How Does Retirement Behavior Respond to Drastic Changes in Social Security Rules? Evidence from the Norwegian 2011 Pension Reform*

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Abstract

We study earnings and employment responses of the 2011 Norwegian pension reform. This reform brought three major changes: (i) the possibility to start claiming pensions anytime between ages 62 and 75; (ii) actuarially neutral pension adjustments for early/late claiming; and (iii) the abolishment of the earnings test. Prior to the reform, only workers eligible to a supplementary occupational pension scheme (AFP workers) had access to a pension from age 62, while nonAFP workers had access not until age 67; there were no actuarial pension adjustments, and there was a restrictive earnings test. Using a difference-in-differences framework we find substantially higher earnings and higher employment for AFP workers; and lower earnings and unchanged employment for nonAFP workers. Using the bunching approach, we estimate labor supply elasticities from retirement spikes at age 62. For APF workers, we find a large spike before and a lower spike after the reform, while there is no spike for nonAPF workers. We argue that these responses are in line with the (changes in) work incentives of Norwegian pension rules. The implied labor supply elasticity, however, is small: while employment responses (among AFP workers) are substantial, the implicit work incentives of the (changes in) pension rules are huge.

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

JEL Classification: J14; J26; J32; H55.

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1 Introduction

In response to dramatic demographic changes and the associated financial pressures on PAYGO old-age pension systems, many countries have implemented reforms to their old age social security systems to increase the work incentives for older individuals. This paper studies the labor supply responses of older workers to the Norwegian 2011 pension reform, which fundamentally changed the existing old age social security system.\(^1\)

Prior to the reform, the Norwegian pension system had three main features: (i) a regular/statutory retirement age (RRA, age 67) and an early retirement age (ERA, age 62); (ii) an absence of increases in future pensions for postponing retirement (between ages 62 and 67); and (iii) a rather restrictive earnings test\(^2\). The 2011 pension reform brought drastic changes along all three dimensions. First, all individuals can now start claiming their pension anytime from age 62, while previously, claiming at age 62 was available only to a subset of workers. Second, the reform introduced actuarially fair pension adjustments for postponing pension claiming up to age 75. Third, the earnings test was abolished. These three changes together imply that the decision to claim pension benefits is now largely disentangled from the decision to withdraw from the labor market. The RRA at 67 is effectively abolished, and workers can claim their pension anytime between ages 62 and 75 without affecting their social security wealth (the expected present value of pension benefits).

A major intention of the reform was to increase work incentives for older workers. Under the old system, work incentives at age 62 and later were very weak. The absence of pension adjustments between ages 62 and 67 was associated with strong incentives for pension claiming at the earliest possible age, the ERA. Moreover, the restrictive earnings

\(^1\)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. 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 (2013). The Norwegian 2011 pension reform has also been studied by Hernæs et al. (2016), who report findings in line with our estimated reform impacts.

\(^2\)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.
test provided incentives that strongly discouraged continued work after pension claiming. In other words, the combination of a restrictive earnings test and an absence of a pension deferral mechanism (that rewards claiming at a later age with a higher pension) implies a high implicit tax on earnings. The resulting reduction in the net wage generates a kink in the lifetime budget constraint at the ERA. As a result, many workers claimed the pension at age 62 and completely stopped working at the same time, leading to retirement “spikes” or “bunching” at the ERA 62.3

An important feature of the Norwegian pension system is the contractual AFP pension to which only a subset of (mainly unionized) workers are eligible. AFP is an early retirement scheme that is granted to workers employed in a firm subject to the AFP scheme on the basis of union contracts (“AFP workers” in the following). AFP affiliation is associated with a large increase in lifetime income for eligible workers: On average, the discounted value of an AFP pension drawn from age 62 to age 67 amounts to more than 2 yearly earnings. In other words, AFP affiliation is associated with a non-negligible (5 percent) increase in lifetime earnings. If a worker quits or loses her job for other reasons, without first claiming the AFP pension, access to the AFP pension is lost.

The 2011 reform affected AFP- and nonAFP workers in distinctively different ways. Under the old system, claiming a pension at the ERA was only possible for AFP workers; workers in firms not affiliated with AFP (“nonAFP” workers) could only claim their pension at or after the RRA. After the reform, nonAFP workers could claim from age 62 albeit with an actuarially fair reduction of the pension. For AFP workers, the ERA remained unchanged but the pension formula became actuarially neutral between ages 62 and 75 (a substantially lower pension at age 62, but higher when the pension is claimed at later ages). The reform thereby provides us with an opportunity to study the effects of a reduction in the ERA for nonAFP workers, and the effects of a substantial increase

3Spikes at the early (and regular) retirement age are observed in many countries. However, it is not clear whether 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. See inter alia Rust and Phelan (1997); Baker and Benjamin (1999); Gruber and Wise (2004); Behaghel and Blau (2012); Manoli and Weber (2012).
in the net returns to work after the ERA for AFP workers.

Our empirical approach is twofold. First, we perform difference-in-differences analyses by age and calendar time to study 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 on employment and annual earnings. Interestingly, the diff-in-diff analysis does not indicate major employment responses for nonAFP workers following the decrease in the retirement age from 67 to 62. This suggests that nonAFP workers are neither behaving in a purely myopic manner, nor are they subject to binding liquidity constraints (which would have induced them to retire at the earliest possible age, generating bunching at age 62). However, while the extensive margin of labor supply is not affected, we find some evidence of responses along the intensive margin. NonAFP workers generate moderately (but statistically significantly) lower earnings after 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.

Our second empirical approach focuses on “excess retirement”, i.e. on the spikes in retirement at age 62 that are observed among AFP workers. This second approach is based on the bunching method (Saez (2010); Kleven and Waseem (2013)). Under the pre-reform regime, there are two institutional features giving rise to excess retirement at age 62. The first is the kink in the lifetime budget constraint at the ERA (due to the absence of a pension deferral mechanism and a restrictive earnings test) which substantially reduces the net returns to work beyond the ERA. This kink in the lifetime budget constraint generates “bunching from above”: In the absence of a kink, some workers would retire at an age above the ERA rather than exactly at the ERA. The second feature is that AFP benefits are lost for individuals retiring prior to the ERA. This creates a strong incentive not to retire before age 62, in terms of an upward notch in the lifetime budget constraint at the ERA, and generates “bunching from below”: In the absence of the notch, some individuals would retire at an age below the ERA rather than exactly at the ERA. With the 2011 reform, the kink disappears due to the introduction of an actuarially fair pension
formula and the abolishment of the earnings test. The notch remains: being eligible for an AFP pension still makes a big difference also after the reform, although the present value of the AFP pension is slightly lower than before, due to a change in the pension benefits formula.

Our bunching analysis based on AFP (and nonAFP) workers’ retirement age distributions suggests that empirically observed retirement patterns are well in line with theoretical predictions: The large spike for AFP workers occurring exactly at the ERA is significantly lower for post-reform cohorts than for pre-reform cohorts. Moreover, what appears to be a pent-up desire for early retirement materializes 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 – and that adjustment frictions that have been found relevant in other settings (Kleven and Waseem (2013); Gelber et al. (2013)) are less prevalent in the Norwegian case.

The paper is organized as follows: In Section 2 we describe 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

The Norwegian pension system consists of several different parts, the most important one for a majority of the pensioners being the National Insurance Scheme (NIS). The NIS is a universal coverage pay-as-you-go pension system, providing all Norwegian citizens with a minimum pension, and with an additional earnings related pension for those who have had sufficient earnings throughout their working lives. Prior to the reform, pension benefits from the NIS were only available from age 67, but the contractual early retirement scheme AFP, which covered about 50% of all private sector workers, provided covered workers
with pension benefits between ages 62 and 67. The AFP scheme was rather generous, in that benefits from age 62 were the same as they would have been had the worker continued working until age 67, but postponed claiming was not compensated with higher future benefits, and there was a strict earnings testing system in place. The 2011 reform brought major changes to both the public pension system, the NIS, and to the private sector AFP scheme, with AFP now being completely integrated with the NIS in terms of a supplemental benefit for eligible workers. In the post-reform system, both the NIS and the AFP pension schemes can be characterized by three main features: (i) claiming of pensions can take place at any age between 62 and 75; (ii) annual benefits are subject to actuarial adjustments based on the mean expected longevity of each cohort; and (iii) there is no earnings testing.

Our analysis focuses on private sector workers\(^4\), and distinguishes between two groups of private sector workers that were affected by the reform in very different ways. Workers employed in private sector firms affiliated with the early retirement scheme AFP experienced the most pronounced changes in work incentives as a result of the reform, with the earnings testing and the implicit tax on continued work past the ERA being completely removed. For AFP covered workers, the ERA was not changed by the reform. Workers not covered by AFP, on the other hand, got access to public pension benefits from the NIS up to five years earlier than before, at actuarially neutral terms.

Changes in work incentives for AFP workers are illustrated in Figure 1. The figure shows the pension wealth (left panel) and the annual pension benefits (right panel) of a hypothetical individual with 40 years of earnings at age 62, earning 6 Basic Amounts\(^5\) every year (which is close to the average yearly income of an AFP worker). In the old system, pension wealth was decreasing with age at claiming (i.e. the worker’s age when the pension is claimed for the first time). This stands in sharp contrast to the new system,

\(^4\)Public sector workers are also covered by a contractual AFP pension scheme, but a breakdown in negotiations about the pension reform in the public sector left the public sector AFP scheme largely unchanged. For this reason we confine the analysis to private sector workers.

\(^5\)The Basic Amount (BA) is a central feature of the public pension system in Norway. It is adjusted every year, with a nominal rate of growth varying between 2 and 13% since its introduction in 1967, and from the late nineties onward in accordance with the average wage growth in the economy. In 2013, one BA was equal to NOK 84,204, which at the time of writing corresponds to about USD 10,200.
in which pension wealth is independent of claiming age.

The right panel of Figure 1 illustrates the impact of actuarial adjustments in terms of annuitized annual pensions, defined as total pension wealth divided by the expected number of years with pension receipt. These are close to being constant in the old system, and increasing with claiming age in the new system. We also note that, for the hypothetical individual of our 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 pension 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 simple model of labor supply and pension claiming, to highlight the differences in incentives and the resulting differences with respect to optimal pension claiming age and optimal age of withdrawing from the labor force. 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 test imposes an implicit tax on continuing work after having claimed the pensions. Solving for the optimal claiming age as a function of retire-
Figure 1: Total pension 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, earning 6 Basic Amounts every year. In 2013, 1BA = NOK 84,204 \approx USD 10,200.

We show that individuals who stop working before they are allowed to claim will claim benefits at the ERA, while those working longer than the ERA will optimally claim benefits at the age when they withdraw from the labor market. In other words, under the old system, it is never optimal to combine work and pension claiming. Under the post-reform system, in contrast, the pension claiming age and the age of labor force withdrawal 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 an earnings test.

Figure 2 shows lifetime budget constraints in the pre- and post-reform regimes, separately for AFP and nonAFP workers. Notice first that, before age 62, the lifetime budget constraints of AFP and nonAFP workers coincide. If an AFP worker stops working before age 62, all prospective AFP claims are lost and the two workers are in the exact same situation. Differences arise from the ERA and beyond. While the budget constraint is smooth and continuous for nonAFP workers, the budget constraints for AFP workers are discontinuous, with upward notches at the ERA. The size of the notches correspond to the value of AFP affiliation. As we will discuss in section 5 below, the size of this upward notch is substantial. In our pre-reform sample the average notch size is equal
to 2.55 yearly incomes, while in the post-reform sample the number decreases to 1.95 yearly incomes. Moreover, the slope of the lifetime budget constraint for pre-reform AFP workers is relatively flat from age 62 onward, reflecting the earnings test and the absence of a pension deferral mechanism. In the post-reform system, the slope of the budget constraint is the same on both sides of the ERA, due to the actuarially neutral pension deferral mechanism and the absence of earnings testing.

Consider a population of individuals with heterogeneous preferences for leisure that are smoothly distributed across the population, and assume that there is no variation in lifetime budget constraints within each of the following three groups of workers: non-AFP workers; AFP workers, pre reform; and AFP workers, post reform. In this stylized example, retirement age will be smoothly distributed among non-AFP workers, due to the continuous budget constraint. However, for both pre- and post-reform AFP workers, changes in the level and slope of the lifetime budget constraint at the ERA will be reflected in the distribution of optimal retirement ages. In particular, both the notch and the kink (for pre-reform workers only) in the lifetime budget constraints will create an excess mass of workers for whom it is optimal to retire exactly at age 62, the ERA. In section 5 we will adopt the bunching methodology (Saez (2010); Kleven and Waseem (2013)) that exploits kinks and notches in budget schedules to estimate labor supply elasticities.

3 Data, samples, and descriptive statistics

The data used in this paper combines several administrative registers linked by unique personal identification numbers. Our main data source 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 baseline samples consist of private sector workers who were employed at the end of the calendar year in which they turned 58, and did not receive any disability or unemployment insurance benefits. The estimation samples include a set of pre-reform cohorts, consisting of individuals who turned 62 prior to the reform (born 1945-1948), and a set of post-reform cohorts, consisting of individuals who were younger than 62 in 2010 (born 1949-1955). 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. We also exclude the corresponding age-year observations in the pre-reform period, to make sure that the sample contains the same number of cohorts at each age on both sides of the reform. Hence, our estimation results are based on observations of pre-reform cohorts over the period 2007-2010, and on observations of post-reform cohorts over the period 2008-2014.

Descriptive statistics for pre- and post-reform cohorts of workers divided into four
different groups in accordance with our difference-in-differences framework 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 (about 20% 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.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Post Mean (sd)</th>
<th>Pre Mean (sd)</th>
<th>Post Mean (sd)</th>
<th>Pre Mean (sd)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>0.71 (0.45)</td>
<td>0.72 (0.45)</td>
<td>0.70 (0.46)</td>
<td>0.72 (0.45)</td>
</tr>
<tr>
<td>Married</td>
<td>0.70 (0.46)</td>
<td>0.73 (0.44)</td>
<td>0.68 (0.47)</td>
<td>0.72 (0.45)</td>
</tr>
<tr>
<td>Higher education$^a$</td>
<td>0.19 (0.40)</td>
<td>0.18 (0.39)</td>
<td>0.21 (0.41)</td>
<td>0.19 (0.39)</td>
</tr>
<tr>
<td>Earnings (in BA)$^b$</td>
<td>7.00 (4.59)</td>
<td>6.79 (3.37)</td>
<td>6.95 (4.41)</td>
<td>6.92 (4.18)</td>
</tr>
<tr>
<td>Experience$^c$</td>
<td>23.3 (2.53)</td>
<td>23.3 (2.33)</td>
<td>23.2 (2.79)</td>
<td>23.3 (2.41)</td>
</tr>
<tr>
<td>At least 1 yr without pension points$^d$</td>
<td>0.15 (0.36)</td>
<td>0.16 (0.37)</td>
<td>0.15 (0.35)</td>
<td>0.16 (0.36)</td>
</tr>
<tr>
<td>Months with sick leave benefits$^e$</td>
<td>0.83 (2.03)</td>
<td>0.88 (2.12)</td>
<td>0.79 (2.00)</td>
<td>0.84 (2.06)</td>
</tr>
<tr>
<td>Sick leave at age 58</td>
<td>0.21 (0.41)</td>
<td>0.22 (0.41)</td>
<td>0.20 (0.40)</td>
<td>0.21 (0.41)</td>
</tr>
<tr>
<td>Employed in small firm$^f$</td>
<td>0.03 (0.18)</td>
<td>0.05 (0.21)</td>
<td>0.03 (0.17)</td>
<td>0.04 (0.20)</td>
</tr>
<tr>
<td>Employed in manufacturing</td>
<td>0.35 (0.48)</td>
<td>0.39 (0.49)</td>
<td>0.31 (0.46)</td>
<td>0.37 (0.48)</td>
</tr>
<tr>
<td>Eastern Norway</td>
<td>0.40 (0.49)</td>
<td>0.43 (0.49)</td>
<td>0.39 (0.49)</td>
<td>0.41 (0.49)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variable</th>
<th>nonAFP workers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>0.73 (0.44)</td>
</tr>
<tr>
<td>Married</td>
<td>0.73 (0.45)</td>
</tr>
<tr>
<td>Higher education$^a$</td>
<td>0.25 (0.43)</td>
</tr>
<tr>
<td>Earnings (in BA)$^b$</td>
<td>7.15 (4.53)</td>
</tr>
<tr>
<td>Experience$^c$</td>
<td>22.8 (3.40)</td>
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<tr>
<td>At least 1 yr without pension points$^d$</td>
<td>0.25 (0.43)</td>
</tr>
<tr>
<td>Months with sick leave benefits$^e$</td>
<td>0.76 (2.00)</td>
</tr>
<tr>
<td>Sick leave at age 58</td>
<td>0.18 (0.39)</td>
</tr>
<tr>
<td>Employed in small firm$^f$</td>
<td>0.51 (0.50)</td>
</tr>
<tr>
<td>Employed in manufacturing</td>
<td>0.10 (0.31)</td>
</tr>
<tr>
<td>Eastern Norway</td>
<td>0.41 (0.49)</td>
</tr>
</tbody>
</table>

| N. of individuals | 37,222 | 38,314 | 56,095 | 57,186 |
| N. of observations | 93,406 | 94,755 | 111,618 | 114,685 |

The sample includes workers born between 1945 and 1955, and the observation period covers the years 2007-2014. We observe workers in the sample at ages 59-65, but exclude post-reform observations of workers who turned 62 prior to the reform. We also exclude the corresponding age-year observations in the pre-reform period, to make sure that the sample contains the same number of cohorts at each age on both sides of the reform. “Pre-reform” (“post-reform”) refers to the years 2007-2010 (2011-2014).

$^a$ University level education.

$^b$ Total earnings in base year, i.e. at age 58.

$^c$ Number of years with income > $1BA between ages 34 and 57.

$^d$ Measured from age 34.

$^e$ Number of months with receipt of sickness leave benefits during the base year.

$^f$ = 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 on behavioral responses to the 2011 pension reform among AFP workers. Starting with the labor market exit hazards in the left panel, we see that there are large spikes at the early and regular retirement ages. Comparing the pre- and post-reform hazards, we note that the labor market exit spike at the ERA is significantly lower for the post-reform cohorts, suggesting that the reform indeed generated postponed withdrawal from the labor force. (Notice that the lower labor market exit hazards before the ERA for post-reform workers most likely reflects a general trend towards later retirement that is unrelated to the reform.) The right panel shows pension claiming hazard rates for AFP workers. Among the pre-reform cohorts of workers, about 30 percent claim their AFP pension at the ERA. This fraction corresponds very well to the increase in the labor market exit hazard from age 61 to age 62 for the same cohorts of workers. In response to the reform, the claiming hazard at age 62 and above increases significantly. The two panels together show how the tight connection between pension claiming and labor market exit decisions has been loosened up by the reform: claiming pensions at age 62 has become much more common, while exiting at age 62 has become less common.

To estimate reform effects on different outcomes we rely on the following difference-in-differences specification:

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

(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 62-65, 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 62-65 (the treatment group), relative to the before-
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 (1949-1955) cohorts, and pre-reform (post-reform) hazard rates are averages of annual hazards over the period 2000-2010 (2008-2014).

Figure 4 shows trends in employment rates for the different age groups in our sample. 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 markers for age 63 in 2011, for age 64 in 2011 and 2012, and for age 65 in 2011-2013. This is due to our estimation sample excluding 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.

Figure 4: Trends in employment rates, AFP workers.
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 62-65, the difference-in-differences estimates indicate an increase in registered employment of about 26 percent, and an increase in annual earnings of about 15 percent. These estimates are to a large extent driven by responses at age 62, since on each side of the reform we observe four cohorts at age 62, three cohorts at age 63, two at age 64, and only one cohort at age 65. As responses 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 63-65 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 20% (6%) at age 62; 30% (22%) at age 63; 39% (30%) at age 64; and 43% (36%) at age 65.

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 0.016 (0.001), and the corresponding difference (standard error) in mean earnings is 0.015 (0.022). Annual earnings are measured in Basic Amounts; in 2013, 1BA = NOK 84,204 ≈ USD 10,200.
Table 2: Diff-in-diff regressions, employment and labor earnings\(^a\) of AFP workers.

<table>
<thead>
<tr>
<th></th>
<th>Employment</th>
<th>Yearly labor earnings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>DD estimate</td>
<td>0.133***</td>
<td>0.132***</td>
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<tr>
<td></td>
<td>(0.002)</td>
<td>(0.002)</td>
</tr>
<tr>
<td>Controls included</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Linear time-trend for age &gt; 62</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Mean pre-reform, ages 62-64</td>
<td>0.510</td>
<td>0.510</td>
</tr>
<tr>
<td>N. of individuals</td>
<td>103,833</td>
<td>103,833</td>
</tr>
<tr>
<td>N. of observations</td>
<td>414,464</td>
<td>414,464</td>
</tr>
</tbody>
</table>

The sample includes AFP workers of age 59-65, and the DD estimator is defined as the difference in mean outcomes between post-reform workers ages 62-65 and 59-61, minus the same difference for pre-reform workers. The pre-reform (post-reform) group includes the cohorts 1945-1948 (1949-1955). The pre-reform (post-reform) group is observed between 2007 and 2010 (2007 and 2014).

Heteroskedasticity robust standard errors in parentheses. \( * p < 0.10, \*\* p < 0.05, \*\*\* p < 0.01. \)
\( a \) Earnings measured in Basic Amounts (BA). In 2013, 1BA = NOK 84,204 \approx USD 10,200.

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 towards 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 62-65. We see that combining pension receipt with continued work has become much more common. Note further that the increase in the probability of “pension and working” can be divided approximately equally between decreases in the two “not working” outcomes (with and without a pension), on the one hand, and the decrease in the “no pensions and working” outcome, on the other.

Since the old-age pension system is one of several social insurance programs, changes in the pension system could generate changes in the take-up of unemployment and disability insurance benefits.\(^6\) To check whether this is indeed the case, we apply our difference-

\(^6\)Such “benefit substitution” has been the subject of several studies, see e.g. Autor and Duggan (2003);
Table 3: Single difference regressions, work and pension outcomes, AFP workers.

<table>
<thead>
<tr>
<th></th>
<th>Pension</th>
<th>No pension</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Working</td>
<td>Not working</td>
</tr>
<tr>
<td>Difference estimate</td>
<td>0.324***</td>
<td>-0.085***</td>
</tr>
<tr>
<td></td>
<td>(0.002)</td>
<td>(0.002)</td>
</tr>
<tr>
<td>Controls included</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Mean pre-reform</td>
<td>0.093</td>
<td>0.306</td>
</tr>
<tr>
<td>N. of individuals</td>
<td>75,536</td>
<td>75,536</td>
</tr>
<tr>
<td>N. of observations</td>
<td>188,161</td>
<td>188,161</td>
</tr>
</tbody>
</table>


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

...in-differences framework to estimate reform impacts on unemployment and disability insurance benefits receipt.\(^7\) Results from this exercise are reported in Section A.4 in the Appendix. We find a slight increase in unemployment benefit receipt, which is entirely driven by an increase in the fraction of individuals receiving both pension and unemployment benefits, a combination which was not possible in the pre-reform regime. We also find a small increase in terms of disability benefit receipt (in the specification where all controls are included), but the effect is not robust and varies across alternative specifications. Also, the estimated employment effects are an order of magnitude larger than the unemployment and disability responses.

### 4.2 Impacts of the reform on nonAFP workers

As mentioned above, AFP and nonAFP workers were quite differently affected by the 2011 reform. Recall that the latter group of workers could only claim pensions from age 67 in the pre-reform system, while in the post-reform system they have access to the pension benefits already from age 62. Given the actuarially neutral pension adjustments Duggan et al. (2007); Karlström et al. (2008); Staubli (2011); Inderbitzin et al. (2013); Vestad (2013); Borghans et al. (2014).

\(^7\)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.
introduced with the 2011 reform, the only change for non-AFP workers is in terms of increased flexibility with respect to how to allocate one’s pension wealth. In the absence of liquidity constraints and myopic behavior there is no reason why this access to liquidity should have an impact on non-AFP workers’ 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 their pension benefits at younger ages: About 30% of non-AFP 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 (1949-1955) cohorts, and pre-reform (post-reform) hazard rates are averages of annual hazards over the period 2000-2010 (2008-2014).

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 but, perhaps surprisingly, the reform had a negative impact on annual earnings after age 62. Evaluated at pre-reform sample means, the point estimates correspond to reductions in annual earnings of 1, 3, and 5% at ages 62, 63, and 64-65, respectively. Compared to the large positive earnings effects for AFP workers, these effects are modest though not negligible. This might suggest that liquidity constraints could have some impact on non-AFP workers’ labor market behavior, that shows up in terms of intensive margin responses (earnings), but not in terms of extensive margin.
responses (employment). One interpretation is that non-AFP workers are using their own pension wealth to finance gradual retirement. This hypothesis is further investigated below.

Table 4: Diff-in-diff regressions, employment and labor earnings\(^a\) of non-AFP workers.

<table>
<thead>
<tr>
<th>DD estimate</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>-0.001</td>
<td>-0.004</td>
<td>-0.016**</td>
<td>-0.166***</td>
<td>-0.169***</td>
<td>-0.444***</td>
<td></td>
</tr>
<tr>
<td>(0.003)</td>
<td>(0.003)</td>
<td>(0.007)</td>
<td>(0.041)</td>
<td>(0.034)</td>
<td>(0.074)</td>
<td></td>
</tr>
</tbody>
</table>

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: 0.741 0.741 0.741 5.190 5.190 5.190

N. of individuals: 71,865 71,865 71,865 71,865 71,865 71,865

N. of observations: 277,440 277,440 277,440 277,440 277,440 277,440

The sample includes non-AFP workers of age 59-65, and the DD estimator is defined as the difference in mean outcomes between post-reform workers ages 62-65 and 59-61, minus the same difference for pre-reform workers. The pre-reform (post-reform) group includes the cohorts 1945-1948 (1949-1955). The pre-reform (post-reform) group is observed between 2007 and 2010 (2007 and 2014). Heteroskedasticity robust standard errors in parentheses. \( * p < 0.10, ** p < 0.05, *** p < 0.01. \)

\(^a\) Earnings measured in Basic Amounts (BA). In 2013, 1BA = NOK 84,204 \( \approx \) USD 10,200.

As for the combined pension and work outcomes, the single-difference estimates for non-AFP workers in Table 5 show how responses to the reform appear to be driven by substantial increases in pension claiming and not by extensive margin labor supply responses. The 31.9 percentage point increase in the “pension and working” outcome is mirrored by a 30 percentage point decrease in the “no pension and working” outcome, and the 8.3 percentage points increase in the “pension and not working” outcome is counteracted by a 10.2 percentage points decrease in the “no pension and not working” outcome. There is no robust evidence of changes in the inflows into unemployment or disability insurance benefits among non-AFP workers. (Results reported in Section A.5 in the Appendix.)
A closer look at extensive margin responses among nonAFP workers

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 1949-1952, 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 pension benefits 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.5 in the Appendix, which shows the frequency of individuals by distance from the eligibility

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

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.

A closer look at intensive margin responses among nonAFP workers

The negative impacts of the 2011 reform on the intensive margin of labor supply for nonAFP workers is somewhat puzzling. One possible explanation is binding liquidity constraints: the estimated earnings reductions after age 62 could be driven by individuals

<table>
<thead>
<tr>
<th></th>
<th>Pension</th>
<th>No pension</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Working</td>
<td>Not working</td>
</tr>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>Difference estimate</td>
<td>0.319***</td>
<td>0.083***</td>
</tr>
<tr>
<td></td>
<td>(0.002)</td>
<td>(0.001)</td>
</tr>
<tr>
<td>Controls included</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Mean pre-reform</td>
<td>0.005</td>
<td>0.013</td>
</tr>
<tr>
<td>N. of individuals</td>
<td>48,579</td>
<td>48,579</td>
</tr>
<tr>
<td>N. of observations</td>
<td>119,524</td>
<td>119,524</td>
</tr>
</tbody>
</table>
who could not support a reduction in hours by own private savings before the reform, but take the opportunity to reduce their hours after gaining access to their own pension wealth from age 62 in the post-reform system. If the negative impacts on earnings are indeed driven by liquidity constraints, one would expect the effects to be stronger towards the lower parts than towards the upper parts of the net wealth distribution. Table 6 shows reform impacts on annual earnings, estimated separately for each quartile of the age 58 net wealth distribution. Results from the specification that does not adjust for observable characteristics show significant negative earnings impacts only at the lower half of the distribution, but when controls for observable characteristics are included, the estimated effects are very similar across the four quartiles (especially when evaluated relative to pre-reform mean earnings). From this we conclude that the negative intensive margin effects are unlikely to be driven by binding liquidity constraints.

Another possible explanation for the negative earnings responses is related to marginal tax rates. Some nonAFP workers may claim pensions at the earliest possible age and reduce employment slightly, so as to avoid being pushed up into a higher marginal tax rate bracket. In that case, one would expect effects to be driven primarily by individuals being close to the top marginal tax rate bracket, which corresponds to about 6 BA.
Table 6: Diff-in-diff estimates of reform impacts on earnings, non-AFP workers

<table>
<thead>
<tr>
<th>Specification</th>
<th>Q1</th>
<th>Q2</th>
<th>Q3</th>
<th>Q4</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>No controls</td>
<td>-0.231***</td>
<td>-0.225***</td>
<td>-0.059</td>
<td>-0.193</td>
<td>-0.177***</td>
</tr>
<tr>
<td></td>
<td>(0.059)</td>
<td>(0.054)</td>
<td>(0.069)</td>
<td>(0.118)</td>
<td>(0.041)</td>
</tr>
<tr>
<td>With controls</td>
<td>-0.151***</td>
<td>-0.150***</td>
<td>-0.209***</td>
<td>-0.239**</td>
<td>-0.182***</td>
</tr>
<tr>
<td></td>
<td>(0.051)</td>
<td>(0.043)</td>
<td>(0.056)</td>
<td>(0.104)</td>
<td>(0.034)</td>
</tr>
<tr>
<td>With controls + linear time-trend for age &gt; 62</td>
<td>-0.336***</td>
<td>-0.508***</td>
<td>-0.391***</td>
<td>-0.544**</td>
<td>-0.437***</td>
</tr>
<tr>
<td></td>
<td>(0.098)</td>
<td>(0.095)</td>
<td>(0.129)</td>
<td>(0.221)</td>
<td>(0.073)</td>
</tr>
</tbody>
</table>

Mean pre-reform, ages 62-65

<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>N. of individuals</td>
<td>15,887</td>
<td>15,881</td>
<td>15,885</td>
<td>15,878</td>
<td>63,531</td>
</tr>
<tr>
<td>N. of observations</td>
<td>67,293</td>
<td>67,271</td>
<td>67,287</td>
<td>67,255</td>
<td>269,106</td>
</tr>
</tbody>
</table>

The sample includes non-AFP workers of age 59-65, and the DD estimator is defined as the difference in mean outcomes between post-reform workers ages 62-65 and 59-61, minus the same difference for pre-reform workers. The pre-reform (post-reform) group includes the cohorts 1945-1948 (1949-1955). The pre-reform (post-reform) group is observed between 2007 and 2010 (2008 and 2014). Heteroskedasticity robust standard errors in parentheses. * p < 0.10, ** p < 0.05, *** p < 0.01.

a Outcome: Earnings measured in Basic Amounts (BA). In 2013, 1BA = NOK 84,204 ≈ EUR 10,800.

Investigate this possibility, we estimate reform impacts on the probabilities of having annual earnings above different thresholds; 0, 2, 4, 6, 8, and 10 BAs, respectively. Results from these regressions are reported in Table 7. We find significant effects at all parts of the earnings distribution, except at the extensive margin.

The reductions in earnings could also be a response to positive wealth effects, as individuals with short expected longevities will increase their total pension payouts by claiming early. In further results (not reported here) we find no robust evidence of differential responses across groups that are known to differ in terms of expected longevity; that is, when comparing men and women, and groups with high versus low education.

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8Brinch et al. (2016) find evidence of substantial selection in terms of early claiming decisions in the Norwegian pension system, after the 2011 reform: individuals who choose to claim pensions early are to a large extent those who gain in terms of expected lifetime pensions from claiming early.
Table 7: Diff-in-diff estimates of distributional impacts, non-AFP workers

<table>
<thead>
<tr>
<th>Specification:</th>
<th>$Y &gt; 0$</th>
<th>$Y &gt; 2$</th>
<th>$Y &gt; 4$</th>
<th>$Y &gt; 6$</th>
<th>$Y &gt; 8$</th>
<th>$Y &gt; 10$</th>
</tr>
</thead>
<tbody>
<tr>
<td>No controls</td>
<td>-0.000</td>
<td>-0.009***</td>
<td>-0.024***</td>
<td>-0.018***</td>
<td>-0.005</td>
<td>-0.005*</td>
</tr>
<tr>
<td></td>
<td>(0.002)</td>
<td>(0.003)</td>
<td>(0.004)</td>
<td>(0.004)</td>
<td>(0.003)</td>
<td>(0.003)</td>
</tr>
<tr>
<td>With controls</td>
<td>-0.001</td>
<td>-0.010***</td>
<td>-0.026***</td>
<td>-0.021***</td>
<td>-0.007***</td>
<td>-0.006***</td>
</tr>
<tr>
<td></td>
<td>(0.002)</td>
<td>(0.003)</td>
<td>(0.003)</td>
<td>(0.003)</td>
<td>(0.002)</td>
<td>(0.002)</td>
</tr>
<tr>
<td>With controls + linear time-trend for age &gt; 62</td>
<td>-0.015***</td>
<td>-0.037***</td>
<td>-0.053***</td>
<td>-0.058***</td>
<td>-0.032***</td>
<td>-0.013***</td>
</tr>
<tr>
<td></td>
<td>(0.005)</td>
<td>(0.006)</td>
<td>(0.007)</td>
<td>(0.007)</td>
<td>(0.005)</td>
<td>(0.005)</td>
</tr>
</tbody>
</table>

Mean pre-reform, ages 62-64:
- 0.868
- 0.754
- 0.625
- 0.362
- 0.183
- 0.097

N. of individuals:
- 63,531
- 63,531
- 63,531
- 63,531
- 63,531
- 63,531

N. of observations:
- 277,440
- 277,440
- 277,440
- 277,440
- 277,440
- 277,440

The sample includes non-AFP workers of age 59-65, and the DD estimator is defined as the difference in mean outcomes between post-reform workers ages 62-65 and 59-61, minus the same difference for pre-reform workers. The pre-reform (post-reform) group includes the cohorts 1945-1948 (1949-1955). The pre-reform (post-reform) group is observed between 2007 and 2010 (2008 and 2014).

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

a Earnings measured in Basic Amounts (BA). In 2013, 1BA = NOK 84,204 ≈ EUR 10,800.

5 Excess retirement at age 62

The above diff-in-diff analysis has shown that AFP workers increase earnings and employment in response to the reform. However, even after the reform, a large fraction of workers continue to retire at the ERA, the earliest possible age when workers can exit the labor force and claim pension benefits. The observation that a substantial retirement spike at the ERA prevails also for post-reform cohorts comes as no big surprise, given the strong and salient incentives faced by AFP workers both in the pre- and post-reform pension systems. The “excess” mass of AFP workers retiring exactly at the ERA suggests that applying the “bunching” methodology (see Saez (2010); Kleven and Waseem (2013); Kleven (2016)) is potentially useful for a better understanding of the labor supply elasticities underlying the observed earnings and employment responses.

Let “excess retirement” be defined as a mass point in the distribution of retirement ages. 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”). Recall that the budget set of nonAFP workers can be approximated by a linear budget constraint, both in the old and in the new system. This is particularly useful in the present context as the behavior of nonAFP workers provides us with a simple test of whether conditions (i)-(iii) are likely to hold true in the Norwegian context.

The left panel of Figure 9 shows the distribution of exit ages for nonAFP workers; 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. The small jump exactly at age 62 is likely due to mis-classifications. This supports the idea of the excess retirement at the ERA that we observe for AFP workers being due to the incentives in the pension system, rather than to non-standard preferences or liquidity constraints.

In contrast, the right panel of Figure 9 shows a large spike at the ERA for AFP workers. As illustrated by the lifetime budget constraints in Figure 2, in the pre-reform system there are two main reasons why excess retirement at the ERA is to be expected for AFP workers: (i) the smaller slope in the budget constraint that is due to the absence of actuarially neutral adjustments pensions if pension claiming is postponed to an age after the ERA; and (ii) the discontinuity created by the retirement bonus for remaining employed until age 62 that is granted to workers by the AFP scheme. The latter creates an “upward notch”, while the former creates a “kink” in AFP workers’ lifetime budget constraint. As a result of the kink, there will be “bunching from above”: workers who – in the absence of the kink – would retire at an age above 62, now decide to advance their

---

9To 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 as in many other countries job mobility of older workers is very low in Norway.

25
retirement to the ERA, due to the lower net return to work. As a result of the upward notch, there will be “bunching from below”: workers who – in the absence of the upward notch – would retire at an age below 62, now decide to postpone their retirement to avoid losing the AFP bonus.

The 2011 reform eliminated the kink at the ERA. However, the reform did only reduce – but not remove – the upward notch. As a result, one would still expect excess retirement under the post-reform regime, but excess retirement should be smaller, both because of the elimination of the kink and the reduction in the upward notch. This is indeed what we see from the right panel of Figure 9: Cohorts subject to the post-reform rules show a substantially lower excess retirement at age 62. Another interesting point to note is that the desire to postpone (or advance) retirement to the ERA appears to materialize into labor force exits occurring over the first few months after pension eligibility, and even more so after the reform than prior to the reform. In what follows, we will define “bunching at the ERA” as the excess retirement in the three first months after a worker age 62.

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).

In order to assess whether the (pre- and post-reform) ERA spikes for AFP workers can be reconciled with the incentives in the pension system that could potentially generate such bunching we proceed as follows: First, we estimate the amount of excess retirement
at the ERA by contrasting the observed retirement age distributions to an estimated counterfactual distribution. Second, we quantify the change in work incentives due to the kink and the upward-notch in the lifetime budget constraint. Since both the kink and the size of the notch vary across individuals (as the AFP bonus depends on work history), we need to quantify the notch for each individual separately. In a third step, we use the values obtained in steps one and two to calculate labor supply elasticities consistent with the observed bunching due to (changes in) pension incentives around the ERA. 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.

5.1 Bunching and counterfactual retirement age distributions

The simplest model of retirement is the canonical static labor supply model, where leisure is interpreted as the number of years spent in retirement. In the context of this model, we can apply the bunching methodology (Saez (2010) and Kleven and Waseem (2013)), which uses kinks and notches to estimate the elasticity of lifetime labor supply with respect to net wages. The three key assumptions in our application of the bunching approach are the following: (i) retirement behavior is similar across cohorts, in the absence of changes in incentives; (ii) there are no income effects; and (iii) retirement behavior is smooth in age when the lifetime budget constraint is linear.

Under the above assumptions, we can estimate the retirement age distribution in the absence of a distorting pension system. Note that the retirement age of AFP workers \textit{after age 62} should be unaffected under the post-reform system. With actuarially neutral pension adjustments (and in the absence of an earnings test), the bunching approach predicts that the retirement age distribution should only be affected by workers who postpone their retirement to make sure they get access to the AFP bonus. The prediction that optimal retirement ages after age 62 are unaffected relies on the assumption of no income effects.\textsuperscript{10}

\textsuperscript{10}This is an artifact of the quasilinear preferences that are standard in the bunching approach. Assuming quasilinear preferences implies that a parallel shift in the budget constraint changes consumption
The standard bunching approach is based on the assumption that, in the absence of discontinuities in the budget set, the density of retirement age is constant. We generalize this to polynomial densities. The counterfactual densities are estimated based on information about how many individuals have retired by age 62 years and three months, and the retirement behavior thereafter. We estimate the counterfactual densities by a regression of the non-employment rate on a third order polynomial in the distance from age 58, i.e.

\[ 1 - e_t = \sum_{j=1}^{3} \beta_j(t - 58)^j + \varepsilon_t, \]

using employment rates for workers above age 62 years and three months only. The counterfactual retirement age distribution is then derived as the negative of the derivative of the counterfactual employment rate function. The resulting counterfactual employment rates and the corresponding counterfactual retirement age distribution are shown in Figure 10, along with employment rates and the retirement age distribution, respectively, for post-reform AFP workers.

Figure 10: Actual employment rates and estimated counterfactual employment rates (left panel); age distribution of retirees and estimated counterfactual distribution (right panel).

Note: The sample includes post-reform AFP workers, cohorts 1949-1955. The counterfactual employment rates are estimated based on a regression of the non-employment rate on a third order polynomial in the distance from age 58, i.e. \( 1 - e_t = \sum_{j=1}^{3} \beta_j(t - 58)^j + \varepsilon_t \), using employment rates for workers above age 62 years and three months only, and the counterfactual retirement age distribution is derived as the negative of the derivative of the counterfactual employment rate function.

one for one, but leaves labor supply unaffected.
Having estimated the counterfactual retirement age distribution, we calculate the amount of bunching in retirement at the ERA simply as the sum of the differences between the actual and the counterfactual retirement age distributions over the first three months after age 62, relative to the counterfactual probability mass over the same age range. According to this procedure, the excess mass corresponds to 10.6 months of retirement for the post-reform cohorts, and 20.8 months for the pre-reform cohorts in the constant density model. Our estimates in the following are based on a counterfactual model with a quadratic retirement density. The estimated elasticities are quite robust with respect to the particular functional form with which the counterfactual density is estimated.

5.2 Measuring (changes in) work incentives

To measure the distortions in work incentives resulting from pension rules we have to quantify the size of the kink (in the pre-reform system) and the size of the upward notch (both in the pre-reform and the post-reform systems) of AFP workers’ lifetime budget constraints. The size of the upward notch is measured by the expected present value (EPV) of the pension granted to AFP workers (relative to nonAFP workers who do not have access to such a pension) and varies across individuals. To calculate EPVs of AFP affiliation for each worker in the sample, we use: pre- and post-reform pension formulas, earnings histories, and the age- and cohort-specific survival probabilities (obtained from the Norwegian Labour and Welfare Administration, NAV). The size of the kink in the lifetime-budget constraint is measured by the change in the net-of-tax rate at the ERA (for pre-reform workers). Notice that the change in the net-of-tax-rate at the ERA is generated by earnings testing of the pension against labor income. The change in the net-of-tax rate equals the compensation rate of the pension, which differs across individuals because the pension is a complex function of earnings over the lifetime.

The upper panels of Figure 11 show the distributions of EPVs of AFP affiliation relative to a measure of previous earnings\textsuperscript{11} for pre- and post-reform workers. We see that for both pre- and post-reform workers, the value of future AFP benefits varies considerably across

\textsuperscript{11}Our measure of previous earnings is implemented as the average of the three highest annual pensionable earnings from the last five years prior to age 62.
Figure 11: Expected present values (upper panels) and gross replacement rates (lower panel) of AFP benefits.

Note: The expected present values are measured relative to previous earnings in terms of Basic Amounts.

individuals. Among pre-reform workers, the average size of the upward notch amounts to 2.55 times annual earnings. The average notch size for post-reform workers amounts to 1.95 times annual earnings.

The distribution of gross replacement rates for pre-reform workers is shown in the lower panel of Figure 11. The mean replacement rate is 0.52. This means that the change in net income generated by an additional month of work is on average 52% lower after age 62 than prior to age 62 – up until the point at which current earnings exceed previous earnings and AFP benefits are set to zero. However, there is strong variation in this work-incentive measure across individuals. A detailed description of the procedures for calculating AFP benefits in the pre- and post-reform regimes, along with an explanation of why the relative change in the net-of-tax rate is captured by the gross replacement rate, is given in Appendix A.3.
5.3 Estimating labor supply elasticities from bunching

In what follows we apply the bunching approach to estimate the elasticity of lifetime labor supply with respect to the net wage within the context of the Norwegian pension system. Our starting point is the static labor supply model, where we interpret the quantity of work as the number of years one is willing to work and the budget constraint as a lifetime budget constraint. Assume that an individual’s preferences can be described by a quasi-linear utility function which, combined with a binding budget constraint, can be represented as

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

where \( w \) is the wage rate, \( l \) the quantity of labor supplied, \( T \) is a tax-benefit function that adjusts lifetime income based on lifetime earnings and the choice of quantity of work, and \( n \) is a heterogeneous skill parameter. With a baseline linear tax, \( T(wl, l) = T + twl \), the first order condition for optimum gives

\[ wl = n(1 - t)^e, \]

where \( e \) is the elasticity of labor supply with respect to the net of tax rate.

To capture the relevant pension rules for AFP workers, we need to specify their lifetime budget constraint in more detail. AFP workers receive an (after-tax) bonus \( b \) for working up to (or beyond) the ERA \( l = l^* \), with \( l^* \) being the number of years an individual has worked when reaching the ERA. Denote by \( t_1 \) the marginal tax rate before \( l^* \) and by \( t_2 \) the marginal tax rate thereafter. In the pre-reform system we have \( t_2 > t_1 \), due to the earnings test, while in the post-reform system we have \( t_2 = t_1 \). The tax schedule can be written as follows:

\[ T(wl, l) = \begin{cases} 
  t_1 wl & \text{when } l < l^* \\
  t_1 w l^* + t_2 w (l - l^*) - b & \text{when } l \geq l^*
\end{cases}. \]

The Norwegian pension rules feature an upward notch of size \( b \) at \( l^* \), which creates an
incentive to postpone retirement to age 62 to become eligible to the AFP bonus. This incentive is present in both the pre- and the post-reform system. Kleven and Waseem (2013) show how the bunching approach can be applied to upward notches in the budget constraint. In the online appendix they provide a formula from which the labor supply elasticity can be retrieved. Our formula below is equivalent to equation A1 in the online appendix of Kleven and Waseem (2013).

In the post-reform system, where the lifetime budget constraint can be approximated by a constant slope but an upward notch at \( l^* \), we estimate the elasticity as the only elasticity consistent with the observed bunching, using the following formula:

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

(6)

where \( l^* + \Delta l_b \) is the retirement age of the “marginal buncher” – the individual that is indifferent between retiring at age 62 and retiring before age 62. \( \Delta l_b < 0 \) tells us how may periods earlier than \( l^* \) the “marginal buncher” would retire in the absence of the notch. We obtain the retirement age of the marginal buncher, \( l^* + \Delta l_b \), from redistributing the observed excess mass at the ERA \( l^* \) to the counterfactual retirement density.

In the pre-reform (but not in the post-reform) system, the slope of the lifetime budget constraint becomes flatter after \( l^* \). This generates bunching from above (people adjust their retirement down to age 62 due to the higher implicit marginal tax rates). This means that the analysis of kinks, pioneered by Saez (2010), can be applied to explain bunching in the pre-reform system. We estimate the elasticity from the pre-reform data as the only elasticity consistent with bunching from below, as given by the formula above, and bunching from above, as in Saez (2010);

\[
\frac{\Delta l_a}{l^*} = -e \left( \frac{1 - t_1}{1 - t_2} \right),
\]

(7)

where \( l^* + \Delta l_a \) is the retirement age of the marginal buncher – the individual that optimally chooses retirement age \( l^* \) when the marginal tax rate is \( t_2 \) while he would optimally choose retirement age \( l^* + \Delta l_a \) with a marginal tax rate of \( t_1 \). In other words, \( \Delta l_a > 0 \) tells us
how may periods later than \( t^* \) the “marginal buncher” would retire in the counterfactual case where there is no kink in the lifetime budget constraint (i.e. the slope is as steep after \( t^* \) as it is before \( t^* \)). We obtain \( \Delta l_a \) by distributing the excess mass of retirees at \( t^* \) successively to the counterfactual retirement density.

Specifically, denoting the estimated counterfactual retirement distribution function as \( \hat{F} \) and the empirical distribution of retirement by \( \hat{G} \), we estimate bunching from below, \( M_b \) as \( \hat{M}_b = [\hat{G}(62 + \frac{3}{12}) - \hat{G}(62)] - [\hat{F}(62 + \frac{3}{12}) - \hat{F}(62)] \), that is, the difference between actual and counterfactual retirement in the interval defined as the relevant interval for bunching. For the post-reform data, with only a notch, we find our estimate \( \Delta l_b \) implicitly as \( \hat{M}_b = \hat{F}(62) - \hat{F}(62 + \Delta l_b) \). We then estimate the elasticity \( e \) based on Equation (6), plugging in the estimated \( \hat{M}_b \).

For the pre-reform data, that also include a kink, total bunching \( M \) is estimated as for the post-reform data with \( \hat{M} = [\hat{G}(62 + \frac{3}{12}) - \hat{G}(62)] - [\hat{F}(62 + \frac{3}{12}) - \hat{F}(62)] \). Total bunching consists of bunching from above and bunching from below, that is \( M = M_a + M_b \). In this case, we cannot decompose total bunching into bunching from above and bunching from below directly from the data, but we can do so through the model. Given the notch and kink sizes, along with experience \( t^* \), any particular elasticity \( e \) gives us \( l_b \) from equation (6) and \( l_a \) from equation (7). From these, we can work out \( M_a = \hat{F}(62 + \Delta l_a) - \hat{F}(62) \), \( M_b = \hat{F}(62) - \hat{F}(62 + \Delta l_b) \) and \( M \). \( M_a, M_b \) and \( M \) are all increasing functions in \( e \). We can therefore find the unique elasticity that equates bunching predicted from the model with bunching observed in the data, that is, solving \( \hat{M} = M(\hat{e}) \). This procedure is equivalent to the elasticity estimation procedures in Kleven and Waseem (2013), although we allow for non-constant densities. However, this procedure also gives a decomposition of total bunching into bunching from above and bunching from below as a by-product.\(^{12}\)

Table 8 gives the sample averages of the relevant incentives measures and average years of experience at age 61, along with the elasticities as calculated by equations (6) and (7). For the post-reform period, the observed bunching amounts to 0.886 years of

\(^{12}\)Specifically, we use \( M(e) = M_b(e) + M_a(e) = [\hat{F}(62) - \hat{F}(62 + \Delta l_b(e))] + [\hat{F}(62 + \Delta l_a(e)) - \hat{F}(62)], \) where \( l_a(e) \) is the implicit function generated by equation (7) and \( l_b(e) \) is the implicit function generated by equation (6).
retirement. This means that, in the baseline model where all workers have the same labor supply elasticity $e$ (and differ only in $w$ and $n$), no one would retire in the last 0.886 years (10.5 months) before age 62. This, in turn, means that the marginal buncher is indifferent between the interior solution of retirement at age 61.114 and retiring at age 62.

In order to estimate the elasticities we also need a measure of $l^*$. Measured in years, the average number of years worked at age 62 in our data is $l^* = 40.61$ and $l^* = 39.34$ in the pre- and post-reform regime, respectively. We use these averages in the estimation of the elasticities.

Table 8: Compensated lifetime labor supply elasticities estimated from bunching at age 62

<table>
<thead>
<tr>
<th></th>
<th>Post-reform</th>
<th>Pre-reform</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size of notch $(b/w)$</td>
<td>1.94</td>
<td>2.55</td>
</tr>
<tr>
<td>Size of “kink” $(1 - t_2)/(1 - t_1)$</td>
<td>1</td>
<td>0.48</td>
</tr>
<tr>
<td>Experience $l^*$ (lifetime)</td>
<td>40.61</td>
<td>39.34</td>
</tr>
<tr>
<td>Total bunching in years $(\Delta l)$</td>
<td>0.886</td>
<td>1.731</td>
</tr>
<tr>
<td>Bunching from above</td>
<td>0</td>
<td>0.387</td>
</tr>
<tr>
<td>Bunching from below</td>
<td>0.886</td>
<td>1.346</td>
</tr>
<tr>
<td>Lifetime labor supply elasticity</td>
<td>0.011</td>
<td>0.019</td>
</tr>
</tbody>
</table>

Note: The standard errors of the elasticities are 0.001, based on a bootstrap taking into account both the estimation of the counterfactual distribution and the estimation of the number of individuals bunching.

The estimation results are presented in Table 8. For the post-reform period, total bunching in years is measured in the simplified constant retirement density model as 0.9 years. The implied elasticity $e$ is quite small, equal to 0.011. Some back of the envelope calculations support the magnitude of this elasticity: As a result of the notch, an individual who would otherwise retire at exactly age 61 will gain approximately two annual incomes from the notch in addition to the standard income gained from working for one year. This 200 percent increase in the returns to work is not sufficient to generate a behavioral response of one year, which would mean that total bunching in years would be at least one. One year is an increase in labor supply of approximately 2.5 percent. Hence, the elasticity should be lower than $2.5/200 = 0.0125$.

For the pre-reform period, the observed bunching amounts to 1.731 years of retirement in the simplified constant retirement density model. However, we do not know how many of these workers would have retired before age 62 (due to the upward notch, bunching from
below) and how many would have retired after age 62 (due to the lower net returns after age 62 in the pre-reform system, bunching from above). The reported elasticity of 0.019 is the implicit elasticity generating the observed pre-reform bunching. An implication of this elasticity is that 1.346 years of retirement is bunching from below and 0.387 years is bunching from above. We see that the notch generates somewhat stronger incentives than the kink, in that the bunching from below is quite a bit larger than the bunching from above. This is related to our low elasticities. Even with a very low elasticity, a notch at age 62 will lead to discernible bunching because the welfare gains from moving from just below age 62 to just above age 62 are first order, while the welfare costs of a small deviation from an interior optimum are only of second order. The same mechanism is not at play for the kink.

When interpreting the very small lifetime labor supply elasticities estimated and reported in Table 8, it is important to keep in mind that the base used for labor supply is quite large. A one-year change in retirement age, which in some contexts may seem like a rather large change, thus translates into a 2.5 percent change in lifetime labor supply, which may seem like a small number. Of course, these are only different ways to frame the same fact. It is straightforward to go from our estimated elasticities to absolute effects on labor supply, for practical purposes - simply by multiplying the elasticity by 40. That is, our estimates, using a mid-estimate of 0.015, suggest that a ten percent change in net wages will increase labor supply by $0.015 \times 40 \times 0.1 = 0.06$ years, or about 22 days.

The assumptions from the simple static labor supply framework are rather strong and may raise doubt about the validity of the estimated elasticities. In particular, preferences and the life time budget constraint are assumed to be “static” in the sense that the values of $w$ and $n$ attached to a particular worker do not change over the life cycle. Moreover, individuals have perfect foresight, so that the optimal retirement age is effectively determined at the beginning of life. In reality, $w$ and $n$ are subject to (income and health) shocks, making retirement a sequential decision: retirement plans may be revised when new information is revealed to the worker. Such effects are not taken into account in our estimation procedures. Therefore, we may well underestimate the behavioral responses
by not appropriately taking into account the dynamic aspect of the retirement choice.\textsuperscript{13}

5.4 Heterogeneity in notch (and kink) sizes

The estimates in Table 8 above abstract from heterogeneity in work incentives created by the pension rules. However, we have seen above that both the size of the upward notch and the size of the kink vary substantially across workers. Clearly, the larger the size of the notch, the more people should bunch at age 62; and a more pronounced reduction in the slope of the budget constraint ("kink") should give rise to more bunching from above in the pre-reform regime.

Figure 12 provides a simple graphical check of this hypothesis with respect to the upward notch. It reports the cross-sectional relationship between the fractions of bunchers and the sizes of the notches both for the pre-reform (left panel) and the post-reform regime (right panel).\textsuperscript{14} Both figures reveal a strong positive relationship between the notch size and the amount of bunching.

The elasticities presented above were computed under the assumption that everyone was facing the same notch size. In Table 9, both pre- and post-reform workers have been sorted into three equally sized groups according to their notch sizes, as measured in terms of the expected present value of pension benefits over previous earnings. From the size of the elasticities in Table 9, we see that the estimated elasticities reported in Table 8 capture the average elasticities quite well. The main message from the two tables is that the (lifetime) elasticities are small. Moreover, the estimated elasticities are higher when the upward notch is more pronounced. This is consistent with a model of fixed adjustment costs. When adjustment costs are independent of notch size, we should expect larger

\textsuperscript{13}In a recent paper, Einav et al. (2016) study alternative economic models that can match the basic bunching pattern but have very different quantitative implications for the estimated counterfactual response. While their context is quite different (prescription drug insurance for the elderly in Medicare Part D, where a kink in the individual’s budget set generates substantial bunching in annual drug expenditure), the underlying problem is similar in the present context. The results from that paper suggest that the elasticity estimated from a model taking appropriately into account the dynamic nature of the retirement choice is likely larger than the one implied by a static model.

\textsuperscript{14}Pre-reform work incentives depend on both the size of the notch and the size of the kink. However, the notch and the kink are roughly proportional, so a larger notch also indicates a more pronounced kink. Kink- and notch-sizes are proportional because the EPV of pensions over previous earnings is proportional to the compensation rate in the pension system, and because the earnings testing is proportional to the compensation rate.
Figure 12: Cross sectional relationship between notch size and bunching mass in the pre- and post-reform systems

Note: Fraction of exits at the notch (age 62y1m) in bins of 25% of previous earnings, with the size of the circles being proportional to the number of individuals in each bin.

behavioral responses among workers with higher work incentives.

The above analysis has assumed that workers differ in $w$ and $n$, but the elasticity $e$ is identical across workers. In that case, the static labor supply model predicts that there should be a hole (zero mass) in the retirement distribution to the left of the notch. With identical (non-zero) elasticities and the same notch $b/w$ for all workers, all workers who react to the notch – i.e. who would assign themselves between $l^* + \Delta b$ (the marginal buncher) and $l^*$ in the absence of the notch will move to the notch, while other workers’ retirement age remains unaffected.\footnote{Strictly speaking, this argument requires the same work incentives. This does not hold true in the Norwegian context, as notch (and kink) sizes differ substantially across individuals. Nevertheless, the observed retirement age pattern cannot be explained by heterogeneity in incentives.} This pattern can potentially be explained by frictions, as in Manoli and Weber (2011), or by heterogeneity in incentives.

6 Conclusion

This paper studies the impacts of the 2011 reform of the Norwegian public pension system. Prior to the reform, the Norwegian system was characterized by three main 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 postponing pension claiming; and (iii) a rather
Table 9: Compensated lifetime labor supply elasticities estimated from bunching at age 62, by notch size

| Upward notch is ... | Post-reform | | | Pre-reform | | |
|---------------------|-------------|----------|----------|-------------|----------|
|                      | small | medium | large | small | medium | large |
| Size of notch (b/w)  | 1.37  | 1.98   | 2.47   | 1.93   | 2.61   | 3.10  |
| Size of “kink” (1 – t2)/(1 – t1) | 1 | 1 | 1 | 0.61 | 0.47 | 0.37 |
| Total bunching in years (∆l) | 0.47 | 0.82 | 1.37 | 1.15 | 1.74 | 2.30 |
| Lifetime experience t* | 38.9 | 40.7 | 43.3 | 38.5 | 39.1 | 40.4 |
| Bunching from below | 0.47 | 0.82 | 1.37 | 1.00 | 1.36 | 1.70 |
| Bunching from above | 0 | 0 | 0 | 0.15 | 0.39 | 0.61 |
| **Lifetime labor supply elasticity** | **0.006** | **0.010** | **0.018** | **0.014** | **0.019** | **0.024** |

restrictive earnings test. The 2011 pension reform changed these three features in a fundamental way. It introduced “flexible retirement”, meaning that individuals may claim their pension at any age between 62 and 75 without affecting their expected social security wealth, and without being subject to earnings testing of pension benefits. These changes largely disentangled the decision of when to start claiming the pension from the decision of when to withdraw from the labor market.

The 2011 reform affected two groups of private sector workers in very different ways. Workers in firms affiliated with the early retirement scheme AFP had access to pension benefits from age 62 in the pre-reform pension regime, but these were subject to a strict earnings test, and there were no actuarial adjustments in place. For AFP workers, the early retirement age remained fixed at age 62, but the incentives to work also after age 62 have dramatically increased. In contrast, workers not affiliated with AFP did not have access to pension benefits prior to age 67 in the pre-reform regime. After the reform, they could start claiming pensions from age 62, subject to actuarially neutral adjustments for early (or late) claiming.

Our analysis evaluates the 2011 pension reform and provides two pieces of evidence. *First*, based on difference-in-differences analyses we find strong employment and earnings responses for AFP workers. For nonAFP workers, we do not find any effect of the reform on employment rates (the extensive margin of labor supply) but we find some evidence of intensive margin responses, i.e. lower earnings after age 62. For both AFP and nonAFP
workers, we find no evidence of benefit substitution: neither disability nor unemployment insurance rates changed in any substantive way in response to the 2011 pension reform.

The second piece of evidence relates to the “excess” retirement at age 62 which is observed for AFP workers but not for nonAFP workers. While the spike at age 62 is strongly reduced with the reform, effects on employment are not large enough to remove the spike completely. The main reason for the remaining bunching in retirement at age 62 appears to be an upward notch in the lifetime budget constraint for AFP workers, which provides strong incentives to remain employed until age 62.

A closer look at excess retirement at age 62 reveals the importance of pension rules. One reason for excess retirement is that AFP benefits are lost when workers affiliated with the AFP scheme withdraw from the labor market before age 62. This work requirement rule of the AFP scheme creates an upward notch in the lifetime budget constraint and induces AFP workers who would otherwise have retired at an earlier age to postpone retirement to age 62. This incentive holds both in the pre- and the post-reform regimes. The fact that there is strong excess retirement for AFP workers at age 62 but no excess retirement for nonAFP workers at age 62 further suggests that myopic behavior and liquidity constraints are unlikely to be important drivers of the retirement spike observed among AFP workers.

In the pre-reform system, two further features were contributing to excess retirement at age 62: the absence of a deferral mechanism and a rather restrictive earnings test. This induced AFP workers who would otherwise have retired at a later age to advance their retirement to age 62. This incentive was eliminated with the 2011 reform. As a result, excess retirement at age 62 is substantially lower after the reform. We conclude that excess retirement before and after the 2011 reform is indeed mainly driven by work incentives created by pension rules.
References


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 Pension claiming and exiting employment: a simple model

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 $M$:

$$\max_{c,M,N} U = u(c) \cdot T + \theta \cdot (T - N)$$

$$s.t. \ cT \leq w(1 - p) \cdot \min(M, N)$$

$$+ w(1 - \tau) \mathbb{1}\{N > M\} (N - M) + b(M, N) (T - M) \quad (A1)$$

$$M \geq M \quad (A2)$$

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 ($\tau >> p$).

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 ($\tau = p$);

$$cT \leq w(1 - p) \cdot N + b(M, N)(T - M),$$

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 chose when they want to retire without regards to their choice of claiming age.
A.3 Measuring changes in work incentives around the ERA

A.3.1 AFP benefits in the post-reform system

We start out by calculating the basis for annual AFP benefits as

$$w_0 = \sum_{a=17}^{61} \min(E_a, 7.1) \cdot 0.00314,$$  \hspace{1cm} (A4)

where $E_a$ denotes annual earnings at age $a$, measured in Basic Amounts. $w_1$, the first component of annual AFP benefits conditional on claiming at age 62, is then obtained by dividing $w_0$ by a cohort specific adjustment factor. This factor is 1.319, 1.323, and 1.328, respectively, for cohorts 1949, 1950, and 1951. On top of this comes a compensation amount of NOK 10,400, 10,800, and 11,200 for the respective cohorts. Finally, there is an adjustment (cash addition) that ensures a higher annual AFP benefit prior to age 67 than later on: Approximately 0.25 Basic Amounts is added to the annual pension before age 67, while an amount is reduced from the pension from age 67 to cancel out the expected present value of the cash addition.

Denoting the compensation amount measured in basic amounts by $w_2$, we calculate the expected present value of AFP benefits as

$$W^1 = \sum_{a=62}^{T} p_a w_1 (1 - 0.0075)^{a-62} + \sum_{a=62}^{T} p_a w_2,$$  \hspace{1cm} (A5)

where $p_a$ denotes age and cohort specific survival probabilities provided by the Norwegian Labour and Welfare Administration (NAV), and $T = 107$. We set the annual discount rate equal to the average wage growth in the economy, and hence equal to the growth in the Basic Amount. $w_1$ is regulated according to the average wage growth in the economy, minus 0.75 percent.

A.3.2 AFP benefits in the pre-reform system

The benefits in the pre-reform AFP early retirement scheme are closely connected to the NIS old age pension scheme. First, pension rights are earned (computed) for the years 62-66 according to the following formula:
\[ FP = \max \left( \frac{P_{61} + P_{60} + P_{59}}{3}, P^{61} \right), \]  
\( (A6) \)

that is, as the maximum of the average of the pension points in the last three years prior to pension claiming and \( P^{61} \), the average of the 20 best years of pension points up until and including age 61. Pension points earned in any year are computed based on the following formula:

\[ P_a = \max (0, \min (E_a - 1, 5)) + \frac{1}{3} \max (0, \min (E_a - 6, 6)). \]  
\( (A7) \)

AFP pension benefits are then computed as

\[ B_1 = b + \max \left( 1, (0.42 + 0.03s) \min \left( \frac{N}{40}, 40 \right) P \right), \]  
\( (A8) \)

where \( b \) equals 1 (0.85) for single (married) individuals, \( s \) is the proportion of an individual’s years of pension points that are accrued before 1992, \( N \) is the number of years with positive pension points, and \( P \) is the average of the 20 best years of pension points. The five years between pension claiming and age 67 are included in \( N \), and \( P \) is calculated based on actual pension points plus five years with pension points equal to \( FP \).

Total annual AFP benefits between ages 62 and 67 are given by

\[ B = \min \left( B_1 + B_2, 0.7E^{61} \right), \]  
\( (A9) \)

where \( B_2 \) is a cash addition of NOK 20,400, measured in Basic Amounts, and \( E^{61} \) is a measure of previous earnings\(^{16}\). Setting the annual discount rate equal to the average wage growth in the economy, we calculate the expected present value of AFP benefits as

\[ W^0 = \sum_{a=62}^{66} p_a B. \]  
\( (A10) \)

\(^{16}\) \( E^{61} \) is the average of the three highest annual pensionable earnings from the last five years prior to pension claiming, counting earnings up to 12 Basic Amounts and including points accumulated due to a compensation for unpaid care.
A.3.3 Why the gross replacement rate measures the relative change in the net-of-tax rate in the pre-reform system

We start out with gross earnings $Y$ and tax $T$ given by a linear tax function

$$T = t_0 + t_1 Y.$$  \hfill (A11)

Net income is now

$$y = Y(1 - t_1) - t_0,$$  \hfill (A12)

so that $\partial y / \partial Y = (1 - t_1)$.

The next thing we add to the set up is a gross benefit $B$ with gross replacement rate $c$, such that

$$B = c Y^*,$$  \hfill (A13)

if $Y = 0$, where $Y^*$ is e.g. earnings last year. The benefits are taxed like labor earnings so that

$$y = (Y + B)(1 - t_1) - t_0.$$  \hfill (A14)

Assume this benefit is earnings tested, so that for every dollar earned, you lose $c$ dollars in benefits. (This is essentially the way AFP was earnings tested pre-reform.) Then,

$$B = c (Y^* - Y).$$  \hfill (A15)

Inserting this into the net income expression, we get

$$y = c Y^* (1 - t_1) + Y (1 - c)(1 - t_1) - t_0,$$  \hfill (A16)

hence $\partial y / \partial Y = (1 - t_1)(1 - c)$. So the gross replacement rate is a very good measure of the relative change in the net-of-tax rate as a consequence of earnings testing.
A.4 Additional results, AFP workers

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

<table>
<thead>
<tr>
<th></th>
<th>UI</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
<td>(5)</td>
<td>(6)</td>
</tr>
<tr>
<td>DD estimate</td>
<td>0.010***</td>
<td>0.010***</td>
<td>0.007***</td>
<td>-0.005***</td>
<td>-0.006***</td>
<td>0.022***</td>
</tr>
<tr>
<td>(0.001)</td>
<td>(0.001)</td>
<td>(0.002)</td>
<td>(0.002)</td>
<td>(0.002)</td>
<td>(0.004)</td>
<td></td>
</tr>
<tr>
<td>Controls included</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Linear time-trend for age &gt; 62</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Mean pre-reform, ages 62-65</td>
<td>0.006</td>
<td>0.006</td>
<td>0.006</td>
<td>0.108</td>
<td>0.108</td>
<td>0.108</td>
</tr>
<tr>
<td>N. of individuals</td>
<td>103,833</td>
<td>103,833</td>
<td>103,833</td>
<td>103,833</td>
<td>103,833</td>
<td>103,833</td>
</tr>
<tr>
<td>N. of observations</td>
<td>414,464</td>
<td>414,464</td>
<td>414,464</td>
<td>414,464</td>
<td>414,464</td>
<td>414,464</td>
</tr>
</tbody>
</table>

The sample includes AFP workers of age 59-65, and the DD estimator is defined as the difference in mean outcomes between post-reform workers ages 62-65 and 59-61, minus the same difference for pre-reform workers. The pre-reform (post-reform) group includes the cohorts 1945-1948 (1949-1955). The pre-reform (post-reform) group is observed between 2007 and 2010 (2007 and 2014). 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 -0.001 (0.001).
A.5 Additional results, non-AFP workers

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

<table>
<thead>
<tr>
<th></th>
<th>UI</th>
<th>DI</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>DD estimate</td>
<td>-0.002*</td>
<td>-0.002*</td>
</tr>
<tr>
<td></td>
<td>(0.001)</td>
<td>(0.001)</td>
</tr>
<tr>
<td>Controls included</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Linear time-trend</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Mean pre-reform,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ages 62-65</td>
<td>0.027</td>
<td>0.027</td>
</tr>
<tr>
<td>N. of individuals</td>
<td>71,865</td>
<td>71,865</td>
</tr>
<tr>
<td>N. of observations</td>
<td>277,440</td>
<td>277,440</td>
</tr>
</tbody>
</table>

The sample includes non-AFP workers of age 59-65, and the DD estimator is defined as the difference in mean outcomes between post-reform workers ages 62-65 and 59-61, minus the same difference for pre-reform workers. The pre-reform (post-reform) group includes the cohorts 1945-1948 (1949-1955). The pre-reform (post-reform) group is observed between 2007 and 2010 (2007 and 2014). 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 0.000 (0.001), and the corresponding difference (standard error) in DI rates is -0.005 (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 1949-1952, excluding workers with a history of DI receipt prior to age 62. n = 21,490.