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Erik Hernæs† Zhiyang Jia‡ John Piggott§ Trond Christian Vigtel‡

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Abstract

Reducing the eligibility age for pension benefits is considered by many as a policy that will discourage labor supply by mature workers. This paper analyzes a recent Norwegian pension reform which effectively lowered the eligibility age of retirement from 67 to 62 for a group of workers. For the individuals we study, the expected present value of benefits was held constant by introducing flexible claiming and actuarially adjusting the periodic pension payment. This neutralized the income effect of decreasing the access age, while the absence of any earnings test ensured constant present value of the pension, independent of the age when it is claimed. This provides us with a unique opportunity to study the isolated impact of increased flexibility. This paper employs a particular difference-in-difference approach, which allows us to study the effect on the distribution of labor supply behavior (represented by earnings) instead of just the mean. As expected, we find that on average workers reduced their earnings and working hours. However, this initial negative effect is partially offset by an increase in labor force participation rate later at age 64 and 65. An increase in labor force participation after age 65 could well give a positive effect on earnings among elderly from age 62. Our findings thus suggest that increased flexibility could potentially serve as a policy aimed at increasing the labor supply of older workers through promoting gradual exit from the labor force.

JEL Classification: J14; J23; J26

Keywords: Retirement; Pension; Flexibility

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†Ragnar Frisch Centre for Economic Research, Gaustadalleen 21, 0349 Oslo, Norway. E-mail: erik.hernas@frisch.uio.no.

‡Statistics Norway, Post Box 2633, 0131 Oslo, Norway. E-mail: zhiyang.jia@ssb.no (Jia) and trond.vigtel@ssb.no (Vigtel).

§ARC Centre of Excellence in Population Ageing Research (CEPAR), UNSW Business School, University of New South Wales, Sydney 2052, Australia. E-mail: j.piggott@unsw.edu.au.

1 Introduction

The access age for retirement benefits is generally seen as a key driver of the retirement decision. As life expectancy increases, more than a dozen countries in the OECD group have increased access age to induce workers to postpone their withdrawal from the labor force (OECD, 2017). Such reforms necessarily reduce flexibility in labor force withdrawal, potentially discouraging workers from gradually phasing in retirement as they age.

By contrast, the 2011 Norwegian pension reform introduced additional flexibility in pension access age. Overall, it sought to unify the budget constraints confronting various subgroups in the retirement window, which before the reform had faced a disparate array of incentives and access ages. The reform has allowed for analysis of the behavioral responses to these changes.

For a particular subgroup of workers impacted by the reform package, a fixed retirement pension access age of 67 was replaced by a non-earnings tested pension available from age 62, with payments actuarially adjusted to hold constant the present value of benefits. The dominant change for this group was therefore an earlier access age. This increased flexibility can have important welfare effects by allowing individuals an expanded range of choice with regard to labor market exit, while simultaneously claiming part or full pension.

This paper studies how this subgroup of workers has responded to this reform, through changes in the labor force participation and the earnings distribution. To our knowledge, this is the first paper to analyze observed changes in the distribution of work resulting from lowering the access age to pension benefits, holding the present value of the pension constant. A previous paper (Hernæs et al., 2016) showed a large response on the extensive margin to an increase in the work incentives from the repeal of the earnings test in the private sector early retirement scheme (AFP). This effect was observed in the group covered by the AFP, while the present study looks at the group without AFP, who was only exposed to the new flexibility option. We base our analysis on comprehensive administrative data on labor earnings and weekly working hours. Results are based on a difference-in-difference approach, where the earnings behavior of those impacted by the reform is compared with those whose retirement trajectories preceded the reform.

We find that the flexibility component of the reform leads to two distinct effects: (i) a reduction in labor supply at the intensive margin, but also (ii) an increase in labor supply at the extensive margin. Elderly workers are found to stay longer in the labor market but with reduced intensity, implying a higher incidence of gradual exit.[1] The net effect of these two opposing forces is a small reduction in average work effort by the elderly. On average, the annual earnings over the age range 62-65 among male workers who were employed at age 59 fell by around 3.5 percent (EUR 1,420). The distributional difference-in-difference approach we employ shows that this average effect masks that some high earners reduced their annual earnings after becoming eligible for the pension at age 62, which again increased the fraction of medium earners. Further evidence using weekly working hours indicates that the reduction in earnings is caused by the high earners reducing their hours of work. At the same time, there is an increase in labor force participation. The age-specific results furthermore show that the labor force participation increase occurs at age 64 and 65. Due to data limitations we are only able to include ages up to 65, and the effect on annual earnings of may therefore well be positive if higher ages are taken into account.

Therefore, the notion that reduced workload may make it easier to continue to work for longer, thus increasing the net amount of work, is potentially borne out in our setting. This contrasts with an international comparison by Börsch-Supan et al. (2018) who find little response to the introduction of partial retirement schemes, as well as Albanese et al. (2020) who find that Belgian senior workers respond to a (subsidized) gradual

[1] Since a majority of the eligible workers claim the pension, the increase in gradual retirement involves a combination of work and claiming of pension benefits.

retirement scheme by reducing their labor supply. Similarly, Eurofound (2016) examines partial retirement and concludes that there was "no scheme [...] identified that unambiguously extended working lives for all participants" (p. 1). There are a number of possible reasons why more widespread gradual labor market exit is in general not observed. Some employers may not be willing to accommodate reduced hours. There may be fixed costs to having an employee such as office space; there may be certain tasks such as meetings that take the same amount of time for all and therefore a higher proportion for part-time employees; there may be a loss of skill through less practice in a part-time job; and there may be a loss of productivity for other employees because of interdependencies (see e.g. Hutchens & Grace-Martin, 2006; Hutchens, 2010; Blau & Shvydko, 2011; Even & MacPherson, 2004; Cahill et al., 2014). For the individual there may be a fixed disutility to having a job, such as restrictions on leisure activities, commuting time and strains from work (Fan, 2015; Angrisani et al., 2015; Böckerman & Ilmakunnas, 2019). On the other hand, a job may entail a stimulating environment (Kantarci & van Soest, 2013b). Several surveys (Dalen, 2016; Brown, 2005; Tuominen, 2013) report a desire by workers to gradually reduce work and by employers to retain the competence of experienced employees. Our results do however accord well with a recent paper by Ameriks et al. (2020), which uses data from strategic survey questions and finds that older Americans would work longer if jobs were flexible.

The rest of the paper is organized as follows. Section 2 provides some institutional background to the Norwegian reform to place the policy reform that we focus on in a broader context. Section 3 provides a brief discussion of the effect of a flexible retirement scheme. Section 4 describes our data and the sample used. Section 5 presents our empirical approach used in this analysis. Section 6 reports our difference-in-difference approaches and estimation results. In Section 7 we discuss the results and possible mechanisms, while Section 8 concludes.

2 Institutional Setting

2.1 Before the Reform

The backbone of retirement provision in Norway is a mandatory benefit plan, the old-age pension in the National Insurance Scheme (NIS).[2] It is dependent on the income history, but bounded from below and above. The accrual rate is capped at around average full-time earnings and the pension is based on average accrual over the best 20 years, indexed to wages. At constant real earnings at a level generating a pension equal to the guaranteed minimum pension level, the replacement rate is 60 percent. At constant real earnings at the maximum pension accrual level, the replacement rate is 33 percent. In 2017, the NIS old-age pension provided two thirds of total income received by individuals aged 75, an age at which earnings play a very small role in the total income. Occupational pensions provided another 20 percent and capital income most of the remainder.

Prior to the 2011 pension reform, there was little flexibility in pension claiming in Norway. The occupational pensions in the private and public sector and the NIS old-age pension had an eligibility age of 67, as had most of the private sector occupational pensions. Some occupations had lower retirement age. There were generally strict earnings tests after the eligibility age and no deferral of benefits, going a long way to define age 67 as the retirement age, when earnings stopped and pension was received.

There were only two exit routes of any importance before eligibility age, the first of which was permanent disability pension. At age 66, around 40 percent of the population were on permanent disability benefits. The other exit route before the reform was the early retirement pension (*avtalefestet pensjon* in Norwegian, henceforth AFP) which was introduced in 1989. The AFP covers the public sector and around half of the private sector, where firms have to choose to participate to give employees the option of early retirement. In

[2]Further details on the NIS can be found in Norwegian Ministry of Labour and Social Affairs (2019).

addition, individuals have to meet a set of requirements with respect to earnings and employment history. Before 2011, the AFP scheme covered the age range from 62 and up to the general pension age of 67. Those eligible had three options of combining work and pension benefits, with the percentage of normal earnings and the percentage of a full pension adding up to 100 percent. However, any pension benefit that was not claimed was not preserved, implying a high total tax of continued work (Hernæs et al., 2016).[3]

2.2 After the Reform

Flexibility was introduced in the 2011 pension reform (Brinch et al., 2017; Kudrna, 2017). The NIS old-age pension, all occupational pensions and the private sector AFP could all be claimed between age 62 and age 75, with actuarial adjustment and without tests against continued earnings. There was also an option of claiming only a part of the pension benefits. However, claiming the NIS old-age pension required entitlements which gave an annual pension level at least equal to the guaranteed minimum pension from age 67.[4]

The AFP in the private sector was transformed from a strictly earnings-tested early retirement pension over the age range 62-66 into a non-tested, life-long pension which had to be claimed in combination with the NIS old-age pension. Since the earnings test was repealed, work incentives for those with AFP increased sharply, delaying labor market exit (Hernæs et al., 2016). The annual benefit level was reduced so as to preserve the present value of the AFP public subsidy.

For the workers who had sufficient entitlements to be eligible for the new NIS old-age pension from age 62, and who were not covered by the AFP scheme, the only change was the access to the new, flexible old-age public pension, and in most cases of any occupational pension, from age 62. The annual level of the NIS old-age pension benefits was actuarially adjusted to preserve a constant present value. Hence, the main change for this group was a change in the flexibility of pension, and this is the group we will analyze for impact on work behavior.

The actuarial adjustment of the annual old-age pensions described above is designed to be neutral, but the adjustment implies the same implicit discount rate for all. If the subjective discount rate deviates from the internal rate in the pension system, this could give rise to incentives for early or late claiming. For instance, there is a strong mortality gradient in income which could lead to deviations from the system's implicit discount rate (see e.g. Brinch et al., 2018 for an empirical study). However, it is important to emphasize while this may alter the incentives for *claiming*, it does not alter the incentives for *work*.

3 The Effect of Flexible Retirement Schemes

A fixed retirement age imposes restrictions on individuals' labor supply behavior. Elderly below the eligibility age may be forced to stay in the labor force against their own preference. The introduction of a flexible retirement scheme removes this restriction and thus we should expect that individuals who are constrained under the fixed retirement age reduce their labor supply, either on the intensive or extensive margin. In other words, a flexible retirement age will have a negative effect on elderly labor supply.

However, the above arguments ignore a possible dynamic effect: the possibility of working and pension claiming in combination has "the potential to increase work satisfaction and quality of life by better matching preferred and actual working hours" (Eurofound, 2016), which in turn could lead to a longer working life. Our hypothesis is the following: a flexible retirement scheme allows older workers to reduce their work intensity when they want, which will lead to more job satisfaction (better matching of personal working capacity and working load) and eventually lead to a positive labor supply response: they will stay longer, but work less, so

[3]An illustration of the retirement transitions for the pre-reform 1942 birth cohort is deferred to Appendix A1.

[4]The reform did not change the incentives for individuals to claim old-age pensions instead of disability benefits or vice versa.

that the impact on total amount of work is ambiguous. If the reduced number of working hours per year leads to more years of work, the effect of this gradual retirement process on total labor supply may be positive.

This hypothesis implies some patterns in the observed effects: we should expect to find a negative effect on intensive margin and a positive effect on the extensive margin. However, the extensive margin will mostly not be observed before the intensive margin effect. So this will imply that the effects on labor force participation (LFP) differ across age and across time. We expect that there will be no or only a small effect on LFP at the new eligibility age, but that the effect becomes larger with age. Similarly, we expect no effect on LFP at the year of reform, and that the effects will only be observed after the reform is phased in. As we show later, these patterns are largely what we observe in the data. In our results, the two effects balance over the age range 62-65 and may well be positive if higher ages are included. However, we cannot test our hypothesis using the data directly, due to the fact we cannot identify the workers who reduced their labor supply on the extensive margin using our empirical approach.

4 Data and Descriptive Statistics

4.1 Data

The empirical basis for the analyses is an extensive set of administrative register data from Statistics Norway, and a data set with all private firms offering AFP, received from the early retirement administration unit. The two are linked by encrypted firm identification numbers. The register data sets cover the whole population of Norway and are linked by unique encrypted personal identification numbers. The most important information is annual earnings, weekly hours in the most important job each year, industry affiliation of the firm, worker occupation, wealth, age, gender and education.[5,6]

4.2 Sample

The large and abrupt changes in options for potential retirees following the 2011 pension reform provide a unique opportunity to investigate the impact of pure flexibility without any influence of changed incentives. For the analyses below, we use pre- and post-reform groups that are constructed in the same way so that they differ only with respect to the pension system they were exposed to: (i) individuals in the post-reform group had access to the new flexible NIS pension from age 62, while (ii) individuals in the pre-reform group only had access to the old NIS pension at age 67. None had access to the private sector AFP. The difference is therefore only the introduction of flexibility and there are no changes in the economic incentives. In a difference-in-difference setup, we use ages 60-61 as controls for general labor market changes and ages 62-65 as treated. Specifically, the sample is constructed as described below and illustrated in Table 1 for the 1949 birth cohort.

In the first step we select from the birth cohorts 1944-1954 observed in the years 2009-2014. In the second step we restrict attention to those who in the year they became 59 (i) were employed as wage earners, (ii) earned at least EUR 10,000 and (iii) did not receive disability benefits (either permanent or temporary). In the third step, we include from this group only those who were not eligible for AFP (due to their employer not participating in the AFP scheme). In the fourth step, we include only those who met the after-reform requirements for claiming the new public old-age pension, with actuarial adjustment, at age 62. Before the

[5] All monetary amounts used in this paper are derived from amounts measured in NOK. The amounts are first deflated by employing the consumer price index (CPI). We have then converted the CPI-adjusted amounts to 2014-EUR using the average exchange rate between EUR and NOK in that year (1 EUR = 8.35 NOK).

[6] Note that self-employed workers are not included in the sample.

reform, they would have access age at 67, with no deferral.[7] We only use males, since there are fairly few females in this category. Many women are employed in the public sector, and among those who are in the private sector without AFP many do not meet the post-reform pension requirements. The year-age groups each comprise about 5,000 males, about 20 percent of the population group.

Table 1: Sampling in the 1949 birth cohort

	All	Males	Females
Birth cohort 1949 at age 59	52,495	27,240	25,255
Working at age 59 and no disability benefits	39,578	22,091	17,487
Not covered by early retirement (AFP) scheme	7,982	5,422	2,560
Eligible for new old-age pension from age 62 after reform	6,952	5,227	1,725

Source: Authors' own calculations using data from Statistics Norway.
Note: Number of observations in 1949 birth cohort by sample restriction. Working is defined as having labor earnings above EUR 10,000, while disability benefits consist of both temporary and permanent disability benefits.

While the pension point accrual formula allows for individuals to improve their annual old-age pension payout by working past the age of 62, there are several reasons why we do not expect this to be a driving force behind the observed labor supply behavior of our treatment group. Firstly, having conditioned the sample of individuals to be eligible for the new old-age pension from age 62, most individuals have a sufficient number of years of residence (40) to obtain the full basic old-age public pension (first pillar). Secondly, most have their 20 best earnings-years before the age of 62, which means that there is no further accumulation of the earnings-related old-age public pension (second pillar) beyond the age of 62. Thirdly, as demonstrated by Brinch et al. (2017) in a different but related setting, there is a lack of salience in the accrual incentives such that individuals do not take the old-age pension accrual into account when determining their labor supply.

4.3 Measuring Work

Our main measure of work is annual labor earnings. Annual earnings year-by-year will capture aspects of work which working hours do not, among them changes to less demanding and lower paid jobs, without a corresponding reduction in working hours. Our data contain contracted weekly working hours of all jobs held within the year. However, even if we constructed average hours in all jobs over the year, this would only be on a monthly basis. We have therefore used total earnings in all jobs over the year as our main outcome, as it reflects work effort in a more precise manner.[8]

4.4 Descriptive Statistics

Table 2 gives the labor force participation rate and the average annual earnings in the sample analyzed, with rows representing age and columns representing year of observation, respectively. In this table, the main diagonal line represents the 1949 birth cohort. We see a clear time trend in both the labor force participation (LFP) and earnings over time: for the workers of same age, we observe higher LFP and earnings for the

[7] By including only those whom we have found not to be in the public sector or in a private sector firm with AFP at age 59, we are sure that they do not qualify for the AFP by the pre-reform requirements. A small group of workers have a lower eligibility age, but we cannot identity these individuals in the data.

[8] While the hourly wage rate might be the most accurate measure of effort per unit of work, we do not have data on this for our whole sample. However, merging our sample from Table 3 with the Norwegian Wage Statistics for the years 2009-2014, which consists of a representative sample of private sector establishments with precise information on hourly wages, we find little indicative evidence of substantial downward adjustment in mean (real) hourly wages for male workers aged 59 to 65, with an average decline of only 5.7 percent from age 59 to age 65.

Table 2: Labor force participation rate and annual earnings, by year and age

Age	2009	2010	2011	2012	2013	2014
60	94.5	93.7	94.4	95.1	94.6	95.3
	63,474	64,686	68,207	69,188	72,235	73,036
61	88.0	87.8	88.2	90.2	90.6	90.2
	58,656	58,503	62,498	66,901	66,455	68,546
62	84.4	83.2	83.6	84.3	86.6	85.7
	54,637	54,228	55,785	59,842	63,399	62,094
63	76.1	74.7	73.8	75.7	77.5	78.0
	48,122	48,084	48,423	51,337	54,922	56,683
64	65.0	68.2	67.4	68.2	70.0	71.4
	39,375	42,718	43,575	45,263	47,837	49,719
65	58.0	56.5	60.0	61.4	62.4	63.3
	34,904	33,362	36,779	39,237	40,269	41,511

Source: Authors' own calculations using data from Statistics Norway.
Note: Each cell shows the labor force participation rate in percent (first row) and the average earnings in EUR (second row). The sample consists of those working at age 59 (without receiving disability benefits) and not covered by AFP, but meeting the requirements for claiming the new public pension at age 62. We assign zero earnings for those not in the labor force.

more recent years. There is also a clear aging trend as well. For the same year, older workers have lower LFP and earnings than the younger workers. However, the time trend is far from enough to offset the aging effect: for the same cohort, we still observe a large reduction in labor supply over time. From Table 3 we notice an increase in the labor force participation rate of the control group after the reform, but an even stronger increase after the reform in the treated group. Furthermore, the average earnings increased more in the treatment group than in the control group.

5 Empirical Approach

To study the impact of the 2011 pension reform, we apply a distributional difference-in-differences approach, comparing the change in outcomes for the treatment group in the pre- and post-treatment periods with the corresponding change for the control group. The key identifying assumption is then that the cumulative distribution function of the treatment group would, in the absence of treatment, change from the pre- to the post-treatment periods in parallel with the change for the control group.

The control group consists of individuals who are 60-61 years old, while our treatment group consists of individuals who are 62 years and older. The treatment period is 2011 and later, when workers aged 62 and older can withdraw from the labor force with no loss in pension benefits, while the 60- and 61-year-olds cannot. Thus, before 2011, both the treatment group and the control group are constrained by the eligibility age, while after 2011, only those in the control group are constrained. Table 2 illustrates the difference-in-difference structure. The control group is above the solid horizontal line and the treatment group below. Within the treated group, those to the right of the dashed "staircase" have had the new option from eligibility age 62 while those to the left of the staircase but to the right of the solid vertical line had the new option from

Table 3: Descriptive statistics

	Control		Treatment	
	Before	After	Before	After
Labor force participation (%)	91	92	71	73
Annual earnings (EUR)				
Average	61,314	68,410	44,398	49,556
75th percentile	77,525	85,294	65,838	72,148
Median	55,933	62,003	44,132	44,757
25th percentile	40,181	45,256	0	4,265
Covariates, average values				
Years of completed education	12.8	12.9	12.7	12.8
Annual earnings ages 30-59 (EUR)	55,334	58,297	52,543	55,260
Net liquid wealth at age 59 (EUR)	21,788	14,321	22,495	20,683
Number of observations	20,006	38,322	40,971	79,145

Source: Authors' own calculations using data from Statistics Norway.
Note: Descriptive statistics for the treatment and control group, before and after the reform. Labor force participation is defined as labor earnings above EUR 10,000. Net liquid wealth is defined as the sum of all assets less property and debt.

ages 63-65, depending on the birth cohort.[9]

To investigate the changes over the whole annual earnings distribution, we use the Complementary Conditional Distribution Function (CCDF). It is defined as 1 minus the cumulative distribution function (CDF), such that $CCDF(y) \equiv 1 - F(y)$. The construction of such distribution functions and the accompanying regression analyses of shifts and the impact of covariates are described in Hernæs and Jia (2013) and Brinch et al. (2017). When analyzing shifts and effects which can vary across the distribution, this approach is an alternative to quantile regressions (Lingxin & Naiman, 2007). Intuitively, while quantile analysis models the horizontal shifts in the cumulative function, CCDF models the vertical shifts. Both are well suited for analyses of shifts which vary over the distribution, but the CCDF method is less cumbersome numerically.[10]

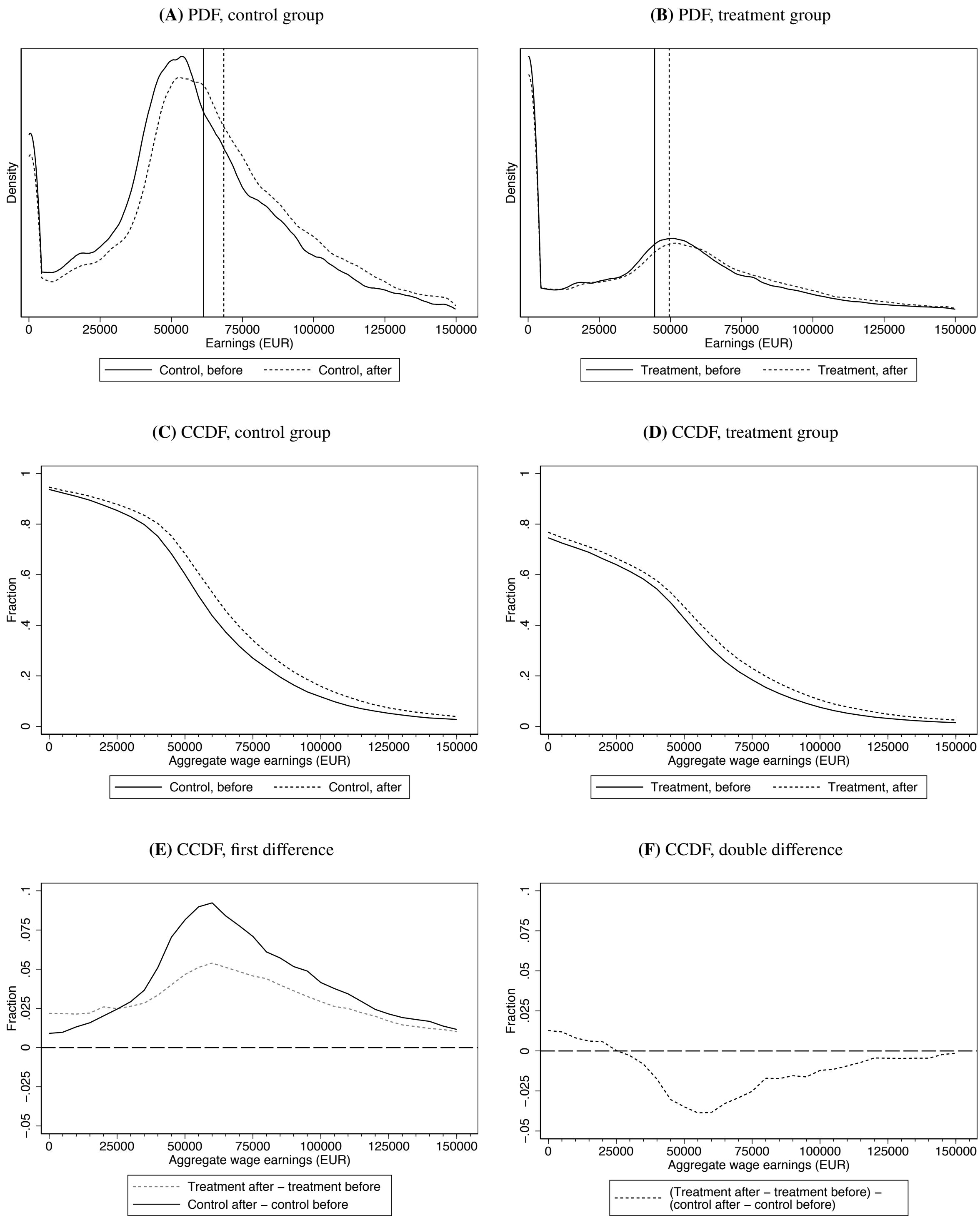
For an initial overview of our sample in terms of the earnings distribution, Panel A and Panel B in Figure 1 show the (unconditional) probability density functions (PDF) before and after the reform for the control and treatment group, respectively. Panel C and Panel D show the corresponding CCDF before and after the reform. From these diagrams, we see clearly that the earnings distribution has shifted after the reform for both the control and the treatment group. However, these figures are not very informative if we are interested in studying the shifts in more detail.

To illustrate the distribution shift more clearly, we plot the (vertical) difference of the CCDFs before and after the reform ($\Delta CCDF$) for both the treatment and control group in Panel E. This corresponds to the *observed* changes in the earnings distribution after the reform. For example, a difference of 2.5 percentage points at $y = 0$ for the treatment group implies that the raw labor force participation rate of that group increased by 2.5 percentage points after the reform. Other than the values of the differences, the slope of the curve also provides important information: for any given interval, the difference in $\Delta CCDF$ between the two endpoints represents the change in fractions of individuals with earnings in this interval before and after the reform.

[9] Note that some individuals are in the control group in one year and in the treatment group the following year. This does not invalidate any point estimates, but it needs to be taken into account when we compute standard errors. We report block-bootstrapped standard errors, with individuals as the unit for bootstrapping. We perform 200 bootstrap replications (see e.g. Efron and Tibshirani (1993) for rule of thumb regarding the necessary number of replications).

[10] A simulation exercise illustrating the qualitative equivalence of the two methods is available from the authors upon request.

Figure 1: Changes in earnings distribution, by group



Source: Authors' own calculations using data from Statistics Norway.
Note: Panel A and Panel B show the empirical plots of the (unconditional) probability density functions (PDF) of aggregate wage earnings (expressed in EUR) for the control and treatment group, respectively. Panel C and Panel D show the empirical plots of the Complementary Cumulative Distribution Functions (CCDF) of aggregate wage earnings (expressed in EUR) for the control and treatment group, respectively. Panel E and Panel F show the first and second vertical differences of the CCDFs in Panel C and Panel D, respectively. The sample is described in Table 3.

A positive (negative) average slope implies a drop (increase) in the fraction of individuals with earnings in this interval. Moreover, the steeper this slope is, the larger is the magnitude of the change. For example, for both the treatment and control group, Panel E implies a drop in the fraction of individuals within the earnings interval $(25000, 60000)$ due to the positive slopes for both groups over this interval. However, the drop is larger for the control than for the treatment group, since the former has a much steeper slope than the latter.

For both the treatment and control group, Panel E shows that $\Delta CCDF$ is positive for all earnings so that the before-reform and after-reform distribution do not cross. More formally, the after-reform earnings distribution stochastically dominates the before-reform earnings distribution, indicating higher levels of *observed* earnings after the reform. In order to isolate the treatment effect of the reform, Panel F in Figure 1 shows the difference-in-difference based on Panel E. In contrast to the first difference, the second difference is positive in the earnings interval $[0, 25000)$ and negative in the interval $(25000, 150000)$. The reform has a very uneven effect over the earnings distribution and no stochastic dominance can be established. The disagreements in effects at different parts of the distribution highlight the need for distributional analysis: while useful, no given summary measure can provide a complete picture of the reform effect.

From Panel F, we see that the reform has drawn more people into the labor force (positive reform effect at $y = 0$). However, the drop in the non-working fraction is offset by the increase over the interval $(0, 25000)$. The net result is that the fraction of individuals with earnings less than EUR 25,000 is the same before and after the reform. In the meantime, the reform shifts the rest of the earnings distribution to the left: there is an increase in the fraction of individuals with earnings between EUR 25,000 and EUR 60,000, and a reduction between EUR 60,000 and EUR 150,000. In sum, the reform seems to have increased the relative fraction of workers aged 62-65 in the lower part of the earnings distribution (below EUR 60,000) and decreased the relative fraction of workers aged 62-65 in the upper part of the earnings distribution (above EUR 60,000 and up to EUR 150,000). So the reform has a positive effect on the labor participation rate, while a negative effect on earnings by shifting the mass from the upper part of the earnings distribution to the lower part of it. These two effects point in opposite directions, which means that the overall effect cannot be recovered by simple visual inspection. In Section 6, we formalize the above idea and also include (pre-determined) covariates and dummies for time and age to partial out compositional differences, which is not done in the construction of the graphs in Figure 1.

6 Empirical Results

In this section, we present the difference-in-differences analysis of the 2011 Norwegian pension reform on labor earnings. We first present the effect on mean earnings and then the effects on the earnings distribution.

6.1 Effect on Mean Earnings

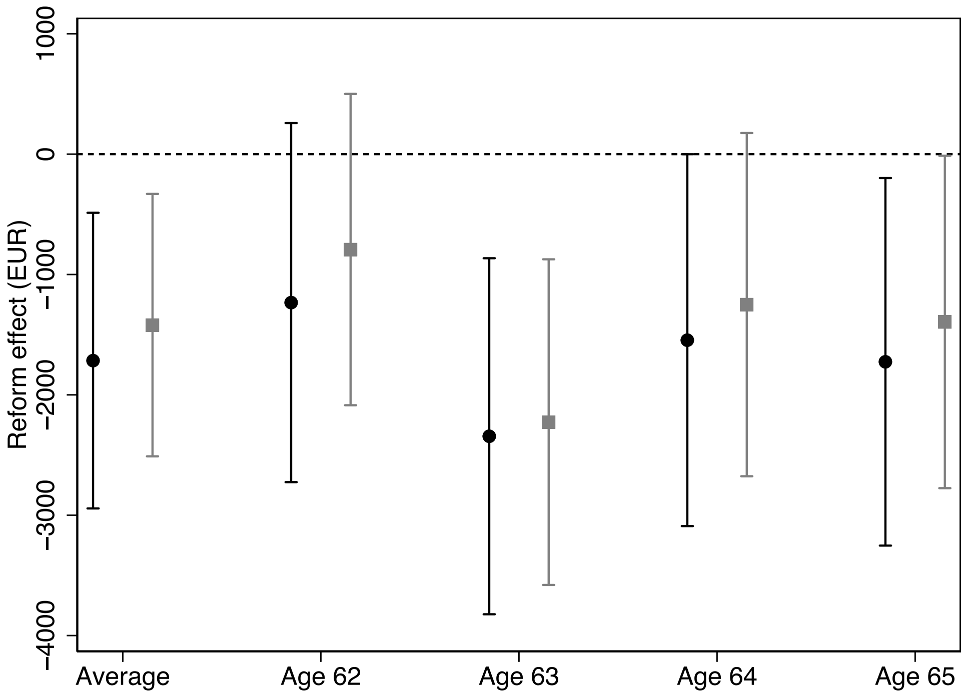
We estimate the following linear difference-in-difference equation to derive the effect on mean earnings:

$$y_{i,a,t} = \alpha + X_i\beta + \sum_{s=61}^{65} \gamma_s DA_s + \sum_{l=2010}^{2014} \lambda_l DT_l + \eta \Delta_{i,a,t} + \varepsilon_{i,a,t} \tag{1}$$

Here $y_{i,a,t}$ is the annual pre-tax labor earnings of individual i at age a in year t. The vector X_i includes controls for education length, education length squared, log average annual pre-tax earnings from age 30 to age 59, and net liquid wealth at age 59. $\Delta_{i,a,t}$ indicates the treatment variable, and equals one when individual i is in the treatment group after the reform and zero otherwise. DA_s are dummy variables for age (with age 60 as the reference age) and DT_l are dummy variables for year (with 2009 as the reference year). $\varepsilon_{i,a,t}$ is the error term. In order to explore potential age-dependent effects of introducing the flexible pension on mean earnings, we also estimate the following model:

$$y_{i,a,t} = \alpha + X_i\beta + \sum_{s=61}^{65} \gamma_s DA_s + \sum_{l=2010}^{2014} \lambda_l DT_l + \sum_{m=62}^{65} \eta_m DA_m \Delta_{i,a,t} + \varepsilon_{i,a,t} \tag{2}$$

Figure 2: Reform effect on mean earnings



Source: Authors' own calculations using data from Statistics Norway.
Note: OLS estimation results of the average reform effect on earnings from Equation (1) and the age-specific reform effects on earnings from Equation (2). Black lines indicate estimation results with no control variables, gray lines indicate estimation results with control variables. Control variables are pre-determined and include linear controls for education length, education length squared, log average annual pre-tax earnings from age 30 to age 59, and net liquid wealth at age 59. The caped lines show the 95 percent confidence intervals, based on standard errors clustered on the individual level with 200 non-parametric bootstrap replications.

Figure 2 shows the OLS estimates for the average effect on the earnings and the age-specific effects on earnings. When only controlling for age and year dummies (black lines), there is a negative and significant effect on average over ages 62-65 (a reduction of EUR 1,715, or 3.9 percent of pre-reform earnings of the treatment group) while the age-dependent effects are significant for all ages except age 62. Adding the pre-determined covariates (gray lines) makes the age-dependent estimates of the reform effect statistically insignificant, with the exception of age 63 and age 65. However, the average effect (a reduction of EUR 1,420, or 3.5 percent) is still statistically significant after adding the pre-determined covariates.[11]

However, the differential changes to the shape of the earnings distributions illustrated in Panel A and Panel B in Figure 1 suggest that the results in Figure 2 are not necessarily sufficient to capture the full effect of introducing the flexible old-age pension.[12] We now turn to this question.

6.2 The CCDF Method

While Figure 1 shows the simple difference-in-difference estimate of the reform effect, it does not take into account the observables used for estimating the effect on mean earnings using OLS. To take these into account, we run a series of linear regressions on the probability of having earnings above a series of steps, each of length EUR 5,000, up to EUR 150,000. Intuitively, this explores vertical shifts in the CCDF distributions

[11]The complete table of estimation results is found in Appendix A4.1.

[12]To illustrate this with a conventional approach, we show the effect of introducing the flexible pension on earnings at different deciles of the (unconditional) earnings distribution using the recentered influence function difference-in-difference (RIF-DiD) approach (Firpo et al., 2009), and compare this to the mean (OLS) impact of the reform shown in Figure 2. The complete estimation results are available from the authors upon request.

shown in Panel B in Figure 1. With a constant treatment effect for all years and ages we assume, for each earnings level $y_{i,a,t}$ for individual i at age $a = 60,\dots,65$, that the vertical shifts can be expressed as:

$$\mathbf{1}(y_{i,a,t} > y_k) = \alpha + X_i\beta + \sum_{s=61}^{65} \gamma_s DA_s + \sum_{l=2010}^{2014} \lambda_l DT_l + \eta\Delta_{i,a,t} + \varepsilon_{i,a,t} \tag{3}$$

The variables are defined as in Equation (1), where the outcome variable on the left-hand side equals one if $y_{i,a,t} > y_k$ and zero otherwise. We estimate the specification for 31 specific cases, letting y_k vary from EUR 0 to EUR 150,000 by increments of EUR 5,000 such that $y_k \in \{0, 5000, 10000, \dots, 145000, 150000\}$. The coefficient η measures the treatment effect of interest.[13]

With a constant treatment effect for all years, but allowing for different treatment effects over ages 62-65, we assume that for each earnings level $y_{i,a,t}$ for individual i at age $a = 60,\dots,65$ this can be expressed as:

$$\mathbf{1}(y_{i,a,t} > y_k) = \alpha + X_i\beta + \sum_{s=61}^{65} \gamma_s DA_s + \sum_{l=2010}^{2014} \lambda_l DT_l + \sum_{m=62}^{65} \eta_m DA_m \Delta_{i,a,t} + \varepsilon_{i,a,t} \tag{4}$$

Here, η_m for $m = 62,\dots,65$ measures the age-specific treatment effect. The age-specific treatment effects will capture any gradually increasing impact of the reform on the earnings distribution.[14]

The graphs in Figures 3-7 are all based on 31 separate estimations, one for each of the earnings levels described above. The estimated effects are used to simulate the CCDF of the earnings distributions of the type given in Panel B in Figure 1, which then shows the marginal effects equal to the difference in the post-reform and pre-reform probability of earnings higher than a given level y_k: $P(y_{i,a,t} > y_k | \Delta_{i,a,t} = 1, X_i, DA_s, DT_l) - P(y_{i,a,t} > y_k | \Delta_{i,a,t} = 0, X_i, DA_s, DT_l)$. The identifying assumption is the standard one within the difference-in-difference framework, namely no selection on the change in the non-treatment outcome level. However, in our setting the identifying assumption must hold at *each* point on the support of the dependent variable:

$$\begin{gathered} E\left(\mathbf{1}\left\{y^0_{i,a,t\geq 2011} > y_k\right\} - \mathbf{1}\left\{y^0_{i,a,t<2011} > y_k\right\} | a_{t\geq 2011} \geq 62\right) \\ = \\ E\left(\mathbf{1}\left\{y^0_{i,a,t\geq 2011} > y_k\right\} - \mathbf{1}\left\{y^0_{i,a,t<2011} > y_k\right\} | a_{t\geq 2011} < 62\right), \ \forall k \end{gathered} \tag{5}$$

Here, $\mathbf{1}\{\bullet\}$ denotes the indicator function, equal to one if the argument holds true and zero otherwise, while the superscript 0 indicates the potential outcome if not treated. This means that the first line of Equation (5) expresses the expected value of the difference in likelihood of potential earnings under non-treatment ($y^0_{i,a,t}$) being greater than y_k after and before the reform in 2011, conditional on being aged 62 or more after the reform in 2011 (i.e. being in the treatment group). In full, the identifying assumption therefore states that in the absence of the reform, the change in the population shares at each of the earnings thresholds would have been the same in the treatment and control group.

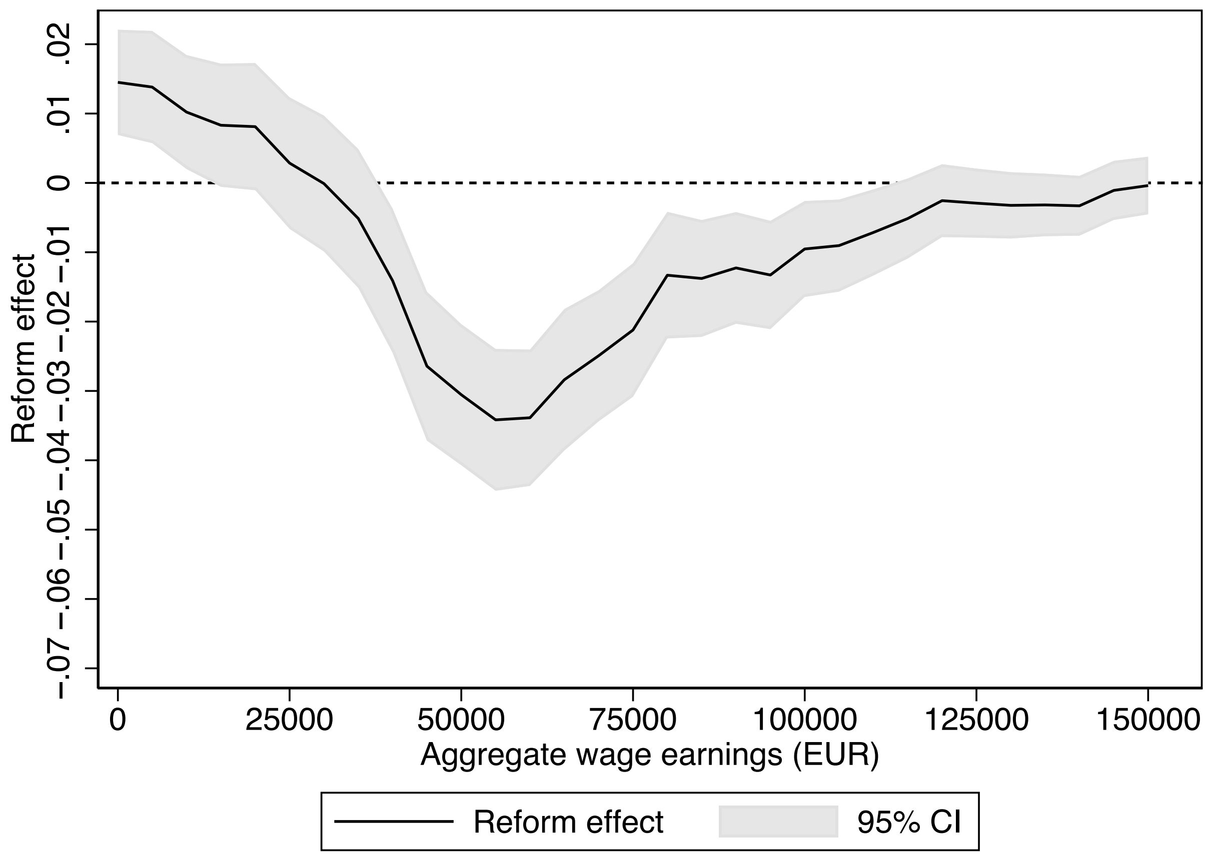
6.3 Reform Effect

Figure 3 shows, based on estimating Equation (3) with controls for individual (pre-determined) characteristics and dummies for age and calendar year, the average effect over all ages and years of the reform on the probability of having earnings above the earnings levels of the horizontal axis. The gray-shaded area around

[13] This specification assumes that age effects are constant across cohorts. While this is a strong assumption, the trends in earnings by age prior to the reform are parallel, indicating that this assumption is not too restrictive. See Appendix A3.2 for more details.

[14] While the assumption of a constant treatment effect for all years might seem restrictive, estimating a similar model where we instead hold age-specific treatment effects constant and allow for different treatment effects over years yields fairly similar effects across years. The empirical approach for the year-by-year approach and associated estimation results are shown in Appendix A3.1.

Figure 3: Reform effect on earnings distribution



Source: Authors' own calculations using data from Statistics Norway.
Note: Simulation results from estimation of Equation (3), showing the difference in the CCDF for the treatment group and the control group. The gray-shaded area shows the 95 percent confidence intervals (based on 200 non-parametric bootstrap replications for each estimation, clustered on individual level). Aggregate earnings are expressed in EUR. Marginal effects and the associated standard errors are deferred to Appendix A3.3.

the curve with point estimates gives the 95 percent confidence interval. We see that compared to the data-based plots in Panel F in Figure 1, the estimated effect when taking into account covariates and time- and age-fixed effects is very similar to the raw difference-in-difference estimate.

The point estimates in Figure 3 start above zero, which means that the reform resulted in an increase in the labor force participation rate (of 1.5 percentage points). At EUR 55,000 (approximately 84 percent of average full-time earnings for men in 2014), the point estimate is significantly negative at -3.4 percentage points, with a 95 percent confidence interval from -3.9 to -2.9 percentage points. This means that the reform has increased the net fraction of the sample with earnings up to about EUR 55,000 by about 3 percentage points, which is mirrored by a reduction in the fraction above EUR 55,000.

The corresponding shifts in the probability of being in different intervals of the earnings distribution are shown in Table 4. The shifts in the earnings distribution are compatible with the process of gradual retirement, with both an increase in the mass in the middle part of the earnings distribution and an increase in the labor force participation rate.

6.4 Age-Specific Reform Effects

The age-by-age results from estimating Equation (4) are illustrated in Figure 4. Looking at the starting points in Figure 4, the labor force participation rate is estimated to be 2.5 percentage points higher for age 64 and 4.0 percentage points for age 65, and both changes are statistically significant. In all of the panels, the point

Table 4: Probability of being in selected earnings intervals

Earnings interval	Density before reform	Reform effect	
		Estimate	Standard error
Non-participation (EUR 0)	0.254	-0.015	0.004
EUR 0 - EUR 30,000	0.133	0.015	0.006
EUR 30,000 - EUR 50,000	0.186	0.030	0.007
EUR 50,000 - EUR 80,000	0.273	-0.017	0.007
$>$ EUR 80,000	0.154	-0.013	0.005

Source: Authors' own calculations using data from Statistics Norway.
Note: Probability of being in different earnings intervals and the reform effect on the probability of being in the different intervals. The reform effect is generated using the marginal effects from Figure 3, with pooled standard errors in the last column. The procedure is described in detail in Appendix A3.4.

estimates show larger effects on the lower part of the earnings distribution, up to about EUR 50,000. It seems that the flexible claiming option increases gradual labor market withdrawal (by means of reducing earnings) as far as we can follow, which is up to age 65. From the age-by-age analysis, there also seems to be a state dependence in labor supply which translates into reduced earnings among those working over the ages 62-65, since more people are found in the below-average earnings range.

This suggests that the flexible claiming option to some degree facilitates gradual retirement, with a positive effect on the labor force participation rate at age 64 and age 65, suggesting the notion that reduced work per period (at age 62 and age 63) may make it easier to continue work for longer. The changes in the probabilities of being in different earnings intervals by age are illustrated in Figure 5, and underline the dynamic effects of the reform as discussed in Section 3. This point is further elaborated on in Section 7.1.

We also estimated a version of Equation (3) where we allow for year-specific treatment effects. As we expected in Section 3, we find no effect on the labor force participation rate at the year of reform (2011). The effect on labor force participation, however, increases over time, as shown in Figure 6.

6.5 Comparison with OLS Results

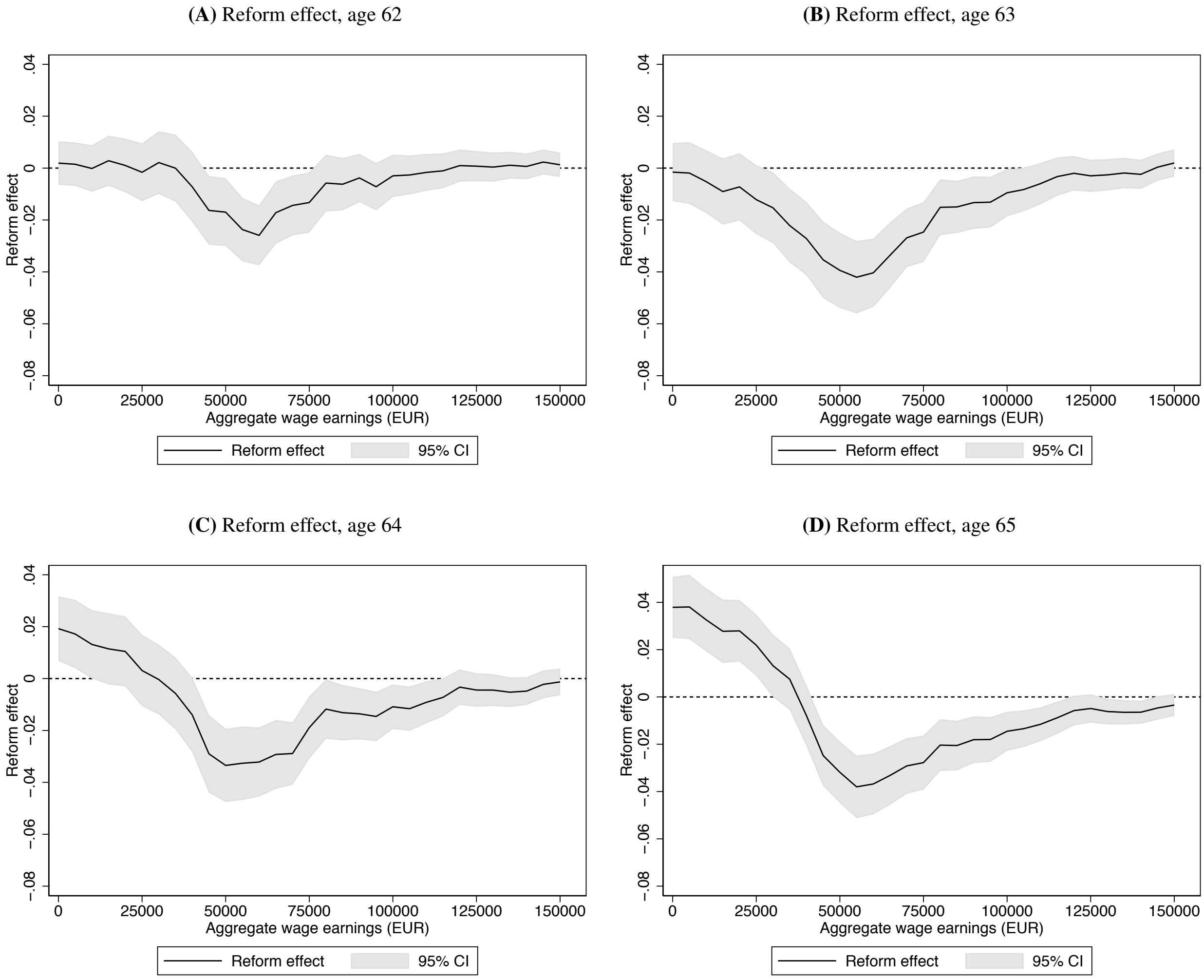
In order to compare the age-specific CCDF estimates in Figure 4 with the OLS estimates in Figure 2, we can calculate the age-specific differences in the CCDF (denote this $\Delta CCDF_{s,a}$, which is the difference between the counterfactual CCDF before and after the reform, i.e. the estimated reform effect) at each earnings increment multiplied by the step size of each of the 31 increments (EUR 5,000) as follows:

$$\Delta E_a = \sum_{r=1}^{31} \Delta CCDF_{r,a} \times 5000 \tag{6}$$

The estimated reform effect for each age ΔE_a from the CCDF approach is reported in Table 5, where the age-specific OLS estimates from Figure 2 are included for comparison. From Table 5 we find that the magnitudes of the age-specific CCDF estimates are fairly well in accordance with age-specific OLS estimates.[15] For instance, the CCDF approach implies a negative reform effect of EUR 2,186 for age 63, while the OLS estimates for age 63 implies a negative effect of EUR 2,227. While the average effect over the age range 62-65 is significantly negative at an average of 3.5 percent, it also clearly diminishing over age. This is the

[15] We do not report the standard errors of the age-specific CCDF estimates in Equation (6) due to potential correlations across the estimates of $\Delta CCDF_{r,a}$. While bootstrapping techniques can be used to obtain the standard errors, we do not consider these standard errors important for this comparison exercise.

Figure 4: Reform effect on earnings distribution, by age



Source: Authors' own calculations using data from Statistics Norway.
Note: Simulation results from estimation of Equation (4), showing the difference in the CCDF for the treatment group and the control group. The gray-shaded area shows the 95 percent confidence intervals (based on 200 non-parametric bootstrap replications for each estimation, clustered on individual level). Aggregate earnings are expressed in EUR. Marginal effects and the associated standard errors are deferred to Appendix A3.5.

Table 5: Age-specific reform effects, CCDF and OLS

Age (a)	CCDF estimate (ΔE_a)	OLS estimate (η_a)
62	-756	-793
63	-2,186	-2,227
64	-1,338	-1,250
65	-927	-1,394

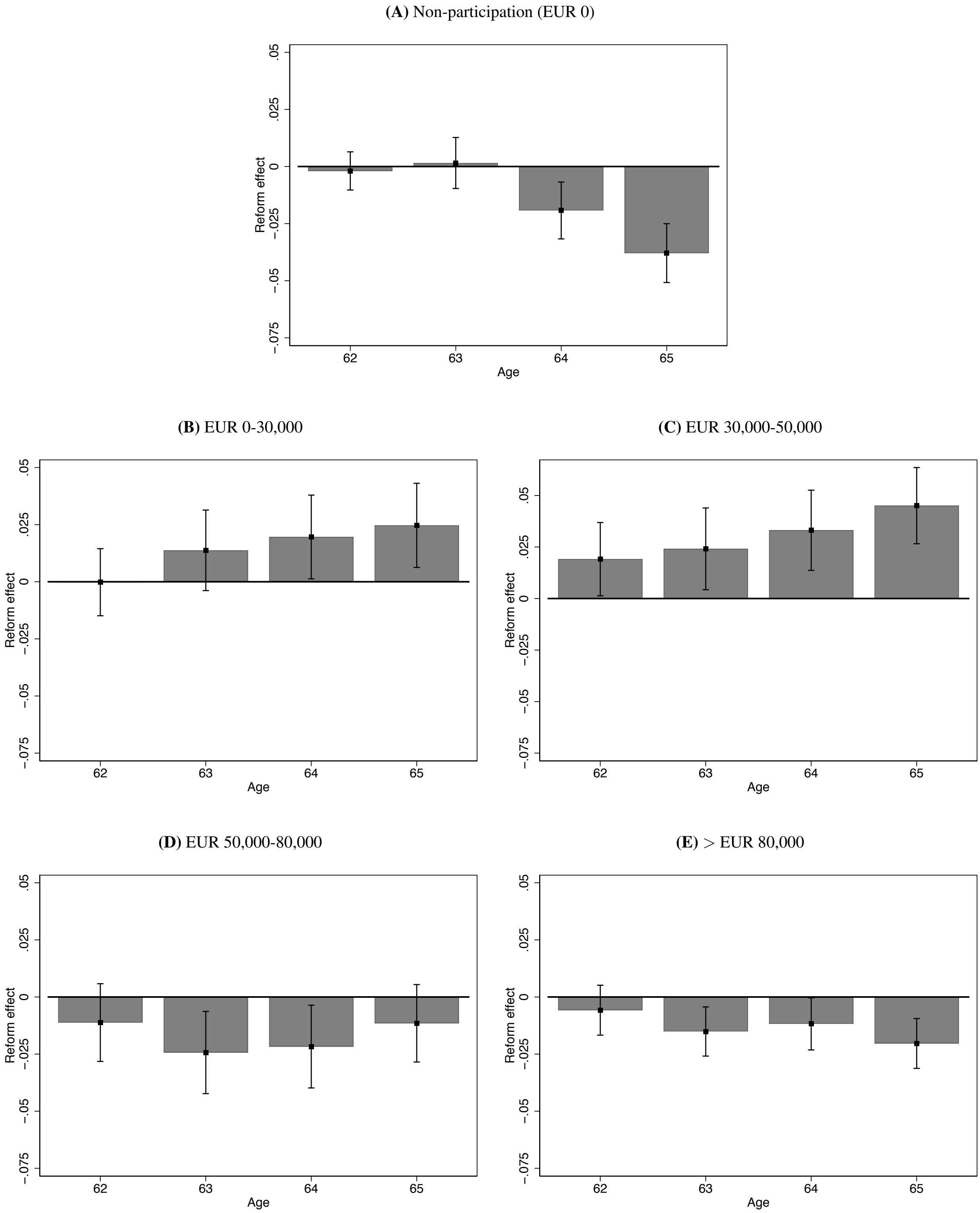
Source: Authors' own calculations using data from Statistics Norway.
Note: Estimated CCDF reform effect for each age (measured in EUR) from Equation (6), and the estimated OLS reform effect for each age from Equation (2).

net result of the increasing effect of labor force participation offsetting a part of the reduced average earnings.

6.6 Robustness

As a placebo exercise to test the identifying assumption stated in Equation (5), we use a year-by-year version of Equation (4) to derive the year-specific reform effects (as detailed in Appendix A3.1) and estimate the

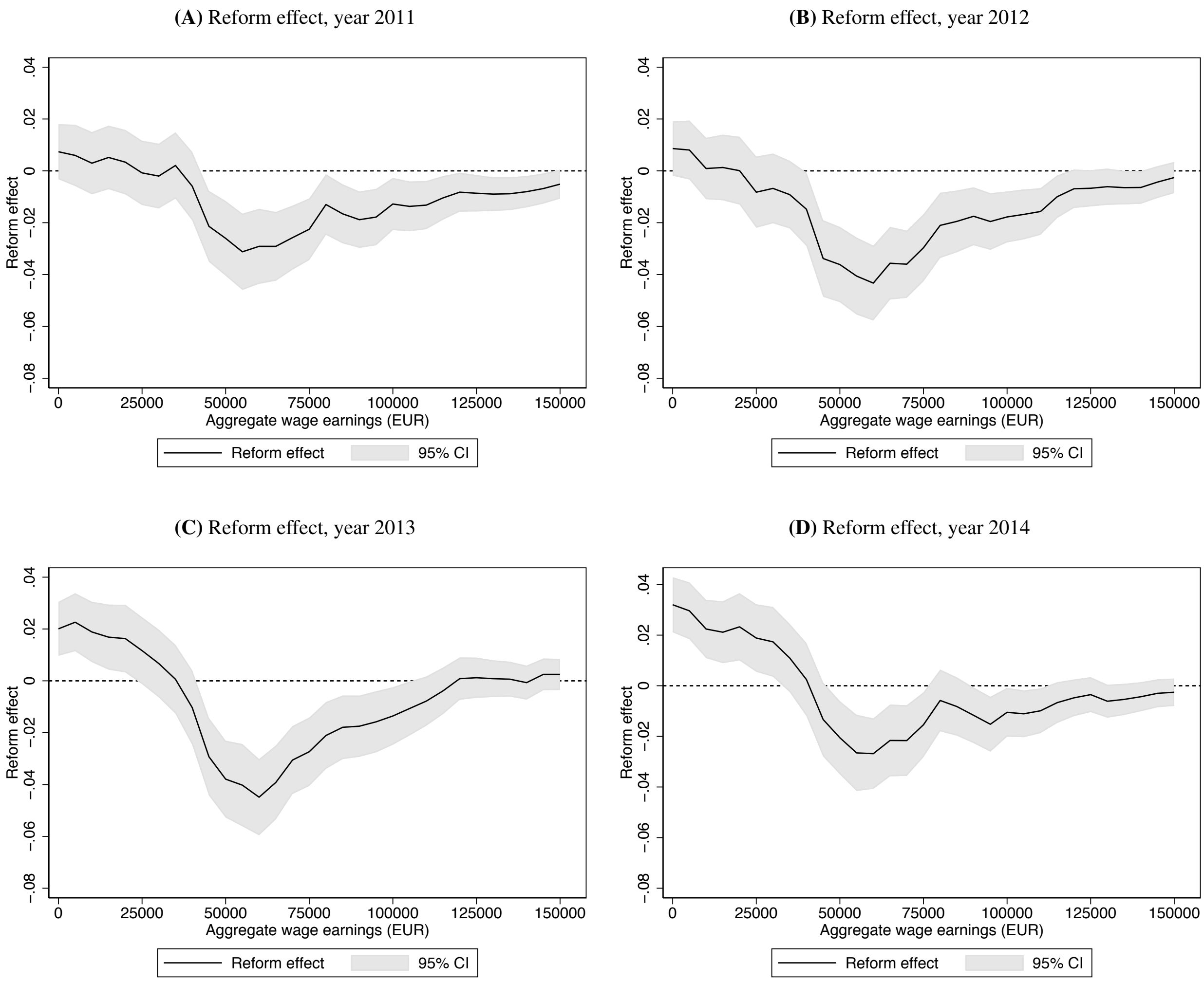
Figure 5: Change in probability of being in selected earnings intervals, by age



Source: Authors' own calculations using data from Statistics Norway.
Note: The reform effect on the probability of being in the different intervals, by age. The reform effects are generated using the marginal effects as visualized by Figure 4, with the caped lines showing the 95 percent confidence intervals. The procedure for deriving reform effects and the associated standard errors is described in detail in Appendix A3.4.

reform effect across the whole earnings distribution in the pre-reform year 2010. As the reform had not been implemented at this stage, we should expect there to be no effect on the changes in the earnings distribution, in line with the identifying assumption in Equation (5). The estimation results from this exercise are illustrated

Figure 6: Reform effect on earnings distribution, by year



Source: Authors' own calculations using data from Statistics Norway.
Note: Simulation results from estimation of a year-by-year version of Equation (3), showing the difference in the CCDF for the treatment group and the control group. The gray-shaded area shows the 95 percent confidence intervals (based on 200 non-parametric bootstrap replications for each estimation, clustered on individual level). Aggregate earnings are expressed in EUR. Marginal effects and the associated standard errors are deferred to Appendix A3.1.

in Figure 7, and show only marginally significant effects at some parts of the earnings distribution.[16] This suggests that the change in the population shares at each of the 31 earnings thresholds would have been the same in the treatment and control group in the absence of the reform.

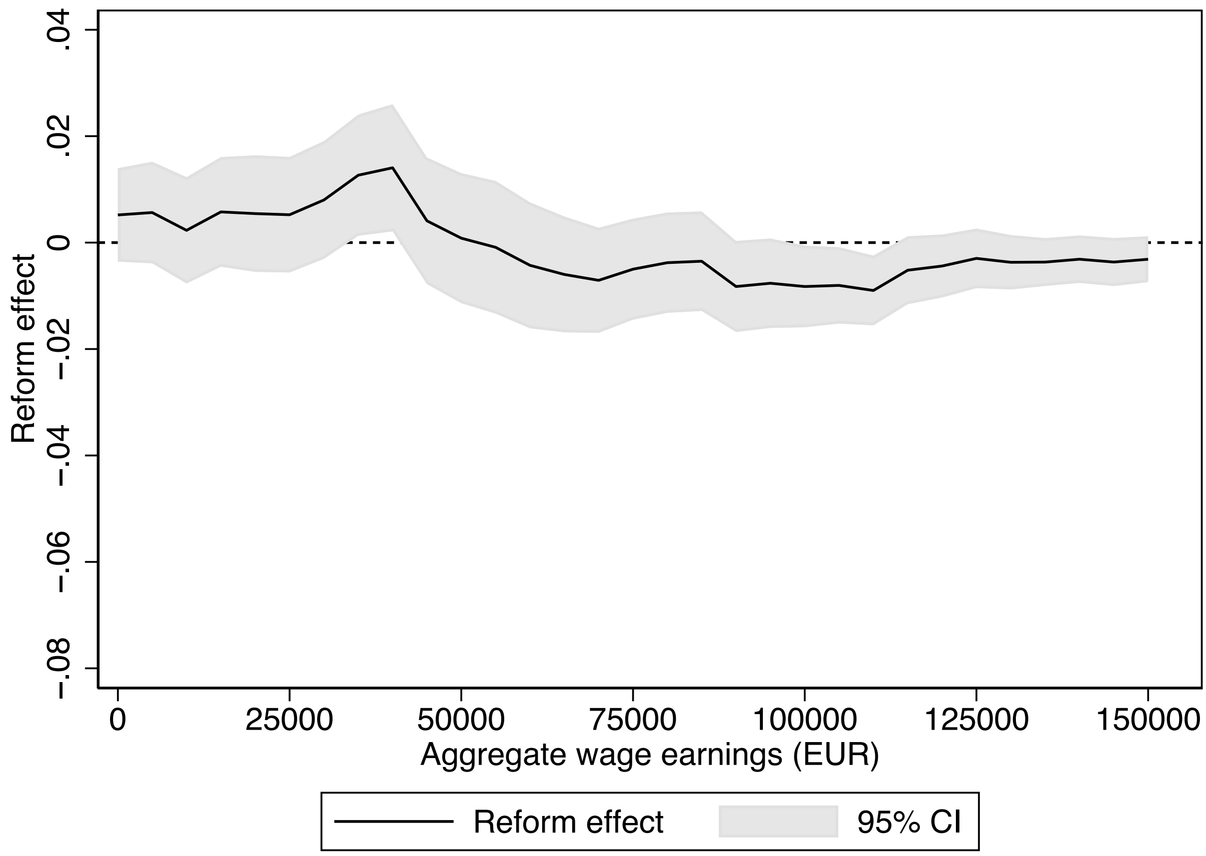
While the largely insignificant effects in the placebo exercise suggest that our difference-in-difference approach is valid, it is worthwhile examining the robustness of our results further. As a robustness check, we follow Brinch et al. (2017) and include group-specific linear time trends (estimated on pre-reform data covering the period 2006-2010) in Equation (3) to discern whether there are secular group-specific trends driving our results.[17] The estimation results (reported in Appendix A3.6) are largely similar to the estimation results for the average reform effect reported in Section 6.5, suggesting that there are no significant differential trends in earnings that are driving our results.

Another challenge to our identification strategy could be that forward-looking workers plan their work career,

[16]Estimating a year-by-year linear specification similar to the OLS specification in Equation (2) yields statistically insignificant reform effects for the pre-reform year 2010. These estimation results are reported in Appendix A4.2.

[17]Including group-specific time trends for our sample period (2009-2014) directly into our main specification in Equation (3) instead yields qualitatively the same results. These results are reported in Appendix A3.6.

Figure 7: Reform effect, 2010



Source: Authors' own calculations using data from Statistics Norway.
Note: Simulation results from a year-by-year version of Equation (3), showing the difference in the CCDF for the treatment group and the control group in 2010. The gray-shaded area shows the 95 percent confidence intervals (based on 200 non-parametric bootstrap replications for each estimation, clustered on individual level). Aggregate earnings are expressed in EUR. Marginal effects and the associated standard errors are deferred to Appendix A3.1.

and the potential effect of the reform on the labor supply in the control group that this type of behavior would imply. To illustrate this, consider a 60-year old worker in the pre-reform period. This person had to wait until age 67 to retire and claim old-age pension benefits. After the reform a worker aged 60 had to wait just two years before claiming the pension benefits, which puts the worker much closer to the end of working life. The former group could therefore have a greater incentive to invest in human capital, health etc. to ensure work capacity up until the retirement age compared to the latter group. If the control group had less incentive to prepare for a longer working life after the reform, they might have a lower labor supply later on - meaning that also the control group was affected by the reform. At the same time, we could imagine that workers who would, before the reform, apply for disability benefits at age 61 now instead "wait it out" until the earliest retirement age. This would mean the reform potentially increased their labor force participation rate also later on after age 62, if the continuation in the labor force implies sustained labor supply later on as well.

To investigate the extent of changes in forward-looking labor market responses, we consider (i) the labor force participation rates at age 60, and (ii) the average number of working hours for the relevant sample of birth cohorts at age 60 (namely the birth cohorts 1944-1954). The results in Table 6 indicate that there seems to be no differential labor force participation rates (which is steady at around 93-94 percent) or working hours unconditional on working (which is steady at around 36-37 hours, and set to zero for non-working) across the birth cohorts in our analysis.

Table 6: Labor force participation and weekly working hours, by birth cohort

	Birth cohort										
	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954
Labor force participation (%)	91.5	91.6	92.8	93.3	94.1	94.5	93.7	94.4	95.1	94.6	95.3
Weekly working hours	36.1	36.3	36.4	36.5	36.7	36.6	36.8	36.8	37.1	37.2	37.2

Source: Authors' own calculations using data from Statistics Norway.
Note: Percentage of individuals working at age 60 and average number of working hours (unconditional on working, set to zero for non-working individuals) at age 60, by birth cohort.

7 Discussion

7.1 Weekly Working Hours

The results for earnings in Figure 5 point to gradual retirement being a potential explanation for the shift in the earnings distribution. To investigate if this could be a mechanism, we use an alternative measure of work effort - namely weekly working hours - as an outcome variable. To derive the age-specific effects of the reform on the number of weekly working hours, and allow for covariates and dummies for age and calendar year, we estimate the following non-linear difference-in-difference model for the alternatives $j \in \{$not working, short part-time, long part-time, full-time/overtime$\}$:

$$P(y_{i,a,t} = j) = \frac{\exp(\eta_{i,j,t})}{\sum_{k=1}^{4} \exp(\eta_{i,k,t})}, \quad \eta_{i,j,t} = \alpha + X_i\beta + \sum_{s=61}^{65} \gamma_s DA_s + \sum_{l=2010}^{2014} \lambda_l DT_l + \sum_{m=62}^{65} \delta_m DA_m \Delta_{i,a,t} \tag{7}$$

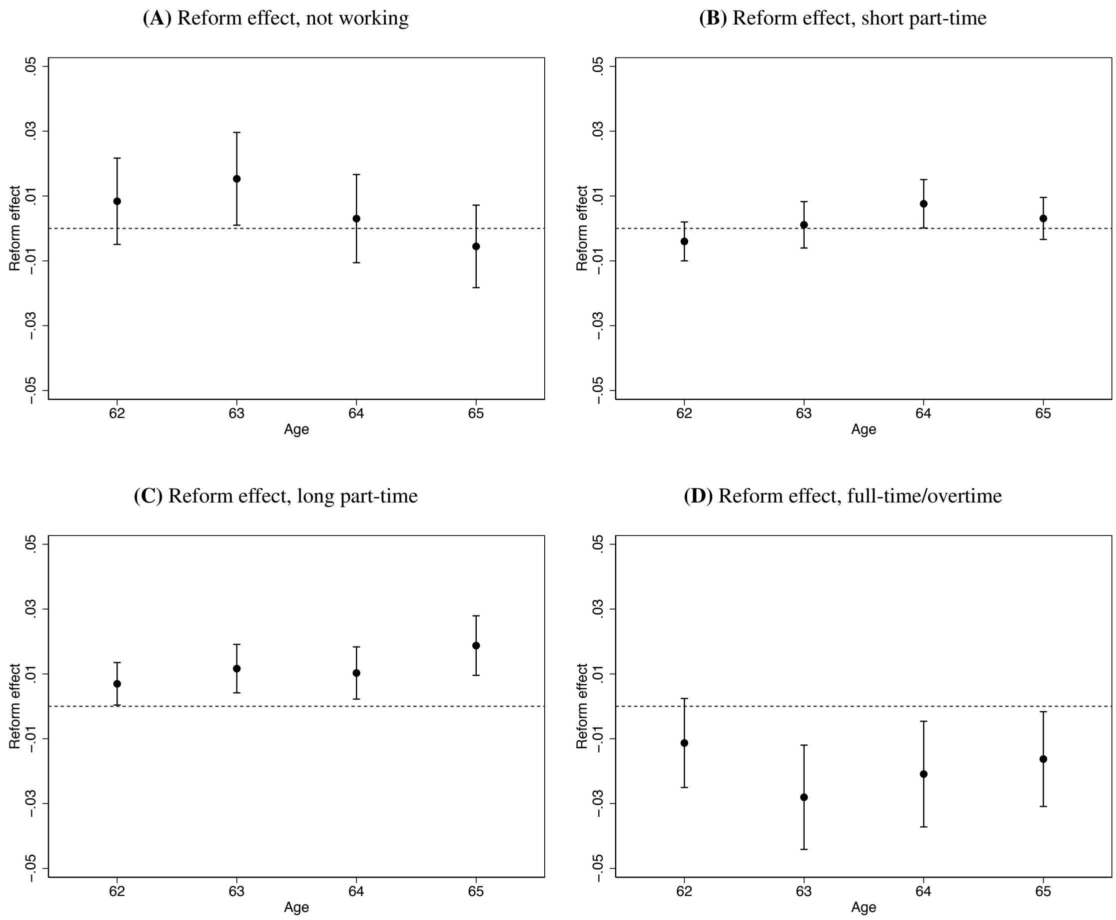
The variables in the linear index ($\eta_{i,j,t}$) in Equation (7) are defined as in Equation (3). The results from this exercise are illustrated in Figure 8. The figure shows the marginal effect of the treatment evaluated at the covariate values equal to the average of the treatment group in the post-reform period. The results indicate that more people work long part-time (Panel C), doing so by working less full-time/overtime (Panel D). The results are statistically significant and generally increasing over the age range which we can follow (ages 62-65), which suggests a substantial state dependence in labor supply.[18] To be consistent, the earnings analysis and the hours analysis should give the same qualitative effect on the labor supply, and they do so. The earnings analysis gives more people between EUR 30,000 and EUR 50,000 and fewer above EUR 50,000, while the hours analyses gives an increase in long part-time work and a decrease in full-time work.

7.2 Total Income

The results so far point to a decrease in full-time work and an increase in long part-time work corresponding to an increase in gradual retirement as measured by reduced earnings. One would expect that the individuals compensate for the income loss of reduced work effort by claiming old-age pension benefits to sustain the same consumption level as they would have in absence of the additional liquidity provided after the reform. To assess this, we find the average old-age pension benefits withdrawal in each of the 31 earnings intervals over ages 62-65, as shown in Figure 9. The changes in the earnings distribution as a result of the reform given in Figure 3 align well with Figure 9. More to the point, the increased mass in the middle of the earnings distribution and the reduced mass at the lower part of the earnings distribution aligns with workers in the

[18]Estimation results for a similar model to Equation (7) with year-specific reform effects are deferred to Appendix A5.2.

Figure 8: Reform effect on weekly hours, by age



Source: Authors' own calculations using data from Statistics Norway.
Note: Results from estimation of Equation (7), showing the estimated marginal reform effects by age and the associated 95 percent confidence intervals (caped lines, based on 200 non-parametric bootstrap replications, clustered on individual level). The weekly-hours groups are defined as follows: (i) not working: 0 hours, (ii) short part-time: 0-20 hours, (iii) long part-time: 20-34 hours, and (iv) full-time/overtime: 34 hours or more. Marginal effects and the associated standard errors are deferred to Appendix A5.3.

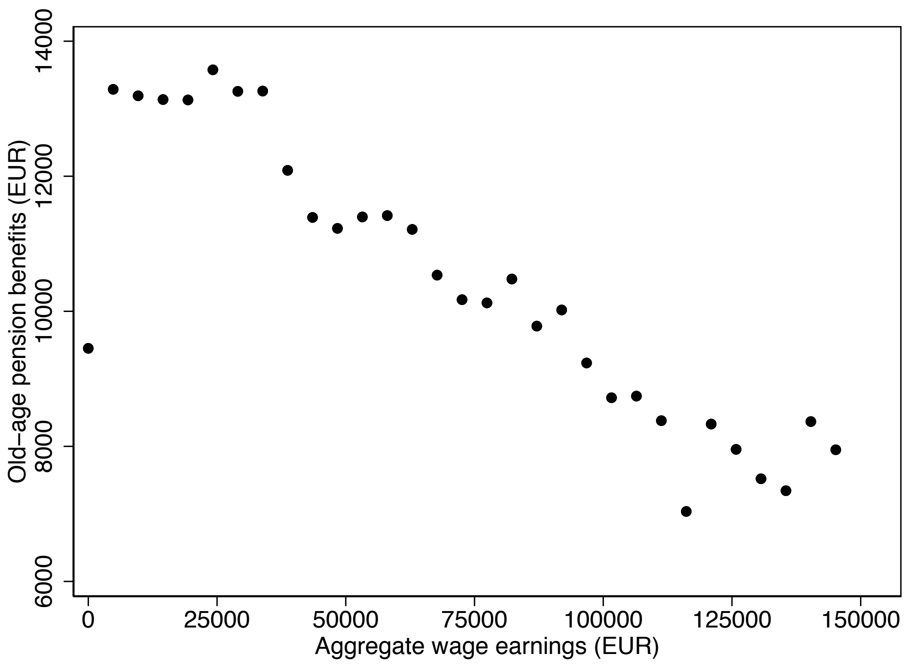
lower part of the earnings distribution claiming old-age pension benefits.

7.3 Job Changes

To look at what potential mechanisms might be behind the increased mass in the middle of the earnings distribution beyond that of reduced weekly working hours, we also examined job transitions. Workers may systematically change jobs at the end of the working career as a part of partial retirement, by switching from the career job to another less demanding and lower paid job and thereby reducing their earnings (Kantarci, 2013). Here we follow the extent of job changes from age 59 and until age 65. The fraction of the pre-reform birth cohort 1945 and the post-reform birth cohort 1949 that changes jobs and the fraction working during ages 59-65 are shown in Panel A and Panel B in Figure 10, respectively. Clearly, there are few job changes taking place at these ages (ranging between 7-14 percent each year) and, more importantly, very little difference between the pre- and post-reform birth cohorts.[19] Thus, it seems that the reduction in earnings and weekly working hours we find are not driven by workers switching employers at the end of their working life (partial retirement) but rather by reducing earnings and working hours at their career employer (phased retirement). Estimating a model similar to Equation (1) with an indicator for partial retirement as the outcome

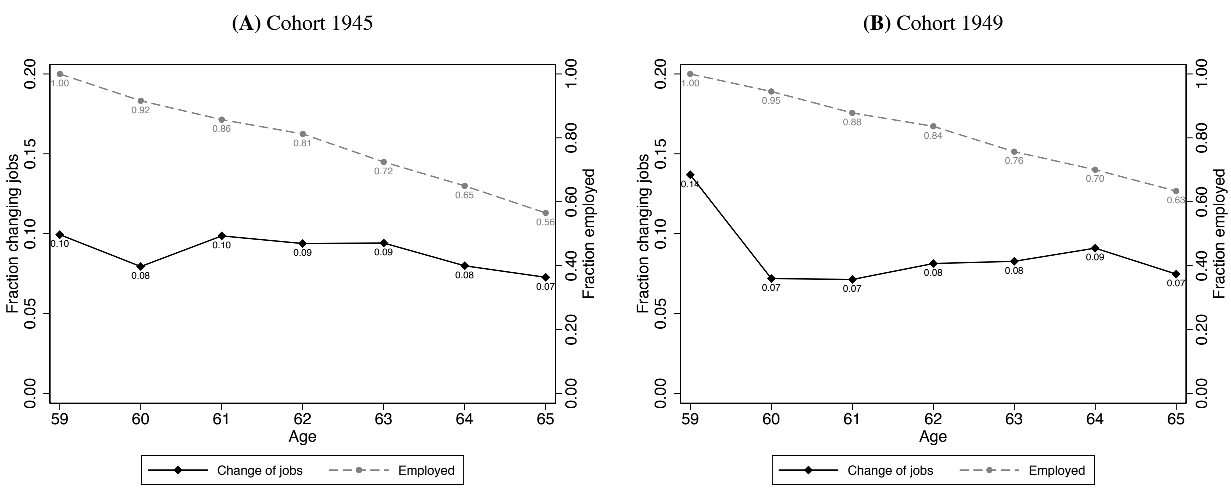
[19]Employer is defined on the establishment level, and we are not readily able to identify job changes within the establishment.

Figure 9: Old-age pension benefit withdrawal, by earnings



Source: Authors' own calculations using data from Statistics Norway.
Note: Average old-age public pension benefit withdrawal (measured in EUR) in each of the 31 earnings intervals over ages 62-65 after the reform, using the sample described in Table 3.

Figure 10: Job changes, by birth cohort and age



Source: Authors' own calculations using data from Statistics Norway.
Note: Percent of pre-reform birth cohort 1945 (Panel A) and after-reform cohort 1949 (Panel B) from the sample described in Table 3 that are employed (gray line, right-hand axis) and changing jobs (black line, left-hand axis), by age. See Appendix A6 for the definition of a job change.

variable on our sample in Table 3 yields a statistically insignificant reform effect, supporting the job change patterns documented in Figure 10.[20]

8 Conclusion

We have studied the impact of reforming a pension by reducing the access age while retaining the expected present value of the benefit stream constant, regardless of claiming age. One element of the comprehensive

[20] See Appendix A4.3 for a complete table of estimation results.

Norwegian pension reform of 2011 did exactly this, reducing a long-standing access age of 67 to age 62. The impact of this change is studied by identifying a group that was exposed only to the new option, without any changes in the present value of the pension. After taking into account the strong upwards trend in employment of the elderly population, we find that the earnings distribution shifted downwards, reducing the average earnings over the age range 62-65 by 3.5 percent. Analyses of transitions over age between working hours' groups show the downward shift to be caused mainly by high earners reducing their earnings per period through reduced working hours, implying a higher incidence of gradual retirement. Labor force participation increases with age and with the phasing in of the reform, and the fall in mean earnings becomes steadily smaller. The apparent dynamic effect over age and phasing in of the reform suggest that the total effect on earnings over a longer age span than 62-65 might be positive if this dynamic effect continues. Such a result would run contrary to most existing analysis.

While we have focused on the supply side of the labor market, there is good reason to believe there are restrictions on the demand side in terms of accommodating gradual retirement (Midtsundstad, 2018; Clark et al., 2019). This would in turn imply that our results constitute a lower bound on the effect of introducing a flexible pension on gradual retirement. Stated preference analysis indicates that workers prefer gradual retirement with decreasing labor supply over several years before entering full retirement over abrupt full retirement (Kantarci & van Soest, 2013a), a finding backed up by a host of surveys (OECD, 2017). While we cannot identify the reasons why some individuals undertake gradual retirement, surveys conducted in Finland (Takala & Väänänen, 2016) suggest that older workers opt for gradual retirement to (i) devote more time to hobbies and family and (ii) say that they had been working full-time for too long. Thus there seems to be a latent desire for phased retirement. Our results indicated that a reduced access age, holding the overall value of the pension constant, can facilitate such a transition to full retirement. The dynamic effect, with increasing labor force participation over age, reinforces such an argument. This presents a case for regulatory policies aimed at making jobs more suitable for older and part-time workers.

References

Albanese, A., Cockx, B., & Thuy, Y. (2020). Working Time Reductions at the End of the Career: Do They Prolong the Time Spent in Employment? *Empirical Economics*, *59*, 99–141.

Ameriks, J., Briggs, J., Caplin, A., Lee, M., Shapiro, M. D., & Tonetti, C. (2020). Older Americans Would Work Longer If Jobs Were Flexible. *American Economic Journal: Macroeconomics*, *12*(1), 174–209.

Angrisani, M., Kapteyn, A., & Meijer, E. (2015). *Nonmonetary Characteristics and Employment Transitions at Older Ages.* (Working Paper WP2015-326, Michigan Retirement Research Center, University of Michigan)

Blau, D., & Shvydko, T. (2011). Labor Market Rigidities and the Employment of Older Workers. *Industrial and Labor Relations Review*, *64*(3), 464–484.

Böckerman, P., & Ilmakunnas, P. (2019). Do Good Working Conditions Make You Work Longer? Analyzing Retirement Decisions Using Linked Survey and Register Data. *The Journal of the Economics of Ageing*. (In Press)

Börsch-Supan, A. H., Bucher-Koenen, T., Kutlu-Koc, V., & Goll, N. (2018). Dangerous Flexibility - Retirement Reforms Reconsidered. *Economic Policy*, *33*, 315–355.

Brinch, C. N., Fredriksen, D., & Vestad, O. L. (2018). Life Expectancy and Claiming Behavior in a Flexible Pension System. *Scandinavian Journal of Economics*, *120*(4), 979–1010.

Brinch, C. N., Hernæs, E., & Jia, Z. (2017). Salience and Social Security Benefits. *Journal of Labor Economics*, *35*(1), 265–297.

Brown, K. (2005). *Attitudes of Individuals 50 and Older Toward Phased Retirement.* (AARP Knowledge Management)

Cahill, K. E., Giandrea, M. D., & Quinn, J. F. (2014). *The Impact of Hours Flexibility on Career Employment, Bridge Jobs, and the Timing of Retirement.* (BLS Working Paper 472, U.S. Bureau of Labor Statistics)

Clark, R., Nyce, S., Ritter, B., & Shoven, J. B. (2019). *Employer Concerns and Responses to an Aging Workforce.* (NBER Working Paper No. 25572)

Dalen, E. (2016). *Norsk Seniorpolitisk Barometer: Ledere [The Norwegian Senior Policy Barometer Survey: Managers].* (Ipsos MMI)

Efron, B., & Tibshirani, R. J. (1993). *An Introduction to the Bootstrap*. New York: Chapman and Hall.

Eurofound. (2016). *Extending Working Lives Through Flexible Retirement Schemes: Partial Retirement.* (Publications Office of the European Union, Luxembourg)

Even, W. E., & MacPherson, D. A. (2004). *Do Pensions Impede Phased Retirement?* (IZA Discussion Paper No. 1353)

Fan, X. (2015). *Retiring Cold Turkey.* (CEPAR Working Paper 2015/20)

Firpo, S., Fortin, N. M., & Lemieux, T. (2009). Unconditional Quantile Regressions. *Econometrica*, *77*(3), 953–973.

Hernæs, E., & Jia, Z. (2013). Earnings Distribution and Labour Supply after a Retirement Earnings Test Reform. *Oxford Bulletin of Economics and Statistics*, *75*(3), 410–434.

Hernæs, E., Markussen, S., Piggott, J., & Røed, K. (2016). Pension Reform and Labor Supply. *Journal of Public Economics*, *142*, 39–55.

Hutchens, R. (2010). Worker Characteristics, Job Characteristics, and Opportunities for Phased Retirement. *Labour Economics*, *17*(6), 1010–1021.

Hutchens, R., & Grace-Martin, K. (2006). Employer Willingness to Permit Phased Retirement: Why Are Some More Willing than Others. *Industrial and Labor Relations Review*, *59*(4), 525–546.

Kantarci, T. (2013). *Factors Limiting the Opportunities for Partial Retirement.* (CESR-Schaeffer Working Paper Series, Paper No. 2013-009)

Kantarci, T., & van Soest, A. (2013a). *Full or Partial Retirement? Effects of the Pension Incentives and Increasing Retirement Age in the United States and the Netherlands.* (Netspar Discussion Paper No. 10/2013-038)

Kantarci, T., & van Soest, A. (2013b). *Stated Preference Analysis of Full and Partial Retirement in the United States.* (CESR-Schaeffer Working Paper Series, Paper No. 2013-011)

Kudrna, G. (2017). *The Norwegian Pension Reform: An External Perspective.* (CEPAR Working Paper 2017/07)

Lingxin, H., & Naiman, D. Q. (2007). *Quantile Regression*. London: SAGE Publications.

Midtsundstad, T. (2018). Seniorers mulighet for gradvis nedtrapping fra arbeidslivet. *Søkelys på arbeidslivet*, *4*, 313–329.

Norwegian Ministry of Labour and Social Affairs. (2019). *The Norwegian Social Insurance Scheme.* (Survey, January 2019)

OECD. (2017). *Pensions at a Glance 2017: OECD and G20 Indicators.* (OECD Publishing, Paris)

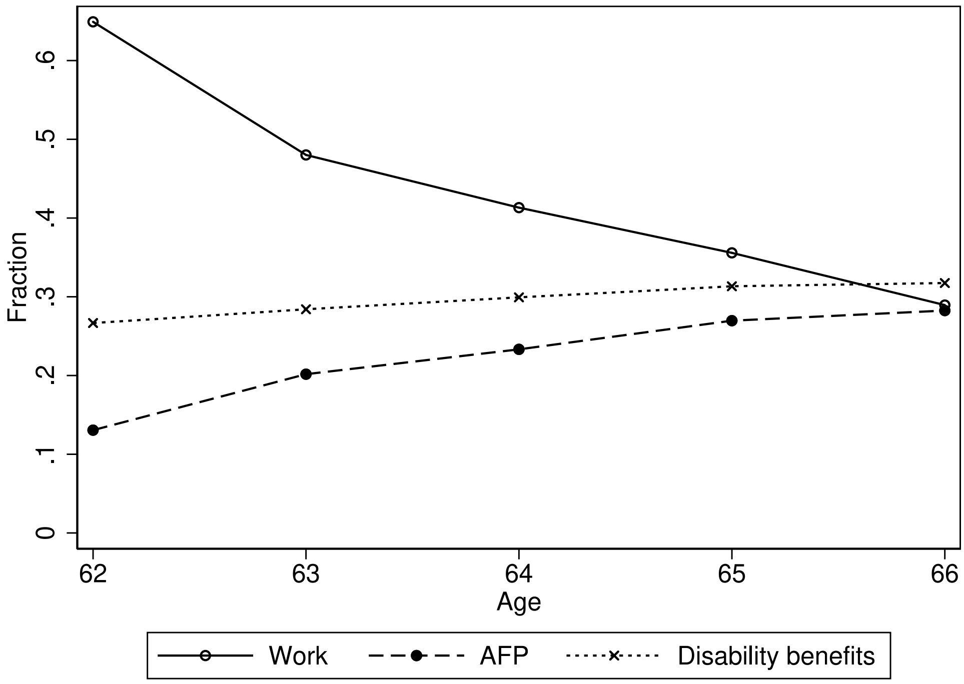
Takala, M., & Väänänen, N. (2016). *Does Part-Time Pension Extend Working Lives? A Finnish Case Study.* (Report No. 05/2016, Finnish Centre for Pensions)

Tuominen, E. (2013). *Flexible Retirement Age in Finland.* (Working Paper 03/2013, Finnish Centre for Pensions)

A1 Gradual Retirement Before the Reform

To illustrate the extent of gradual retirement before the 2011 Norwegian pension reform, we consider the (pre-reform) 1942 birth cohort. Before the reform, disability program enrollment and early retirement (AFP) for those eligible were the only exit routes before age 67, and these exit routes are illustrated in Figure A1. The drop in labor force participation closely mirrors the increase in disability benefit receipt and AFP claiming. AFP was the only option that combined reduced earnings with claiming part of the pension, and that carried a proportional earnings test. As a result of the strict earnings test, among those claiming the AFP benefits about 85 percent claimed the full pension and quit work.

Figure A1: Gradual retirement, 1942 birth cohort

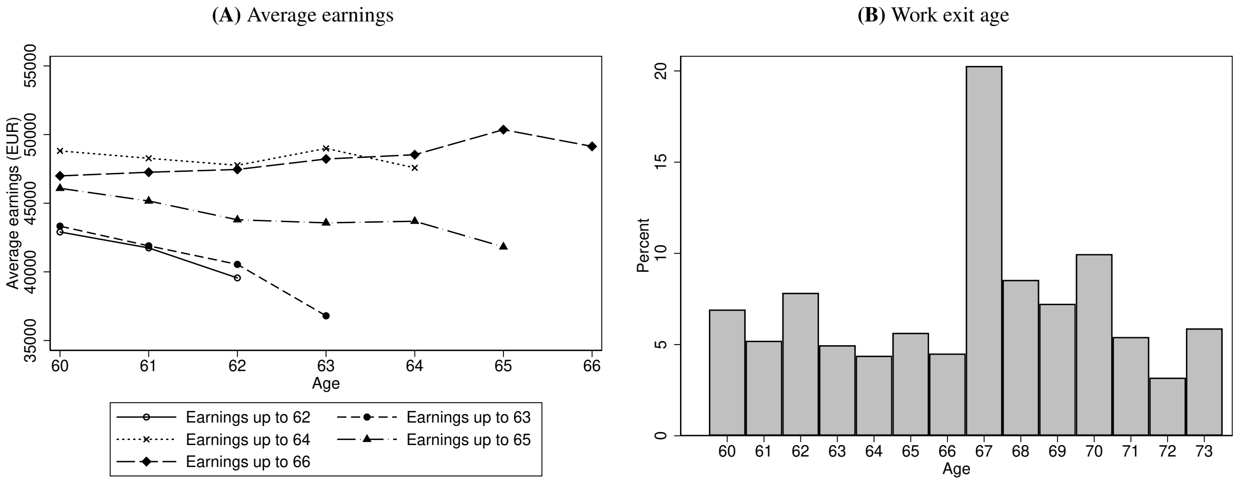


Source: Authors' own calculations using data from Statistics Norway.
Note: Fraction of 1942 birth cohort in the labor force (hollow circles), claiming AFP benefits (solid circles) and receiving permanent disability benefits (crosses), by age. Work is defined as earnings over EUR 10,000, while AFP claiming and disability benefit claiming is defined as any positive amount claimed.

Earnings among those who continued to work either stayed fairly constant or fell very modestly up to the year before retirement, as illustrated in Panel A in Figure A2. To focus on gradual retirement, we have included only those who at age 66 neither received permanent disability benefits nor claimed AFP benefits. There is a somewhat larger drop among those who left the labor market early, with earnings the last year before the transition to retirement dropping up to 20 percent. This was also a group with lower earnings at age 60. For the 1942 birth cohort as a whole, almost one quarter leave work at age 67 (have the second-to-last earnings year at age 66), but apart from that, exit is spread out over a range of ages (as illustrated in Panel B in Figure A2).

We conclude that the reduction in the labor force participation rate and earnings before the reform among those working at age 60 was almost exclusively related to claiming AFP benefits. Work reduction played a minor role, as only about 3 percent of those working at age 60 took a part-time AFP. That carried a strict earnings test and required combining part pension benefits and part earnings. Apart from that, about a quarter went on disability benefits and the rest continued at the earnings level they had at age 60 until they quit.

Figure A2: Gradual retirement, 1942 birth cohort

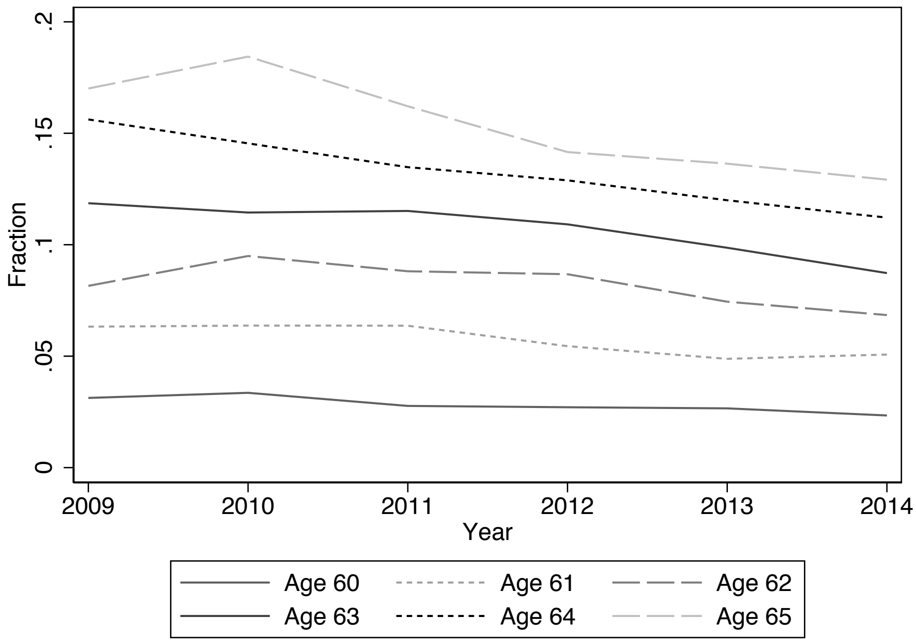


Source: Authors' own calculations using data from Statistics Norway.
Note: Average earnings (expressed in EUR, conditional on positive earnings) of 1942 birth cohort (up to and including the year prior to retirement) for retirement ages 63-67, by age and age of retirement (Panel A) and distribution of work exit age for 1942 birth cohort, where work exit age is defined as the last age with positive earnings (Panel B). The sample is conditional on not receiving permanent disability benefits or claiming AFP benefits at age 66.

A2 Disability Insurance Rates

Figure A3 shows the fraction claiming disability insurance benefits (defined as any positive amount of disability insurance benefits claimed), by calendar year and age.

Figure A3: Fraction claiming disability insurance benefits, by calendar year and age



Source: Authors' own calculations using data from Statistics Norway.
Note: Claiming is defined as any positive amount of disability insurance benefits claimed.

A3 CCDF

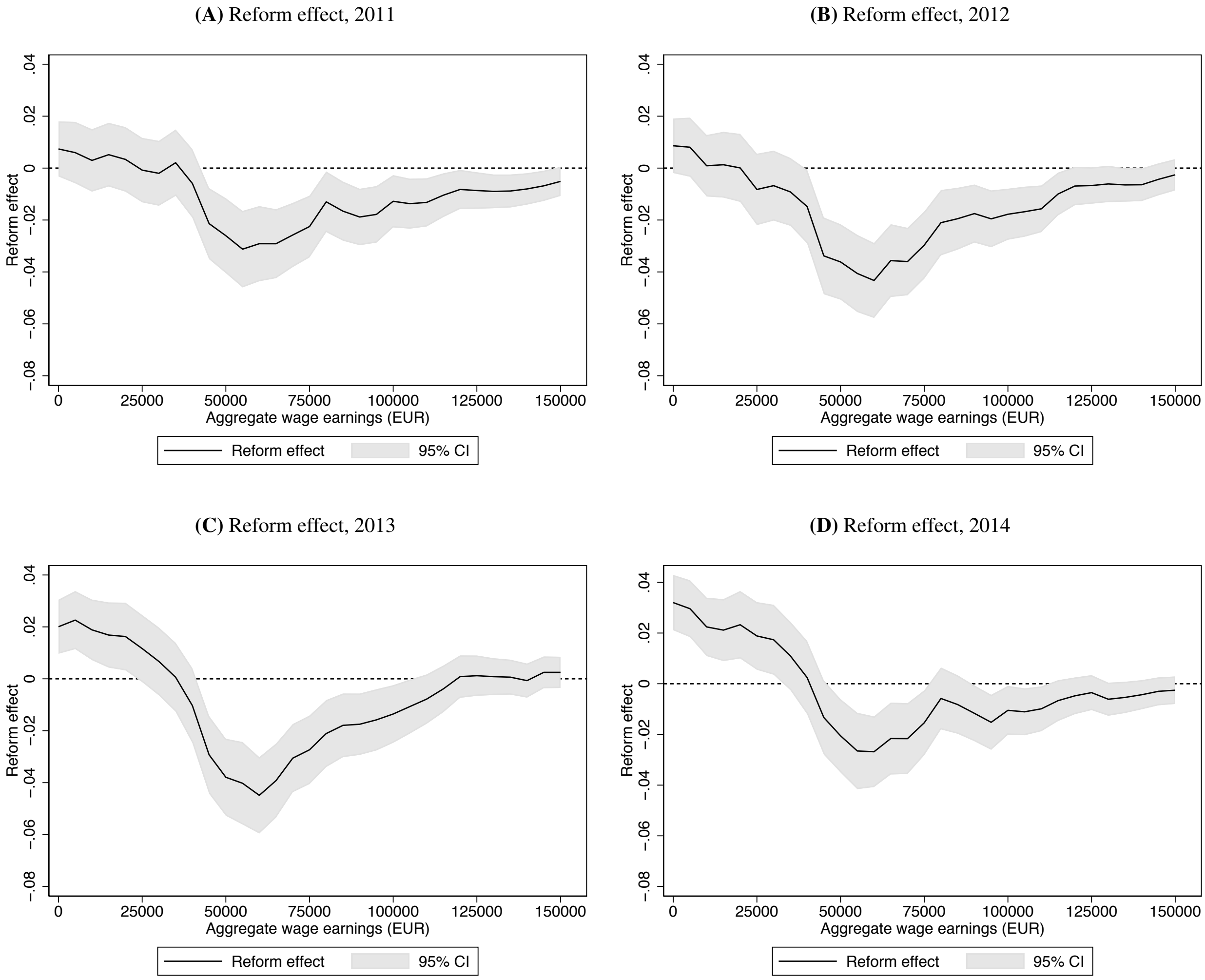
A3.1 Year-by-Year Effect

We assume that for each earnings level $y_{i,a,t}$ for individual i at age a in year $t = 2009, \ldots, 2014$:

$$\mathbf{1}(y_{i,a,t} > y_k) = \alpha + X_i\beta + \sum_{s=61}^{65} \gamma_s DA_s + \sum_{l=2010}^{2014} \lambda_l DT_l + \sum_{m=2010}^{2014} \eta_m DT_m \Delta_{i,a,t} + \varepsilon_{i,a,t} \tag{A1}$$

Here, the coefficients λ_l for $l = 2010, \ldots, 2014$ measure the year effects, while η_m for $m = 2010, \ldots, 2014$ measure the year-specific treatment effects. Figure A4 shows the results of simulations of the reform impact for each year separately.

Figure A4: Reform effect on earnings distribution, by year



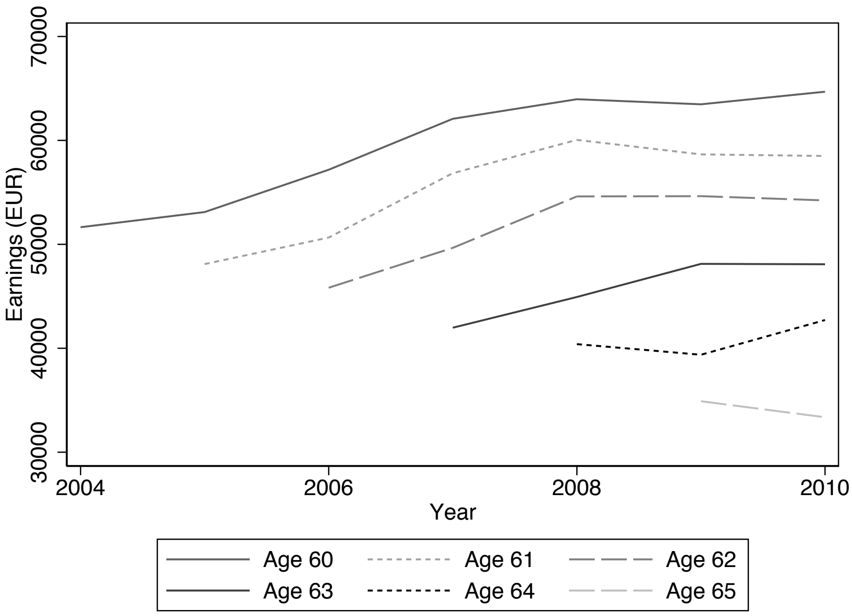
Source: Authors' own calculations using data from Statistics Norway.
Note: Simulation results from estimation of Equation (A1), showing the difference in the CCDF for the treatment group and the control group. The gray-shaded area shows the 95 percent confidence intervals (based on 200 non-parametric bootstrap replications for each estimation, clustered on individual level). Aggregate earnings are expressed in EUR. Marginal effects and the associated standard errors are shown in Table A1.

Table A1 in Section A3.7 in this Appendix shows the marginal effects (ME) and the associated standard errors (SE) for each of the estimations of Equation (A1) used to simulate the year-by-year reform effects on the earnings distribution (shown in Figure 7 for the year 2010 and Figure A4 for the years 2011-2014).

A3.2 Trends in Earnings

Figure A5 shows the average earnings by age and calendar year prior to the reform in 2011, and indicates that the assumption of constant age effects across the birth cohorts in Equation (4) is not too restrictive.

Figure A5: Average earnings, by age and calendar year



Source: Authors' own calculations using data from Statistics Norway.
Note: Average aggegate wage earnings (expressed in EUR), by age and calendar year.

A3.3 Average Effect

Panel A in Table A3 in Section A3.7 in this Appendix shows the marginal effects and the associated standard errors for each of the estimations of the following empirical approach (shown in Figure 3):

$$\mathbf{1}\left(y_{i,a,t} > y_k\right) = \alpha + X_i\beta + \sum_{s=61}^{65} \gamma_s DA_s + \sum_{l=2010}^{2014} \lambda_l DT_l + \eta\Delta_{i,a,t} + \varepsilon_{i,a,t} \tag{A2}$$

A3.4 Probability of Being in Different Earnings Intervals

The change in the probabilities of being in different earnings intervals (reported in Table 4) is derived from the marginal effects reported in Panel A in Table A3 in Section A3.7 in this Appendix. Letting $T \in \{0,1\}$ denote treatment status, $F(\cdot)$ denote the CDF and $\Delta CCDF_k$ denote the marginal effect at the threshold $y = y_k$, the change in the probability of being in an earnings interval $\left[\underline{y}, \bar{y}\right]$ can be expressed as follows using the definition of the CDF and the CCDF:

$$\begin{aligned}
P\left(\underline{y} < y < \bar{y}|T=1\right) - P\left(\underline{y} < y < \bar{y}|T=0\right) &= \left[F\left(\bar{y}|T=1\right) - F\left(\underline{y}|T=1\right)\right] \\
&- \left[F\left(\bar{y}|T=0\right) - F\left(\underline{y}|T=0\right)\right] \\
&= \left[\left[1 - P\left(y > \bar{y}|T=1\right)\right] - \left[1 - P\left(y > \underline{y}|T=1\right)\right]\right] \\
&- \left[\left[1 - P\left(y > \bar{y}|T=0\right)\right] - \left[1 - P\left(y > \underline{y}|T=0\right)\right]\right] \\
&= P\left(y > \underline{y}|T=1\right) - P\left(y > \underline{y}|T=0\right) \\
&- \left[P\left(y > \bar{y}|T=1\right) - P\left(y > \bar{y}|T=0\right)\right] \\
&= \Delta CCDF_{\underline{y}} - \Delta CCDF_{\bar{y}}
\end{aligned} \tag{A3}$$

Based on the formula in Equation (A3), we find the following changes in probabilities:

$$
\begin{aligned}
P(y=0|T=1)-P(y=0|T=0) &= -\Delta CCDF_0 = -0.015 \\
P(0<y<30,000|T=1)-P(0<y<30,000|T=0) &= \Delta CCDF_0 - \Delta CCDF_{30,000} \\
&= (0.015)-(0.000) \\
&= 0.015 \\
P(30,000<y<50,000|T=1)-P(30,000<y<50,000|T=0) &= \Delta CCDF_{30,000} - \Delta CCDF_{50,000} \\
&= (0.000)-(-0.030) \\
&= 0.030 \\
P(50,000<y<80,000|T=1)-P(50,000<y<80,000|T=0) &= \Delta CCDF_{50,000} - \Delta CCDF_{80,000} \\
&= (-0.030)-(-0.013) \\
&= -0.017 \\
P(y>80,000|T=1)-P(y>80,000|T=0) &= \Delta CCDF_{80,000} = -0.013
\end{aligned}
\tag{A4}
$$

The standard errors are derived using the conventional pooled variance of the estimated marginal effects, where we assume independence of the estimates:[1]

$$SE(\Delta CCDF_s - \Delta CCDF_j) = \sqrt{[SE(\Delta CCDF_s)]^2 + [SE(\Delta CCDF_j)]^2} \tag{A5}$$

Using the general formula in Equation (A5), we derive the following standard errors:

$$
\begin{aligned}
SE(\Delta CCDF) &= 0.004 \\
SE(\Delta CCDF_0 - \Delta CCDF_{30,000}) &= \sqrt{[0.004]^2 + [0.005]^2} = 0.006 \\
SE(\Delta CCDF_{30,000} - \Delta CCDF_{50,000}) &= \sqrt{[0.005]^2 + [0.005]^2} = 0.007 \\
SE(\Delta CCDF_{50,000} - \Delta CCDF_{80,000}) &= \sqrt{[0.005]^2 + [0.005]^2} = 0.007 \\
SE(\Delta CCDF_{80,000}) &= 0.005
\end{aligned}
\tag{A6}
$$

The same method is also used for deriving the probabilities and the associated standard errors appearing in Figure 5.

A3.5 Age-by-Age Effect

Table A2 in Section A3.7 in this Appendix shows the marginal effects and the associated standard errors for each of the estimations of Equation (4) used to simulate the age-by-age reform effects on the earnings distribution (shown in Figure 4), where we assume a constant treatment effect across years.

A3.6 Robustness

To include a pre-reform trend in our main specification, we first estimate treatment-specific trends for each of the earnings intervals using data covering the pre-reform period (2006-2010) with the following model:

$$\mathbf{1}(y_{i,a,t} > y_k) = \alpha + \tau t + \gamma \mathbf{1}\{a_{i,t} \geq 62\} + \omega(t \times \mathbf{1}\{a_{i,t} \geq 62\}) + \varepsilon_{i,a,t} \tag{A7}$$

[1]Given that we bootstrap each estimation with individuals as the unit of clustering, this should alleviate the issue of age-dependency of the estimates. This allows us to derive the standard errors here using the conventional pooled standard error formula.

With the saturated model in Equation (A7), we obtain an estimated slope of the (linear) time trend for the treatment group (individuals aged 62-65) relative to the control group (individuals aged 60-61), denoted $\hat{\omega}$, which we then include into our main specification as follows:

$$\mathbf{1}\left(y_{i,a,t} > y_k\right) = \alpha + X_i\beta + \sum_{s=61}^{65} \gamma_s DA_s + \sum_{l=2010}^{2014} \lambda_l DT_l + \hat{\omega}\left(t \times \mathbf{1}\left\{a_{i,t} \geq 62\right\}\right) + \eta\Delta_{i,a,t} + \varepsilon_{i,a,t} \tag{A8}$$

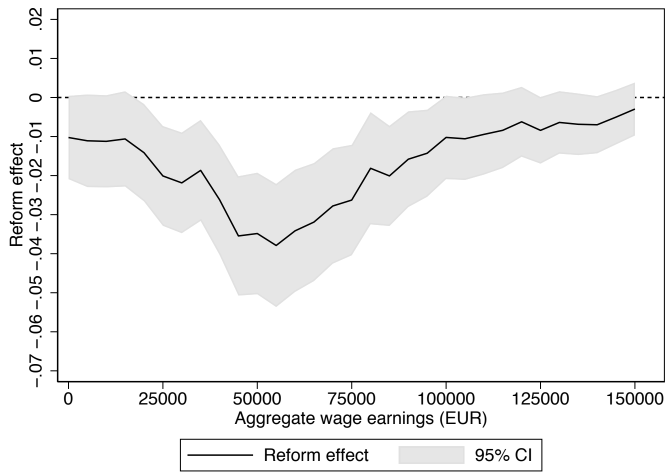
To instead include a linear time trend estimated using the sample years we use otherwise in the analysis (2009-2014), we estimate the following version of our main specification:

$$\mathbf{1}\left(y_{i,a,t} > y_k\right) = \alpha + X_i\beta + \sum_{s=61}^{65} \gamma_s DA_s + \sum_{l=2010}^{2014} \lambda_l DT_l + \varphi\left(t \times \mathbf{1}\left\{a_{i,t} \geq 62\right\}\right) + \eta\Delta_{i,a,t} + \varepsilon_{i,a,t} \tag{A9}$$

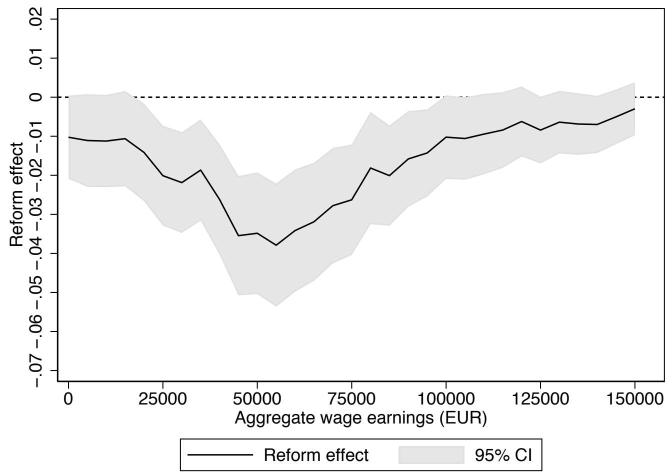
The marginal effects and standard errors from estimating Equation (A8) and Equation (A9) are shown in Panel A and B in Figure A6, and reported in Panel B and Panel C in Table A3 in Section A3.7 in this Appendix.

Figure A6: Reform effect on earnings distribution, time trend

(A) Pre-reform time trend



(B) Time trend



Source: Authors' own calculations using data from Statistics Norway.
Note: Simulation results from estimation of Equation (A8) (Panel A) and Equation (A9) (Panel B), showing the difference in the CCDF for the treatment group and the control group. The gray-shaded area shows the 95 percent confidence intervals (based on 200 non-parametric bootstrap replications for each estimation, clustered on individual level). Aggregate earnings are expressed in EUR. Marginal effects and the associated standard errors are reported in Table A3.

A3.7 Tables

Table A1: Marginal effects, CCDF, reform effect by year

Outcome	2010		2011		2012		2013		2014	
	ME	SE	ME	SE	ME	SE	ME	SE	ME	SE
$P(y_{i,a,t} > 0)$	0.005	0.004	0.007	0.005	0.009	0.005	0.020	0.005	0.032	0.006
$P(y_{i,a,t} > 5,000)$	0.006	0.005	0.006	0.006	0.008	0.006	0.023	0.006	0.030	0.006
$P(y_{i,a,t} > 10,000)$	0.002	0.005	0.003	0.006	0.001	0.006	0.019	0.006	0.022	0.006
$P(y_{i,a,t} > 15,000)$	0.006	0.005	0.005	0.006	0.001	0.006	0.017	0.006	0.021	0.006
$P(y_{i,a,t} > 20,000)$	0.005	0.006	0.003	0.006	0.000	0.007	0.016	0.007	0.023	0.007
$P(y_{i,a,t} > 25,000)$	0.005	0.006	-0.001	0.006	-0.008	0.007	0.012	0.007	0.019	0.007
$P(y_{i,a,t} > 30,000)$	0.008	0.006	-0.002	0.006	-0.007	0.007	0.007	0.007	0.017	0.007
$P(y_{i,a,t} > 35,000)$	0.013	0.006	0.002	0.007	-0.009	0.007	0.001	0.007	0.011	0.007
$P(y_{i,a,t} > 40,000)$	0.014	0.006	-0.006	0.007	-0.015	0.007	-0.010	0.007	0.002	0.007
$P(y_{i,a,t} > 45,000)$	0.004	0.006	-0.021	0.007	-0.034	0.008	-0.029	0.008	-0.013	0.007
$P(y_{i,a,t} > 50,000)$	0.001	0.006	-0.026	0.007	-0.036	0.007	-0.038	0.008	-0.021	0.007
$P(y_{i,a,t} > 55,000)$	-0.001	0.006	-0.031	0.008	-0.041	0.008	-0.040	0.008	-0.027	0.008
$P(y_{i,a,t} > 60,000)$	-0.004	0.006	-0.029	0.007	-0.043	0.007	-0.045	0.008	-0.027	0.007
$P(y_{i,a,t} > 65,000)$	-0.006	0.006	-0.029	0.007	-0.036	0.007	-0.039	0.007	-0.022	0.007
$P(y_{i,a,t} > 70,000)$	-0.007	0.005	-0.026	0.006	-0.036	0.007	-0.031	0.007	-0.022	0.007
$P(y_{i,a,t} > 75,000)$	-0.005	0.005	-0.023	0.006	-0.030	0.007	-0.027	0.007	-0.015	0.007
$P(y_{i,a,t} > 80,000)$	-0.004	0.005	-0.013	0.006	-0.021	0.006	-0.021	0.007	-0.006	0.006
$P(y_{i,a,t} > 85,000)$	-0.003	0.005	-0.017	0.006	-0.019	0.006	-0.018	0.006	-0.008	0.006
$P(y_{i,a,t} > 90,000)$	-0.008	0.004	-0.019	0.006	-0.018	0.006	-0.017	0.006	-0.012	0.006
$P(y_{i,a,t} > 95,000)$	-0.008	0.004	-0.018	0.006	-0.020	0.006	-0.016	0.006	-0.015	0.006
$P(y_{i,a,t} > 100,000)$	-0.008	0.004	-0.013	0.005	-0.018	0.005	-0.014	0.006	-0.010	0.005
$P(y_{i,a,t} > 105,000)$	-0.008	0.004	-0.014	0.005	-0.017	0.005	-0.011	0.005	-0.011	0.005
$P(y_{i,a,t} > 110,000)$	-0.009	0.003	-0.013	0.005	-0.016	0.005	-0.008	0.005	-0.010	0.005
$P(y_{i,a,t} > 115,000)$	-0.005	0.003	-0.010	0.004	-0.010	0.004	-0.004	0.005	-0.007	0.004
$P(y_{i,a,t} > 120,000)$	-0.004	0.003	-0.008	0.004	-0.007	0.004	0.001	0.004	-0.005	0.004
$P(y_{i,a,t} > 125,000)$	-0.003	0.003	-0.009	0.004	-0.007	0.004	0.001	0.004	-0.004	0.004
$P(y_{i,a,t} > 130,000)$	-0.004	0.003	-0.009	0.003	-0.006	0.004	0.001	0.004	-0.006	0.003
$P(y_{i,a,t} > 135,000)$	-0.004	0.002	-0.009	0.003	-0.006	0.003	0.001	0.003	-0.005	0.003
$P(y_{i,a,t} > 140,000)$	-0.003	0.002	-0.008	0.003	-0.006	0.003	-0.001	0.003	-0.004	0.003
$P(y_{i,a,t} > 145,000)$	-0.004	0.002	-0.007	0.003	-0.004	0.003	0.002	0.003	-0.003	0.003
$P(y_{i,a,t} > 150,000)$	-0.003	0.002	-0.005	0.003	-0.003	0.003	0.002	0.003	-0.003	0.003

Source: Authors' own calculations using data from Statistics Norway.
Note: Marginal effects (ME) and associated standard errors (SE) for each of the estimations of Equation (A1). Standard errors are based on 200 non-parametric bootstrap replications for each estimation, clustered on individual level.

Table A2: Marginal effects, CCDF, reform effect by age

Outcome	Age 62		Age 63		Age 64		Age 65	
	ME	SE	ME	SE	ME	SE	ME	SE
$P(y_{i,a,t} > 0)$	0.002	0.004	-0.002	0.006	0.019	0.006	0.038	0.007
$P(y_{i,a,t} > 5,000)$	0.001	0.004	-0.002	0.006	0.017	0.007	0.038	0.007
$P(y_{i,a,t} > 10,000)$	0.000	0.005	-0.005	0.006	0.013	0.007	0.033	0.007
$P(y_{i,a,t} > 15,000)$	0.003	0.005	-0.009	0.006	0.011	0.007	0.028	0.007
$P(y_{i,a,t} > 20,000)$	0.001	0.005	-0.007	0.007	0.010	0.007	0.028	0.007
$P(y_{i,a,t} > 25,000)$	-0.002	0.006	-0.012	0.007	0.003	0.007	0.022	0.007
$P(y_{i,a,t} > 30,000)$	0.002	0.006	-0.015	0.007	0.000	0.007	0.013	0.007
$P(y_{i,a,t} > 35,000)$	0.000	0.007	-0.022	0.007	-0.006	0.007	0.008	0.007
$P(y_{i,a,t} > 40,000)$	-0.007	0.007	-0.027	0.007	-0.014	0.007	-0.008	0.007
$P(y_{i,a,t} > 45,000)$	-0.016	0.007	-0.035	0.008	-0.029	0.008	-0.025	0.007
$P(y_{i,a,t} > 50,000)$	-0.017	0.007	-0.039	0.007	-0.033	0.007	-0.032	0.007
$P(y_{i,a,t} > 55,000)$	-0.024	0.006	-0.042	0.007	-0.033	0.007	-0.038	0.007
$P(y_{i,a,t} > 60,000)$	-0.026	0.006	-0.040	0.007	-0.032	0.007	-0.037	0.007
$P(y_{i,a,t} > 65,000)$	-0.017	0.006	-0.034	0.006	-0.029	0.007	-0.033	0.006
$P(y_{i,a,t} > 70,000)$	-0.014	0.006	-0.027	0.006	-0.029	0.006	-0.029	0.006
$P(y_{i,a,t} > 75,000)$	-0.013	0.006	-0.025	0.006	-0.019	0.006	-0.028	0.006
$P(y_{i,a,t} > 80,000)$	-0.006	0.006	-0.015	0.005	-0.012	0.006	-0.020	0.006
$P(y_{i,a,t} > 85,000)$	-0.006	0.005	-0.015	0.005	-0.013	0.005	-0.021	0.005
$P(y_{i,a,t} > 90,000)$	-0.004	0.005	-0.013	0.005	-0.014	0.005	-0.018	0.005
$P(y_{i,a,t} > 95,000)$	-0.007	0.005	-0.013	0.005	-0.015	0.005	-0.018	0.005
$P(y_{i,a,t} > 100,000)$	-0.003	0.004	-0.010	0.005	-0.011	0.004	-0.015	0.004
$P(y_{i,a,t} > 105,000)$	-0.003	0.004	-0.008	0.004	-0.012	0.004	-0.013	0.004
$P(y_{i,a,t} > 110,000)$	-0.002	0.004	-0.006	0.004	-0.009	0.004	-0.012	0.004
$P(y_{i,a,t} > 115,000)$	-0.001	0.003	-0.003	0.004	-0.007	0.004	-0.009	0.003
$P(y_{i,a,t} > 120,000)$	0.001	0.003	-0.002	0.003	-0.003	0.003	-0.006	0.003
$P(y_{i,a,t} > 125,000)$	0.001	0.003	-0.003	0.003	-0.004	0.003	-0.005	0.003
$P(y_{i,a,t} > 130,000)$	0.000	0.003	-0.003	0.003	-0.004	0.003	-0.006	0.003
$P(y_{i,a,t} > 135,000)$	0.001	0.003	-0.002	0.003	-0.005	0.003	-0.006	0.003
$P(y_{i,a,t} > 140,000)$	0.001	0.003	-0.002	0.003	-0.005	0.003	-0.006	0.002
$P(y_{i,a,t} > 145,000)$	0.002	0.002	0.000	0.003	-0.002	0.003	-0.005	0.003
$P(y_{i,a,t} > 150,000)$	0.001	0.002	0.002	0.003	-0.001	0.003	-0.003	0.002

Source: Authors' own calculations using data from Statistics Norway.
Note: Marginal effects (ME) and associated standard errors (SE) for each of the estimations of Equation (4). Standard errors are based on 200 non-parametric bootstrap replications for each estimation, clustered on individual level.

Table A3: Marginal effects, CCDF, average reform effect

Outcome	A. Average reform effect		B. Linear time trend, pre-reform years (2006-2010)		C. Linear time trend, sample years (2009-2014)	
	ME	SE	ME	SE	ME	SE
$P(y_{i,a,t} > 0)$	0.015	0.004	-0.010	0.005	-0.010	0.005
$P(y_{i,a,t} > 5,000)$	0.014	0.004	-0.011	0.006	-0.011	0.006
$P(y_{i,a,t} > 10,000)$	0.010	0.004	-0.011	0.006	-0.011	0.006
$P(y_{i,a,t} > 15,000)$	0.008	0.005	-0.011	0.006	-0.011	0.006
$P(y_{i,a,t} > 20,000)$	0.008	0.005	-0.014	0.006	-0.014	0.006
$P(y_{i,a,t} > 25,000)$	0.003	0.005	-0.020	0.007	-0.020	0.007
$P(y_{i,a,t} > 30,000)$	0.000	0.005	-0.022	0.007	-0.022	0.007
$P(y_{i,a,t} > 35,000)$	-0.005	0.005	-0.019	0.007	-0.019	0.007
$P(y_{i,a,t} > 40,000)$	-0.014	0.005	-0.026	0.007	-0.026	0.007
$P(y_{i,a,t} > 45,000)$	-0.026	0.005	-0.035	0.008	-0.035	0.008
$P(y_{i,a,t} > 50,000)$	-0.031	0.005	-0.035	0.008	-0.035	0.008
$P(y_{i,a,t} > 55,000)$	-0.034	0.005	-0.038	0.008	-0.038	0.008
$P(y_{i,a,t} > 60,000)$	-0.034	0.005	-0.034	0.008	-0.034	0.008
$P(y_{i,a,t} > 65,000)$	-0.028	0.005	-0.032	0.008	-0.032	0.008
$P(y_{i,a,t} > 70,000)$	-0.025	0.005	-0.028	0.008	-0.028	0.008
$P(y_{i,a,t} > 75,000)$	-0.021	0.005	-0.026	0.007	-0.026	0.007
$P(y_{i,a,t} > 80,000)$	-0.013	0.005	-0.018	0.007	-0.018	0.007
$P(y_{i,a,t} > 85,000)$	-0.014	0.004	-0.020	0.007	-0.020	0.007
$P(y_{i,a,t} > 90,000)$	-0.012	0.004	-0.016	0.006	-0.016	0.006
$P(y_{i,a,t} > 95,000)$	-0.013	0.004	-0.014	0.006	-0.014	0.005
$P(y_{i,a,t} > 100,000)$	-0.010	0.004	-0.010	0.005	-0.010	0.005
$P(y_{i,a,t} > 105,000)$	-0.009	0.003	-0.011	0.005	-0.011	0.005
$P(y_{i,a,t} > 110,000)$	-0.007	0.003	-0.009	0.005	-0.009	0.005
$P(y_{i,a,t} > 115,000)$	-0.005	0.003	-0.008	0.005	-0.008	0.005
$P(y_{i,a,t} > 120,000)$	-0.003	0.003	-0.006	0.005	-0.006	0.005
$P(y_{i,a,t} > 125,000)$	-0.003	0.003	-0.008	0.004	-0.008	0.004
$P(y_{i,a,t} > 130,000)$	-0.003	0.002	-0.006	0.004	-0.006	0.004
$P(y_{i,a,t} > 135,000)$	-0.003	0.002	-0.007	0.004	-0.007	0.004
$P(y_{i,a,t} > 140,000)$	-0.003	0.002	-0.007	0.004	-0.007	0.004
$P(y_{i,a,t} > 145,000)$	-0.001	0.002	-0.005	0.004	-0.005	0.004
$P(y_{i,a,t} > 150,000)$	0.000	0.002	-0.003	0.003	-0.003	0.003

Source: Authors' own calculations using data from Statistics Norway.
Note: Marginal effects (ME) and associated standard errors (SE) for each of the estimations of Equation (A2) (Panel A), Equation (A8) (Panel B) and Equation (A9) (Panel C). Standard errors are based on 200 non-parametric bootstrap replications for each estimation, clustered on individual level.

A4 OLS

A4.1 Age-by-Age Effect

In order to derive the age-by-age impact of introducing the flexible old-age pension on mean labor earnings, we estimate the following linear difference-in-difference equation:

$$y_{i,a,t} = \alpha + X_i\beta + \sum_{s=61}^{65} \gamma_s DA_s + \sum_{l=2010}^{2014} \lambda_l DT_l + \sum_{m=62}^{65} \eta_m DA_m \Delta_{i,a,t} + \varepsilon_{i,a,t} \tag{A10}$$

Here $y_{i,a,t}$ is the annual pre-tax earnings of individual i at age a in year t. The vector X_i includes controls for education length, education length squared, log average annual pre-tax earnings from age 30 to age 59, and net liquid wealth at age 59. $\Delta_{i,a,t}$ indicates the treatment variable, and equals one when individual i is in the treatment group after the reform and zero otherwise. DA_s are dummy variables for age (with age 60 as the reference age) and DT_l are dummy variables for year (with 2009 as the reference year). $\varepsilon_{i,a,t}$ is the error term.

Table A4: Reform effect on mean earnings, by age

	A. Average effect		B. Age-specific effects	
	(1)	(2)	(3)	(4)
Treatment effect (η)	-1715	-1420		
	(627)	(556)		
Treatment effect at:				
Age 62 (η_{62})			-1233	-793
			(761)	(660)
Age 63 (η_{63})			-2344	-2227
			(755)	(690)
Age 64 (η_{64})			-1545	-1250
			(788)	(728)
Age 65 (η_{65})			-1725	-1394
			(779)	(705)
Year and age dummies	Yes	Yes	Yes	Yes
Control variables	No	Yes	No	Yes
Adjusted R^2	0.053	0.293	0.053	0.293
No. of individuals (N)	54,720	54,720	54,720	54,720
Sample size ($N \times T$)	178,444	178,444	178,444	178,444

Source: Authors' own calculations using data from Statistics Norway.
Note: OLS estimation results of the average reform effect on earnings (Panel A) from Equation (1) and the age-specific reform effects on earnings (Panel B) from Equation (A10). Control variables are pre-determined and include linear controls for education length, education length squared, log average annual pre-tax earnings from age 30 to age 59, and net liquid wealth at age 59. Standard errors (in parentheses) are clustered on the individual level, based on 200 non-parametric bootstrap replications.

A4.2 Year-by-Year Effect

In order to derive the year-by-year impact of introducing the flexible old-age pension on mean labor earnings, we estimate the following linear difference-in-difference equation:

$$y_{i,a,t} = \alpha + X_i\beta + \sum_{s=61}^{65} \gamma_s DA_s + \sum_{l=2010}^{2014} \lambda_l DT_l + \sum_{m=2010}^{2014} \eta_m DT_m \Delta_{i,a,t} + \varepsilon_{i,a,t} \tag{A11}$$

Here $y_{i,a,t}$ is the annual pre-tax earnings of individual i at age a in year t. The vector X_i includes controls for education length, education length squared, log average annual pre-tax earnings from age 30 to age 59, and net liquid wealth at age 59. $\Delta_{i,a,t}$ indicates the treatment variable, and equals one when individual i is in the treatment group after the reform and zero otherwise. DA_s are dummy variables for age (with age 60 as the reference age) and DT_l are dummy variables for year (with 2009 as the reference year). $\varepsilon_{i,a,t}$ is the error term.

Table A5: Reform effect on mean earnings, by year

	A. Average effect		B. Year-specific effects	
	(1)	(2)	(3)	(4)
Treatment effect (η)	-1715	-1420		
	(627)	(556)		
Treatment effect at:				
Year 2010 (η_{2010})			-171	-456
			(612)	(523)
Year 2011 (η_{2011})			-2393	-2414
			(829)	(686)
Year 2012 (η_{2012})			-2302	-2358
			(809)	(733)
Year 2013 (η_{2013})			-994	-897
			(910)	(775)
Year 2014 (η_{2014})			-1527	-942
			(885)	(756)
Year and age dummies	Yes	Yes	Yes	Yes
Control variables	No	Yes	No	Yes
Adjusted R^2	0.054	0.291	0.054	0.291
No. of individuals (N)	54,720	54,720	54,720	54,720
Sample size ($N \times T$)	178,444	178,444	178,444	178,444

Source: Authors' own calculations using data from Statistics Norway.
Note: OLS estimation results of the average reform effect on earnings (Panel A) from Equation (1) and the year-specific reform effects on earnings (Panel B) from Equation (A11). Control variables are pre-determined and include linear controls for education length, education length squared, log average annual pre-tax earnings from age 30 to age 59, and net liquid wealth at age 59. Standard errors (in parentheses) are clustered on the individual level, based on 200 non-parametric bootstrap replications.

A4.3 Job Changes and Partial Retirement

Table A6 shows the estimated reform effect, using the model in Equation (1), on changing jobs (Panel A) and changing jobs to a lower paid job (Panel B), where we denote the latter "partial retirement". Change of jobs is defined as moving to another establishment, see Section A6 in this Appendix for more details.

Table A6: OLS estimation results, job changes and partial retirement

	A. Job change		B. Partial	
	(1)	(2)	(3)	(4)
Treatment effect (η)	0.002	0.002	0.003	0.003
	(0.002)	(0.003)	(0.002)	(0.002)
Year and age dummies	Yes	Yes	Yes	Yes
Control variables	No	Yes	No	Yes
Pre-reform mean	0.0609	0.0609	0.0293	0.0293
Adjusted R^2	0.002	0.003	0.001	0.002
No. of individuals (N)	54,720	54,720	54,720	54,720
Sample size ($N \times T$)	178,444	178,444	178,444	178,444

Source: Authors' own calculations using data from Statistics Norway.
Note: OLS estimation results of the average reform effect on probability of changing jobs (Panel A) and probability of changing jobs to a lower paid job (Panel B), using the model in Equation (1). Control variables are pre-determined and include linear controls for education length, education length squared, log average annual pre-tax earnings from age 30 to age 59, and net liquid wealth at age 59. Standard errors (in parentheses) are clustered on the individual level, based on 200 non-parametric bootstrap replications.

A5 Weekly Working Hours

A5.1 Description of Data

We use the weekly working hours in the main job each year as a supplementary measure of work, since the extent of multiple job holdings is very low for both pre-reform and post-reform birth cohorts. The low incidence of multiple job holdings allows us to use the weekly working hours measure from the main job as a measure of the aggregate weekly working hours an individual works. To illustrate this, Table A7 shows the fraction of total earnings that comes from the main job over ages 59-65, separately for the pre-reform birth cohort 1945 and the post-reform birth cohort 1949.

Table A7: Earnings from main job, by birth cohort and age

	At age						
	59	60	61	62	63	64	65
Cohort 1945	96.6	97.0	96.9	96.4	96.7	96.6	95.8
Cohort 1949	96.4	97.1	97.0	95.9	95.3	95.5	95.5

Source: Authors' own calculations using data from Statistics Norway.
Note: Fraction of total annual earnings (in percent) derived from the main job by age, for birth cohorts 1945 and 1949 from the sample described in Table 3.

Table A7 shows that there is hardly any difference between the birth cohorts, with earnings from the main job as a percent of total earnings declining only marginally over age and being in the range of 95-97 percent. As a result, we use the weekly working hours from the main job to measure the individual's aggregate weekly working hours to supplement our earnings measure of work and shed light on the gradual retirement process.

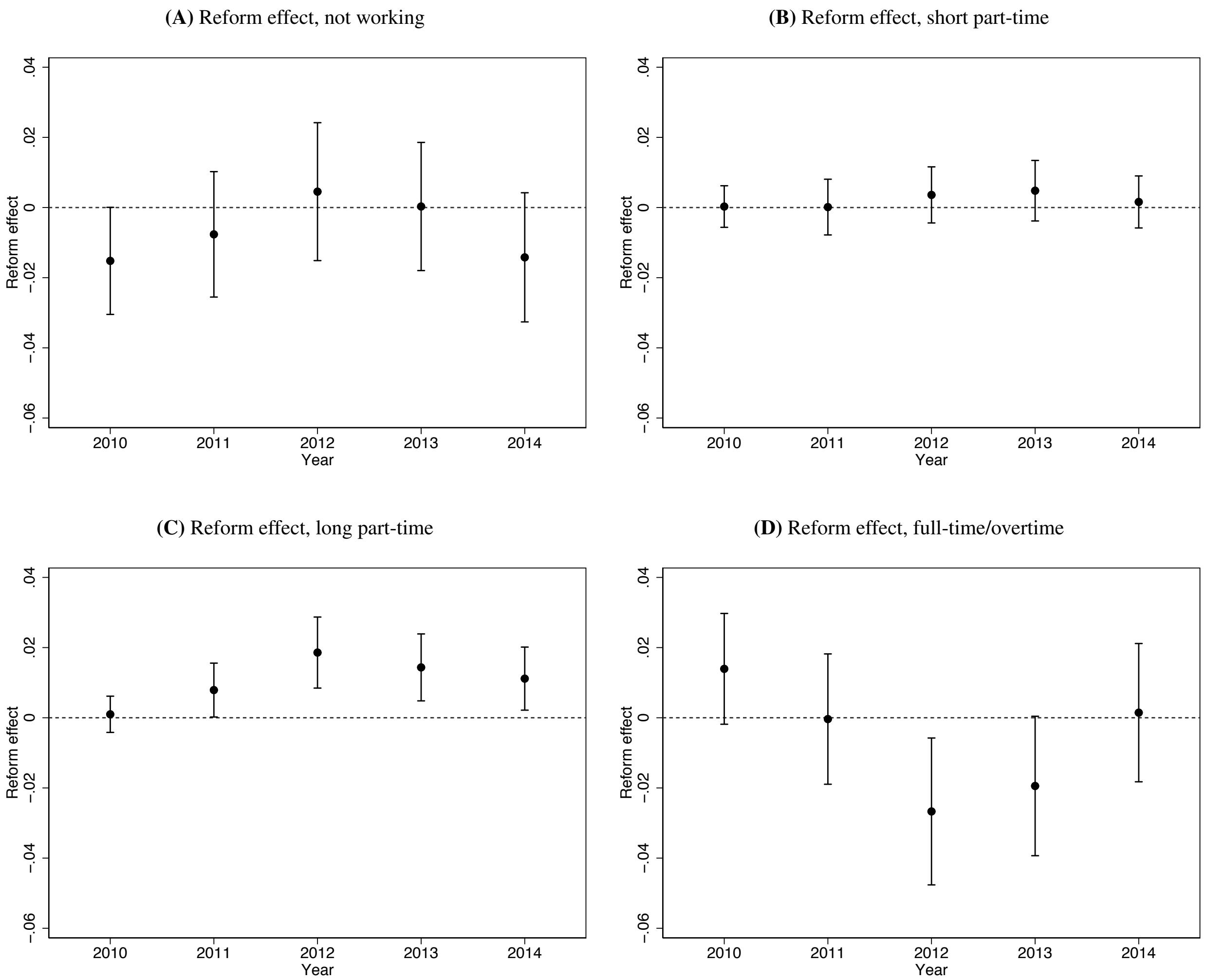
A5.2 Year-by-Year Effect

In order to consider the year-by-year reform effects, we estimate the following multinomial logit model for the four weekly-hours groups keeping the age-specific treatment effects constant:

$$P(y_{i,a,t} = j) = \frac{\exp(\eta_{i,j,t})}{\sum_{k=1}^{4} \exp(\eta_{i,k,t})}, \quad \eta_{i,j,t} = \alpha + X_i\beta + \sum_{s=61}^{65} \gamma_s DA_s + \sum_{l=2010}^{2014} \lambda_l DT_l + \sum_{m=2010}^{2014} \delta_m DT_m \Delta_{i,a,t} \tag{A12}$$

Here the alternatives are $j \in \{\text{not working}, \text{short part-time}, \text{long part-time}, \text{full-time/overtime}\}$. The results from this exercise are illustrated in Figure A7. Table A8 shows the marginal effects (evaluated at the covariate values equal to the average of the treatment group in the post-reform period) and the associated standard errors used to simulate the year-by-year reform effects.

Figure A7: Reform effect on weekly hours, by year



Source: Authors' own calculations using data from Statistics Norway.
Note: Results from estimation of Equation (A12), showing the estimated marginal reform effects by year and the associated 95 percent confidence intervals (caped lines, based on 200 non-parametric bootstrap replications, clustered on individual level). The weekly-hours groups are defined as follows: (i) not working: 0 hours, (ii) short part-time: 0-20 hours, (iii) long part-time: 20-34 hours, and (iv) full-time/overtime: 34 hours or more. Marginal effects and the associated standard errors are shown in Table A8.

Table A8: Marginal effects, reform effect by year

Year	Not working		Short part-time		Long part-time		Full-time/overtime	
	ME	SE	ME	SE	ME	SE	ME	SE
2010	-0.015	0.008	0.000	0.003	0.001	0.003	0.014	0.008
2011	-0.008	0.009	0.000	0.004	0.008	0.004	0.000	0.009
2012	0.005	0.010	0.004	0.004	0.019	0.005	-0.027	0.010
2013	0.000	0.009	0.005	0.004	0.014	0.005	-0.019	0.010
2014	-0.014	0.009	0.002	0.004	0.011	0.004	0.001	0.010

Source: Authors' own calculations using data from Statistics Norway.
Note: Marginal effects (ME) evaluated at the covariate values equal to the average of the treatment group in the post-reform period and associated standard errors (SE) for the estimation of Equation (A12). Standard errors are based on 200 non-parametric bootstrap replications, clustered on individual level.

A5.3 Age-by-Age Effect

Table A9 shows the marginal effects (evaluated at the covariate values equal to the average of the treatment group in the post-reform period) and the associated standard errors used to simulate the age-by-age reform effects (shown in Figure 8).

Table A9: Marginal effects, reform effect by age

Age	Not working		Short part-time		Long part-time		Full-time/overtime	
	ME	SE	ME	SE	ME	SE	ME	SE
62	0.008	0.007	-0.004	0.003	0.007	0.003	-0.011	0.007
63	0.015	0.007	0.001	0.004	0.012	0.004	-0.028	0.008
64	0.003	0.007	0.008	0.004	0.010	0.004	-0.021	0.008
65	-0.006	0.006	0.003	0.003	0.019	0.005	-0.016	0.007

Source: Authors' own calculations using data from Statistics Norway.
Note: Marginal effects (ME) evaluated at the covariate values equal to the average of the treatment group in the post-reform period and associated standard errors (SE) for the estimation of Equation (7). Standard errors are based on 200 non-parametric bootstrap replications, clustered on individual level.

A6 Job Transitions

Job changes in Figure 10 are defined as follows:

1. Starting with the population of workers (excluding self-employed), the main employer for each year 2001-2014 is defined as the establishment identifier from which the worker earns the greatest annual wage income.

2. Using the population of workers and comparing year t with year $t-1$, we define the following states for a worker in year t based on the worker's observed state in year $t-1$:

   (a) Job-to-job transition in year t (new hire): this is defined as worker i's transition from the main establishment identifier in year $t-1$ (denote this j) to another main establishment identifier in year t (denote this k), where the main establishment refers to the establishment identifier of the main employer. The reported starting month in year t is recorded.

   - If we observe that worker i is also registered at establishment identifier k in year $t-1$ as a secondary employer (with a reported starting month later than June and at least 33 percent of total annual wage income derived from establishment k in year $t-1$), we redefine the match to have taken place in year $t-1$ (and not in year t) and the starting month in year t is replaced with the starting month in year $t-1$.
   - This takes into account the possibility that worker i started in the new job already in year $t-1$, but that the new employer was not the main employer (based on the annual wage income) during year $t-1$.

   (b) Same job in year t (not a new hire): if the affiliated main establishment identifier of worker i in year t is identical to the affiliated main establishment identifier in year $t-1$ (meaning that $j=k$), worker i is defined not to be a new hire in year t.

   (c) Transition from out-of-work to job in year t (new hire): if worker i is not in the above-mentioned states (a) or (b) in year t, the worker has come from an out-of-work state.

3. The data set on worker states in year t relative to year $t-1$ is merged with a sample of workers from birth cohorts 1945 and 1949 fulfilling our sample requirements (working at age 59 with no disability benefit receipt, no AFP and being eligible to access to the old-age pension from age 62). This sample is then followed from age 59 until age 65.