

# Excess Early Retirement? Evidence from the Norwegian 2011 Pension Reform\*

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## Abstract

This paper studies how a major reform of the Norwegian pension system affected the labor supply and pension claiming behavior of older workers. The 2011 reform brought three major changes: (i) individuals may start claiming pensions anytime between ages 62 and 75; (ii) there are actuarially neutral pension adjustments for early/late claiming; and (iii) pension benefits are no longer earnings tested. This policy mix implies that the decision of claiming pensions becomes fully disentangled from the decision of exiting the labor force. Prior to the reform, only workers covered by a contractual pension scheme (AFP workers) had access to a pension between ages 62 and 67, while workers not eligible for a contractual pension (nonAFP workers) could claim pension benefits only from age 67. Moreover, AFP pension benefits between ages 62 and 67 were earnings tested and not adjusted for postponed withdrawal. Using a difference-in-differences framework we find that (i) removing the earnings test and introducing actuarial adjustments has large positive effects on employment rates of AFP workers, but a large spike in retirement at age 62 remains; (ii) AFP and nonAFP workers are substantially more likely to claim their pension already at age 62; (iii) labor supply responses of nonAFP workers occur only along the intensive margin, while their employment rates remain unchanged.

Keywords: Pension reform; early retirement age; net returns to work; labor supply.

JEL Classification: J14; J26; J32; H55.

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# 1 Introduction

Dramatic changes in the demographic composition of the population impose severe financial pressures on PAYGO old-age pension systems all over the world. One important reaction to this pressure is various reforms to retirement systems that increase the net return to work for older individuals and aim at inducing older workers stay longer in the work force. While an extensive literature studies the relationship between financial incentives of pension rules and retirement behavior, no firm consensus on the magnitudes of the behavioral responses has yet emerged.<sup>1</sup>

With this paper we contribute to the literature on behavioral responses to pension incentives by studying a major reform to the Norwegian public pension system that was implemented in 2011. Similar to pension systems in many other countries, the Norwegian pension system *prior to the reform* had three important features: (i) a regular/statutory retirement age (RRA, age 67) and an early retirement age (ERA, age 62), with the latter applying only to a subset of workers; (ii) an absence of actuarially neutral adjustments of future pensions for postponed pension claiming; and (iii) an earnings test.<sup>2</sup> The 2011 reform changed these three features fundamentally. First, it introduced “flexible retirement”, meaning that individuals can start claiming pension benefits anytime between ages 62 and 75 without changing their expected social security wealth. This is due to the introduction of actuarially neutral pension adjustments, and implies a de facto abolishment of the RRA. Second, the earnings test was abolished. These changes disentangled the decision of when to start claiming pension benefits from the decision of when to (permanently) withdraw from the labor market.

The interaction of an earnings test and an absence of actuarially neutral pension adjustments implies a substantial reduction of the financial incentives to work past the

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<sup>1</sup>For recent papers, see e.g. Gruber and Orszag (2003), Haider and Loughran (2008), Song and Manchester (2007), Gelber et al. (2013), Manoli and Weber (2011), Brown (2013), Vestad (2013), Staubli and Zweimüller (2014).

<sup>2</sup>The “earnings test” is a common institutional feature of public pension systems, and it affects those who might consider combining pension receipt with continued work: If labor earnings pass a certain threshold, pension benefits are reduced by some fraction. The earnings test comes in addition to regular income taxes (on both pensions and earnings), implying high implicit tax rates on labor earnings for individuals claiming pensions.

early retirement age. This is because the combination of earnings testing and the lack of a pension deferral mechanism (by later age of claiming individuals are rewarded with a higher pension) implies a high implicit tax on earnings, leading to a kink in the lifetime budget constraint at the early retirement age. Indeed, spikes in retirement hazards at the early retirement age are observed in many countries and across many pension systems.<sup>3</sup> It is however not clear that such bunching behavior is caused by the implicit taxes on earnings, because individuals facing pension systems with reasonably neutral deferral mechanisms, such as the one in the US, also exhibit bunching in retirement from the labor force around the earliest possible pension claiming age. Among the factors that have been put forward to explain this phenomenon are liquidity constraints, self-control problems or myopic behavior, and norms regarding what is an acceptable retirement age.

The 2011 Norwegian pension reform affected two groups of private sector workers, defined by their contractual pension coverage, in very different ways. Workers in firms affiliated with the early retirement scheme AFP (“AFP workers” in the following) had access to pension benefits from the age of 62 in the pre-reform pension regime, but these were subject to a strict earnings test, and there were no actuarial adjustments in place. Hence, for AFP workers, the early retirement age has remained fixed at age 62, while there have been dramatic increases in the net returns to work past the early retirement age. Workers in firms not affiliated with AFP (“nonAFP workers”), on the other hand, did not have access to pension benefits prior to the age of 67 in the pre-reform regime. After the reform, they could start claiming non-earnings tested pensions from the age of 62, subject to actuarially neutral adjustments for early or late claiming. The reform thereby provides a unique opportunity to separate the effects of changes in the age from which pension benefits become available, the early retirement age, from the effects of changes in the net returns to work past the early retirement age.

We perform difference-in-differences analyses by age and calendar time to study the impacts of the reform on labor market behavior, separately for AFP and nonAFP workers. For AFP workers, we find that the reform has large positive effects, both on employment

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<sup>3</sup>See inter alia Rust and Phelan (1997); Baker and Benjamin (1999); Gruber and Wise (2004); Behaghel and Blau (2012); Manoli and Weber (2012).

and on annual earnings. One striking result is a strong reduction in the spike in the retirement hazard at age 62, the earliest age (before and after the reform) at which AFP workers could claim pension benefits. While the spike at age 62 is strongly reduced, effects on employment are not large enough to remove the spike completely. We argue that the main reason for the remaining bunching in retirement at age 62 is an upward notch in the lifetime budget constraint for AFP workers, which provides strong incentives to remain employed until age 62.

As for the nonAFP workers, who got access to their own pension wealth five years earlier than under the pre-reform regime, we find no effect of the reform in terms of employment rates (the extensive margin of labor supply). This suggests that myopic behavior and liquidity constraints are not likely to be important drivers of the spike in retirement at the early retirement age that is observed among AFP workers. As for the intensive margin there is evidence of moderate, but statistically significant negative responses among nonAFP workers past age 62, a finding that is not readily reconciled with standard economic theory. For both AFP and nonAFP workers, we find no robust evidence of benefit substitution, that is, of changes in the inflows into the disability or unemployment insurance systems.

We proceed by a closer investigation of the bunching in retirement observed among AFP workers under both the pre- and the post-reform regimes. Under the pre-reform regime, there are two institutional features giving different reasons to suspect excess retirement to be occurring at the early retirement age. The first is the absence of deferral mechanisms and the presence of earnings testing in the pre-reform AFP scheme, which generates bunching in retirement at the early retirement age from above, through a kink in the lifetime budget constraint. The second feature giving rise to bunching at the early retirement age is that all (contractual) AFP benefits will be lost for individuals retiring prior to that age. This creates an upward notch in the budget constraint at the early retirement age, and generates bunching in retirement at the early retirement age from below: Some individuals who would have retired at an earlier age had the budget constraint been continuous are induced to postpone their retirement to the early

retirement age. As actuarial adjustments were introduced with the reform, the prospect of losing out on the AFP benefits is the only feature that is expected to generate excess retirement at the early retirement age in the post-reform regime.

Studying distributions of monthly retirement ages for workers faced with either the pre- or the post-reform regime, we document patterns that are well in line with theoretical predictions: The large spike occurring exactly at the ERA is significantly lower for the post- than for the pre-reform cohorts. Moreover, the pent-up desire for early retirement created by the pension system appears to materialize into exits occurring over the first few months after pension eligibility, and even more so after the reform than prior to the reform. This suggests that the relevant incentives are very salient and well understood. In the continuation of this project we intend to make use of these salient incentives and the pronounced behavioral responses to the same incentives to identify labor supply elasticities.

The paper is organized as follows: In Section 2 we discuss the institutional background in more detail. Section 3 describes the data and provides some descriptive statistics. Results from the difference-in-differences analyses are presented in Section 4, separately for AFP and nonAFP workers. Section 5 discusses in more detail what can be learned from the spike in the retirement hazard at age 62. Section 6 concludes.

## **2 Pension rules and work incentives**

Private sector workers employed by firms affiliated with the early retirement scheme AFP experienced the most pronounced changes in incentives as a result of the reform. These workers had access to pension benefits from the age of 62 in the pre-reform regime, but benefits received prior to age 67 were subject to a strict earnings test, and there were no deferral mechanism to compensate workers by means of higher future benefit levels if they chose not to claim pensions at the earliest possible age. The post-reform system, in contrast, has actuarially neutral deferral mechanisms for both AFP and public pension benefits, and there is no earnings testing. Hence, AFP workers experienced a sharp

increase in the net returns to work past the ERA, while the ERA has remained constant at age 62 for both pre- and post-reform workers.

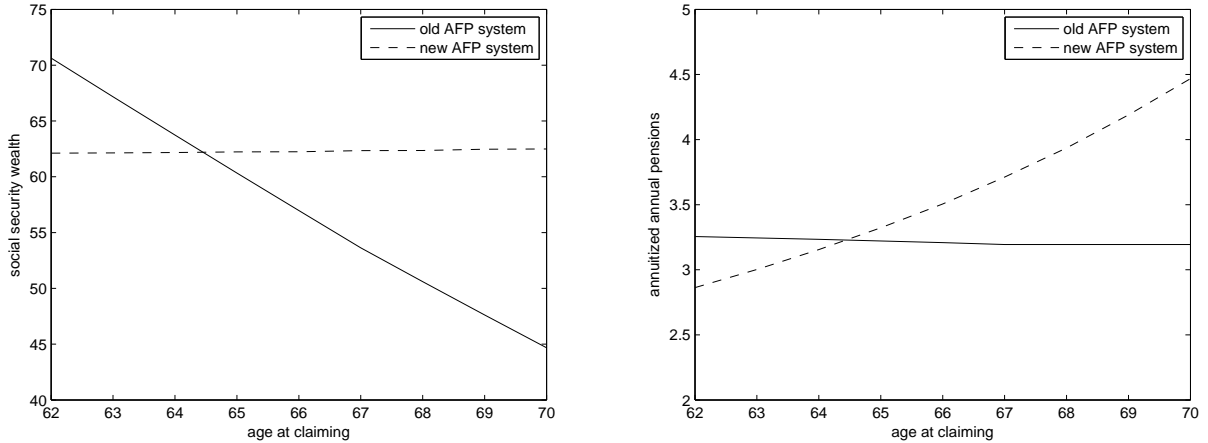
The changes in incentives for AFP workers are illustrated in Figure 1.<sup>4</sup> The left panel shows social security wealth, defined as the expected present value of future AFP and public pension benefits, as a function of pension claiming age. We see a rather pronounced difference across the pre- and post-reform systems, in that social security wealth is decreasing with age at claiming in the old system, and independent of the age at claiming in the new system. The right panel of Figure 1 illustrates the impact of actuarial adjustments in terms of annuitized annual pensions, defined as social security wealth divided by the expected number of years with pension receipt. These are close to being constant (they are slightly decreasing until age 67) in the old system, and increasing with claiming age in the new system. We also note that in this particular example, the pre-reform system is more generous than the post-reform system for those claiming prior to age 64.5. This does not reflect general features of the pre- and post-reform system, as the levels of the curves in Figure 1 depend on the particular income history that is used to calculate the respective pension levels. One important feature that goes in the direction of lower social security wealth in the post-reform system than in the pre-reform system, however, is a change in the indexation of pension benefits: While pension benefits were indexed according to the average wage growth in the economy under the pre-reform regime, in the post-reform regime they are indexed according to average wage growth minus 0.75%. The impact of less generous indexation in the post-reform system is illustrated in Figure A1 in the Appendix, Section A.1. From the left panel, which shows annual pension benefits for individuals claiming pensions at age 62, we see that while there is only a small difference in initial pension levels, the difference in indexation results in rather pronounced differences in pension levels at higher ages.

In Section A.2 in the Appendix we set up a simplistic model of claiming and retirement, to highlight the differences in incentives and the resulting differences with respect to optimal pension claiming and retirement behavior across the pre- and post-reform sys-

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<sup>4</sup>Our illustrative example is based on a hypothetical individual with 40 years of earnings at age 62, with 6 Basic Amounts every year.

Figure 1: Social security wealth and annuitized annual pensions by claiming age.



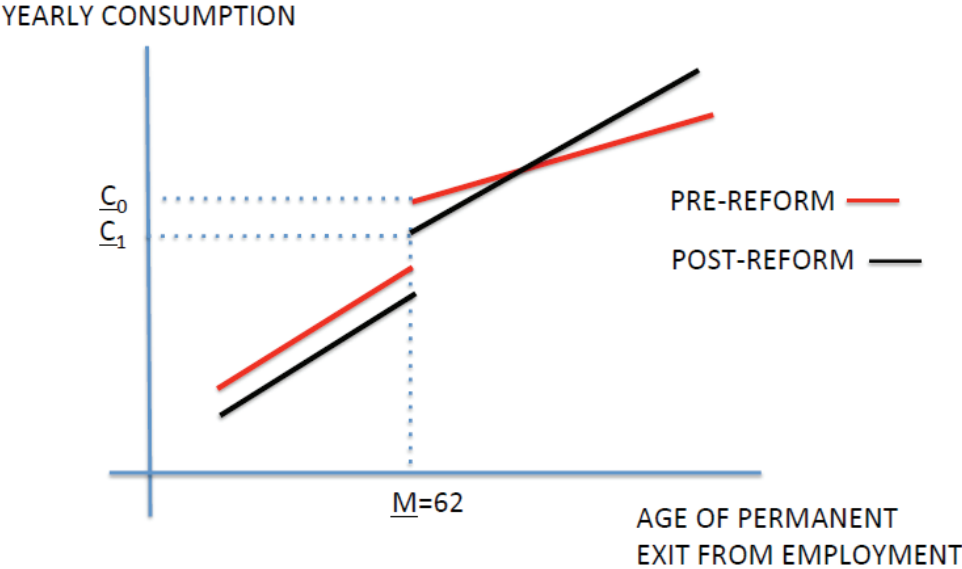
Note: This figure is an illustration of the incentives in the pre-reform and post-reform schemes for workers covered by the AFP early pension scheme. The left panel shows the present value of future AFP and public pension benefits as a function of claiming age, while the right panel shows the annuitized annual pensions as a function of claiming age, both measured in Basic Amounts (BA). Both sets of benefits are computed for an individual born in 1949, with 40 years of earnings history, with 6 Basic Amounts of earnings every year. In 2013, 1BA = NOK 84,204  $\approx$  EUR 10,800 / USD 14,300.

tems. In this model, individuals are choosing annual consumption, claiming age, and retirement age so as to maximize lifetime utility, subject to a lifetime budget constraint and a minimum claiming age. Under the pre-reform regime, net income from work is considerably lower for the years in which individuals are receiving pension benefits than for the years prior to pension claiming, as a result of the earnings testing. Because there is no deferral mechanism, the earnings testing imposes a an implicit tax on continued work after claiming of pensions is possible. Solving for the optimal claiming age as a function of retirement age, we show that individuals who retire before they are allowed to claim benefits should claim benefits as early as possible, while those retiring later should claim benefits in conjunction with retirement from the labor force. It is never optimal to combine work and pension claiming in this system. Under the post-reform system, in contrast, claiming age and retirement age are disentangled – individuals may chose when they want to start claiming benefits without regards to the labor market exit decision. This decoupling results from the absence of earnings testing.

Figure 2 shows lifetime budget constraints in the pre- and post-reform regimes. Starting with the pre-reform regime, we see how the budget constraint becomes flatter after

age 62, the ERA. This is due to the absence of actuarial adjustments, and is sufficient to generate bunching at the ERA, with bunchers coming from above that age. That is, with a linear budget constraint, assuming heterogeneous preferences for leisure that are smoothly distributed across the population, retirement age is also smoothly distributed according to some function. In the presence of a kink in the budget constraint, some individuals whose optimal retirement age with a linear budget constraint would be somewhere above the ERA will instead be retiring at the ERA. This reason for excess retirement at the ERA disappears with the reform, as the post-reform regime has actuarial adjustments. The discontinuities in the budget constraints that are present both pre- and post-reform give an additional reason for excess retirement at the ERA. These are due to the fact that AFP pension benefits are lost for individuals retiring prior to age 62, and will generate bunching in retirement at the ERA from below: some individuals whose optimal retirement age would be below age 62 under a linear budget constraint regime will instead retire at age 62 in the presence of a discontinuity.

Figure 2: Lifetime budget constraints under the pre- and post-reform pension regimes.



Note: This figure is an illustration of the lifetime budget constraint associated with the pre-reform and post-reform schemes for workers covered by the AFP early retirement scheme (AFP workers).

### 3 Data, samples, and descriptive statistics

The data used in this paper combines several administrative registers, linked by unique personal identification numbers. One is the Register of Employers and Employees, which covers the entire Norwegian working age population and gives both firm and individual specific information for all job spells. The data also contains detailed demographic information for all residents, including birth and death dates, gender, and level of education. We can identify recipients of AFP, disability and old age pensions, and we have access to individual pensionable earnings data dating back to 1967, which allows us to identify eligibility for early take-up of NIS pension benefits.

Our samples consist of individuals who were employed and did not receive disability or unemployment insurance benefits at the end of the year in which they turned 58. The estimation samples include a set of pre-reform cohorts, consisting of individuals who turned 62 prior to the reform (born 1946-1948), and a set of post-reform cohorts, consisting of individuals who were younger than 62 in 2010 (born 1949-1954). We exclude post 2010 observations of the pre-reform cohorts, since claiming AFP pensions and exiting the labor force at or shortly after age 62 was a very common response to the incentives in the pre-reform regime among AFP covered workers, which makes those not claiming pensions and continuing working past that age a strongly selected group. Hence, our estimation results are based on observations of pre-reform cohorts over the period 2008-2010, and on observations of post-reform cohorts over the period 2008-2013.

Descriptive statistics for pre- and post-reform cohorts of workers are given in Table 1, separately for AFP and non-AFP workers. For both AFP and non-AFP workers, the pre- and post-reform cohorts are very similar in terms of observable characteristics. We note that more than 70% of the samples are men, and that having received sickness leave benefits at age 58 is fairly common (21% for AFP workers, 18% for non-AFP workers). While rather large fractions of the AFP workers are employed in large firms within the manufacturing sector, the non-AFP workers are more often observed in smaller firms and are less frequently employed in the manufacturing sector.

Table 1: Descriptive statistics, pre- and post-reform workers.

Variable	<i>Pre-reform</i>		<i>Post-reform</i>	
	Mean	(sd)	Mean	(sd)
<i>AFP workers</i>				
Male	0.72	(0.45)	0.71	(0.46)
Married	0.73	(0.44)	0.69	(0.46)
Higher education <sup>a</sup>	0.19	(0.39)	0.21	(0.40)
Earnings (in BA) <sup>b</sup>	6.82	(3.45)	6.96	(4.61)
Experience <sup>c</sup>	24.3	(2.33)	24.2	(2.78)
At least 1 yr without pension points <sup>d</sup>	0.16	(0.37)	0.15	(0.36)
Months with sick leave benefits <sup>e</sup>	0.84	(2.07)	0.81	(2.02)
Sick leave at age 58	0.21	(0.41)	0.21	(0.41)
Employed in small firm <sup>f</sup>	0.05	(0.21)	0.03	(0.17)
Employed in manufacturing	0.38	(0.49)	0.33	(0.47)
Eastern Norway	0.42	(0.49)	0.40	(0.49)
<i>N. of individuals</i>	29,252		55,882	
<i>N. of observations</i>	87,756		195,975	
<i>nonAFP workers</i>				
Male	0.73	(0.44)	0.73	(0.44)
Married	0.75	(0.44)	0.71	(0.45)
Higher education <sup>a</sup>	0.23	(0.42)	0.26	(0.44)
Earnings (in BA) <sup>b</sup>	6.79	(4.31)	7.18	(5.03)
Experience <sup>c</sup>	23.8	(3.00)	23.6	(3.78)
At least 1 yr without pension points <sup>d</sup>	0.25	(0.43)	0.24	(0.43)
Months with sick leave benefits <sup>e</sup>	0.74	(2.00)	0.74	(1.98)
Sick leave at age 58	0.18	(0.38)	0.18	(0.38)
Employed in small firm <sup>f</sup>	0.54	(0.50)	0.49	(0.50)
Employed in manufacturing	0.11	(0.32)	0.10	(0.30)
Eastern Norway	0.44	(0.50)	0.40	(0.49)
<i>N. of individuals</i>	17,611		40,947	
<i>N. of observations</i>	52,833		137,790	

The pre-reform (post-reform) workers are workers who reached age 62 prior to (after) 2011, i.e. the 1946-1948 (1949-1954) cohorts. The pre-reform (post-reform) group is observed between 2008 and 2010 (2008 and 2013).

<sup>a</sup> University level education.

<sup>b</sup> Total earnings in base year, i.e. at age 58.

<sup>c</sup> Number of years with income  $> 1BA$ , counted from age 34.

<sup>d</sup> Measured from age 34.

<sup>e</sup> Number of months with receipt of sickness leave benefits during the base year.

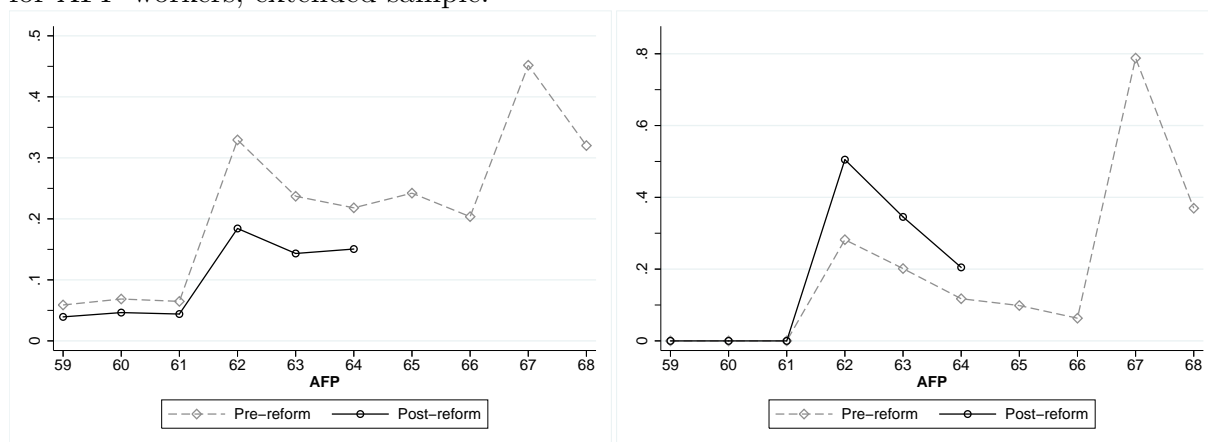
<sup>f</sup> = 1 if base year firm has fewer than 10 full-time, full-year employees.

## 4 The effects of the pension reform

### 4.1 Effects on AFP workers

Figure 3 provides descriptive evidence of the most important behavioral responses to the 2011 pension reform among AFP covered workers. Starting with the labor market exit hazards in the left panel, we see that the widely observed spikes in retirement hazards at the early and regular retirement ages are also present in Norway. Comparing the pre- and post-reform hazards, we note that the spike in retirement at the ERA is significantly lower for the post-reform cohorts, and also that retirement hazards are lower at ages below the ERA for post-reform workers. This latter observation most likely reflects a general trend towards later retirement that should not be attributed to the reform as such. The right panel shows pension claiming hazard rates for the same groups of workers as for the labor market exit hazards in the left panel. We see that for the pre-reform cohorts, about 30 percent claim AFP pensions at the ERA, which corresponds very well to the increase in the retirement hazard at the same age. This stands in sharp contrast to the observed behavior under the post-reform regime, when claiming pensions and exiting the labor force are no longer closely tied together: claiming pensions at age 62 has become much more common, while exiting at the same age has become less common.

Figure 3: Labor market exit (left panel) and pension claiming hazard rates (right panel) for AFP workers, extended sample.



Note: The pre-reform (post-reform) group includes the 1941-1948 (1949-1954) cohorts.

To estimate reform effects on different outcomes we rely on the following difference-

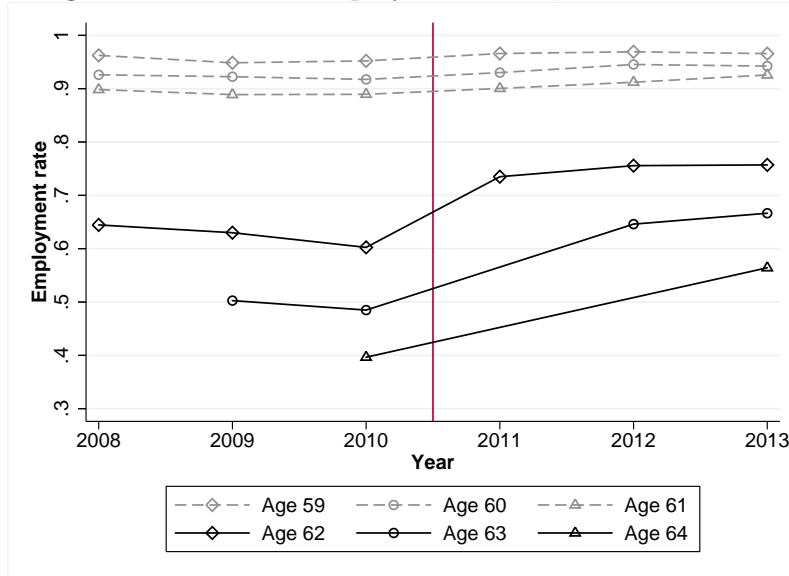
in-differences specification:

$$Y_{at} = \alpha + \lambda_t + \gamma_a + \beta(Post_t \times D_a) + \eta X + \varepsilon_{at}, \quad (1)$$

where  $\lambda_t$  and  $\gamma_a$  are year and age fixed effects, respectively,  $Post_t$  is an indicator for post-reform observations,  $D_a$  is an indicator for ages 62-64, and  $X$  is a set of observable characteristics: dummies for sex, civil status, educational attainment, labor income quartiles, firm size, industry affiliation, region, earnings history, and sick leave, all measured at age 58. The difference-in-differences estimator  $\beta$  captures the difference in mean outcomes before and after the reform for ages 62-64 (the treatment group), relative to the before-after difference in mean outcomes for ages 59-61. Figure 4 shows trends in employment rates for the different age groups in our sample. Employment rates for ages 59-61 (62-64) are drawn with dashed (solid) lines, and the data are such that employment rates for 59-year-olds are always above those for 60-year-olds, which in turn are above those for 61-year-olds (and correspondingly for the 62-64-year-olds). We see that there is a slight tendency towards higher employment in the post-reform years for the younger age group, which was also clear from Figure 3. Another point to note is related to the missing circles for age 63 in 2011, and for age 64 in 2011 and 2012. This is to illustrate that our estimation sample excludes post-reform observations of workers who turned 62 prior to 2011, and therefore had the opportunity to claim AFP pensions under the pre-reform regime.

Difference-in-differences estimates for the outcomes registered employment and annual earnings are provided in Table 2. We see that the point estimates are fairly robust to variations in the empirical specification; without controls, with controls, and allowing for differential linear trends for treatment and control groups, that is, for individuals above and below age 62. When evaluated relative to the pre-reform means for ages 62-64, they difference-in-differences estimates indicate an increase in registered employment of about 22 percent, and an increase in annual earnings of about 10 percent. These estimates are to a large extent driven by responses at age 62, since on each side of the reform we observe three cohorts at age 62, two cohorts at age 63, and only one cohort at age 64. As responses

Figure 4: Trends in employment rates, AFP workers.



are likely to differ by age, both in absolute and relative terms, we have also estimated versions of our baseline specification with age specific difference-in-differences-estimators; point estimates for the outcomes registered employment and annual earnings are shown in Figure 5. These estimates provide support to our parallel trends assumption, in that the point estimates at ages 60 and 61 are very close to zero. We also see that the point estimates are higher at ages 63 and 64 than at age 62, and when evaluated relative to the respective pre-reform sample means the age differences are even more pronounced: The results indicate a relative increase in registered employment (annual earnings) of 18% (6%) at age 62; 29% (20%) at age 63; and 35% (28%) at age 64.

While combining pension receipt with continued work was to a large extent discouraged in the pre-reform system, the post-reform system goes a long way in disentangling the decision of when to exit the labor market from the decision of when to start claiming benefits. We have seen that both employment and pension claiming went up as a result of the reform (Figure 3), and with Table 3 we go one step further along the work and pension dimension: the table shows single differences in each of the four combined pension and work outcomes, post- minus pre-reform, for AFP covered workers aged 62-64. We see that combining pension receipt with continued work has become much more common as a result of the reform, at the expense of all the three other combined outcomes. Another point to

Table 2: Diff-in-diff regressions, employment and labor earnings of AFP workers.

	Employment			Yearly labor earnings		
	(1)	(2)	(3)	(4)	(5)	(6)
DD estimate	0.120*** (0.003)	0.121*** (0.003)	0.133*** (0.007)	0.452*** (0.031)	0.502*** (0.025)	0.385*** (0.058)
Controls included	No	Yes	Yes	No	Yes	Yes
Linear time-trend for age > 62	No	No	Yes	No	No	Yes
Mean pre-reform, ages 62-64	0.543	0.543	0.543	4.411	4.411	4.411
<i>N. of individuals</i>	85,134	85,134	85,134	85,134	85,134	85,134
<i>N. of observations</i>	283,731	283,731	283,731	283,731	283,731	283,731

The sample includes AFP workers of age 59-64, and the DD estimator is defined as the difference in mean outcomes for post-reform workers ages 62-64 and 59-61, minus the same difference for pre-reform workers. The pre-reform (post-reform) group includes the cohorts 1946-1948 (1949-1954). The pre-reform (post-reform) group is observed between 2008 and 2010 (2008 and 2013). Heteroskedasticity robust standard errors in parentheses. \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .  
<sup>a</sup> Earnings measured in Basic Amounts (BA). In 2013, 1BA = NOK 84,204  $\approx$  EUR 10,800 / USD 14,300.

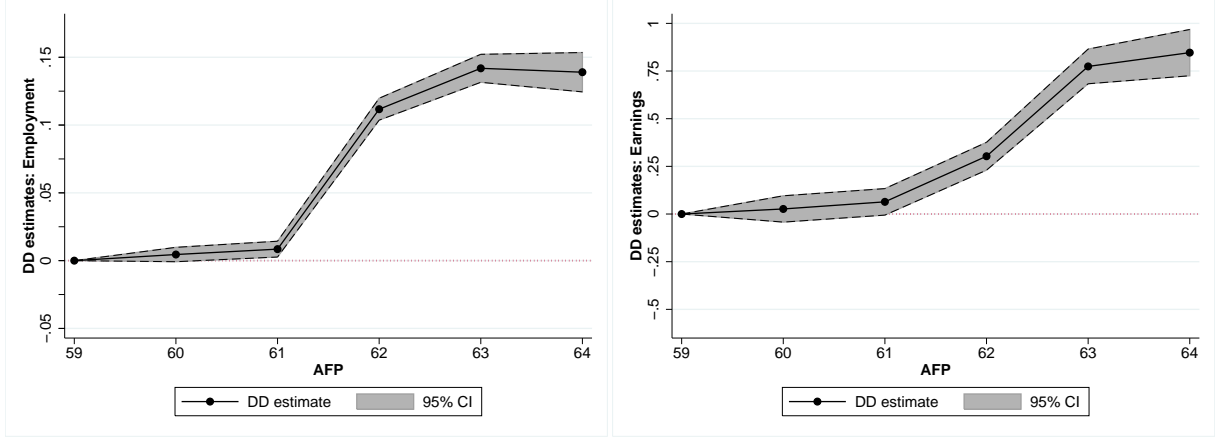
note is that the increase in the “pension and working” outcome is due to decreases in the two “not working” outcomes that together are of approximately the same magnitude as the decrease in the “no pension and working” outcome.

The co-existence of an old-age pension system and social insurance programs such as unemployment and disability insurance can complicate matters when it comes to studying the effects of changes in pension systems. If, for instance, the pension system becomes less generous, one might suspect the estimated impacts on e.g. employment to be contaminated by contemporaneous inflows into the unemployment and/or disability insurance systems.<sup>5</sup> We therefore apply our difference-in-differences framework to estimate reform impacts on unemployment and disability insurance benefits receipt.<sup>6</sup> Results from this exercise are reported in Section A.3 in the Appendix: We find no evidence of changes in unemployment rates, but some indications of significant changes in disability rates at ages 62-64, that are not robust to alternative specifications.

<sup>5</sup>This phenomenon is sometimes referred to as “benefit substitution” and has been the subject of several studies, see e.g. Autor and Duggan (2003); Duggan et al. (2007); Karlström et al. (2008); Staubli (2011); Inderbitzin et al. (2013); Vestad (2013); Borghans et al. (2014).

<sup>6</sup>Disability insurance (DI) benefits include vocational or medical rehabilitation benefits, temporary disability benefits, work assessment allowance benefits (AAP, introduced in March 2010 as a replacement for rehabilitation and temporary disability benefits), and permanent disability benefits.

Figure 5: Age specific DD estimates from employment (left panel) and earnings (right panel) regressions, AFP workers.



Note: The estimated pre-post reform difference in employment rates (standard error) at age 59 is 0.011 (0.002), and the corresponding difference (standard error) in mean earnings is -0.015 (0.026). Annual earnings are measured in Basic Amounts; in 2013, 1BA = NOK 84,204  $\approx$  EUR 10,800 / USD 14,300.

Table 3: Single difference regressions, work and pension outcomes, AFP workers.

	Pension		No pension	
	Working (1)	Not working (2)	Working (3)	Not working (4)
Difference estimate	0.296*** (0.002)	-0.087*** (0.002)	-0.153*** (0.003)	-0.056*** (0.002)
Controls included	Yes	Yes	Yes	Yes
Mean pre-reform	0.099	0.285	0.444	0.172
<i>N. of individuals</i>	57,229	57,229	57,229	57,229
<i>N. of observations</i>	114,739	114,739	114,739	114,739

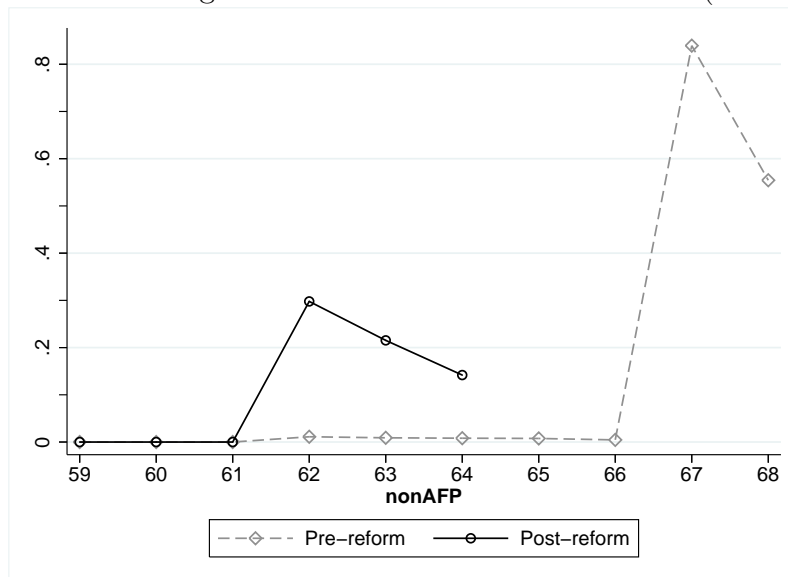
The sample includes AFP workers of age 62-64. The pre-reform (post-reform) group includes the cohorts 1946-1948 (1949-1951). We include observations of pre-reform (post-reform) workers until 2010 (2013).

Heteroskedasticity robust standard errors in parentheses. \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

## 4.2 The impact of the reform on nonAFP workers

Turning to the private sector workers not covered by AFP, we recall that they could only claim pensions from the age of 67 in the pre-reform system, whereas post-reform workers have access to the new and flexible pension system already from the age of 62. Given the actuarially neutral adjustments of pension benefits for early or late claiming, the only change that occurred as a result of the reform for non-AFP workers is that they got more flexibility in terms of how to allocate their own pension wealth. In the absence of liquidity constraints and myopic behavior we would not expect this access to liquidity to have any impact on their labor market behavior. It is clear from the pension claiming hazard rates in Figure 6, however, that a large fraction of non-AFP workers do take the opportunity to claim pension benefits from the new ERA: About 30% of the workers in the post-reform cohorts claim pension benefits at the earliest possible age.

Figure 6: Pension claiming hazard rates for non-AFP workers (extended sample).



Note: The pre-reform (post-reform) group includes the 1941-1948 (1949-1954) cohorts.

Difference-in-differences estimates for the outcomes registered employment and annual earnings are provided in Table 4 and Figure 7. We see that there are no significant effects on employment rates<sup>7</sup>, as expected, but somewhat surprisingly there are negative impacts

<sup>7</sup>The point estimates from our baseline specification are statistically significant (columns 1 and 2 in Table 4), but very small in magnitude, and not robust to including a linear trend for the treatment group (column 3).

on annual earnings past age 62. When evaluated relative to the pre-reform sample means at the respective ages, the point estimates correspond to reductions in annual earnings of 3, 5, and 8% at ages 62, 63, and 64, respectively. These are fairly modest impacts, compared to the corresponding positive impacts that are estimated for AFP workers, but they are far from being negligible. This suggests that liquidity constraints could have a minor impact on non-AFP workers' labor market behavior, that shows up in terms of intensive margin responses, but not in terms of extensive margin responses. One interpretation of these results, in light of the significant fraction of workers who are claiming pension benefits from age 62, is that non-AFP workers are using their own pension wealth to finance some kind of a gradual retirement process.

Table 4: Diff-in-diff regressions, employment and labor earnings of non-AFP workers.

	Employment			Yearly labor earnings		
	(1)	(2)	(3)	(4)	(5)	(6)
DD estimate	-0.009*** (0.004)	-0.011*** (0.003)	-0.001 (0.008)	-0.254*** (0.048)	-0.245*** (0.040)	-0.342*** (0.092)
Controls included	No	Yes	Yes	No	Yes	Yes
Linear time-trend for age > 62	No	No	Yes	No	No	Yes
Mean pre-reform, ages 62-64	0.766	0.766	0.766	5.418	5.418	5.418
<i>N. of individuals</i>	58,558	58,558	58,558	58,558	58,558	58,558
<i>N. of observations</i>	190,623	190,623	190,623	190,623	190,623	190,623

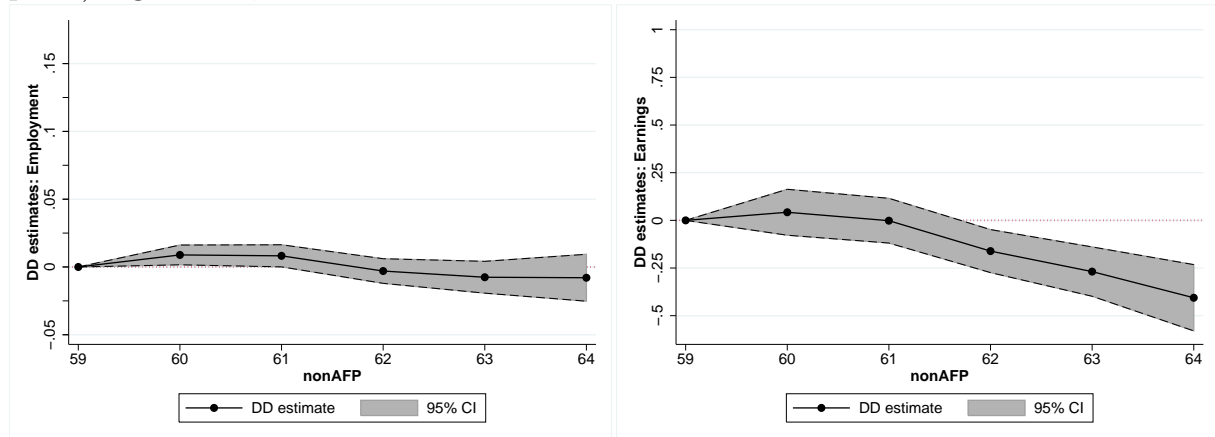
The sample includes nonAFP workers of age 59-64, and the DD estimator is defined as the difference in mean outcomes for post-reform workers ages 62-64 and 59-61, minus the same difference for pre-reform workers. The pre-reform (post-reform) group includes the cohorts 1946-1948 (1949-1954). The pre-reform (post-reform) group is observed between 2008 and 2010 (2008 and 2013).

Heteroskedasticity robust standard errors in parentheses. \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

<sup>a</sup> Earnings measured in Basic Amounts (BA). In 2013, 1BA = NOK 84,204  $\approx$  EUR 10,800 / USD 14,300.

As for the combined pension and work outcomes, the single difference estimates for non-AFP workers in Table 5 clearly show how the responses to the reform are driven by substantial increases in pension claiming and not by extensive margin labor supply responses: The 29.4% increase in the “pension and working” outcome is mirrored by a 29% decrease in the “no pension and working” outcome, and the 7.2% increase in the “pension and not working” outcome is counteracted by a 7.6% decrease in the “no pension

Figure 7: Age specific DD estimates from employment (left panel) and earnings (right panel) regressions, nonAFP workers.



Note: The estimated pre-post reform difference in employment rates (standard error) at age 59 is 0.006 (0.002), and the corresponding difference (standard error) in mean earnings is 0.128 (0.040). Annual earnings are measured in Basic Amounts; in 2013, 1BA = NOK 84,204  $\approx$  EUR 10,800 / USD 14,300.

and not working” outcome. Just as for the AFP covered workers, there are no signs of reform related changes in the inflows into unemployment insurance benefits among non-AFP workers, and there is no robust evidence of changes in receipt of disability insurance benefits. (Results reported in Section A.4 in the Appendix.)

Table 5: Single difference regressions, work and pension outcomes, non-AFP workers.

	Pension		No pension	
	Working (1)	Not working (2)	Working (3)	Not working (4)
Difference estimate	0.294*** (0.002)	0.072*** (0.002)	-0.290*** (0.003)	-0.076*** (0.003)
Controls included	Yes	Yes	Yes	Yes
Mean pre-reform	0.004	0.010	0.762	0.224
<i>N. of individuals</i>	36,617	36,617	36,617	36,617
<i>N. of observations</i>	73,178	73,178	73,178	73,178

The sample includes nonAFP workers of age 62-64. The pre-reform (post-reform) group includes the cohorts 1946-1948 (1949-1951). We include observations of pre-reform (post-reform) workers until 2010 (2013).

Heteroskedasticity robust standard errors in parentheses. \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

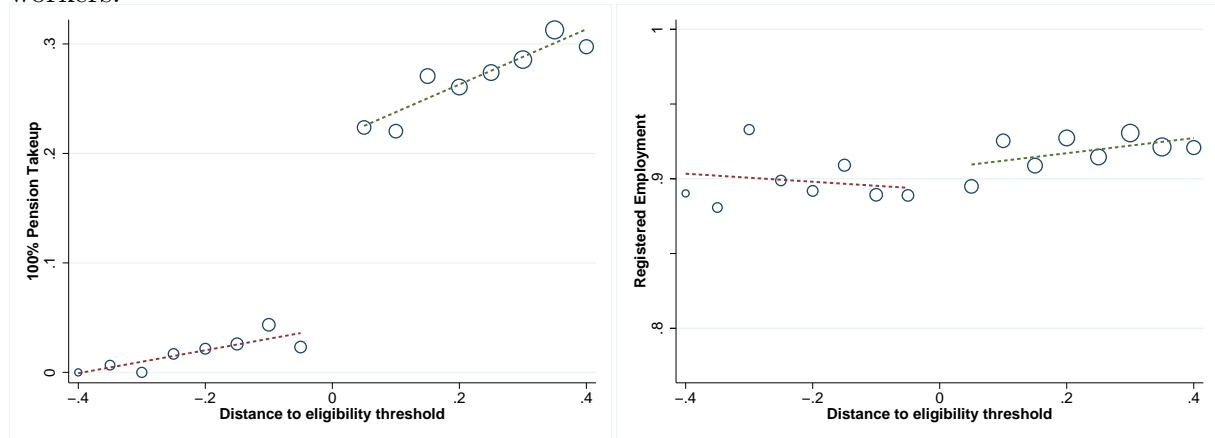
To verify the lack of extensive margin responses among non-AFP workers, we complement our difference-in-differences analyses by studying the effect of a reduction of the ERA within a regression discontinuity framework. This analysis is based on eligibility for

receipt of pension benefits at age 62 being dependent of having a certain level of social security wealth. That is, eligibility for claiming pensions at age 62 is restricted to individuals for which annual benefits at age 62 are above a birth month specific threshold, which is set in order for benefits at age 67 to be above a given minimum level. We focus on the immediate post-reform cohorts of non-AFP workers, born 1949-1951, excluding individuals who received DI benefits at some point between 1992 and age 61, since it is difficult to get the pension points right for individuals with a combination of DI benefits and wage income. The running variable is defined as the distance from the eligibility threshold, measured in Basic Amounts.

Since eligibility for claiming at age 62 is determined based on the full earnings history until age 60, manipulation of the running variable should not be a concern in this particular setting. This is confirmed by Figure A4 in Section A.4 in the Appendix, which shows the frequency of individuals by distance from the eligibility threshold: Besides a large number of individuals at or just above the minimum pension level, the distribution is rather smooth, and there is no sign of a significant discontinuity in the vicinity of the eligibility threshold.

The left panel of Figure 8 shows the fractions of individuals claiming full pension benefits at the earliest possible age by distance from the eligibility threshold, i.e. the first stage. We see that the fractions of pension claimers are close to zero below the eligibility threshold, and increase by about 20 percentage points from just below to just above the threshold. The right panel of Figure 8 shows the second stage of our regression discontinuity analysis, i.e. the fractions of individuals in registered employment at the ERA by distance from the eligibility threshold. This lends additional support to our finding of no extensive margin responses among non-AFP workers; there is no sign of a discontinuity around the eligibility threshold in the probability of being employed at age 62.

Figure 8: Fractions of individuals claiming full pensions at the earliest possible age (left panel) and employment rates (right panel) by distance from eligibility threshold, nonAFP workers.



Note: Both the fraction of pension claimers and the employment rates are reported in bins of 0.05 of the running variable, excluding observations in the interval  $[-0.025, 0.025]$ . The size of the circles is proportional to the number of observations in each bin. Sample: Workers in non-AFP firms born 1949-1951, no more than 0.4 Basic Amounts away from the eligibility threshold, excluding workers with a history of DI receipt prior to age 62.  $n = 4,524$ .

## 5 Excess retirement at age 62

We have seen that although AFP covered workers respond very strongly to the reform in terms of increased employment, there is a substantial spike in the labor market exit hazard at the ERA also among the post-reform cohorts. This comes as no big surprise, given the incentives at play in the pre- and post-reform pension systems for this particular group of workers, but the strong and salient incentives, and the clear responses to changes in the same incentives, makes our setting a most promising starting point for generating new knowledge about elderly workers' behavioral responses to incentives in pension systems.

Let excess retirement be defined as a mass point in the distribution of retirement ages. That is, there is some age at which the probability of retirement is strictly positive, or at which exiting the labor force is excessively popular. Such excess retirement should not occur when (i) preferences are smoothly distributed across the population; (ii) individuals are making rational decisions; (iii) there are no liquidity constraints; and (iv) the budget constraint is linear, which in our setting is to be understood as “when there are no kinks or discontinuities in the budget constraint due to the pension system”. Since non-AFP workers were faced with a linear budget constraint both in the old and in the new system,

we make use of their observed behavior to assess whether conditions (i)-(iii) are likely to hold true in our setting. The left panel of Figure 9 shows the distribution of exit ages for workers not covered by AFP; the number of exits at each monthly age as a fraction of the total number of individuals in the cohort. We see that the distribution is close to uniform, both pre- and post-reform, except for a small jump exactly at age 62, which is partly due to mis-classifications.<sup>8</sup> This supports the idea of the excess retirement at the ERA that we observe for the AFP workers being due to the incentives in the pension system, rather than to non-standard preferences or liquidity constraints.

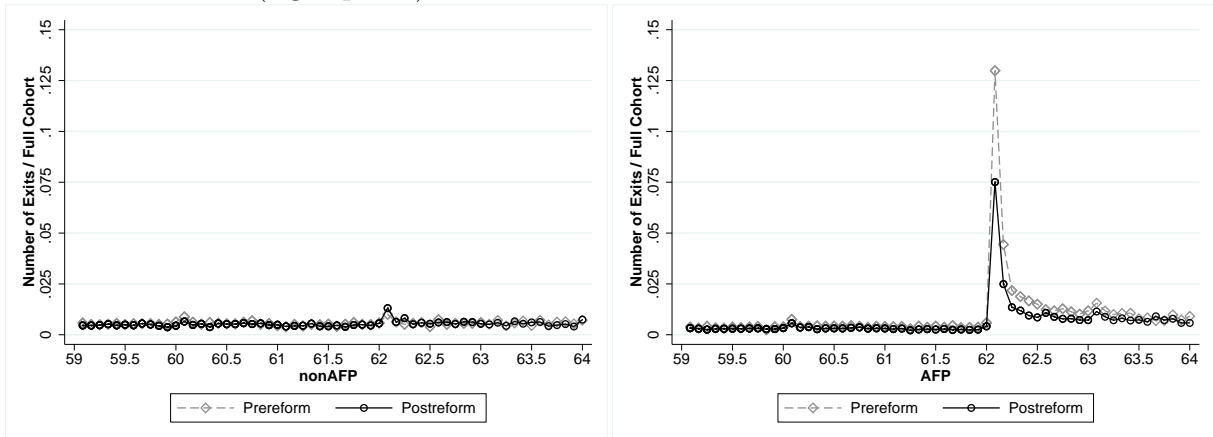
As illustrated by the lifetime budget constraints for AFP workers in Figure 2, the incentives in the pre-reform system give two reasons to expect excess retirement at the ERA for AFP covered workers: the kink in the budget constraint that is due to the absence of a deferral mechanism and the discontinuity created by the bonus for remaining employed until age 62. The kink would create bunching in retirement from above age 62, while the discontinuity would create bunching from below. As only one of the reasons for excess retirement, the kink at the ERA, is removed by the reform, one should expect less excess retirement under the post-reform regime, but it should not disappear completely. This is indeed what we see from the right panel of Figure 9: a reduction, but still substantial excess retirement at age 62. Another point to note is that the pent-up desire for early retirement created by the pension system appears to materialize into exits occurring over the first few months after pension eligibility, and even more so after the reform than prior to the reform.

**Bunching and missing mass in the pre- and post-reform pension systems** The first aim of this analysis is to investigate to what extent the excess retirement at age 62 in the post-reform system can reasonably be explained by bunching from below. The

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<sup>8</sup>To identify the AFP affiliation of private sector firms, we make use of the fact that all workers in an AFP affiliated firm are automatically covered by the scheme: We track the previous employment of all individuals observed to be receiving early retirement pensions, and classify a firm as AFP affiliated if it has at least one previous employee who later received AFP pension benefits. This gives room for some measurement error; some recipients of AFP pensions are registered with more than one job prior to receipt of pension benefits, and some firms might be affiliated with AFP even though none of their former employees receive AFP pensions. It is also possible to move jobs after age 58 and obtain AFP eligibility in the new job at age 62, but job mobility is very low among Norwegian workers in their late fifties.

Figure 9: Age distribution of retirees by AFP affiliation at age 58; nonAFP (left panel) and AFP workers (right panel).



Note: The figures show the number of exits in each monthly age band as fractions of the total number of individuals in each cohort who are registered as employed at age 59. The pre-reform (post-reform) distribution is constructed by averaging with equal weights over the 1946-1948 (1949-1953) cohorts, whose exits are observed over the period 2007-2010 (2008-2013).

second aim is to investigate the implied elasticities of lifetime labor supply that the exhibited bunching is consistent with. The analysis is inspired by Brown (2013), who studies bunching due to kinks and notches in the labor market in a lifetime labor supply model, and by Kleven and Waseem (2013) who show how to estimate elasticities from notches. In what follows, our key assumptions are that retirement behavior is similar across cohorts, in the absence of changes in incentives; that there are no income effects; and that retirement behavior is smooth in age when the lifetime budget constraint is linear. Under these assumptions, we can estimate retirement behavior in the absence of distorting pension systems based on the post-reform, post-age-62 distribution of retirement: The labor supply behavior past age 62 of post-reform workers should be unaffected by the pension system, given the absence of earnings testing and the actuarially neutral deferral mechanism.

More formally, we estimate a regression for  $x_{m,c}$ , the share of individuals from cohort

$c$  retiring when they are exactly  $m$  months old;

$$\begin{aligned}
x_{m,c} = & \alpha_0 + \alpha_1 c + \alpha_2 m + \sum_{i=59*12+1}^{64*12} \gamma_i \mathbb{1}\{m = i\} z_{i,c} \\
& + \sum_{i=59*12+1}^{62*12} \delta_i \mathbb{1}\{m = i\} + \sum_{i=62*12+1}^{62*12+3} \theta_{i-62*12} \mathbb{1}\{m = i\} + \varepsilon_{m,c}, \tag{2}
\end{aligned}$$

for  $m = 59*12 + 1, \dots, 64*12$  and  $c = 1946, \dots, 1953$ , with  $z_{m,c}$  being an indicator variable taking the value 1 for pre-reform cohorts. The parametric part of the model is identified from the post-reform, post-age-62 data. Assuming that the bunching from below in the post-reform regime materializes into exits over the first three months after pension eligibility, the excess mass at the notch among the post-reform cohorts is captured by the parameter  $\hat{\theta} = \hat{\theta}_1 + \hat{\theta}_2 + \hat{\theta}_3$ . Our first analysis is to ask the question: “How many months of retirement does the excess retirement associated with the bunching amount to?” We then compare the predicted retirement at age 62 with bunching, with the predicted retirement at age 62 without bunching. With the additive specification we have set up here, this is answered by comparing taking the ratio

$$B_1 = \frac{\hat{\theta}}{\hat{\alpha}_0 + \hat{\alpha}_1 c + \hat{\alpha}_2 (62 * 12 + 1)}, \tag{3}$$

it makes sense just to take the average of the ratios over the post-reform cohorts.

The second question we want to ask is, how many months of missing retirement mass is necessary to explain the observed bunching. That is, we are (approximately) asking for the constant  $x$  in the equation:

$$\sum_{i=62*12-x}^{62*12} \delta_i + \theta = 0. \tag{4}$$

This tells us something about the heterogeneity in responses. Even if the excess bunching amounts to  $B_1$  months of retirement, the densities of retirement in the months before the notch age are not exactly zero - because of heterogeneity or adjustment frictions, so we may need more than  $B_1$  months of low retirement before the notch to account for the bunching, even if the bunching amounts to  $B_1$  months of retirement. Note that this is a

key question for us: We want to investigate whether the notch at age 62 post-reform can be explained by missing retirement just before the notch age or if it is necessary to come up with other explanations, such as the post-reform notch being a result of pre-reform retirement norms.

Estimating equation (2) on the same sample as in Figure 9, we get  $\hat{\theta} = 0.083$ ,  $B_1 = 7.92$  (with standard errors 0.002 and 0.47, respectively), and  $x = 9.6$ . (With  $x = 9$  (10) in equation (3), the left hand side equals 0.006 (-0.004); 9.6 is simply the weighted average of 9 and 10, with 0.4 being the weight assigned to 9.) (We should also report results with  $\alpha_2$  constrained to zero. This is also a sensible assumption locally, even if it can be refuted empirically, and leads to a somewhat higher number of months. We should also compare with retirement patterns in the non-afp group as an alternative counterfactual.)

The next stage is to compare the retirement before the notch age in the pre- and post-retirement cohorts. The aim of this comparison is twofold. First, we want to validate that the retirement densities and hence the “missing mass” in retirement before the notch is similar for both groups. The “missing mass” and hence the densities should be similar, because the rewards of postponing retirement age until age 62 is similar for the immediate pre- and postreform cohorts. Secondly, we want to quantify the bunching from below in the pre-reform system. The incentives in the pre-reform system lead to bunching both from below and above at the notch (and kink) age. To estimate elasticities, we need to somehow quantify the amount of bunching that is from above and the part of the bunching that is from below. Our approach is to measure the bunching from below by comparing pre-notch age retirement with the post-reform scheme. We then measure total bunching and find the bunching from above residually.

**Labor supply elasticities implied by bunching** Having obtained estimates of bunching, it is possible to derive elasticities of lifetime labor supply that are consistent with the observed bunching. First, using the post-reform data, we study labour supply elasticities based on bunching from below. For the pre-reform system, we study elasticities based on bunching from above. Since bunching from above in the pre-reform system is

partly measured also using post-reform data to recover the bunching from below, the two elasticities that we find are not statistically independent. However, the measurements are independent in the sense that there is no logical connection leading from a low elasticity in the post-reform data to a low elasticity in the pre-reform data. Therefore, there is an element of cross-validation in the two estimated labor supply elasticities.

Let us consider a utility function

$$u = wl - T(wl, l) - \frac{n}{1 + 1/e} \left( \frac{wl}{n} \right)^{1+1/e},$$

this is the same as in Kleven and Waseem (2013) except that we have substituted  $wl$  for  $z$ , the gross earnings. Take  $w$  (annual wage rate) as exogenous and  $l$  labor in years, as the decision variable. Let us start with a baseline linear tax,  $T(wl, l) = T + twl$ . Maximization now yields

$$wl = n(1 - t)^e$$

so  $n$ , an ability variable, represents lifetime earnings in the absence of taxation. Different  $n$  leads individuals with the same annual wage to retire at different ages. We should think about  $n$  as having a distribution function. Assume now that we introduce an after-tax bonus  $b$  for supplying labor beyond age 62.  $l \geq 62 = l^*$ . This will introduce bunching at age 62, from below. We then proceed to find the elasticity  $e$  that is consistent with an individual being indifferent between retiring at age 62 and at age  $62 - \Delta l$ . This can be characterized by the equation

$$\frac{b - w\Delta l}{w(l^* + \Delta l)} = \frac{1}{1 + 1/e} \left[ \left( \frac{l^*}{l^* + \Delta l} \right)^{1+1/e} - 1 \right],$$

which is interpretable, given the change in the rewards to work on the left hand side and the change in labor supplied on the right hand side. For a given  $\Delta l$ , a bonus for working until age  $l^*$  induces a certain change in the relative rewards to working  $\Delta l$  months more. This change must be compared to the costs of deviating from the optimum (in the absence of bonus) at  $l^* + \Delta l$ .

We saw from the above results that the bunching in the post-reform data correspond to approximately 9 months of retirement. 9 months of supplied labour is a change in labour supply of approximately 2 percent (this corresponds to using 37 and a half years as a base for experience at age 61 years and 3 months. The relative change in the payoff to working for these 9 months is in the excess of 200 percent (the value of qualifying for AFP amounts to more than two years of pay.) The implied elasticity of labor supply is thus less than 0,01. In other terms, even tripling the net compensation for moving retirement from age 61 to age 62 (as happens through becoming eligible for AFP) is not sufficient for a representative individual to move the retirement age from 61 to 62.

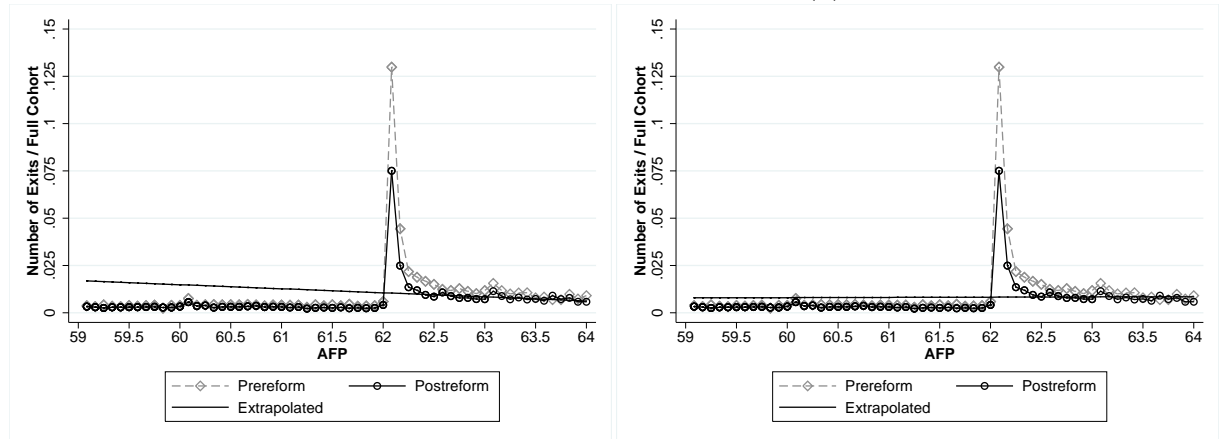
Empirical stuff we need to flesh out the above paragraph: (1) Empirical distribution of years of work experience (from pension points). (2) Empirical distribution of net present value of the AFP benefits (in post-reform system). (3) Empirical distribution of annual net income. (4) Empirical distribution of the ratio of (3) to (2).

We found the pre-reform bunching from above to amount to approximately 9 months of retirement. Since the retirement before the notch age is about the same for the pre- and post-reform data, the bunching from above is essentially measured as the difference between the bunching in the pre- and postreform systems. The kink in the budget line induced by earnings testing of the pre-reform AFP system is approximately equal to the compensation rate in the pre-reform AFP system, which we will (for now) approximate with 50 percent. The data thus tells us that a doubling of the compensation would lead to approximately 9 months longer lifetime labor supply. This amounts to a compensated elasticity of 0,02. (Doubling of net marginal compensation to work leads to increased supply of 2 percent.) While this number is a little larger than the number estimated by the bunching from below in the post-reform data, both sources suggest quite small compensated elasticities. Only dramatic kinks and discontinuities in the data would lead to discernible bunching in such a system - and our data indeed provide such dramatic kinks and discontinuities. Bunching from above equal to 9 months of retirement means that the marginal buncher would in the absence of the kink choose to work 9 months longer than in the presence of the kink. So figuring our the elasticity is as straightforward

as figuring out the change in log months of work over the lifetime and compare with the change in the log net marginal income associated with the kink. (Here, it is not clear that we need to write up a formula.)

Empirical stuff that we need to flesh out the above paragraph: (1) Empirical distribution of net present value of AFP benefits in pre-reform system - (conditional on retirement at age 62) (2) Empirical distribution of replacement rate in pre-reform AFP system.

Figure 10: Age distribution of retirees and estimated counterfactual distribution, AFP workers. “Extrapolated” =  $\hat{\alpha}_0 + \hat{\alpha}_1c + \hat{\alpha}_2m$  from equation (2).



Note: In the left panel, “Extrapolated” =  $\hat{\alpha}_0 + \hat{\alpha}_1c + \hat{\alpha}_2m$  from equation (2); in the right panel, “Extrapolated” =  $\hat{\alpha}_0 + \hat{\alpha}_1c$  from equation (2) with  $\alpha_2 = 0$ .

Table 6: Elasticities based on pre- and post-reform retirement distributions.

		Linear trend in age	
		Yes	No
<i>Post reform</i>			
$W^1/P^{61}$	EPV of AFP / Previous Earnings	1.95	1.95
$E^{61}$	Years of experience	39.67	39.67
$B_1$	Bunching from below (= total bunching)	7.92	10.63
$x$	Number of months of delayed retirement	9.60	16.60
	Elasticity <sup>a</sup>	0.01	0.01
<i>Pre reform</i>			
$c$	AFP gross replacement rate	0.52	0.52
$E^{61}$	Years of experience	38.38	38.38
$B_0$	Total bunching	18.95	23.62
$B_0^1$	Bunching from above (= $B_0 - x$ )	9.35	7.02
	Elasticity <sup>b</sup>	0.03	0.02

<sup>a</sup> Calculated as  $(B_1/E^{61} * 12)/(W^1/P^{61})$ .

<sup>b</sup> Calculated as  $(B_0^1/E^{61} * 12)/\ln 0.52$ .

## 6 Conclusion

This paper studies the impacts of the 2011 reform of the Norwegian public pension system. Prior to the reform, the main features of the Norwegian system were similar to those of the pension systems in many other countries; (i) a regular/statutory retirement age (RRA, age 67) and an early retirement age (ERA, age 62), with the latter applying only to a subset of workers; (ii) an absence of actuarially neutral adjustments of future pensions for postponed pension claiming; and (iii) an earnings test. The 2011 reform changed these three features in a fundamental way by introducing “flexible retirement”, meaning that individuals may choose when to start claiming pension benefits between ages 62 and 75 without affecting their expected social security wealth, and without being subject to earnings testing of pension benefits. These changes effectively disentangled the decision of when to start claiming pension benefits from the decision of when to withdraw from the labor market.

The 2011 reform affected two groups of private sector workers, defined by their contractual pension coverage, in very different ways. Workers in firms affiliated with the early retirement scheme AFP had access to pension benefits from the age of 62 in the pre-reform pension regime, but these were subject to a strict earnings test, and there were no actuarial adjustments in place. Hence, for AFP workers, the early retirement age has remained fixed at age 62, while there have been dramatic increases in the net returns to work past the early retirement age. Workers in firms not affiliated with AFP (“nonAFP workers”), on the other hand, did not have access to pension benefits prior to the age of 67 in the pre-reform regime. After the reform, they could start claiming non-earnings tested pensions from the age of 62, subject to actuarially neutral adjustments for early or late claiming.

Our main results are based on difference-in-differences analyses, undertaken separately for AFP and nonAFP workers. For AFP workers, we find that the reform has large positive effects, both on employment and on annual earnings. One striking result is a strong reduction in the spike in the retirement hazard at age 62, the earliest age (before and after the reform) at which AFP workers could claim pension benefits. While the spike

at age 62 is strongly reduced, effects on employment are not large enough to remove the spike completely. We argue that the main reason for the remaining bunching in retirement at age 62 is an upward notch in the lifetime budget constraint for AFP workers, which provides strong incentives to remain employed until age 62.

As for the nonAFP workers, who got access to their own pension wealth five years earlier than under the pre-reform regime, we find no effect of the reform in terms of employment rates (the extensive margin of labor supply). This suggests that myopic behavior and liquidity constraints are not likely to be important drivers of the spike in retirement at the early retirement age that is observed among AFP workers. There is, however, evidence of negative intensive margin responses among nonAFP workers past age 62, suggesting that liquidity constraints might nevertheless have some impact on elderly workers' labor market behavior. For both AFP and nonAFP workers, we find no evidence of benefit substitution, that is, of changes in the inflows into the disability or unemployment insurance systems.

A closer look at excess retirement – the bunching in retirement at age 62 among AFP workers – reveals that two institutional features give rise to the spike in the retirement hazard rate at age 62. The first is the absence of deferral mechanisms and the presence of earnings testing in the pre-reform AFP scheme, which generates bunching in retirement at the early retirement age from above, through a kink in the lifetime budget constraint. The second feature giving rise to bunching at the early retirement age is that AFP benefits are lost for eligible workers retiring prior to age 62. This creates an upward notch in the budget constraint, which results in bunching in retirement at the early retirement age from below: Some individuals who would have retired at an earlier age had the budget constraint been continuous are induced to postpone their retirement to the early retirement age. As actuarial adjustments were introduced with the reform, the prospect of losing out on the AFP benefits is the only feature that is expected to generate excess retirement at the early retirement age in the post-reform regime.

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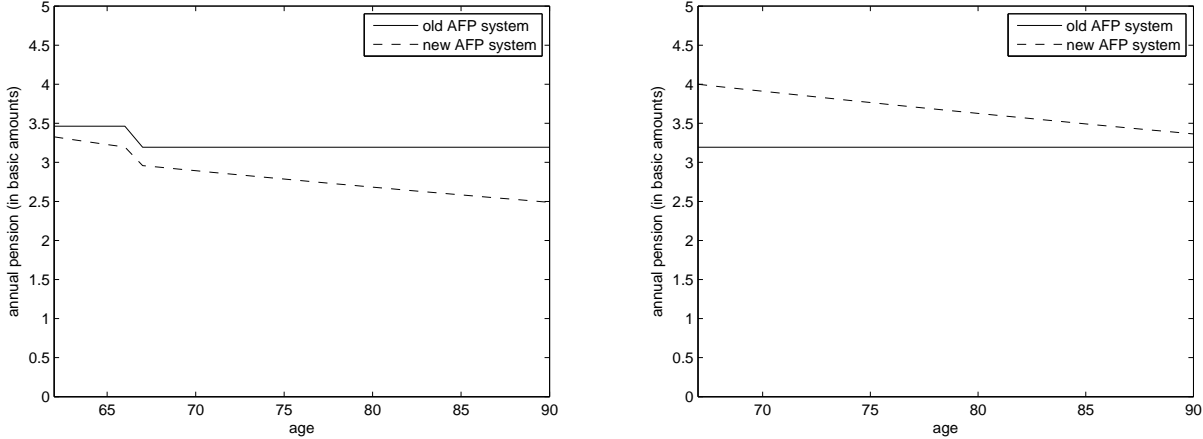
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# A Appendix

## A.1 Pension levels of AFP workers pre- and post-reform

Figure A1: Annual pension benefits when claiming at age 62 (left panel) and 67 (right panel).



## A.2 A simplistic model of pension claiming and retirement

To fix ideas, and highlight the differences in incentives and the resulting differences with respect to optimal pension claiming and retirement behavior across the pre- and post-reform systems, we set up a simplistic model of claiming and retirement. Lifetime utility consists of utility of consumption for the entire lifetime of  $T$  years, and utility of leisure during the years of retirement. Individuals choose annual consumption  $c$ , claiming age  $M$ , and retirement age  $N$  so as to maximize lifetime utility, subject to a lifetime budget constraint and a minimum claiming age  $\underline{M}$ :

$$\begin{aligned} \max_{c, M, N} U &= u(c) \cdot T + \theta \cdot (T - N) \\ \text{s.t. (1)} \quad cT &\leq w(1 - p) \cdot \min(M, N) \\ &\quad + w(1 - \tau) \mathbb{1}\{N > M\} (N - M) + b(M, N)(T - M) \\ \text{(2)} \quad M &\geq \underline{M} \end{aligned}$$

The three term on the right hand side of the budget constraint are net income from work for each year until claiming or retirement occurs ( $w(1 - p)$ ), net income from work for the years between pension claiming and retirement ( $w(1 - \tau)$ ), and total pension benefits ( $b(M, N)(T - M)$ ). In the pre-reform system, the benefit formula is such that annual pension benefits are essentially independent of both claiming age and retirement age, and there is earnings testing, so that the net income from work is considerably lower after claiming than before claiming ( $\tau \gg p$ ).

Since utility is not a function of claiming age, one may solve this problem by first characterizing optimal claiming age as a function of retirement age. That is, by maximizing the right hand side of the budget constraint with respect to claiming age. Individuals who retire prior to the minimum claiming age should claim benefits as early as possible, while those retiring at the minimum claiming age or later should claim benefits in conjunction with retirement. Hence, it is never optimal to combine work and pension claiming in this system. Using the first order conditions with respect to retirement age, one may

show that there will be excess retirement at the minimum retirement age; there will be a group of individuals retiring exactly at the minimum claiming age, while their optimal retirement ages in the absence of earnings testing and with actuarial adjustments would be evenly spread out across the years above the minimum claiming age.

In the post-reform system, the lifetime budget constraint is simplified due to the absence of earnings testing ( $\tau = p$ );

$$(1') \quad cT \leq w(1-p) \cdot N + b(M, N)(T-M),$$

and the benefit formula is such that for individuals postponing claiming by one year, future benefits are increased so as to compensate for the foregone benefits that year ( $b'_M(T-M) = b$ ). In this system, claiming age and retirement age are disentangled – individuals may choose when they want to retire without regards to their choice of claiming age.

### A.3 Additional results, AFP workers

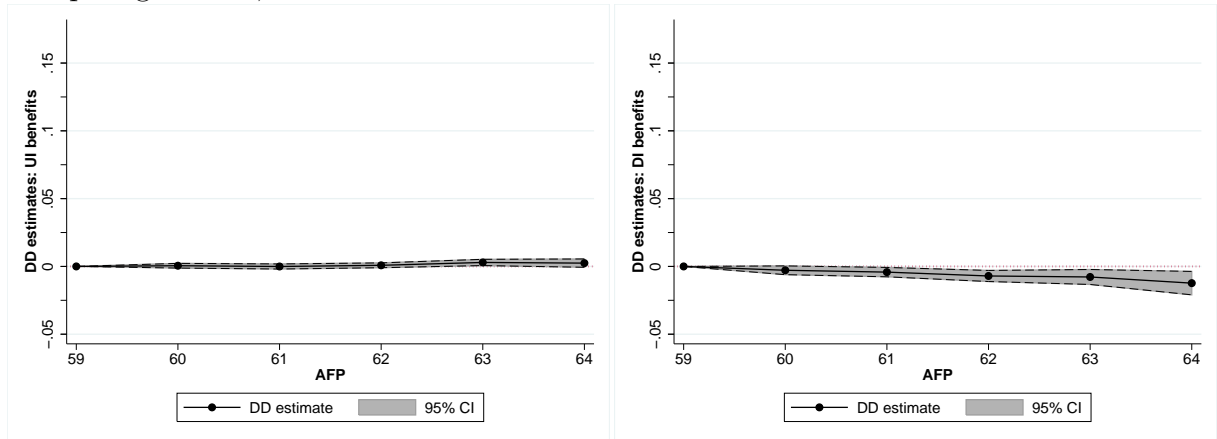
Table A1: Diff-in-diff regressions, UI and DI rates of AFP workers.

	UI			DI		
	(1)	(2)	(3)	(4)	(5)	(6)
DD estimate	0.009*** (0.001)	0.008*** (0.001)	0.006*** (0.002)	0.004** (0.002)	0.002 (0.002)	0.018*** (0.005)
Controls included	No	Yes	Yes	No	Yes	Yes
Linear time-trend for age > 62	No	No	Yes	No	No	Yes
Mean pre-reform, ages 62-64	0.006	0.006	0.006	0.099	0.099	0.099
<i>N. of individuals</i>	85,134	85,134	85,134	85,134	85,134	85,134
<i>N. of observations</i>	283,731	283,731	283,731	283,731	283,731	283,731

The sample includes AFP workers of age 59-64, and the DD estimator is defined as the difference in mean outcomes for post-reform workers ages 62-64 and 59-61, minus the same difference for pre-reform workers. The pre-reform (post-reform) group includes the cohorts 1946-1948 (1949-1954). The pre-reform (post-reform) group is observed between 2008 and 2010 (2008 and 2013).

Heteroskedasticity robust standard errors in parentheses. \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

Figure A2: Age specific DD estimates from UI (left panel) and DI (right panel) benefits receipt regressions, AFP workers.



Note: The estimated pre-post reform difference in UI rates (standard error) at age 59 is -0.001 (0.001), and the corresponding difference (standard error) in DI rates is 0.000 (0.001).

## A.4 Additional results, non-AFP workers

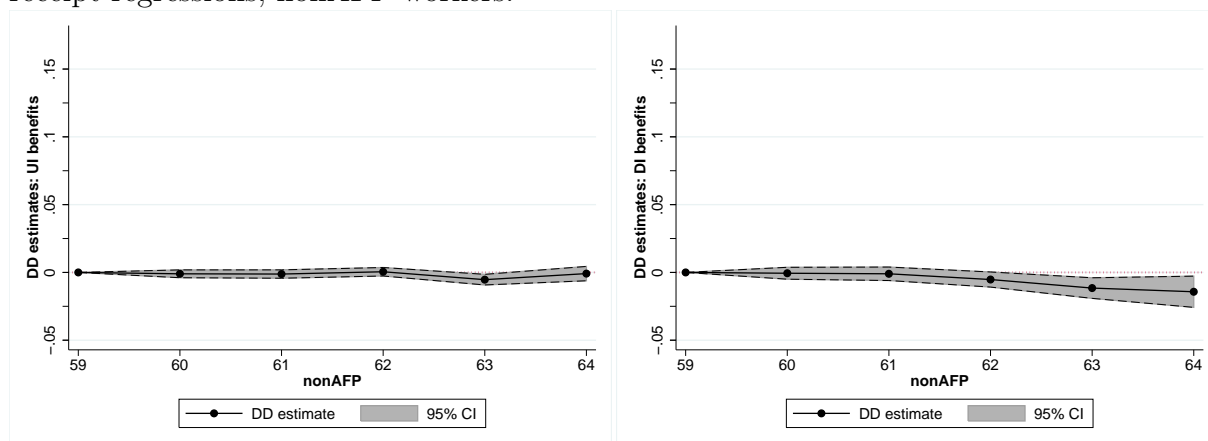
Table A2: Diff-in-diff regressions, UI and DI rates of non-AFP workers.

	UI			DI		
	(1)	(2)	(3)	(4)	(5)	(6)
DD estimate	-0.001 (0.001)	-0.001 (0.001)	0.000 (0.003)	-0.007*** (0.003)	-0.010*** (0.003)	-0.001 (0.006)
Controls included	No	Yes	Yes	No	Yes	Yes
Linear time-trend for age > 62	No	No	Yes	No	No	Yes
Mean pre-reform, ages 62-64	0.027	0.027	0.027	0.132	0.132	0.132
<i>N. of individuals</i>	58,558	58,558	58,558	58,558	58,558	58,558
<i>N. of observations</i>	190,623	190,623	190,623	190,623	190,623	190,623

The sample includes nonAFP workers of age 59-64, and the DD estimator is defined as the difference in mean outcomes for post-reform workers ages 62-64 and 59-61, minus the same difference for pre-reform workers. The pre-reform (post-reform) group includes the cohorts 1946-1948 (1949-1954). The pre-reform (post-reform) group is observed between 2008 and 2010 (2008 and 2013).

Heteroskedasticity robust standard errors in parentheses. \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

Figure A3: Age specific DD estimates from UI (left panel) and DI (right panel) benefits receipt regressions, nonAFP workers.



Note: The estimated pre-post reform difference in UI rates (standard error) at age 59 is -0.002 (0.001), and the corresponding difference (standard error) in DI rates is -0.006 (0.001).

Figure A4: Frequency of individuals by distance from eligibility threshold, in bins of 0.01 of the running variable. Sample: Workers in non-AFP firms born 1949-1951, excluding workers with a history of DI receipt prior to age 62. n = 16,130.

