months more in part-time employment than those in firms that did not.

Policies permitting work hours reductions to be made across months or years (like Germany's did) were more popular than those requiring decreases on a daily or weekly basis (Latulippe and Turner 2000). However, such flexible policies also created a loophole leading to de facto early retirement arrangements that qualified for partial retirement incentives. For example, an employee who continued to work full-time for 1.5 years and not at all for the next 1.5 years would meet the ATZ requirement of a 50% reduction in working time over a minimum of 3 years. In Germany these were known as Block Model arrangements. Critics argued that the use of ATZ for Block Model arrangements subsidized early abrupt transitions from work rather than encouraging gradual

[3] Appendix Table A2 contains the dates and compensation amounts for partial retirement clauses negotiated during our study period.

later retirements as desired, but to our knowledge there has been no formal empirical evaluation of these claims (Schmähl 2003).

Previous studies provide conflicting evidence about whether partial retirement incentives extend working life. Sunden (1994) and Wadensjö (2006) concluded that Sweden's program led to a net increase in labor supply among older workers. Conversely, Graf, Hofer, and Winter-Ebmer (2011) found that Austria's partial retirement policy primarily crowded out full-time employment, resulting in a net reduction in labor supply. Estimates of Germany's ATZ policy are also conflicting. Brussig, Knuth, and Wojtkowski's (2009) descriptive analysis of retirement behavior among ATZ participants in Germany indicated the average age at retirement among participants was above that of non-participants. Using the same data as in this paper, and analyzing firms introducing partial retirement agreements between 2000 and 2002 in response to ATZ, Huber, Lechner, and Wunsch (2013) found that workers spent less time unemployed before retiring when their firm offered partial retirement opportunities, but that they used Block Model arrangements to end work as early as others had before ATZ.[4]

We contribute a new analysis of the ATZ policy that differs from existing studies in four key ways. First, we define (part-time) partial retirement broadly to include all part-time work, whereas many previous estimates were restricted to federally subsidized arrangements, few of which were part-time models. Second, we analyze a representative sample of establishment employees 50 to 65 years old over the 1993 to 2004 period. This allows us to include early and later adopting firms in our analysis. Third, we model age-specific policy effects for workers age 50 through 65 years old before and after ATZ, permitting a careful examination of trends in behavior below the age 55 threshold and prior to the policy, as well as

[4] Their analysis pools policy effects across workers ages 51 to 60 and excludes firms that reached agreements prior to 2000, which as shown in Appendix Table A2 includes a substantial number of industries. As shown below, the Block Model was less important in the earlier years of the ATZ than in the period they study.

impacts of the policy up through the statutory retirement age. Modeling age specific effects in this way is important because many firms rationed partial retirement opportunities so that the average age of entry was 57 (Caliendo and Hogenacker 2012), and the policy effects may persist beyond age 60. Fourth, we separate the post ATZ period into years before the Block Model was widely used and years after. Separating the post policy periods allows us to simulate how the policy may have affected labor market behavior if the Block Model had not become the dominant form of partial retirement.

3. Data and Empirical Strategy

Our analysis sample is drawn from the Linked Employer Employee Data of the Institute for Employment Research (LIAB) cross-sectional model.[5] The LIAB links establishment survey information to individual employment spell data using social security records for *all* employees covered by the social security system and employed in a surveyed establishment on June 30th of each year.[6] Approximately 80% of the German workforce is subject to social security; excluded categories include civil servants, family workers, and marginal workers.[7] The data span 1993 through 2010. Employed individuals in sampled establishments and job seekers are included in the data; retirees are not.

The establishment sample is designed to be representative of the German economy in each year within establishment size (employment), industry, and the state (*Bundesland*) strata. The data contain survey responses from 4,000 to 14,000 establishments per year linked to employment spell data for between 1.6 and 2.6 million individuals.

[5] Detailed information about the LIAB cross sectional model and associated data sets is available in (Heining, Scholz, and Seth 2013).

[6] Other linkages are available but this "cross sectional model" is based on a stratified random sample of surveyed establishments and was chosen for this study to produce representative estimates of the policy.

[7] Marginal workers are persons with temporary employment contracts whose earnings through the marginal employment job fall below legislated thresholds. They are exempt from many of the employment protection and mandated benefits policies in Germany.

3.1. Analytic Sample

Our analytic sample contains data from 1993 through 2004 for 50 to 65 year olds. We exclude years after 2004 because stepwise increases in pensionable age for partial retirees were announced in 2004, and the data suggest dramatic changes in partial retirement participation in response to them. We end the analysis at age 65 because so few older individuals remain in the labor force.[8] We include 50 to 54 year olds to allow for changes in employment behavior below the ATZ eligibility threshold since these may influence our interpretation of policy estimates among 55 to 65 year olds. Employment information for East German establishments is provided from 1993 onward and so both East and West German establishments are included in our analysis, with the state in which the establishment is located controlled for in all specifications (Heining, Scholz, and Seth 2013).

The LIAB is organized as spell data.[9] We retain all spells of employment and partial retirement for workers ages 50 to 65 and convert the data to a panel of person-year observations. In doing so, we lose some information about the specific timing of retirements, but this is necessary because employers only report work schedule information on the annual notification, as detailed below. In cases where an employee is employed in more than one establishment in the same year, we include information from the longest spell only.[10] With these restrictions, our

[8] The number of person-year observations in our data at age 65 is approximately 7% of the number at age 60. At age 66, it falls to 0.8%.

[9] In the cross-sectional model, administrative information from social security records for all employment spells that include June 30th of each calendar year are included on the file. Each observation in the data set refers to a separate spell of employment. Multiple spells per person per year are possible, for example multiple job holders and employees who change jobs will have multiple spells. Detailed information about the cross-sectional LIAB are provided in Heining, Scholz, and Seth (2013)

[10] Multiple spells are not common in our study population – for example, less than 3% of spells were excluded for this reason in 1993.

analytic sample contains 3,643,954 person-year observations of men and 1,920,232 of women.

3.2. Construction of Dependent Variables

We focus on two binary dependent variables: part-time employment and retirement. These measures are created from the notifications employers are statutorily required to provide to the social security system. Employers report part-time work on an annual basis. They do not provide precise work hours, but rather indicate: a schedule that is less than usual full-time hours but is at least 50% of them; or a schedule that is less than 50% of usual full-time hours. Our measure of part-time employment is equal to zero in all years employees are reported as working full-time and one when working either of these part-time schedules. We do not distinguish between the two part-time schedules because ATZ allowed for a wide variety of work arrangements. Restricting focus to arrangements where employees work less than 50% of weekly full-time hours might exclude some portions of partial retirement spells and obscure the timing of policy responses. It is also worth noting that Block Model participants are always coded as zero, for this variable, because they never reduce work hours.

Retirement is defined using the notifications employers are required to file at the end of an employment relationship. We construct a variable equal to zero in all calendar years until an end of employment notification is filed and one in the year it is filed. Because individuals are only included in the LIAB while employed in sampled establishments, they are no longer in the data after this point unless they happen to be re-employed in another sampled establishment. Thus, end of employment need not coincide with Old Age Pension claiming, since some individuals could take a new job in an establishment outside of the sample or postpone pension claiming. This is unlikely to be a major concern. Although the data do not contain information on pension benefit receipt; in our analytic sample, observations of workers in their first year of employment with an establishment

constitute only 2% of person-year observations among individuals 50 and above, suggesting that few older persons start new employment (rather than retiring) after ending a job.

Block Model participants are classified as employed during the Release Phase, even though they are no longer working. Our retirement measure is equal to zero until the last year of the Release Phase to reflect the continuation of the employment relationship. However, as explained below, we also adjust simulated survival rates to produce survival functions that exclude Block Model Release Phase participants, so as to differentiate between end of employment and end of work.

3.3. Construction of the ATZ Policy Variable

Although the ATZ was introduced in 1996, and the compensation floors took effect then, participation was very low until 1999. Figure 1 plots the ratios of daily wages received in the first year of a part-time employment spell to the full-time daily wage earned in the prior year. There is a discrete change in 1997, consistent with the wage floors introduced in the law. Yet very few people began partial retirement prior to 1999 because industries seldom had partial retirement clauses in place before 1998. Table 1 reports the month and year clauses were introduced into the collective bargaining contracts of selected major industries. Appendix Table A2 provides the same information for a broader group of industries, along with details about the terms negotiated. Our analysis of collective bargaining agreements revealed that several industries negotiated compensation above the ATZ floors, which explains why the ratio of part-time wages to prior full-time wages in Figure 1 exceeds the federally required 0.7. Figure 2 plots the trends in flows into part-time employment above and below the age 55 threshold. The trends remain parallel until 1999, which suggests there was no anticipation of enactment of the law and little effect for the first two years after enactment. Figure 2 also shows that Block Model participation was negligible

prior to 2002, but grew rapidly thereafter. There was no change in the original law. Instead, the Block Model interpretation of the ATZ work hours requirements evolved primarily through the collective bargaining process and was not widely applied until after 2001.

Given these institutional details and corresponding trends observed in the data, our policy variable is constructed to reflect three distinct periods. We define 1993 through 1998 as the pre-ATZ period to reflect delayed implementation, 1999 to 2001 are "low Block Model" years, and 2002 through 2004 are "high Block Model" years. Although, as shown in Figure 2, the share of new entrants using the part-time model began to fall in 2001, Block Model participants constituted only 3% of all workers and 10% of partial retirees in 2001, and these shares rose to 7% and 17% by 2002.[11] Distinguishing between high and low Block Model periods allows us to examine the likely effects of a partial retirement policy on retirement and simulated employment durations with and without the Block Model option. We also test the robustness of our findings to excluding years 1996 through 1998 from the analysis, but given the pre-trends in part-time employment displayed in Figure 2 our preferred specification includes these years in the pre-ATZ period.

3.4. Empirical Strategy

We estimate employment effects of the ATZ policy using a difference-in-differences framework. Specifically, our control group consists of 50-54 year olds, who are not directly affected by the program, while 55-65 year olds are the treatment group. We compare changes in part-time work and retirement rates for the baseline (1993-1998) and two post-policy (1991-2001 and 2002-2004) periods. As mentioned, effects in the two post-implementation periods could differ because Block Model arrangements were rare in the earlier one but more widely available subsequently.

[11] Author's calculations. Partial retirees include all part-time workers ages 55 to 65, including those that are not federally subsidized.

Effects of the ATZ policy may differ by age. The policy permitted partial retirements as brief as 3 or as long as 10 years, and allowed persons ending partial retirement spells to claim full old-age pension benefits at age 60. Therefore, the greatest incentives for part-time employment might occur at or near age 57 (three years prior to age 60). However, establishments were permitted to cap the share of the workforce that could be partially retired. If these opportunities were provided based on worker seniority, some workers might first qualify at ages above 57 and they might then delay retirement past 60.

We allow effects of the ATZ to vary flexibly with age by interacting the policy treatment-effects with individual age dummy variables, so that our differences-in-differences estimation equation is:

$$\begin{aligned} Prob\left(E_{ift} = 1 \middle| X\right) \\ &= f\left(b_0 + b_1 Policy1_t + b_2 Policy2_t + b_3 Age_{it}\right. \\ &+ b_4 Policy1_t * Age_{it} + b_5 Policy2_t * Age_{it} + b_5 Indiv_{it} \\ &\left. + b_6 Estab_{ft} + \varepsilon_{ift}\right) \end{aligned} \quad [1]$$

In Equation [1], *E* is one of our two dependent variables - part-time employment or retirement, *Indiv* and *Estab* refer to individual and establishment characteristics, *Policy1* and *Policy2* to the low Block Model and high Block Model periods, Age_{it} is a vector of age dummy variables (with age 50 as the excluded reference category), ε is an error term and the subscripts *i, f* and *t* index the individual, establishment and year. When estimating Equation [1] with our part-time dependent variable, the coefficient estimates are interpreted as changes in part-time employment rates. When retirement is the outcome, Equation [1] becomes a discrete time hazard model and the coefficient estimates indicate

changes in retirement hazard rates. All changes are relative to age 50 and the pre-ATZ period 1993-1998.

The vector of individual characteristics, *Indiv*, includes age, educational attainment, establishment tenure, and experience (since 1975 for West Germans and 1990-1992 for East Germans), individual-specific statutory pensionable ages, and the statutory ages for claiming early old-age pensions due to disability, long term unemployment, or long service history. All statutory pensionable ages were increasing during our study period as explained in the Section A1 of the Appendix.[12] Our preferred specification omits controls for individual occupation and daily wage because these are less plausibly exogenous than other personal characteristics, but we conduct robustness checks with these covariates included and results do not change materially. *Estab* includes the following time varying covariates measured June 30th of each calendar year: total number of employees in the establishment, the proportions who are trainees and employed part-time, total establishment revenue in Euros, and vacancies. *Estab* also includes 17 industry dummy variables, and German federal state dummy variables corresponding to the location of the establishment.

We stratify our estimates by gender, reflecting the very different rates of part-time employment prior to ATZ: only 1% of men in our sample were working part-time in 1993-1998 as compared to 31% of women. Pensionable ages also differ for men and women during the study period and the attractiveness of ATZ arrangements may depend on one's opportunities for abrupt retirement. Additionally, employment across industries differs by gender. ATZ was primarily implemented through the collective bargaining process which, in Germany,

[12] As in the U.S., Germans may access reduced benefit pensions early or full benefits at the pensionable age. We control for both ages in the analysis. These ages varied by birth month and gender, and changed during our analysis period as documented in Appendix Table A1. Disabled persons, the long term unemployed, and those with 35 of service had access pensions at younger ages. These ages were also changing and are controlled for in our analysis.

generally produces industry level agreements. Many of the earliest partial retirement clauses were enacted in male dominated industries (see Table 1).

We estimate Equation [1] using Probit estimation, with heteroskedasticity robust standard errors clustered at the establishment level. Results are reported as percentage point changes in part-time employment or retirement hazard rates, computed as the mean of the individual marginal effects.

3.5. Simulated Employment Survival Rates and Durations

We simulated the effects of ATZ on duration of working lives as follows. First, we take the vector of actual hazard rates in 1993-98 at ages 55 to 65 and calculate the baseline survival function as:

$$S_{j0} = S_{(j-1)0} * (1 - h_{j0}) \quad [2]$$

where S_{j0} and h_{j0} are baseline employment survival and hazard rates at age j. Next, we compute hazard rates in the two post-policy periods by adding to the baseline hazard rates the regression-adjusted estimates of the change at each age and post-policy period attributable to ATZ:

$$h_{jp} = h_{j0} + \Delta h_{jp} \quad [3]$$

where p refers to the post-AZT period and Δh_{jp} is the estimated change in the hazard rate. Survival rates are then calculated analogously to equation [2] and the computed survival rates are used to estimate changes in the duration of employment, D_p, relative to the pre-ATZ period as:

$$D_p = \sum_{j=55}^{65} \left(S_{jp} - S_{j0}\right) \quad [4]$$

where S_{jp} is the computed survival rate at age j for time period p, one of the two post-ATZ time periods (1999-2001 or 2002-2004) and S_{j0} is the corresponding survival rate during the pre-policy period (1993-1998).

To compute full-time employment survival functions and changes in the duration of full-time work we use actual pre-ATZ part-time employment rates at

each age in 1993-1998, and add to them the vector of estimated changes attributable to ATZ in each post policy period to compute part-time employment rates:

$$p_{jp} = p_{j0} + \Delta p_{jp} \quad [5]$$

We then subtract the vectors of part-time employment rates in each period from the computed survival rates to obtain the full-time employment survival rates, F_j, and also subtract the share of workers in Block Model Release Phase, R_{jp}, at each age to ensure F_{jp} captures only those who are actually working. Prior to 2002-2004, R_{jp} are all zero.[13]

$$F_{jp} = S_{jp} - p_{jp} - R_{jp} \quad [6]$$

Changes in the duration of full-time work, W_p, are computed as:

$$W_p = \sum_{j=55}^{65} \left(F_{jp} - F_{j0}\right) \quad [7]$$

4. Descriptive Statistics

Table 2 contains selected descriptive statistics for our analytic sample by time period and gender. Several of the descriptive statistics are noteworthy. First, as mentioned previously, women have much higher rates of part-time employment than men (31% versus 1% in 1993-1998 in the pre-ATZ period), while the increase in part-time work following enactment of ATZ is larger in both absolute and percentage terms for males. Annual retirement hazard rates fall by similar amounts for both genders in the post-ATZ period.

The experience and establishment tenure figures on the table are understated because they are measured beginning in 1975 for West Germans but only since 1990-1992 for East Germans. The regressions control for the German

[13] In the actual data there are so few cases of Release Phase in the 1999-2001 period that actual shares could not be released through data disclosure.

state to account for the differences in tenure measures and other state specific unobservable factors. Average establishment size is smaller among women than men, possibly leading to more limited partial retirement opportunities.

5. Econometric Results

For brevity and ease of interpretation, we present most key econometric results graphically. However, Appendix Section A3 provides all information in the graphs in tabular form, as well as regression coefficients for the supplementary covariates.

5.1 Part-Time Employment

Figures 3A and 3B plot the marginal effects after Probit estimation of Equation [1] with the part-time employment dependent variable. The estimates suggest part-time employment rates rose for both men and women during the post-ATZ period, but not uniformly. The increases begin at age 55 for males and slightly earlier for females, and then peak at age 60 or 61 for both. For men, the estimated increase at age 60 is around 17 percentage points in the 1999-2001 period, versus approximately 10 points for females. As suggested by the descriptive statistics, estimated changes in part-time employment are generally smaller for women than men. Prior to age 55, male part-time employment rates were similar in the pre- and post-ATZ periods – the estimated differences are all smaller than 0.1 percentage point although, given our large sample sizes, still statistically significant – implying that there were no important changes in part-time employment patterns among younger men, and that the estimated increases at age 55 and above are likely attributable to the policy. Conversely, part-time employment did increase among younger women, raising the possibility that some of the growth observed after age 55 higher ages might be attributable to secular trends, rather than the ATZ. This further supports the conclusion that men's part-time employment rates increased more than women's.

Among men, there are few significant differences in estimated effects between 1999-2001, when Block Model arrangements were rare, and 2002-2004 when they were widely available. For women, the results often vary across the two periods, with the estimated increases in part-time employment generally being higher in 2002-2004 than 1999-2001, especially at ages 60 and above. So, although Block Model was more widely available in the second period, we do not find a dramatic decline in part-time participation.

It is interesting that part-time employment rates do not peak until close to or even after age 60 for both men and women, given that partial retirees could retire with full pension benefits at age 60. A potential explanation is that some individuals may not have begun partial retirement in time to complete the minimum three year spell by age 60. This could reflect poor planning on their part. However, an alternative explanation is employer rationing of partial retirement arrangements, which seems plausible since many collective bargaining agreements contained explicit caps on partial retirement participation of 3% to 8% of the workforce (Eurofound 2014).

5.2 Retirement

The ATZ-induced increases in part-time employment identified above reflect some combination of reductions in full-time work and increases in part-time job-holding among persons who would otherwise have been retired. Here, we examine the latter, Figures 4A and 4B show the estimated changes in age-specific annual retirement hazard rates and reveal striking differences by gender. Among men, the estimates imply a discrete drop in retirement likelihood between age 55 and 59 in both post-policy periods. Although part-time employment rates remained high after age 60, the retirement hazard rates are not statistically significantly different from pre-ATZ levels at ages 60 or 61. So, it appears any delay in retirement attributable to ATZ occurred before age 60. For women, we find little evidence of a change in retirement behavior prior to age 60 in either

post-ATZ period. Interestingly, fewer women retired at age 60 in the post-policy periods but more retired at age 61.

To more directly assess how ATZ may have changed the expected duration of working life, Figures 5A and 5B plot the simulated employment survival rates computed from our hazard rate models using Equation [2]. For the 2002-04 period, when use of the Block Model had become common, we calculated employment survival in two ways. The first treats participation in Block Model Release Phase as a continuation of employment, since the individual formally remained attached to the employer. The second treats these persons as retired, since they were no longer at work.

The simulations imply men were substantially more likely to be employed between ages 55 and 59 in both post ATZ periods. When persons in the Block Model Release Phase are treated as employed, the worklife extensions are virtually identical in 1999-2001 and 2002-2004. With the Block Model Release Phase treated as retirement, the probability of continued work is lower in the later post ATZ period but still remains above baseline levels. The estimated ATZ effects on employment survival diminish after age 60, as suggested in the hazard rate analysis, but remain above pre-policy levels through age 65.

The results for women are quite different. In our main estimates, there is little observed ATZ effect on employment continuation rates in either of the post-policy periods, except for a modest increase in survival probabilities at age 60 and 61. However, since a substantial number of 55-65 year old women were in Block Model arrangements in 2002-2004, treating those in the Release Phase as retired implies lower employment survival rates in these years than before the policy.

To further interpret these patterns, Table 3 reports changes in expected employment durations implied by the simulated survival rates, computed using Equations [4] and [7]. Based on these estimates, the expected duration of male employment was 1.8 years longer in the early years of the policy and 1.9 years

longer when Block Model because widely available, treating Release Phase as continued employment. Also, the amount of time spent in full-time employment increased by 0.8 years. This last result may have occurred because employers rationed partial retirement opportunities. Under rationing, some employees might prefer extend the duration of full-time work, so as to qualify for a partial retirement arrangement, rather than retiring early and abruptly. When treating time in the Block Model release phase as being retired, the expected duration of working life in 2002-2004 is just 1.2 years longer than at baseline and the duration of full-time work is 0.2 years longer.

Women's employment duration changed less than men – rising 0.3 years in the low Block Model years and 0.2 years in the high Block Model years, treating Release Phase participants as employed. However the duration of employment *fell* 0.2 years if workers in the Release Phase were counted as retired. Women were estimated to spend less time in full-time employment in both post-periods. From 1999-2001, the predicted reduction in full-time work was only 0.1 years which, when coupled with a 0.3 year estimated increase in employment duration, suggests women's total hours of work increased.

To summarize, the ATZ policy appears to have extended the worklives of men and women and led to a net increase in hours before the Block Model became popular, though this increase was markedly larger among men than women. When the Block Model option became available, women used it to stop working earlier than they otherwise would have, while men continued to work longer than prior to implementation of the ATZ, but less so than when the Block Model had been unavailable.

5.3 Robustness Checks

We also tested how the ATZ affected durations of employment and work using a variety of alternative specifications. The results are summarized in columns (2) through (6) of Table 3. In column (2) controls for individual wage

and occupation were included as supplementary controls.[14] Second, we excluded the period between the passage of ATZ and effective date (1996 to 1998). Third, we restricted the analysis to a subset of industries for which we were able to obtain information about collective bargaining agreements. For this subsample, we use the dates when partial retirement clauses were introduced to define the pre and post policy periods. Fourth, we restricted the sample to persons employed within the establishment since age 50, in order to limit potential selection into (or out of) establishments. Fifth, we added establishment fixed effects to the baseline model.

Across these alternative specifications, we consistently find evidence of longer employment durations among men. In all but one specification (with controls for wage and occupation included), we also find that ATZ led to a net increase in male lifetime work hours in both post policy periods. The magnitude of the estimated durations change substantially when omitting 1996 to 1998 from the sample or using collective bargaining agreement dates, but all other estimates of employment duration remain reasonably close to the baseline estimates. Conversely, the results are much less robust to changes of model specifications for women, but all of the estimates indicate earlier departures from the labor force once the Block Model became available.

6. Discussion and Conclusion

This paper investigates whether incentives for partial-retirement introduced through Germany's federal ATZ policy successfully promoted gradual transitions to retirement and longer working lives. Among men, our findings suggest the policy did work as designed. ATZ was associated with substantial increases in part-time work and reductions in retirement hazard rates that translated into a 1.8 year extension in the expected duration of employment.

[14] These variables were originally excluded from Equation [1] because they might be correlated with unobserved attributes like productivity or labor force attachment.

When the Block Model option, which amounts to a form of early retirement, became available, the ATZ-induced extension of average male working lives fell to around 1.2 years because many men remained employed but did not work during the Block Model Release Phase. Nevertheless, even in this period, our analysis suggests that the ATZ led to a net increase in lifetime hours of work among men.

For women, the results are more difficult to interpret. We do find increases in part-time work among older women but cannot be sure they are attributable to the ATZ policy, because part-time employment also increased for those too young to reduce work hours through the program. Overall, we find little change in women's expected duration of employment, during the early ATZ period, and a 0.2 year reduction in work and a 1.2 year decrease in full-time employment once the Block Model option became available. The divergent responses to ATZ by gender may reflect: differences in the initial prevalence of part-time work, in implementation of the ATZ across male and female dominated industries, and in pension rules or in preferences.

Introduction of the Block Model option provided a unique opportunity to assess how responses to partial retirement incentives change when early abrupt retirement is made available with the same compensation. Among 55-59 year old men ages, part-time employment rates did not change between the 1999-2001 and 2002-2004 periods. Rates were statistically significantly lower among men aged 60 and 61 in the later time span, but still over 10 percentage points above pre-ATZ levels. Women's rates of part-time employment were higher in 2002-2004 than 1999-2001. Both results suggest that gradual reduction of working time was still attractive to many older workers even when early retirement through the Block Model was feasible. This raises the possibility that partial retirement incentives may be successful in promoting gradual transitions from working life even in institutional environments with generous early retirement opportunities.

Previous studies note the most popular partial retirement policies have flexibly defined work reduction requirements to allow part-year schedules or in the extreme, Block Model arrangements (Latulippe and Turner 2000). Our findings suggest that such flexibility may come at the cost of reduced effectiveness in promoting longer working lives. The introduction of early retirement opportunities through the Block Model was associated with earlier departures from work for males than the policy as originally implemented. Among women, it was associated with earlier departures than in the pre-policy period. Nonetheless, employment relationships still lasted longer in the high Block Model period than in the pre-ATZ period, especially among men.

Although we cannot directly compute the actual net costs of the policy, we can use the estimates we have produced to estimate that likely net cost or savings for a representative partial retiree and extrapolate using information from prior studies. The costs of the policy included subsidies paid, any net loss of tax revenue from reduced hours work, and the marginal increase in pension benefit entitlements from postponement of retirement. Using a representative worker with wage earnings equal to the 2004 national average of €38,100, the total subsidy paid per year of partial retirement would be €12,908 (Boss and Elendner 2005; OECD - Social Policy Division 2015).[15] In our data the average duration of partial retirement was 3 years, which implies the total subsidy cost for a subsidized arrangement would be €38,724. Prior studies estimate between 10 and 20 percent of ATZ arrangements were subsidized, depending on the year (Brussig, Knuth, and Wojtkowski 2009). Assuming 20 percent were subsidized, the expected total subsidy cost per partial retiree would be approximately €7,745.

[15] Average earnings figure is from OECD (2004). Subsidies provided 20% of former full-time earnings and 40% of former pension contributions. 20% of average earnings is €7,620. Assumed pension contribution rate is 35.7% based on Boss and Elander (2005), so the pension contribution subsidy amount is €5,288. These figures also correspond with the annual cost per subsidized participant implied by administrative data from the Federal Employment Agency reported in Huber, Lechner, and Wunsch (2013).

The simulated employment and full-time work durations, from our preferred specification for the low Block Model period (1999-2001), imply a net gain in income tax revenue among men of approximately €7,500 per male partial retiree and €160 per female.[16] Previous studies indicate 56% of partial retirees were male, so the average gain in tax revenue is approximately €4,270 per partial retiree (Huber, Lechner, and Wunsch 2013). Using simulated durations from the high Block Model period (2002-2004), the tax savings falls to an average of €470 per partial retiree. Working longer increases the pension benefit received when retired, but accrual is 10% lower during partial retirement. In total, the hypothetical male partial retiree would earn a net increase in annual pension benefits of approximately €560 associated with 2 years of additional years of work, which over a 20 year retirement is approximately equivalent to €7,870 in present value terms.[17] Gains for females are negligible because the estimated increase in years of work is so small, so the average additional pension costs per partial retiree are €4,400.

Because ATZ led to a postponement of retirement, it also created savings to the pension system. During this time period, most early retirees used unemployment insurance benefits equal to 60% of former net earnings, for up to 960 days, to bridge the period between the end of work and claiming of an Old Age Pension ("Social Security Programs Throughout the World: Europe, 2004 - Germany" 2015). Assuming that unemployment benefits would have otherwise been claimed, a 1.8 year extension of working life would have saved the unemployment insurance system approximately €41,150 for the representative male partial retiree, and a 0.3 year extension saves approximately €6,860 for the

[16] Calculations assume €38,100 in annual full-time wage earnings for both men and women, a marginal income tax rate of 24.5 percent income earned beyond 50 percent of full-time earnings, and an average annual tax rate of 11 percent when working part-time (Boss and Elandner 2005).
[17] Figures are based on the 2004 pension value reported in "Social Security Programs Throughout the World: Europe, 2004 - Germany" (2015) and assume a worker with an average earnings history works 2 additional years and receives 90% of full-time benefits.

representative female. So the expected savings to the unemployment insurance system per partial retiree is approximately €26,000 in the low Block Model period. Using the same calculations with high Block Model period simulated durations of employment, the savings is €26,300 per partial retiree.

In total, these calculations imply an average net savings per partial retiree of €18,125 in the low Block Model period and €17,625 in the high Block Model period. Wanger (2010) reports approximately 500,000 partial retirees in 2004, which using these calculations imply a total savings of €9.1 billion attributable to that cohort alone if the policy had continued to operate as it did in the low Block Model period. Using the high Block Model figures, the estimated savings is €8.8 billion. So, although ATZ may not have achieved the aim of promoting actual gradual transitions from work as effectively after the Block Model was available, it likely still created a substantial net savings.

Notably, the savings in unemployment insurance benefits is responsible for the large estimated gains in both periods. In environments with less generous unemployment benefits, or where workers were not originally financing early retirements with public benefits, the savings from partial retirement may be much smaller or even negative. Also, if all partial retirees had been subsidized the policy may have led to a net loss. However, the subsidies were contingent upon the employment of an unemployed worker or trainee to fill the reduced hours, and our calculations do not account for unemployment benefit savings or additional tax revenue associated with hiring these workers.

The extensions in employed life attributable to ATZ, among men, appear large when compared to the corresponding effects from increasing the normal retirement age, another common policy for extending worklives. For example, Gustman and Steinmeier (1985) estimate the percentage of the labor force retiring at age 65 will fall by 6.3 percentage points when the increase in normal U.S. retirement age from 65 to 67 legislated in 1983 is fully phased in. For comparison,

our estimates imply the percentage of men who retired at age 55 fell by 8 percentage points in 1999-2001, and the percentage who retired between ages 55 and 59 fell by 24 percentage points.[18] Among women, however, our estimates imply that retirement probabilities between 55 and 59 fell by only 3 percentage points.

Because few employers took advantage of ATZ subsidies it may seem that the results of the policy could have been achieved without the policy. Yet, finding ways to manage demographic transition in the workforce that do not violate age discrimination protection can be difficult for employers. For example, this is the reason that U.S. employers define eligibility for buyouts based on tenure rather than age. ATZ offered German employers a way to legally target a specific age group for transition out of the establishment when pension system reforms had increased statutory retirement ages and made buyouts or other mechanisms more expensive.

Our analysis is subject to several limitations. First, although we have attempted to parse out the effects of pension reforms occurring at the same time as the ATZ policy, the relationship between these reforms and labor supply could be complex such that our estimates may misattribute some of the effects of the pension reforms to ATZ. We believe this is unlikely because we find very small changes in employment durations among women. Women experienced the same changes in statutory ages of eligibility for Old Age benefits due to unemployment and disability as men did and their age of eligibility for regular access to Old Age benefits increased from 60 to 65 whereas men's remained at 65. Second, as mentioned, individuals leaving a sampled establishment will generally no longer be observed in the data, so we are unable to examine retirement transitions that

[18] Probabilities computed by multiplying estimated hazard and computed survival rates for each age. Our simulations imply a 16 percentage point decline in retirement probabilities between ages 55 and 59 and a 20 percentage point decline in 2002-2004.

involve job changes. However, we have also provided evidence (the small number of person-year observations in their first year of employment) that this limitation is likely to minor. Third, we do not observe exact hours of work, limiting our ability to quantify changes in hours of labor supplied implied by our analysis. We also miss partial retirements occurring among those who were already part-time workers. This may help to explain why we find smaller policy responses in women's part-time employment rates than men's. Finally, we are unable to link spouses in the LIAB data and so cannot account for any joint decision-making or the influence of spousal incentives on retirement decisions. However, since Germany does not have a spousal entitlement to pension benefits, this limitation may be less troubling than it would be for analyses of other countries.

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Tables and Figures

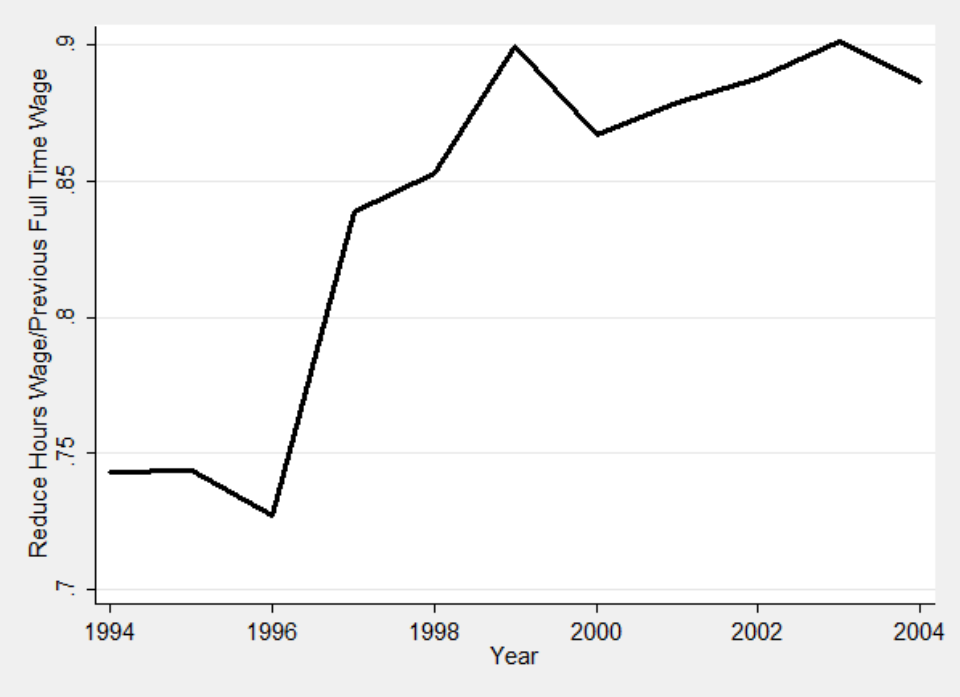

FIGURE 1. TREND IN COMPENSATION FOR REDUCED HOURS WORK RELATIVE TO FULL TIME WORK

Notes: Ratios computed in the first year of reduced hours work using workers age 55 to 65 beginning a part time schedule.
Source: Authors' calculation. Linked Employer-Employee Data of IAB (LIAB).

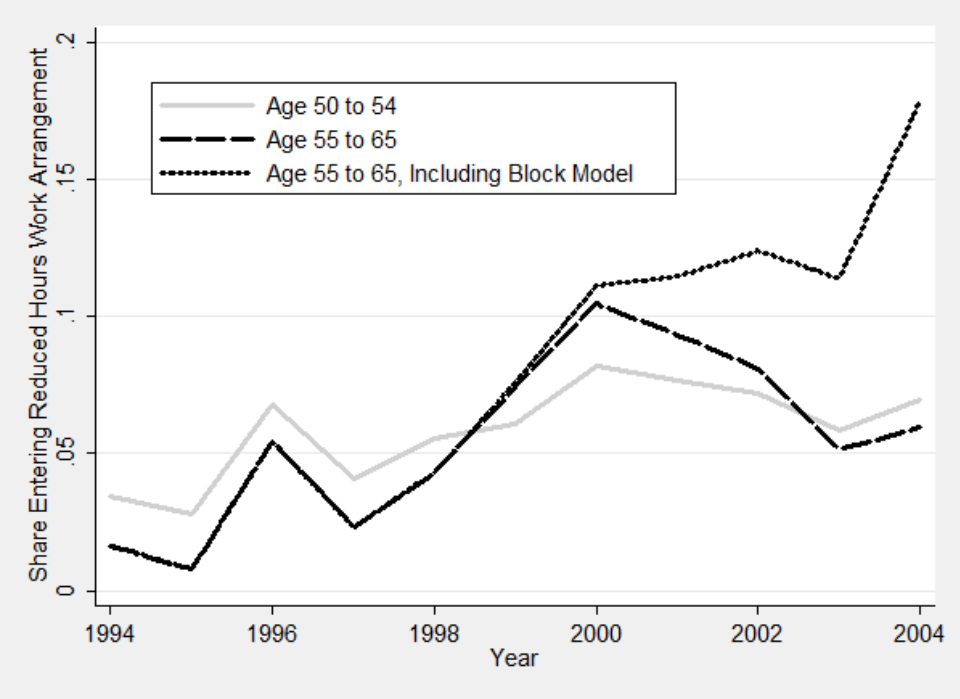

FIGURE 2. TRENDS IN ENTRY INTO REDUCED HOURS WORK ARRANGEMENTS ABOVE AND BELOW ATZ AGE THRESHOLD

Source: Authors' calculation. Linked Employer-Employee Data of IAB (LIAB).

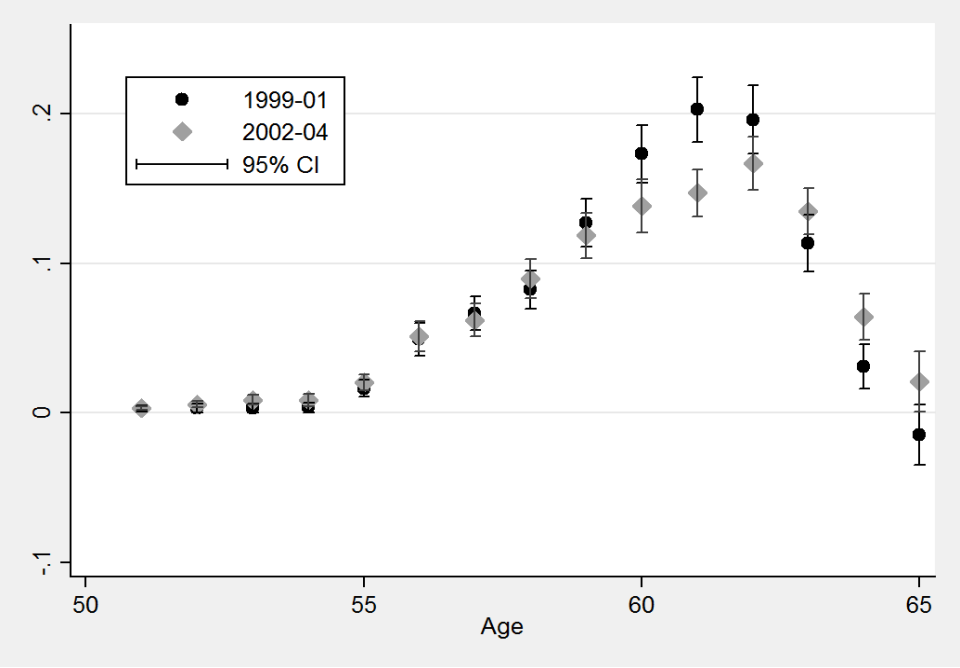

FIGURE 3A. ESTIMATED CHANGES IN PART TIME EMPLOYMENT RATES, MEN

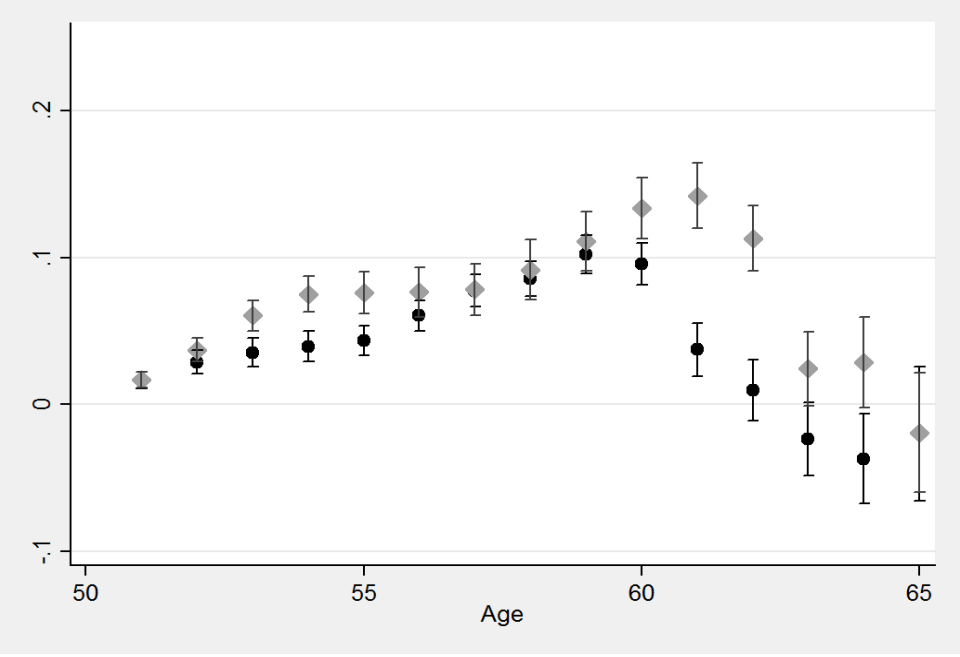

FIGURE 3B. ESTIMATED CHANGES IN PART TIME EMPLOYMENT RATES, WOMEN

Notes: Estimates are means of marginal effects after probit estimation and are changes in part time employment rates relative to age 50 and the pre ATZ period 1993 to 1998.

Source: Authors' calculation. Linked Employer-Employee Data of IAB (LIAB).

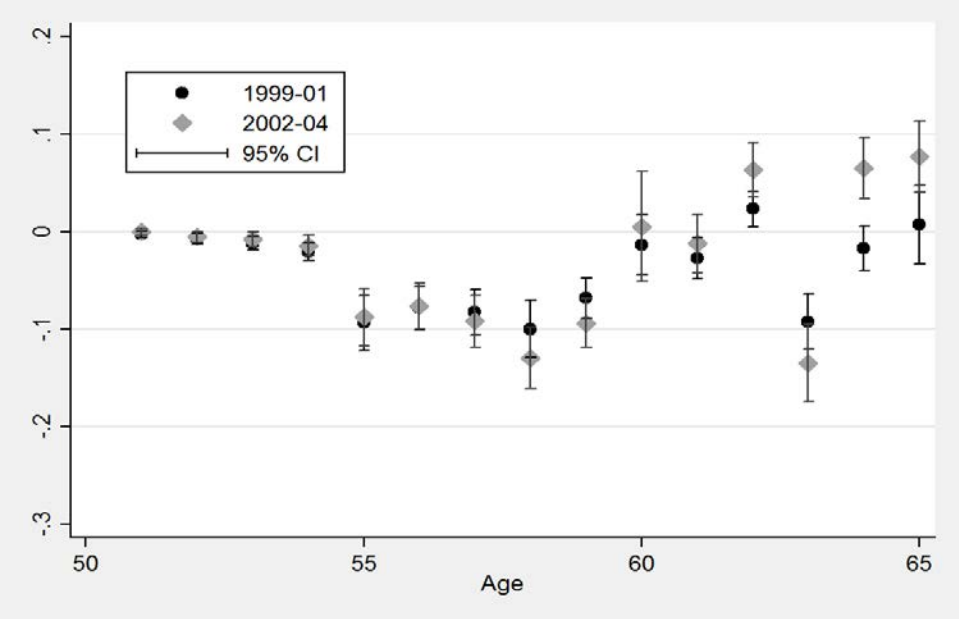

FIGURE 4A. ESTIMATED CHANGES IN RETIREMENT HAZARD RATES, MEN

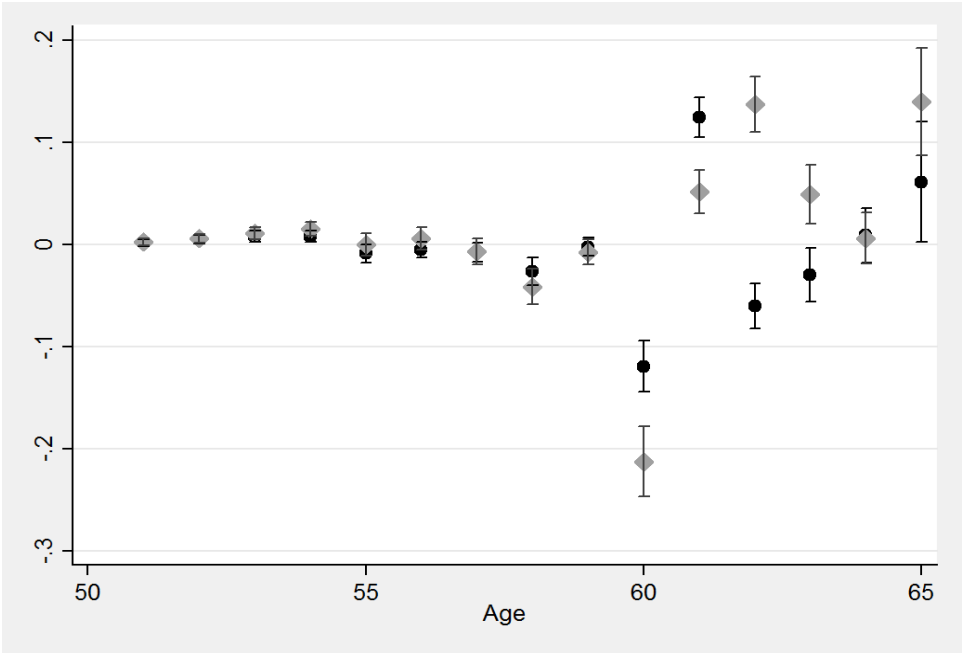

FIGURE 4B. ESTIMATED CHANGES IN RETIREMENT HAZARD RATES, WOMEN

Notes: Estimates are means of marginal effects after probit estimation and are changes in retirement hazard rates relative to age 50 and the pre ATZ period 1993 to 1998. Retirement is defined as exit from the establishment and is coincident with labor force exit for the majority of individuals.

Source: Authors' calculation. Linked Employer-Employee Data of IAB (LIAB).

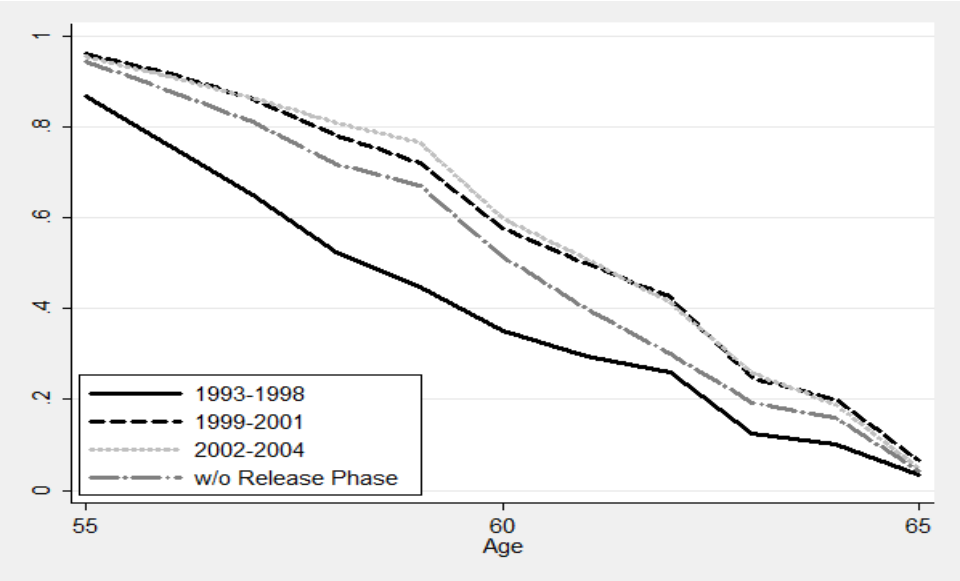

FIGURE 5A. COMPUTED EMPLOYMENT SURVIVAL RATES, MEN

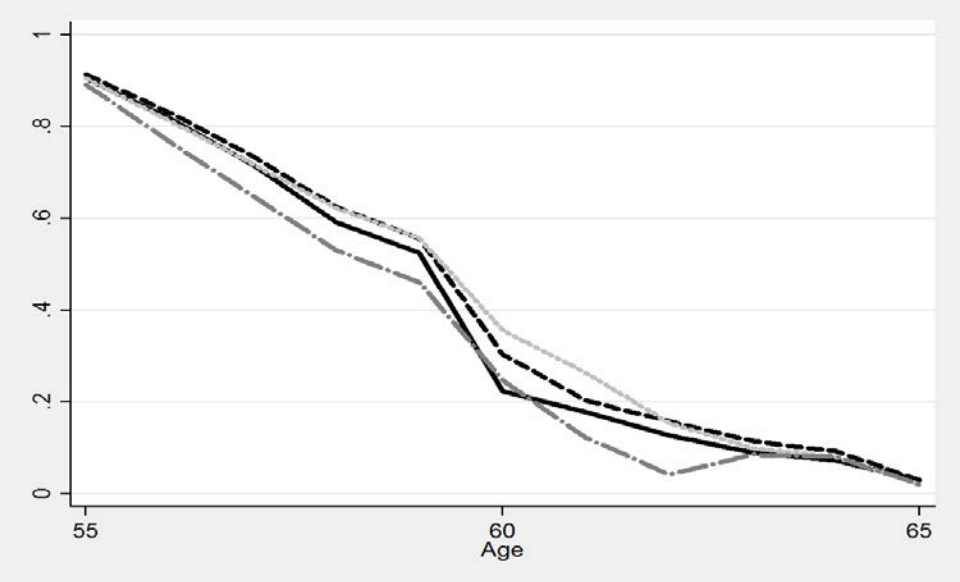

FIGURE 5B. COMPUTED EMPLOYMENT SURVIVAL RATES, WOMEN

Notes: Survival rates are computed using unadjusted retirement hazard rates from 1993 to 1998 and regression adjusted estimated changes in hazard rates reported in Figures 4A and 4B. Retirement is defined as exit from the establishment and is coincident with labor force exit for the majority of individuals. Survival rates excluding Block Model Release Phase are computed by subtracting the share of workers at each age who are in the Release Phase of a Block Model arrangement and thus still employed but no longer working any hours from the computed 2002-2004 survival rates.

Source: Authors' calculation. Linked Employer-Employee Data of IAB (LIAB).

TABLE 1—TIMELINE OF COLLECTIVE BARGAINING AGREEMENT (CBA) PROVISIONS IN SELECTED INDUSTRIES

August 1996	Altersteilzeit (ATZ) Policy Passed
August 1996	Chemical Industry CBA (IG CPK/IG BCE and BA Chemie), all West German states
January 1998	Auto Industry CBA (IG Metall and Gesamtmetall), North Rhein Westphalia
January 1999	Chemical Industry CBA (IG BCE and BA Chemie), nationally
March 1999	Retail Industry CBA (HBV/DAG and EHV NRW), North Rhein Westphalia
April 2000	Construction Industry CBA (IG BAU and ZDB/HDB), nationally
June 2000	Steel Industry CBA (IG Metall and AGV-Stahl), North Rhein Westphalia

Notes: Table contains agreements that could be reliably linked to individuals in LIAB data and for use as a sensitivity check of main results. See Appendix Table A2 for full listing of CBA passed between 1996 and 2004 and summary of provisions.

Source: WSI Tarifarchiv, Hans Böckler Foundation

TABLE 2—DESCRIPTIVE STATISTICS FOR KEY VARIABLES BY GENDER AND TIME PERIOD

	Men			Women		
	1993-1998	1999-2001	2002-2004	1993-1998	1999-2001	2002-2004
Panel A. Individual Characteristics						
Share Part-Time Employed	0.01	0.07	0.07	0.31	0.35	0.34
	(0.11)	(0.26)	(0.25)	(0.46)	(0.48)	(0.48)
Share Retiring Next Year	0.10	0.07	0.07	0.10	0.08	0.07
	(0.30)	(0.26)	(0.26)	(0.30)	(0.28)	(0.25)
Share in Block Model Arrangement	n/a	0.01	0.12	n/a	0.02	0.14
		(0.11)	(0.32)		(0.13)	(0.35)
Average Age	54.84	55.29	55.30	54.51	54.62	54.72
	(3.31)	(3.72)	(3.81)	(3.03)	(3.34)	(3.50)
Average Establishment Tenure, Years[a]	14.22	14.34	15.79	13.68	11.08	12.87
	(7.14)	(9.08)	(9.58)	(6.40)	(7.81)	(8.32)
Average Experience, Years[a]	17.66	20.05	22.76	15.89	15.21	18.12
	(5.48)	(7.56)	(7.43)	(5.87)	(7.75)	(7.74)
Average Daily Wage, €	97.36	102.25	110.62		71.94	77.11
	(28.67)	(32.62)	(36.22)		(29.90)	(31.96)
Panel B. Establishment Characteristics						
Average Employment (in 1000s)	4.38	3.30	5.03	2.66	1.60	1.93
	(7.84)	(7.22)	(11.08)	(4.80)	(3.58)	(5.32)
Average Proportion of Trainees	0.04	0.04	0.04	0.05	0.04	0.04
	(0.04)	(0.05)	(0.05)	(0.04)	(0.05)	(0.06)
Average Proportion Part-Time	0.01	0.03	0.03	0.02	0.05	0.06
	(0.02)	(0.06)	(0.06)	(0.03)	(0.09)	(0.09)
Average Total Sales, Billions €	1.91	4.09	2.65	3.52	5.06	3.52
	(9.64)	(38.10)	(25.20)	(16.00)	(40.90)	(27.70)
Average Number of Vacancies	7.77	15.16	13.63	11.05	9.88	77.12
	(30.08)	(44.43)	(41.37)	(41.89)	(39.06)	(31.96)
N		3,643,954			1,920,232	

Notes: Standard deviations in parentheses. Individual and establishment characteristics are computed at the person-year level.

Source: Author calculations. Linked Employer-Employee Data of IAB (LIAB).

[a] Tenure and experience are computed since 1975 for West Germans and 1990-1992 for East Germans. Actual data are reported in days. West and East German citizenship is included as a control variable in the analysis.

TABLE 3—SIMULATED ATZ EFFECTS ON DURATION OF EMPLOYMENT AND WORK (IN YEARS) USING ALTERNATIVE SPECIFICATIONS

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. Men						
Employment Duration (Years)						
1999-01	1.8	1.4	2.6	0.9	1.8	1.6
2002-04	1.9	1.2	2.5		1.8	1.5
2002-04, Excluding Release	1.2	0.5	1.9	0.4	1.1	0.8
Full-Time Work (Years)						
1999-01	0.8	0.5	1.9	0.2	1.0	0.7
2002-04	0.2	-0.6	1.1		-0.2	-0.4
N						
Panel B. Women						
Employment Duration (Years)						
1999-01	0.3	0.1	-0.2	-0.1	0.3	0.3
2002-04	0.2	0.1	-0.2		0.4	0.4
2002-04, Excluding Release	-0.2	-0.5	-0.9	-0.6	-0.3	-0.2
Full-Time Work (Years)						
1999-01	-0.1	-0.5	0.2	-1.3	0.1	-0.3
2002-04	-1.2	-1.6	-0.9		-1.0	-1.3
N						
Additional Covariates or Sample Restrictions	None	Occupation Daily Wage	Excludes 1996-98	CBA Dates[a]	Employed at age 50	Fixed Effects[b]

Notes: Simulated durations are computed using actual 1993-1998 retirement hazard rates at each age from 55 to 65 to produce the baseline survival function, and regression adjusted estimates of changes in hazard rates to produce survival functions in each post policy period. Durations are the integral of the difference in between each post period survival function and the pre period survival function.

Source: Author's calculations using LIAB data.

[a] Dates of partial retirement clauses in collective bargaining agreements define the post policy period. Agreements are only available for a subset of industries and effects are estimated across all post agreement years through 2004.

[b]Establishment level fixed effects.

Appendix

A1. Changes in Pensionable Ages

In 1992, the German government announced gradual increases in pensionable age. These changes are outlined in Table A1, with pre-reform pensionable ages displayed in the first row. Prior to the reforms, German men could claim full old age pensions at age 60 if they were receiving unemployment or disability benefits, and many Germans did so because the requirements for receiving these benefits were minimal. Employers subsidized exits as early as age 56 or 57 through "dismissal contracts" which were essentially buy-out agreements. Individuals would finance early retirement with a combination of payments from their employers and disability/unemployment benefits until they could claim their pensions age 60. Women were eligible for pensions at age 60 even without receiving unemployment or disability benefits.

The first of the 1992 reforms became binding in 1998, but were known to all cohorts in 1992. As shown in Table A1, these reforms affected cohorts across all three of our study periods. To control for these changes in the results presented in Table 2, we created a variable for each pension "pathway" (reduced unemployment, reduced disability, reduced long service, full men's, full women's, full unemployment, full disability, and full long service) equal to the age the cohort could claim benefits as displayed in Table A1.

TABLE A1—CHANGES IN PENSIONABLE AGES DURING STUDY PERIOD BY BIRTH COHORT

	Early Access, Reduced Benefits			Full Benefits			
	Unemployed	Disability	Long Service	Old Age Women	Unemployed	Disability	Long Service
1928>	[a]	[a]	[a]	60	60	60	63
1938	60	[a]	63	60	60.5	60	63.5
1939	60	[a]	63	60	61.5	60	64.5
1940	60	[a]	63	60	62.5	60	65
1941	60	[a]	63	60.5	63.5	60	65
1942	60	60	63	61.5	64.5	60.5	65
1943	60	60	63	62.5	65	62.5	65
1944	60	60	63	63.5	65	62.5	65
1945	60	60	63	64.5	65	63	65
1946	60	60	63	65	65	63	65
1947	60	60	63	65	65	63	65
1948	60	60	63	65	65	63	65
1949	60	60	63	65	65	63	65
1950	60	60	62.5	65	65	63	65
1951	61	60	62	65	65	63	65
1952	65	60	62	65	65	63	65
1953	65	60	62	65	65	63	65

Notes: All changes in pensionable age were announced in 1993. Men's Old Age pensionable age remained 65 throughout the study period.

Source: Adapted from Börsch-Supan and Wilke (2004).

[a] Before the 1993 reforms there was no actuarial adjustment for early receipt of pension benefits. Full benefits were available at age 60 for reason of unemployment or disability and at age 63 for those with long service histories (35 years or more).

A2. Collective Agreement Clauses on Partial Retirement

Partial retirement was a major topic of bargaining in many industries in 1998 (Eurofound 2014). In Germany, collective bargaining primarily occurs regionally and within industries. While it was technically feasible for firms and individuals to specify partial retirement arrangements, the vast majority of opportunities were governed by collective bargaining agreements. Table A2 provides the key details of all available collective bargaining agreements reached from 1996 through 2004. Notably, many agreements contained wage and pension benefit minimums that exceeded the ATZ floors, and several agreements also included explicit caps on participation. Also, most of the early adopting industries were male dominated.

In one of our robustness checks, we use the effective dates from a subset of collective agreements to define pre and post policy periods. The subset used is

reported in Table 1. Bargaining unit designations do not always directly correspond to industry definitions used in the administrative pension system. This subset of agreements included only those where we were confident in our ability to identify the likely group of covered establishments using the industry and region information available in the LIAB and where the agreement applied to all employees within the establishment to avoid errors in identifying covered and excluded employees. The results of this analysis and other robustness checks are presented in Table 3 as simulated employment and full-time work durations. The underlying regression results are available upon request.

TABLE A2—EXPANDED TIMELINE OF COLLECTIVE BARGAINING AGREEMENT (CBA) PROVISIONS

Date	Industry	Employees	Region	Union	% Wage	% Pension	% Cap
7/23/96	Chemical	All	BE, BW, BY, HB, HH, HE, NI, NW, RP, SL, SH	Chemie-Papier-Keramik	85	90	5
1/1/97	Metal	All[a]	BW	IG Metall	82	95	
5/15/97	Energy	Energy	BE	IGBCE	70	90	
7/1/97	Insurance	Internal & Sales	National	HBV	75	90	5
7/1/97	Energy	Energy	HE	IGBCE			
1/12/98	Metal	All[a]	ST	IG Metall	82	95	
1/12/98	Auto	All[a]	NW	IG Metall	82	95	
3/1/98	Energy	Energy	BE	IGBCE, OTV,	80	90	
4/1/98	Telecom	All	National	Deut. Post Gewerk	90	90	
7/1/98	Public Sector	[b]	National	OTV	83	90	
7/1/98	Insurance	Internal &	National	AG V	75	90	5
1/1/99	Chemical	Chemical	National	IGBCE	85	90	5
3/1/99	Retail	All	NW	HBV, DAG	82.5	90	
7/1/99	Retail	All	BB	HBV	82.5	90	
1/1/00	Metal	All[a]	BW	IB Metall	82	95	
2/1/00	Telecom	All	National	Deut. Post Gewerk	91	90	5
3/1/00	Chemical	Chemical	National	IGBCE	85[c]	90	5
4/1/00	Construction	All	National	IGBAU	70	90	
6/1/00	Iron & Steel	All	NW	IG Metall	85	95	
6/27/00	Retail	All	NW	HBV, DAG	82.5	90	
7/1/00	Public Sector	[b]	National	OTV	83	90	
8/1/00	Auto	All[a]	NW	IG Metall	70	90	
8/1/00	Paper, Cardboard, Plastic	All	Nationald	IG Medien	85	90	5
8/1/00	Printing	All	Nationale	IG Median	80	90	5
8/4/00	Retail	All	BB	DAG	82.5	90	
7/1/01	Insurance	Internal & Sales	National	Verdi	75	90	5
8/1/02	Auto	All	TH	IG Metall	83[f]	95[f]	
4/1/03	Land & Forest	All	BY	IG BAU	70	90	
1/1/04	Insurance	Internal & Sales	National	Verdi	75	90	5
4/1/04	Metal	All	BW	IG Metall	82	95	
5/28/04	Construction	All	National	IG BAU	70	80	
7/1/04	Insurance	Internal & Sales	National	Verdi	75	80	5

Notes: Table contains agreements that could be reliably linked to individuals in LIAB data and for use as a sensitivity check of main results.

Source: WSI Tarifarchiv, Hans Böckler Foundation

[a] Clause left the terms of partial retirement open for Works Agreements to specify. If no Works Agreement was in place, employees had the right to Block Model.

[b] Employee group includes public sector police, construction workers, agricultural workers, environmental occupations, educators and scientists.

[c] Up to 100%.

[d] Excluding East Berlin, Mecklenburg Vorpommern, and Bandenberg.

[e] Excluding Sachsen, Sachsen-Anhalt, Thuringen, East Berlin, Mecklenburg Vorpommern, and Bandenburg.

[f] Employees also could take 84% of previous wages and 90% of pension contributions.

A3. Detailed Reporting of Estimates

The tables in this section contain all estimates plotted Figures 3 and 4 (Tables A3 and A5) and estimated coefficients for covariates (Tables A4 and A6). Table A7 contains the computed hazard and survival rates plotted in Figure 5 and used to compute durations reported in Table 3.

TABLE A3—ESTIMATED CHANGES IN PART-TIME EMPLOYMENT RATES

	Men		Women	
	1999-2001 Relative to 1993-1998 and Age 50 (b_4)	2002-2004 Relative to 1993-1998 and Age 50 (b_5)	1999-2001 Relative to 1993-1998 and Age 50 (b_4)	2002-2004 Relative to 1993-1998 and Age 50 (b_5)
51	0.003***	0.003***	0.016***	0.017***
	(0.001-0.005)	(0.002-0.004)	(0.010-0.022)	(0.011-0.022)
52	0.003**	0.005***	0.029***	0.037***
	(0.000-0.006)	(0.004-0.007)	(0.021-0.037)	(0.029-0.045)
53	0.003**	0.008***	0.035***	0.060***
	(0.000-0.006)	(0.005-0.012)	(0.026-0.045)	(0.050-0.071)
54	0.003**	0.008***	0.039***	0.075***
	(0.000-0.007)	(0.004-0.013)	(0.029-0.050)	(0.063-0.088)
55	0.016***	0.020***	0.044***	0.076***
	(0.011-0.022)	(0.015-0.026)	(0.033-0.054)	(0.062-0.090)
56	0.049***	0.051***	0.060***	0.076***
	(0.038-0.060)	(0.041-0.061)	(0.050-0.071)	(0.059-0.093)
57	0.066***	0.062***	0.077***	0.078***
	(0.055-0.078)	(0.051-0.073)	(0.066-0.089)	(0.061-0.096)
58	0.082***	0.090***	0.086***	0.092***
	(0.070-0.095)	(0.077-0.103)	(0.074-0.098)	(0.071-0.112)
59	0.127***	0.118***	0.102***	0.111***
	(0.111-0.143)	(0.104-0.133)	(0.089-0.115)	(0.091-0.131)
60	0.173***	0.138***	0.096***	0.134***
	(0.154-0.192)	(0.121-0.156)	(0.081-0.110)	(0.113-0.154)
61	0.203***	0.147***	0.037***	0.142***
	(0.181-0.224)	(0.131-0.163)	(0.019-0.055)	(0.120-0.164)
62	0.196***	0.167***	0.010	0.113***
	(0.173-0.219)	(0.149-0.185)	(-0.011-0.030)	(0.091-0.135)
63	0.113***	0.135***	-0.024	0.024
	(0.094-0.132)	(0.119-0.150)	(-0.049-0.002)	(-0.001-0.049)
64	0.031***	0.064***	-0.037**	0.028
	(0.016-0.046)	(0.049)	(-0.068--0.006)	(-0.002-0.059)
65	-0.015	0.021**	-0.020	-0.019
	(-0.035-0.005)	(0.001-0.041)	(-0.066-0.025)	(-0.060-0.021)
N	3,643,954		1,920,232	

Notes: Table contains estimated means of marginal effects after Probit estimation of Equation 1 with binary measure of part-time employment as the dependent variable. These estimates are plotted in Figures 3A and 3B. Marginal effects for additional covariates are reported in Table 3. 95% CIs in parentheses.

Source: Author calculations. Linked Employer-Employee Data of IAB (LIAB).

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level

TABLE A4—REGRESSION ANALYSIS OF CHANGES IN PART-TIME EMPLOYMENT RATES ASSOCIATED WITH ATZ, ESTIMATED MARGINAL EFFECTS FOR OTHER COVARIATES

	Men	Women
Education: Secondary with Vocational	0.003**	-0.023***
	(0.001)	(0.005)
Education: Upper Secondary w/o Vocational	0.005	-0.082***
	(0.004)	(0.012)
Education: Upper Secondary with Vocational	0.002	-0.067***
	(0.003)	(0.011)
Education: Completion of Applied Sciences Degree	-0.007***	-0.087***
	(0.002)	(0.017)
Education: College Degree	-0.011***	-0.123***
	(0.002)	(0.009)
Establishment Tenure, 10 Years	-0.003***	0.012***
	(0.001)	(0.003)
Employment Tenure, 10 Years	-0.016***	-0.089***
	(0.001)	(0.004)
Establishment Employment, 10 Thousands	-0.002	-0.025**
	(0.004)	(0.011)
Establishment Training Rate	-0.075***	-0.101**
	(0.020)	(0.046)
Establishment Part-Time Rate	0.030**	0.527***
	(0.013)	(0.041)
Average Total Sales, Billions €	0.000	0.000
	(0.000)	(0.000)
Vacancies	0.000	-0.000
	(0.000)	(0.000)
Early Long Service Pension Age	-0.002	-0.004
	(0.002)	(0.005)
Long Service Pension Age	0.012***	-0.033***
	(0.001)	(0.004)
Early Unemployment Pension Age	0.002***	0.009***
	(0.001)	(0.001)
Unemployment Pension Age	0.001	0.014***
	(0.001)	(0.002)
Disability Pension Age	-0.001	0.015***
	(0.001)	(0.005)
Old Age Pension Age (Normal Retirement)	[a]	-0.030***
		(0.004)
N	3,643,954	1,920,232

Notes: Dependent variable is equal to 0 for all full-time employed persons and 1 for part-time employed persons. All regressions include year, industry, and German state dummies. Estimates are means of marginal effects computed after Probit estimation and interpreted as changes in the probability of part-time employment expressed as a decimal. These regressions are the source of changes in age specific part-time employment rates plotted in Figures 3A and 3B, too.

Source: Author calculations. Linked Employer-Employee Data of IAB (LIAB).

[a] Age of eligibility for full benefits from old age pension remained constant at 65 for all men during this time period. See Appendix Section A1 for detailed explanation of changes in pensionable age that occurred during study period.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

TABLE A5—ESTIMATED CHANGES IN RETIREMENT HAZARD RATES

	Men		Women	
	1999-2001 Relative to 1993-1998 and Age 50 (b_4)	2002-2004 Relative to 1993-1998 and Age 50 (b_5)	1999-2001 Relative to 1993-1998 and Age 50 (b_4)	2002-2004 Relative to 1993-1998 and Age 50 (b_5)
51	-0.003	-0.000	0.001	0.002
	(-0.005 - 0.001)	(-0.003 - 0.003)	(-0.002 - 0.005)	(-0.001 - 0.005)
52	-0.007**	-0.006**	0.005**	0.005**
	(-0.013 - -0.002)	(-0.011 - -0.000)	(0.001 - 0.009)	(0.001 - 0.010)
53	-0.012***	-0.008**	0.008***	0.011***
	(-0.019 - -0.005)	(-0.015 - -0.000)	(0.003 - 0.013)	(0.005 - 0.016)
54	-0.021***	-0.015***	0.008***	0.015***
	(-0.030 - -0.012)	(-0.025 - -0.004)	(0.002 - 0.014)	(0.008 - 0.022)
55	-0.094***	-0.088	-0.009**	0.000
	(-0.122 - -0.066)	(-0.112 - -0.059)	(-0.017 - -0.001)	(-0.011 - 0.011)
56	-0.079***	-0.077***	-0.005	0.006
	(-0.101 - -0.056)	(-0.100 - -0.056)	(-0.013 - 0.002)	(-0.005 - 0.016)
57	-0.083***	-0.092***	-0.008*	-0.007
	(-0.106 - -0.059)	(-0.119 - -0.065)	(-0.017 - 0.001)	(-0.020 - 0.006)
58	-0.100***	-0.130***	-0.026***	-0.042***
	(-0.129 - -0.071)	(-0.162 - -0.099)	(-0.040 - -0.013)	(-0.059 - -0.024)
59	-0.068***	-0.094***	-0.002	-0.008
	(-0.089 - -0.048)	(-0.119 - -0.069)	(-0.011 - 0.006)	(-0.020 - 0.005)
60	-0.014	0.005	-0.120***	-0.213***
	(-0.045 - 0.017)	(-0.051 - 0.061)	(-0.115 - -0.095)	(-0.247 - -0.179)
61	-0.028***	-0.012	0.124***	0.051***
	(-0.049 - -0.006)	(-0.043 - 0.018)	(0.105 - 0.144)	(0.030 - 0.072)
62	0.023***	0.063***	-0.060***	0.137***
	(0.005 - 0.041)	(0.036 - 0.091)	(-0.082 - -0.038)	(0.110 - 0.164)
63	-0.092***	-0.135***	-0.030**	0.049***
	(-0.121 - -0.063)	(-0.175 - -0.095)	(-0.056 - -0.003)	(0.020 - 0.078)
64	-0.017	0.065***	0.009**	0.006***
	(-0.040 - 0.006)	(0.034 - 0.096)	(-0.018 - 0.036)	(-0.019 - 0.031)
65	0.007	0.077***	0.061	0.140
	(-0.033 - 0.047)	(0.041 - 0.114)	(0.002 - 0.120)	(0.087 - 0.192)
N	3,643,954		1,920,232	

Notes: Table contains estimated means of marginal effects after Probit estimation of Equation 1 with binary measure of retirement as the dependent variable. These estimates are plotted in Figures 4A and 4B. Marginal effects for additional covariates are reported in Table 4. 95% CIs in parentheses.

Source: Author calculations. Linked Employer-Employee Data of IAB (LIAB).

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level

TABLE A6—REGRESSION ANALYSIS OF CHANGES IN RETIREMENT HAZARD RATES ASSOCIATED WITH ATZ, ESTIMATED MARGINAL EFFECTS FOR OTHER COVARIATES

	Men	Women
Education: Secondary with Vocational	-0.014***	-0.013***
	(0.002)	(0.001)
Education: Upper Secondary w/o Vocational	-0.025***	-0.025***
	(0.005)	(0.003)
Education: Upper Secondary with Vocational	-0.029***	-0.032***
	(0.005)	(0.003)
Education: Completion of Applied Sciences Degree	-0.037***	-0.038***
	(0.003)	(0.002)
Education: College Degree	-0.052***	-0.046***
	(0.003)	(0.002)
Establishment Tenure, 10 Years	-0.014***	-0.024***
	(0.002)	(0.002)
Employment Tenure, 10 Years	-0.020***	-0.009***
	(0.002)	(0.001)
Establishment Employment, 10 Thousands	0.014***	0.016***
	(0.004)	(0.003)
Establishment Training Rate	-0.033	-0.016
	(0.023)	(0.022)
Establishment Part-Time Rate	-0.088***	-0.041***
	(0.021)	(0.013)
Average Total Sales, Billions €	0.000	0.000
	(0.000)	(0.000)
Vacancies	-0.000	-0.000
	(0.000)	(0.000)
Early Long Service Pension Age	-0.002	-0.008***
	(0.005)	(0.003)
Long Service Pension Age	0.003	0.011***
	(0.003)	(0.002)
Early Unemployment Pension Age	0.001	0.001
	(0.001)	(0.001)
Unemployment Pension Age	-0.009***	-0.012***
	(0.002)	(0.001)
Disability Pension Age	0.015***	0.000
	(0.003)	(0.002)
Old Age Pension Age (Normal Retirement)	[a]	0.000
		(0.002)
N	3,643,954	1,920,232

Notes: Dependent variable is equal to 0 for all persons still employed at all (including Block Model participants) until the last year of employment when dependent variable equals 1. Last year of employment is only counted if an end of employment notification is filed. All regressions include year, industry, and German state dummies. Estimates are means of marginal effects computed after Probit estimation and interpreted as changes in the retirement (defined as end of the employment relationship) hazard rate. These regressions are the source of changes in age specific retirement hazard rates plotted in Figures 4A and 4B, too.

Source: Author calculations. Linked Employer-Employee Data of IAB (LIAB).

[a] Age of eligibility for full benefits from old age pension remained constant at 65 for all men during this time period. See Appendix Section A1 for detailed explanation of changes in pensionable age that occurred during study period.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

TABLE A7—COMPUTED HAZARD AND SURVIVAL RATES

	Baseline Hazard	Hazard 1999-2001	Hazard 2002-2004	Baseline Survival	Survival 1999-2001	Survival 2002-2004
Panel A. Men						
55	0.134	0.040	0.046	0.866	0.960	0.954
56	0.122	0.044	0.046	0.760	0.910	0.910
57	0.144	0.061	0.052	0.651	0.863	0.863
58	0.193	0.093	0.062	0.525	0.809	0.809
59	0.147	0.078	0.053	0.448	0.766	0.766
60	0.215	0.201	0.219	0.352	0.598	0.598
61	0.160	0.133	0.148	0.296	0.510	0.509
62	0.124	0.147	0.187	0.259	0.414	0.414
63	0.513	0.420	0.378	0.126	0.258	0.258
64	0.205	0.188	0.270	0.100	0.188	0.188
65	0.664	0.671	0.741	0.034	0.049	0.049
Panel B. Women						
55	0.095	0.086	0.095	0.905	0.914	0.905
56	0.096	0.091	0.102	0.818	0.831	0.813
57	0.123	0.115	0.116	0.717	0.735	0.718
58	0.176	0.149	0.133	0.591	0.625	0.622
59	0.113	0.110	0.105	0.524	0.556	0.556
60	0.574	0.454	0.361	0.223	0.303	0.356
61	0.209	0.333	0.261	0.177	0.202	0.263
62	0.280	0.220	0.417	0.127	0.158	0.153
63	0.305	0.276	0.354	0.088	0.114	0.099
64	0.187	0.196	0.193	0.072	0.092	0.080
65	0.618	0.679	0.757	0.027	0.029	0.019

Notes: Rates in 1999-2001 and 2002-2004 are calculated as the sum of baseline rates (1993-1998) computed from LIAB data and estimated changes in hazard rates associated with ATZ policy. Survival rates computed from hazard rates for individuals employed at age 50.

Source: Author calculations. Linked Employer-Employee Data of IAB (LIAB).