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ARTICLE

Does raising the pension age prolong working life? Evidence from pension age reform in Estonia

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Abstract

We estimate how raising the statutory retirement age affects employment by considering the pension age reform in Estonia, that gradually raised the normal retirement age (NRA) for women from 58 to 61.5 and the early retirement age (ERA) from 56 to 59.5 during the period of 2001–2011. The analysis employs a difference-in-differences estimation strategy on register data covering women born between 1943 and 1952. The reform did have an impact on the employment rate of affected women, with an estimated increase of 4.1 percentage points associated with the rise in the NRA, and 3.4 percentage points with the rise in the ERA. These estimates are at the lower end of those found in previous studies for other countries, pointing to the role of contextual features such as lower replacement rates and fewer disincentives to work while drawing pensions.

Keywords: Employment; older workers; retirement age

JEL classification: H31; H55; J14; J26

1. Introduction

Demographic trends of ageing are raising the pressure on the fiscal sustainability of public pension systems in most industrialised countries. A widely used policy measure for relieving this pressure is to raise the age at which pensions can be drawn. In the European Union, nearly all member states have either raised their pension age over recent decades or are currently in the process of doing so gradually. Furthermore, nine of those EU member states have decided to link further rises in the pension age automatically to advances in life expectancy (European Commission, 2018). The pension age is also being raised in many non-European OECD countries, including the US, Australia and Japan (OECD, 2017).

An important goal of the pension age reforms aside from fiscal savings is to increase the labour supply of older individuals. The capacity of the labour market to absorb the additional supply of labour has important implications for benefit substitution and so for the social insurance budget as a whole. The employment outcomes also have an impact on the social costs of such reforms through the poverty risk for those ineligible for pension benefits. Although pension age reforms have become common in Europe, empirical investigations into the actual labour market outcomes of these reforms are so far available only for a limited number of Western European countries (e.g., Staubli and Zweimüller, 2013; Vestad, 2013; Cribb *et al.*, 2016; Rabaté and Rochut, 2020). Outside Europe, the effect of pension age reform has been studied in the US (Mastrobuoni, 2009; Blau and Goldstein, 2010; Behaghel and Blau, 2012) and in Australia (Atalay and Barrett, 2015). The considerable variation between the findings of these studies about the effects of the reforms warrants further research on this topic.

This study complements the earlier ones by analysing how the statutory pension age affects labour market status using the exogenous variation that a reform of the pension age induced in the retirement age. We examine whether people whose entitlement to an old-age pension was postponed because the statutory retirement age was raised for them stayed in employment longer, claimed unemployment benefits or became economically inactive. In the period we study from 2001 to 2011, the normal retirement age (NRA) for women in Estonia was gradually lifted by 6 months for each birth cohort from 58 to 61.5 years of age and the early retirement age (ERA) was increased from 56 to 59.5 years. We employ the difference-in-differences estimation strategy on micro-level monthly data from the social insurance register covering all the female residents of Estonia born between 1943 and 1952. We also investigate the experience of sub-groups of the population by educational attainment, place of residence as urban or rural, and immigrant status.

The Estonian reform is an interesting case study in a comparative perspective for several reasons. First, Estonia had a flat-rate income tax system with a constant marginal tax rate during the timeframe of the study. This reduces the effect of tax disincentives on the labour supply of those drawing a pension that arises in many countries with progressive income tax systems. Second, working pensioners in Estonia can still draw a full pension that makes it easier for them to extend their working life beyond the NRA. Third, the average replacement rate in Estonia and the spending on pensions per recipient relative to per capita GDP have been among the lowest in the EU, while the at-risk-of-poverty (AROP) rate for older people has been among the highest in the EU. The low level of the public pension creates strong incentives for people to continue working after they reach retirement age. Fourth, private savings and other non-state pension income play quite a limited role in financing retirement in Estonia. Last but not least, Estonia offers the case of an Eastern European country with a recent history of economic and social policy transition to complement the earlier studies that have addressed pension age reform in Western European countries with long-standing pension systems.

The current study extends the literature on the impact of pension age reforms in a number of ways. By adding a new institutional context, our study contributes to a more comprehensive account of the effects of recent pension age reforms. The availability of individual-level data from the Estonian social insurance register allows us to examine the effect of pension age reform with great accuracy. Our relatively low estimates suggest that the employment effect of lifting the pension age depends strongly on the characteristics of the social security system. Low pension replacement rates in combination with a lack of tax and financial disincentives appear to reduce the effect of parametric reforms of pension eligibility criteria on employment decisions.

This article proceeds as follows. Following the introduction, Section 2 provides a brief overview of previous studies on the effects of pension age reforms. Section 3 describes the Estonian setting, while Section 4 presents the data and a descriptive account of our outcome variables. Section 5 summarises the identification strategy, Section 6 presents the empirical results and finally, Section 7 concludes the article.

2. Previous research into pension age reforms

The current paper is related to the literature about how social security systems affect retirement decisions. Early studies were mainly motivated by the steady decline in the labour force participation rate among men aged over 60 that prevailed until the 1990s in many industrialised countries (see Gruber and Wise, 1999). Social security rules were found to have sizable effects on retirement by dynamic life-cycle models in which rational forward-looking individuals choose between labour and leisure (e.g., Burtless and Moffitt, 1984; Gustman and Steinmeier, 1985; Rust and Phelan, 1997). A pension reform was adopted in the US in 1983 that would raise the NRA from 65 to 67 starting from 2003. Gustman and Steinmeier (1985) used structural models to predict that this reform would leave the employment rate 3.5–4% higher for the 65–67 age bracket, which translates to a delay of 1.2–1.4 months in the exit age. Mitchell and Fields (1984) used an indirect utility approach to predict a similar rise of 1.5 months in the average labour force exit age.

Empirical studies evaluating the *ex post* impact of the pension age reforms tend to find the reforms have more impact on labour market outcomes than out-of-sample *ex ante* estimates referenced above. According to Mastrobuoni (2009), the 1983 reform in the US raised the exit age from the labour market by 1 month for 2 months of rise in the NRA on average. This estimate is based on the acceleration of the trend increase in the effective labour market exit age of the cohorts affected by the pension reform compared to the pre-reform cohorts. Analysing the same US reform, Behaghel and Blau (2012) found that the peak in the pension claiming hazard rate observed at the NRA shifted one-to-one with the rise in the pension age, and the peak of exit from employment also shifted. The authors of both papers argued that the reason behind the larger effects found in *ex post* estimations arises from the signalling effect of the statutory pension age that is added to the effect of financial incentives.

Several empirical studies have employed a difference-in-differences strategy (e.g., Staubli and Zweimüller, 2013; Vestad, 2013; Atalay and Barrett, 2015; Cribb *et al.*, 2016; Rabaté and Rochut, 2020) to estimate the effects of retirement age reforms. This method pins down the immediate effect of the rise in the pension age as a difference in the employment rate with and without pension eligibility given age, the business cycle and personal characteristics. The results obtained from these studies are summarised in the Appendix in Table A1. A common finding that emerges from all these studies is that the pension age reform has a positive effect on the employment rates of those affected but the effect size varies markedly.

At the lower end, Cribb *et al.* (2016) estimated that raising the earliest retirement age for women in the UK from 60 to 62 over the years 2010–2014 raised the employment rate at the pre-reform retirement age by 6.3 percentage points. Somewhat larger effects are found by Staubli and Zweimüller (2013), who used register data to estimate the effect of a stepwise increase in the ERA in Austria of 2 years for men and 3.25 years for women from 2000 to 2006. They found that the probability of being employed increased by 9.75 percentage points for men and by 11 percentage points for women among those who were no longer eligible for a pension as a result of the reform. In a more recent study on Austria using a regression kink design, Manoli and Weber (2016) estimated that the same reforms led to a rise of just under 5 months in the average job exit age for each year the ERA rose by.

On the high side among similar studies, Rabaté and Rochut (2020) found that the rise in the eligibility age from 60 to 61 in France resulted in a large increase of 20.9 percentage points in the employment rate at the age of 60. Vestad (2013) used register data and found a rather strong effect: had the ERA in Norway not been cut from 64 to 62, more than two out of three early retirement pension recipients would have been employed at the age of 63. Relatively large effect was also reported by Staubli and Lalive (2016) for Switzerland. Using regression discontinuity method, they found that a 1-year increase in the full retirement age for Swiss women (from age 62 to 63 and from 63 to 64 years) induced an average delay in the exit from employment of 4–6 months.

It is not surprising that the size of the effect of the rise in the retirement age varies, because contextual factors also vary. The NBER comparative study *Retirement Around the World* (see Gruber and Wise, 1999) covers 12 industrialised countries and suggests that the fall in labour force participation rates at older ages is closely related to the implicit tax on working after the statutory retirement age. In countries where the pension adjustment is less than actuarially neutral, people are inclined to take up a pension as soon as they become eligible and to exit the labour market earlier. Gruber and Wise also argue that pension generosity, measured by the replacement rate, correlates with the employment rates of older people. In countries where pension benefits are generous, people are less motivated to work beyond the retirement age. Some studies have investigated whether liquidity constraints play a role in creating high peaks in the hazard rate for retiring at the early pension age. For instance, Rust and Phelan (1997) found that such constraints are indeed significant for medium-income workers without access to private pensions. It follows that in countries in which liquidity constraints matter less, for example, because private savings can be run down, eligibility for the public pension might determine the timing of labour market exit to a lesser degree.

Another contextual feature that might affect benefit claims and the labour supply is the earnings test on pension benefits, which is often applied for those claiming benefits before they reach the NRA. Gruber and Orszag (2003) report that the earnings test in the US becoming less strict increased benefit claims but had no significant effect on the labour supply. By contrast, Hernæs and Jia (2013) found that abolishing the earnings test for early pension claims did increase the labour supply, but mainly through the intensive margin. Laun and Wallenius (2016) pointed out that the availability of disability and unemployment insurance programmes also explains part of the variation in labour market outcomes across countries.

Although there is a fast-growing literature evaluating the effects of pension age reforms, and the pension age has been raised in an overwhelming majority of the Eastern European EU member states, there are very few studies that evaluate the effect of the pension age reforms in these countries. To the best of the authors' knowledge, the only available studies are by Cseres-Gergely (2014), which estimated that a rise in the ERA for Hungarian women had an employment effect in the range of 5.0–7.4 percentage points, and by Komada *et al.* (2019), which found the effect of the 2009 abolition of the early retirement option for most workers in Poland on labour force participation to be economically small, between one and three percentage points. However, the study found no effect on the employment rate at the NRA. The author explained this unexpected finding as a strong spill-over effect from the concurrent increase in the take-up of disability pensions. Our study complements the literature by analysing the effects of pension age reform in another Eastern European setting.

From the policy perspective, it is relevant not just to estimate the overall effects, but also to assess how sub-groups of the population react to rises in the pension age. Both Rabaté and Rochut (2020) and Staubli and Zweimüller (2013) found that the employment effect of the rise in the NRA increased with health. Staubli and Zweimüller (2013) also estimated that a rise in the ERA had heterogeneous effects, with the response increasing with wages. Cribb *et al.* (2016) found a somewhat stronger employment response for single women. In this study, we investigate the variation of responses to the increase in the NRA and ERA associated with educational attainment, place of residence and immigrant status. We are interested whether certain vulnerable groups have greater difficulties in adapting their labour market behaviour to changes in pension policy, meaning they need additional policy support if the desired policy aims are to be achieved.

3. Institutional features

The current Estonian pension system is built on three pillars. The first pillar is the public pay-as-you-go pension scheme. The second pillar is a mandatory pre-funded defined-contribution scheme with individual retirement accounts. The third pillar is a tax-favoured voluntary private scheme. However, the institutional history of the three-pillar pension arrangement is relatively short as Estonia has transformed its pension system in stages from the early 1990s after regaining independence.[1]

In this paper, we focus on the first pillar, which was the main source of retirement income for the period of our study. The second pillar was launched in 2002 and is mandatory only for cohorts born in 1983 and later. The first payments from the second pillar for cohorts who joined voluntarily were only made in 2009. The coverage of the third pillar remains relatively low at <15% of the labour force. This meant that non-state pensions and other financial assets were of marginal relevance during the period studied of 2001–2011.

The public old-age pension scheme effectively has two tiers, with employment-related old-age pensions paid to people who have an employment history of at least 15 years, and residence-based national pensions paid to people who have been resident for at least 5 years but do not qualify for the employment-related old-age pension. The employment-related pension is financed predominantly

[1]A more detailed account of the evolution and features of the Estonian pension system is available in Leppik and Võrk (2006).

from an ear-marked payroll tax called the social tax that is levied on all labour income at the employer level,[2] while the residence-based pension is financed from general revenue transfers. Crucially for this study, the social tax contribution payments were personalised from 1999, meaning the monthly contributions of all employees had to be individually recorded by the tax and social insurance authorities.[3] The individualised contributions affect one part of the state pension by topping up the flat-rate base component. The net replacement rate of the average old-age pension was in the range of 42–45% in the period studied.[4]

The statutory pension age was inherited from the previous Soviet pension system and it remained at 55 for women and 60 for men until 1994.[5] From 1994, the pension age was set to increase gradually in 6-month increments for male cohorts born after 1934 and female cohorts born after 1939, to reach 63 for men by 2001 and for women by 2016.

From April 2000, a general early retirement option was introduced that made it possible to draw an early old-age pension up to 3 years before the NRA, this then becoming the ERA. Claiming the early retirement pension before the NRA permanently reduces the pension received by 0.4% per month. However, the adjustment is less than what would be needed to achieve actuarial neutrality (Medijainen, 2011). There is a 100% earnings test until the NRA is reached, meaning that the early old-age pension is not paid for the months when there is any work income.[6] In essence, this is a very punitive earnings test.[7] About 17–25% of new claimants of the old-age pension each year opted for the general early retirement pension during the period studied.

Deferring the old-age pension after the NRA has been reached increases the pension received by 0.9% per month and there is no earnings test. However, though this adjustment is higher than actuarially neutral, the option of deferring has been little used, accounting for only about 1% of new pension claims during the period studied.[8] Table 1 shows how the NRA and ERA rose for women during the period studied.[9]

There are some exceptional cases when an old-age pension may be drawn before the normal pension age without penalty. The most common special case, covering about 15% of each cohort of women affected by the policy change, is that of parents or guardians who have raised three or more children or a disabled child. Such people have the right to an 'old-age pension under favourable conditions'. The eligibility starts 1–5 years before the NRA depending on the number of children. About 9% of women in the population are eligible for a pension 1 year ahead of the NRA, 2% for 3 years ahead, and 0.4% for 5 years ahead. Another 4% of those in the cohorts affected receive a special early pension for having worked in specific occupations or branches of the economy that are deemed to be hazardous for health or in specific civil service jobs such as the police and the military. These special cases (women with three or more children or a disabled child, and those receiving a special early occupational pension) are excluded from the analysis to ensure the homogeneity of the study population.

[2]For some categories of the inactive, such as parents caring for small children, the social tax is paid by the state.

[3]However, due to some modifications in the information system of the register in 1999–2000, complete individual records are available for analysis only from 2001. This defines the beginning period of our study.

[4]The average old-age pension at the start of the period in 2001 was 99 euros per month, rising to 305 euros by 2011 (Statistics Estonia, 2019).

[5]In this article, we use the notions of the normal retirement age (NRA) and early retirement age (ERA) for the sake of comparison with earlier studies.

[6]From April 2000 to the end of 2004, pension payments were suspended for labour earnings after the NRA was reached. This affected the birth cohorts 1943–1947, for whom it was more costly to claim an early pension during that period than it was for subsequent cohorts.

[7]Nonetheless, once the payment of the early old-age pension is resumed, its amount is recalculated to reflect the additionally accrued employment periods, just as with a normal old-age pension.

[8]In recent years, the share of claimants taking a deferred old-age pension has increased slightly, reaching 4.5% of new claimants in 2017.

[9]The pension age continued to rise for subsequent cohorts after the study period to reach 65 years by 2026, with further increases beyond 2026 linked to increases in life expectancy at the age of 65.

Table 1. Early and normal retirement age in Estonia, women born from 1943 to 1952

	Normal retirement		Early retirement	
Year of birth	Age	Year of reaching retirement age	Age	Year of reaching retirement age
1943	58	2001	57	2000
1944	58y 6m	2002 second half/2003 first half	56y 6m	2000
1945	59	2004	56	2001
1946	59y 6m	2005 second half/2006 first half	56y 6m	2002 second half/2003 first half
1947	60	2007	57	2004
1948	60y 6m	2008 second half/2009 first half	57y 6m	2005 second half/2006 first half
1949	61	2010	58	2007
1950	61y 6m	2011 second half/2012 first half	58y 6m	2008 second half/2009 first half
1951	62	2013	59	2010
1952	62 y 6m	2014 second half/2015 first half	59y 6m	2011 second half/2012 first half

Notes: For women in the 1943–1944 birth cohorts, the effective ERA was less than 3 years before the NRA, as they had already reached a higher age by the time the early retirement option was introduced in 2000.
Source: State Pension Insurance Act

Spending on pensions in Estonia has been among the lowest in the EU, ranging from 5.8% to 8.9% of GDP during the study period, with lower values of 5.8–6.1% in the years of fast economic growth in 2001–2007, and a peak at 8.8–8.9% in the years of the economic crisis in 2009–2010. Consequently, the aggregate replacement ratio, which is the ratio of the median individual gross pensions of people aged 65–74 to the median individual gross earnings of people aged 50–59, in Estonia has been below the EU average at 0.45 in Estonia against the EU average of 0.49 in 2008 (European Commission, 2018). However, the flat-rate base amount of the old-age pension, which is about 35% of the average old-age pension, means the individual replacement rate is higher for low wage earners and lower for high wage earners.

At the same time, Estonia has witnessed some of the highest AROP rates[10] in Europe for older people aged 65 and over, though there was a major fluctuation in the AROP rate for older people during the period studied, with values relatively low at below 20% in 2001–2003 and during the peak of the economic crisis in 2009–2011 but reaching over 40% in the years of the economic upsurge in 2006–2008. These sharp fluctuations are explained by the relatively equal distribution of old-age pensions, as a high share of old-age pensioners have pensions that are close to the AROP threshold, implying that even small changes in the ratio of pensions to earnings from work result in quite large changes in the share of pensioners falling below the threshold (Leppik, 2018).

The flat structure of old-age pensions is confirmed by the relatively low income quintile share ratio of 2.9 for people aged 65 and over in Estonia against the EU average of 4.1 in 2011.[11] Notably, the income quintile ratio for people under 65 years of age was considerably higher at 5.9 in Estonia than the EU average of 5.2 in 2011 (Eurostat).

At the same time, Estonia has had some of the highest employment rates in Europe for older workers in the 55–64 age group at above 55% from the mid-2000s and reaching 62% in 2008, exceeding the EU average by 10–17 percentage points during the period studied. The institutional features of the pension system contribute to these high employment rates for older workers. Although the reduction that applies if the pension is claimed before the NRA is less than actuarially fair, in light of an extremely punitive earnings test and the low level of pensions, it is not considered a favourable exit route from the labour market. Almost all people claim a pension upon reaching the NRA, but the

[10]The at-risk-of-poverty rate (AROP) is the share of people with an equivalised disposable income (after social transfers) below the at-risk-of-poverty threshold, which is set at 60% of the national median equivalised disposable income after social transfers (Eurostat).

[11]The income quintile share ratio is a measure of the inequality of income distribution and is calculated as the ratio of total income received by the top quintile (the 20% of the population with the highest income) to that received by the bottom quintile (the 20% of the population with the lowest income).

relatively low replacement rate of the old-age pension gives them a strong incentive to delay their labour market exit and supplement their pension with labour income if possible.

Apart from the old-age pension, there are two main alternative sources of replacement income for financing an exit from the labour market, and these are public unemployment insurance and the disability pension scheme. The unemployment insurance system was introduced in 2002, and those eligible for benefits under it were people who were fully and involuntarily unemployed with at least 12 months of contributions over the preceding 24 months from 2002 to 2006, a qualification period that was extended to 36 months from 2007. The benefit payment period was up to 180 days until 2007, increasing to 270 days from 2007 for people who had paid contributions for 5 years or more. The unemployment insurance benefit is 50% of the former earnings for the first 100 days, after which the rate declines to 40%. For the unemployed who are not eligible for unemployment insurance benefits, a flat rate unemployment assistance was available under less restrictive eligibility criteria. However, the unemployment assistance allowance has been at a very low rate that does not even reach the subsistence level.[12]

Another pathway out of economic activity has been the disability benefit scheme. During the period studied, disability pensions were paid to people of working age, which is from 16 to the NRA, who had lost at least 40% of their capacity to work. The amount paid as the disability pension was calculated as the accrued old-age pension subject to a flat-rate minimum, multiplied by the percentage of the work capacity lost. As the pension age rose in the 2000s, the take-up of disability pensions increased markedly (Puur *et al.*, 2015). At the same time, claiming a disability pension did not necessarily mean withdrawing from the labour force, as there was no earnings test for a disability pension and not being employed was not among the eligibility criteria.

The disability pension had the advantage over the general early retirement pension of having no earnings test, though it had a lower replacement rate. In addition to being paid without restrictions to working people, even those assessed to suffer full loss of work capacity, the disability pensions were also recalculated annually to reflect the additional pension rights accrued through employment, just like the old-age pensions.

4. Data, variables and descriptive statistics

This study uses individual-level data from administrative registers. The main source of information is the national pension register operated by the Estonian Social Insurance Board (ENSIB). The register data have several important advantages for the purposes of the study, as they cover all Estonian residents who have received pensions or social or family benefits, or have declared labour income or otherwise contributed to social insurance (the register data available for the analysis start from 2001). Furthermore, the data are not affected by non-response or recollection error concerning the labour market status of individuals. The disadvantages of the pension register data are that they do not indicate which individuals form households, and the set of socio-demographic variables is limited.

We use the data on female cohorts born between 1943 and 1952 in our analysis. The cohorts in the sample are chosen so that they reached either the ERA or the NRA or both between 2001 and 2011. We exclude all women who at any point take up a special early occupational pension or a pension on the basis of having raised three or more children or a disabled child. Figure 1 plots the share of old-age and disability pension recipients among those women by age and cohort. Practically all the women who have not already claimed a pension do so at the NRA, which is in line with the very low deferral rate. There is a positive age trend in the take-up of the disability pension, which explains the increase in the share of those receiving a pension before they reach the NRA in subsequent cohorts. The take-up of the disability pension increases from roughly 15% for the 1943 cohort to just above 30% for the 1952 cohort in our sample. This increase is driven not solely by the change in the ERA and

[12]The subsistence minimum is calculated annually by Statistics Estonia from minimum food basket and non-food expenditures. At the end of the period in 2011, the subsistence minimum for a single person household was 186 EUR per month.

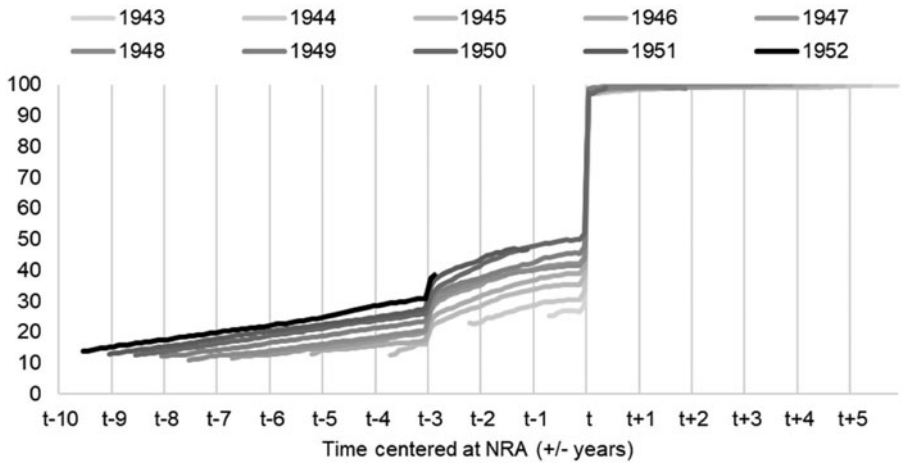

Figure 1. The proportion of pension recipients by cohort of women (%).
Notes: The age variable on the horizontal axis is measured in monthly frequency.
Source: Authors' calculations.

the NRA as the proportion of those receiving a disability pension increased with each cohort in ages well before the ERA. Furthermore, the take-up rates of disability pensions increased for men (Puur *et al.*, 2015), who were not affected by the pension age reform in the period from 2001 to 2011.

The outcome variable that is of primary interest for us is employment, which is available with monthly precision. A person is defined as employed in the given month if social tax was paid on their wages or their income from self-employment. A shortcoming of the administrative data is that individuals who do not receive labour income because they are temporarily absent from their job for holiday or sick leave, and their employer does not therefore make social tax contributions on their behalf, would be coded as inactive. To eliminate the gaps in continuous employment that are generated by regular vacations, we recoded all 1-month periods of inactivity and all 2-month gaps in July and August as employment. Two-month gaps are typical for teachers and affect people with higher education. Another limitation of the data is that the outcome variable only covers declared employment, while informal employment in the shadow economy remains unobserved and is coded as inactivity in our data. Given the relatively large share of working hours for undeclared pay in Estonia, a share which was estimated to be 15% of total hours worked in 2015 (Zukauskas and Schneider, 2016), this may be a concern. To assess the magnitude of the problem, we compared the employment rates from the register data with those from the labour force survey. The results of the comparison suggest that while there is a noticeable gap in employment rates for men in their prime working age, the difference is quite small for women, particularly for the older age groups examined in this study. Finally, we cannot observe working hours in our data, so adjustments along the intensive margin cannot be studied.

Figure 2 shows the age-specific employment rates for the women included in the final sample by cohort. It can immediately be seen that there is an acceleration in the drop in the employment rate at the ERA and at the NRA, but it is much less pronounced and sharp than the change for pension recipients. For certain cohorts, the effect of the economic recession makes the shifts driven by the pension age reform somewhat difficult to discern. There is also an apparent cohort effect as the employment rate is higher throughout for the younger cohorts. Among the older cohorts (1943–1945), the age–employment profiles closely overlap until reaching the NRA, while the drop in employment rates at the NRA is gradually postponed as the retirement age increases. These cohorts were not affected by the increase in the ERA; the increase in the ERA begins with the 1946 cohort. Although the effect is smaller than that of the NRA, it can be discerned in the figure as the reduction in employment

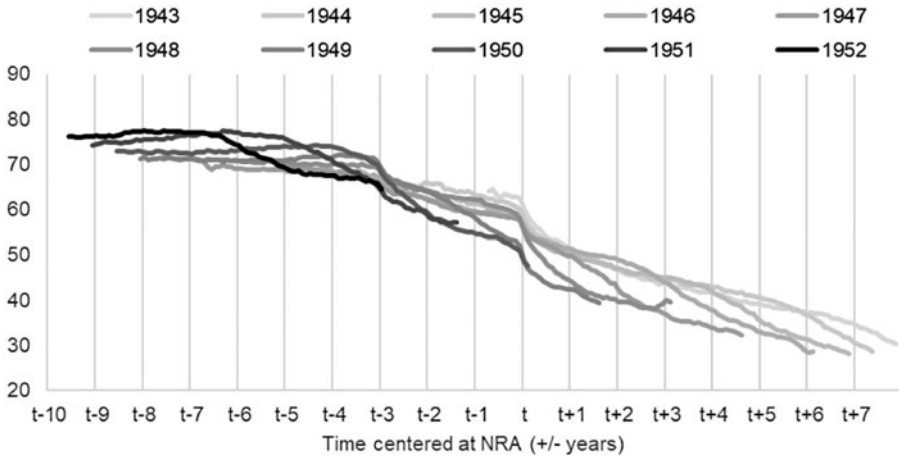

Figure 2. Employment rates by cohort of women (%).
Notes: The age variable on the horizontal axis is measured in monthly frequency.
Source: Authors' calculations.

rates that follows the ERA is postponed with each cohort. For the younger cohorts (1950–1952), the age–employment profiles are strongly influenced by the economic boom and recession, which make the effect of the increase in the ERA difficult to visually identify in the figure.

On top of the social security contributions from employment, those made by the state on behalf of the registered unemployed can also be observed in our data. We use contributions of this type to proxy for a second outcome state, unemployment. However, only those who are under the NRA are eligible to register as unemployed, which means that unemployment registration drops to zero as the NRA is reached. This implies that our study is only able to estimate how raising the ERA affects unemployment, but not how raising the NRA does. Before 2007, an average of 50% of the females aged 55 and over who were registered as unemployed could be identified in our database.[13] Those registered as unemployed who exhausted their insurance benefits or had too little work history to qualify for unemployment assistance could not be observed. From 2007, the coverage ratio of unemployed persons rose to 95%.[14] The change represents a structural break in our data that we account for in the multivariate analysis. If a person was neither employed nor unemployed, they were classified as economically inactive.

Figure 3 shows the age profiles for the proportion of registered unemployment among the cohorts included in our study. Although the profiles are modulated to varying degrees by exogenous macroeconomic factors, a common pattern can be discerned for most of the cohorts. At the beginning, the profiles tend to exhibit a moderate downward trend that reflects the period of economic growth prior to 2008. The break in the time series of registered unemployment noted above is hardly visible, as it occurred at a time of low unemployment and its effect was spread over a period of 12 months for each cohort. The downward trend is subsequently replaced by an increase in the proportion of unemployed. This is an outcome of the financial crisis, which affected Estonia more severely than most of the other European countries from 2008 to 2010. Unemployment increased for all cohorts under the NRA at that time, but especially for the 1951 and 1952 cohorts, which were under the ERA. After reaching

[13]Until 2006, unemployed individuals registered with the Unemployment Insurance Board were covered by state health insurance only while they were receiving benefits from unemployment insurance or assistance, and for the periods during which the social tax was paid and registered.

[14]As of 2007, eligibility for health insurance was extended to cover all those registered as unemployed, provided the social tax was paid.

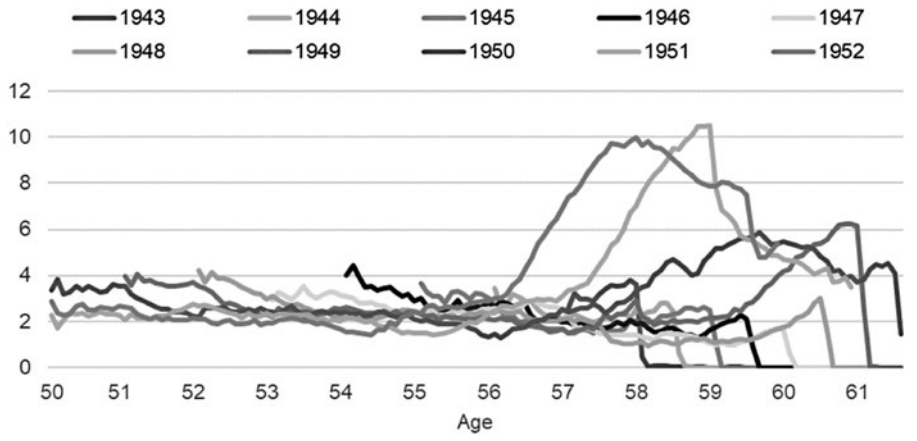

Figure 3. The proportion of registered unemployed by cohort of women (%).
Notes: The age variable on the horizontal axis is measured in monthly frequency.
Source: Authors' calculations.

the NRA, the level of registered unemployment drops to zero, but that drop occurs at older ages with each cohort.

For this study, the pension register was merged with the population census database of 1989 and additional data on educational attainment, type of settlement, immigrant status, language proficiency in a second language and marital status were obtained. All these characteristics are time-fixed, measured at the census date. Table 2 presents the characteristics of the birth cohorts from 1943 to 1952. The marked increase in the proportion of immigrants that starts after the birth cohort for 1945 reflects the emergence of the second generation of immigrants, who were the descendants born to immigrants from the former USSR who started to arrive in Estonia in large numbers after the Second World War.

5. Empirical methodology

The estimation strategy used in this article to evaluate the impact of a rise in the pension age is a difference-in-differences approach similar to that employed by Vestad (2013), Staubli and Zweimüller (2013), and Cribb *et al.* (2016). Since there were parallel shifts in the ERA and the NRA, we use one equation to estimate their effect on employment. The treatment variables are thus below the ERA and below the NRA. For unemployment and inactivity, we are only able to estimate the effect of the ERA. Each individual in the sample is treated at some point in time and non-treated at another. We identify the effect of the treatment by comparing the labour market outcomes at the same age for different cohorts for whom pension eligibility starts at different times, but that are otherwise similar after adjustment for observable characteristics. The assumption underlying the model is that once the effects of the business cycle and individual characteristics are controlled for, the treatment and control groups would share a common age trend in the outcome variable without treatment, and the change or difference in the labour market behaviour would be attributable solely to the treatment variable. To eliminate the effect of fluctuations in labour demand that also impact labour market outcomes, we add quarterly time dummies to our model. The number of women in the treated and non-treated groups is shown in the Appendix (Tables A2 and A3).

For the employment outcome, the comparison between the groups is made by estimating linear probability models in the following form:

$$y_{ict} = \alpha BERA_{ict} + \beta BNRA_{ict} + \sum_t \delta_t T_t + \sum_a \delta_a A_a + \sum_c \delta_c C_c + \gamma X_i + \varepsilon_{ict}. \quad (1)$$

Table 2. Labour market status and socio-demographic characteristics of the study population, women by birth cohort, Estonia

	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952
Labour market status during the year prior to ERA (%)										
Employed	–	–	67.9	68.1	67.6	69.8	71.7	72.4	68.5	66.9
Unemployed	–	–	3.2	2.7	2.6	2.1	1.9	3.3	9.0	8.2
Inactive	–	–	29.0	29.2	29.8	28.1	26.4	24.3	22.4	24.9
Labour market status during the year prior to NRA (%)										
Employed	63.3	62.2	60.1	59.0	58.7	60.8	55.4	53.7	–	–
Unemployed	3.4	2.4	2.3	1.7	1.2	1.8	5.3	4.2	–	–
Inactive	33.3	35.4	37.6	39.3	40.1	37.4	39.3	42.1	–	–
Educational attainment (%)										
Primary or basic	21.4	19.2	17.6	13.9	12.5	11.9	11.6	10.8	10.3	10.1
Secondary	30.1	31.9	32.6	32.8	31.5	32.9	33.5	34.1	32.3	31.9
Post-secondary, non-tertiary	26.2	27.5	27.4	29.3	31.7	32.9	32.8	31.9	32.8	33.6
Tertiary	21.5	20.7	21.6	22.9	23.4	21.4	21.3	22.3	23.9	23.6
Missing	0.8	0.8	0.8	1.1	0.8	0.9	0.8	0.9	0.7	0.9
Place of residence										
Rural	74.4	74.0	74.5	76.6	76.5	76.4	77.0	75.7	74.6	73.2
Urban	22.5	23.0	22.2	19.6	20.2	19.9	19.4	19.9	21.8	22.9
Missing	3.1	3.0	3.2	3.7	3.3	3.6	3.6	4.3	3.6	3.9
Immigrant status										
Native	73.9	71.5	67.8	60.2	58.0	58.0	54.5	55.7	56.5	56.1
Immigrant	22.7	25.1	28.7	35.8	38.4	38.2	41.7	39.7	39.6	39.7
Missing	3.5	3.4	3.5	4.1	3.6	3.9	3.8	4.6	3.9	4.2
Marital status (%)										
Married	68.2	68.2	69.6	70.3	70.1	70.9	72.2	69.7	73.6	74.2
Single	8.6	8.2	7.6	7.5	7.6	7.7	7.5	8.3	7.4	8.1
Widowed	5.2	4.2	3.8	3.3	3.4	2.9	2.1	2.1	2.1	1.8
Divorced, separated	14.9	16.2	15.7	15.1	15.5	14.8	14.5	15.4	13.2	11.9
Missing	3.2	3.2	3.4	3.7	3.4	3.7	3.7	4.4	3.7	4.0
Number of individuals	5,156	5,287	5,473	6,786	7,183	7,209	7,677	7,209	8,319	8,382
Number of observations (thousands)	270	336	381	474	503	505	536	470	453	355
Average number of obs. per individual	52	64	70	70	70	70	70	65	54	42

Note: Women who were granted a pension on the basis of having raised three or more children or a disabled child, having worked in specific occupations or branches of the economy deemed to be hazardous to health, or in specific civil service occupations such as the police or military are excluded.
Source: Authors' calculations based on data of the ENSIB register.

For unemployment and inactivity it is:

$$y_{ict} = \alpha BERA_{ict} + \sum_t \delta_t T_t + \sum_a \delta_a A_a + \sum_c \delta_c C_c + \gamma X_i + \varepsilon_{ict}. \quad (2)$$

The outcome variable of main interest on the left-hand side y_{it} in equation (1) is an indicator for employment that takes the value 1 if a social tax payment was made for the person in the given month. In equation (2) the outcome variable is unemployment, defined as claiming unemployment benefits or being a registered unemployed in the given month, with inactivity as the residual status. On the right-hand side, $BNRA_{ict}$ denotes the treatment variable of being below the NRA in the given month and $BERA_{ict}$ is that of being below the ERA.

Control variables are added to the models in a stepwise fashion. The first model (M1) includes controls for the business cycle and quarterly age dummies. To control for business cycle effects, a series of quarterly time dummies (T_t) is employed. Doing this means the effects of the business cycle are assumed to be similar across the individuals observed in the same quarter, which is a standard

assumption in the difference-in-differences approach. To control for age effects, quarterly age dummies (A_a) are included. In the second model (M2), a control for the effects associated with the birth cohort (C_c) is added. To avoid perfect linearity between age, time and cohort, we use a 2-year specification for the birth cohort variable. Further, model M3 adds controls for individual characteristics of educational attainment, immigrant status, rural or urban place of residence, marital status and language proficiency (X_i). Model M4 loosens the standard assumption about the similarity of the effects of the time variable across individuals. To allow for variation in the time trend, we add the interactions of our quarterly time dummies with educational attainment and place of residence. The thinking behind model M4 is that the global economic recession, which began in 2008, hit people with low educational attainment and rural residents harder. Finally, model M5 introduces individual fixed effects in order to maximise the control of differences between individuals in the population studied.

To make sure that the groups are sufficiently similar, equation (1) is estimated on a narrow age group of 56–61 years and equation (2) is estimated on 56–59 years. In addition, only those birth cohorts that reached the NRA or ERA within the period studied are considered. Technically, we estimate the equations as a panel data GLS random-effects linear probability model with robust standard errors to take account of the panel structure of our data, where disturbance terms may not be independent within individuals. A linear probability model was selected because it provides a straightforward interpretation of the estimates in terms of the change in employment, unemployment and inactivity rates.

To provide an insight into how the response to the pension age reform has varied across sub-groups, we estimate additional models for employment that interact the treatment variables with three individual characteristics of educational attainment, place of residence and immigrant status. The purpose of the interaction models is to ascertain whether the more vulnerable sub-groups of the population, which are people with low educational attainment, people of immigrant origin and rural residents, have experienced greater difficulty in adapting to the rise in the statutory pension age.

6. Results

6.1 The employment response to the rise in the retirement age

Table 3 reports the results for how the rise in the ERA and the NRA affects employment for women born in 1943–1952, who were affected by the pension age reform in Estonia in the years 2001–2011. In the initial model (M1), being under the NRA increases the probability of a person being employed by 4.2 percentage points and being under the ERA increases it by an additional 3.5 percentage points, controlling for age and the business cycle. To put the magnitude of the effect into perspective, the employment rate in the year before reaching the NRA was in the range of 54–63% and before reaching the ERA in the range of 67–72% depending on the cohort.

The estimated effect of being under both the ERA and the NRA varies very little across different specifications. We add 2-year cohort dummies in model M2, but this does not substantially change the estimated treatment effects. In model M3, we add individual time-invariant control variables, and in model M4, we allow for different time trends for people with tertiary education and for those living in rural areas, while finally we estimate the model with fixed effects in M5. The estimates are remarkably stable across the different models, with virtually no change associated with the inclusion of controls in the model. However, the effect associated with being below the ERA tends to be smaller than that associated with being below the NRA. This is in line with there being hardly any discontinuity in the employment rate across age at the ERA, unlike in many industrialised countries (Gruber and Wise, 2004). A plausible explanation for the rise in the ERA having a smaller effect is that an early pension is usually claimed by people who have already left the labour market. The low level of pensions, the additional downward adjustment and the stringent earnings test make the early pension an unattractive reason for exiting employment. While the earnings test is commonly considered a

Table 3. The effect of the ERA and NRA rise on employment, female birth cohorts 1943–1952, Estonia

	M1	M2	M3	M4	M5
Below NRA	0.042***	0.041***	0.041***	0.041***	0.041***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Below ERA	0.035***	0.034***	0.034***	0.034***	0.034***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Random effects	Yes	Yes	Yes	Yes	No
Fixed effects	No	No	No	No	Yes
Quarterly age dummies	Yes	Yes	Yes	Yes	Yes
Two-year cohort dummies	No	Yes	Yes	Yes	No
Quarterly time dummies	Yes	Yes	Yes	No	Yes
Quarterly time dummies×tertiary education	No	No	No	Yes	No
Quarterly time dummies×rural	No	No	No	Yes	No
Individual controls	No	No	Yes	Yes	No
Observations	4,284,535	4,284,535	4,284,535	4,107,709	4,247,576
Number of individuals	68,681	68,681	68,681	65,787	68,077

Reading: Robust standard errors in parentheses.
Significance level: ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.
Notes: The data cover women aged 56–61 from cohorts born between 1943 and 1952.

disincentive to work (e.g., Cribb *et al.*, 2016), it may also operate as a disincentive to claiming an early pension.

That there is no large drop in the employment rate when people reach the statutory pension ages already hints that the immediate effect is small. Notably, the effect observed is smaller than the lower estimates from the literature of 6.3 percentage points found by Cribb *et al.* (2016) for Great Britain, or 9.75–11 percentage points reported by Staubli and Zweimüller (2013) for Austria. Our result is in line with the considerable incentives to work beyond the NRA in Estonia discussed earlier in the article, which come from the low level of wealth, and the low level of pensions compared to average wages. There are equally no disincentives to working past the retirement age like changes in marginal tax rates on earnings, or income tests. Some authors (Behaghel and Blau, 2012; Cribb *et al.*, 2016) have argued that the statutory retirement age has a signalling effect and serves as a benchmark of the appropriate age to retire. In the Estonian case, the benchmark role of the statutory retirement age may have been blurred by the long-lasting stepwise increase in the retirement age, which has loosened the association between reaching a particular age and retiring.

The period of the study included the global financial crisis and the resulting recession in 2008–2009. Although we control for the effect of the economic cycle with quarterly time-dummies, these events may have had a differential effect on cohorts above and below the ERA/NRA. In order to investigate whether the crisis is driving our results, we check the robustness of our main findings by fitting additional models that exclude the years 2009–2011. This reduces the effect of the rises in both the NRA and the ERA on the employment rate,[15] but although the change is statistically significant, the results remain substantively unchanged.

6.2 The response of unemployment and inactivity to the rise in the early retirement age

Eligibility to register as unemployed and claim benefits ends when the NRA is reached, so we are only able to investigate the response of unemployment and inactivity to ERA. We estimate a set of five models, M1–M5, with controls added in a similar stepwise fashion to that used in the analysis of the response of employment. Before 2007 we are able to identify those registered unemployed who receive either insurance benefits or assistance benefits, who are about half of all the registered unemployed. Starting from 2007, we can identify all the registered unemployed whether they are

[15]The effect of the rise in the NRA on the employment rate is reduced to 0.035 (SE 0.02) from 0.041 (SE 0.002) and the effect of the ERA to 0.029 (SE 0.002) from 0.034 (SE 0.002).

Table 4. The effect of the rise in the ERA on unemployment and inactivity, female birth cohorts 1943–1952, Estonia

	M1	M2	M3	M4	M5
Below ERA	0.011***	0.011***	0.011***	0.011***	0.011***
on unemployment	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Below ERA×from 2007 on unemployment	0.007***	0.009***	0.009***	0.009***	0.009***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Below ERA	−0.038***	−0.036***	−0.037***	−0.037***	−0.036***
on inactivity	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Below ERA×from 2007 on inactivity	−0.007***	−0.008***	−0.008***	−0.008***	−0.009***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Random effects	Yes	Yes	Yes	Yes	No
Fixed effects	No	No	No	No	Yes
Quarterly age dummies	Yes	Yes	Yes	Yes	Yes
Two-year cohort dummies	No	Yes	Yes	Yes	No
Quarterly time dummies	Yes	Yes	Yes	No	Yes
Quarterly time dummies×tertiary education	No	No	No	Yes	No
Quarterly time dummies×rural	No	No	No	Yes	No
Individual controls	No	No	Yes	Yes	No
Observations	3,072,934	3,072,934	2,945,363	2,945,363	3,046,561
Number of individuals	68,640	68,640	65,766	65,766	68,044

Reading: Robust standard errors in parentheses.
Significance level: ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.
Notes: The data cover women aged 56–59 from cohorts born between 1943 and 1952.

receiving benefits or not. To account for the significant structural break, we include an interaction term for the treatment effect with an indicator variable for the period after the change. Table 4 reports the results for the change in the ERA, which confirm that the effect is quite small on the whole, however still sizeable compared to the effect on the employment rate. In the period after the change, the effect doubles, like the aggregate number of unemployed does.

Given the relatively strict eligibility criteria, the limited duration of benefit payments and the low generosity, it is not surprising that the unemployment protection system is not an attractive alternative route out of employment for those of pre-retirement age in Estonia.

As the effect of a rising ERA increases the employment rate and the probability of unemployment, it reduces inactivity, meaning pension age reform reduces the likelihood of being economically inactive. However, in line with the estimates for unemployment, the effect of the ERA on inactivity is relatively small. The probability that those below the ERA would be inactive is therefore estimated to be 3.7 percentage points less before 2007 and 4.5 percentage points less as of 2007, controlling for the effects of age, business cycle and individual characteristics. The parameter estimates for the effects of the ERA on both unemployment and inactivity corroborate the modelling results for the employment response reported above, and are also highly stable across models.

6.3 Heterogeneity of the response to the rise in the retirement age

The effect of pension age reforms may vary across sub-groups of the population. The rationale behind this assertion is that some groups of older workers may face greater difficulties than others in extending their stay in employment in response to pension age reforms, for reasons such as poor skills, poor health, employment in declining sectors or occupations, or residence in regions with decreasing demand for labour (e.g., Staubli and Zweimüller, 2013; Rabaté and Rochut, 2020). If there are no alternative exit routes from the labour force available, these groups that we observe may experience disproportionate hardship in adapting to the challenges posed by pension reform. At the same time, it can be assumed that sub-groups with fewer resource constraints or that already have very high employment rates even past the pre-reform eligibility age may exhibit a weaker response to reforms.

To ascertain whether this might be the case in Estonia, we analysed the different experiences of three sub-groups of older people using the information that was available in our dataset for educational attainment, place of residence as rural or urban and immigrant status. The labour market

Table 5. The effect of the rise in the NRA and the ERA on employment by educational attainment, place of residence and nativity, female birth cohorts 1943–1952, Estonia

	M1	M2	M3
Below NRA	0.043***	0.046***	0.041***
	(0.004)	(0.002)	(0.002)
Interaction of below NRA and education (relative to the treatment effect of primary/basic education)			
Below NRA×secondary	0.008		
	(0.005)		
Below NRA×post-secondary non-tertiary	0.002		
	(0.005)		
Below NRA×tertiary	−0.020***		
	(0.005)		
Interaction of below NRA and rural residence (relative to the treatment effect of urban residents)			
Below NRA×rural		−0.022***	
		(0.004)	
Interaction of below NRA and immigrant status (relative to the treatment effect of natives)			
Below NRA×immigrant			0.002
			(0.003)
Below ERA	0.044***	0.039***	0.008***
	(0.004)	(0.002)	(0.002)
Interaction of below ERA and education (relative to the treatment effect of primary/basic education)			
Below ERA×secondary	0.008		
	(0.005)		
Below ERA×post-secondary non-tertiary	−0.007		
	(0.005)		
Below ERA×tertiary	−0.043***		
	(0.005)		
Interaction of below ERA and rural residence (relative to the treatment effect of urban residents)			
Below ERA×rural		−0.020***	
		(0.003)	
Interaction of below ERA and nativity (relative to the treatment effect of natives)			
Below ERA×immigrant			0.064***
			(0.003)
Random effects	Yes	Yes	Yes
Quarterly age dummies	Yes	Yes	Yes
Two-year cohort dummies	Yes	Yes	Yes
Quarterly time dummies	Yes	Yes	Yes
Quarterly time dummies×tertiary education	Yes	Yes	Yes
Quarterly time dummies×rural	Yes	Yes	Yes
Individual controls	Yes	Yes	Yes
Constant	0.496***	0.506***	0.494***
	(0.007)	(0.007)	(0.007)
Observations	4,107,709	4,107,709	4,107,709
Number of individuals	65,787	65,787	65,787

Reading: Robust standard errors in parentheses.
Significance level: ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.
Notes: The data cover women aged 56–61 from cohorts born between 1943 and 1952.

statistics indicate that people with low educational attainment, rural residents and people of immigrant origin perform systematically worse in the job market in Estonia and their employment rate is lower than average (Statistics Estonia, 2019).

In order to investigate the heterogeneity of the employment response to the increase in the NRA and ERA, we estimated models based on Specification M3 (Table 3), adding interaction terms for the treatment variables (being below the ERA and being below the NRA), with educational attainment, place of residence and immigrant status. The estimation results presented in the first column of Table 5 indicate that the effect of being below the NRA and the ERA has a smaller effect on the

employment rate of people with tertiary education relative to people with primary or basic education. In fact, being under the ERA does not change the labour market outcome of people with tertiary education at all. This is consistent with the fact that early pensions take up decreases and on the other hand, employment increases with education. People with tertiary education are more likely to have savings, which means their retirement decisions are determined less by the start of pension eligibility. At the same time, they are healthier on average and probably have a white-collar job, and often continue working past their pension age while drawing a pension.

Rural residents exhibit less response to the increase in both the ERA and NRA compared with urban residents (the second column of Table 5). This can be associated with a higher tendency of rural residents to be in receipt of a disability pension and to have a lower rate of employment in the year preceding the ERA.

According to the last column in Table 5, the impact of the rise in the ERA appears to be mainly driven by people with an immigrant background, who respond more strongly to the rise in the ERA much more than non-immigrants do. Immigrants and their descendants are more than one-third of the total population in Estonia (Statistics Estonia, 2019) and they originate predominantly from other former Soviet republics, mainly Russia and Ukraine. A characteristic feature of the immigrant population in Estonia is its relatively low level of integration with the host society, which is reflected in the limited skills in the language of the host country (Rahnu *et al.*, 2015; Puur *et al.*, 2017). A stronger response to the increase in the ERA among immigrants may be due to their tendency to resort to early retirement more than the native population; the difference with regard to the NRA is negligible.

7. Conclusions

In many countries, governments are currently in the process of raising retirement ages to make public pension systems more sustainable in the long term. An important goal of the policy change is to encourage people to delay their exit from the labour market. There are several ways to do this. Raising the retirement age reduces social security wealth, which should increase the labour supply in response; tax incentives that encourage individuals to retire at the statutory retirement age could be shifted towards a later age; liquidity constraints can stop people from withdrawing from the labour market before they become eligible for an old-age pension; and changing the statutory retirement age might have a signalling effect that it is appropriate to retire at a later age.

This article examined the effect of the Estonian pension reform that raised the NRA for women from consecutive birth cohorts born in 1943–1950 in 6-month steps from 58 to 61.5 in the period from 2000 to 2011, and the ERA from 56 to 59.5 for the cohorts born in 1945–1952. Our results suggest that the reform did indeed have a significant impact on the employment rate for the women who were affected by the reform, with point estimates of a rise of 4.1 percentage points associated with the rise in the NRA, and of 3.4 percentage points associated with the rise in the ERA. The impact of the rise in the ERA had less effect on people with tertiary education and rural residents, while it had more impact on people with an immigrant background. We also find evidence that the rise in the ERA had a positive impact of 1 percentage point on unemployment benefit claims in the first half of the period studied and an impact of 2 percentage points on registered unemployment in the second half, which reduced the fiscal savings from the pension reform. When considered in the context of a 3–4 percentage point impact on employment, the rise in registered unemployment appears quite significant.

The magnitude of the treatment effect is lower than that which earlier studies have found in other countries. This can be explained by contextual factors. The low level of pensions encourages people to earn wages whenever possible, weakening the link between retirement and the start of pension eligibility. Furthermore, a permanent reduction in the amount paid as a pension and a very punitive earnings test for drawing a pension before the NRA discourage early retirement. The relatively lax eligibility criteria and the favourable conditions for claiming disability pensions allowed people with higher disutility from work to exit employment smoothly before they reached retirement age.

Further rises in the pension age are inevitable in Estonia, as in many other countries, if the public pension system is to be kept solvent. As pension take-up shifts in lock step with the start of eligibility, the fiscal gains from the reform are guaranteed, though they are reduced somewhat by the increase in the costs of other social security programmes. Our results suggest that the gains in employment that are directly attributable to the pension age reform may not be large if employment rates for older people are already high, while the disincentives to working while drawing pensions or other benefits like disability benefits are low.

Our study contributes to the literature in two ways. First, our relatively low estimates show that the employment effect of lifting the retirement age depends strongly on the features of the social security system. Low replacement rates in combination with the lack of tax and financial disincentives tend to weaken the link between pension eligibility and employment decisions. Second, we add to the scarce literature on the outcomes of pension age reforms in Central and Eastern European countries, where private pension savings are relatively low, there are next to no company pension schemes, and income tax systems are often less progressive.

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Appendix

Table A1. Estimates of the effect of retirement age rises on employment rates in previous studies

Study	Country	Gender	Retirement age before and after the reform	Selection based on labour market status	Age group	Estimated DD employment rate effect (percentage points)
Staubli and Zweimüller (2013)	Austria	Men	60 → 62	No selection	57–64	9.75
		Women	55 → 58.5	No selection	52–59	11
Cribb *et al.* (2016)	United Kingdom	Women	60 → 62	No selection	60	6,3
Vestad (2013)	Norway	Both sexes	64 → 62	At least 10 years of work experience since the age of 50	63	−27.1
Rabaté and Rochut (2020)	France	Both sexes	60 → 61	No selection	60–61	21
						Estimated RDD employment rate effect
Staubli and Lalive (2016)	Switzerland	Women	62 → 63	Worked at least once between 50 and 53	63	4–6 months delay

Table A2. Number of individuals in the study population by age and birth cohort in the treatment and control groups in the models estimating the effect of the NRA rise

	Age (completed years)					
Birth cohort	56	57	58	59	60	61
1943		2,525	5,111	5,064	5,019	4,979
1944	2,574	5,244	5,189	5,135	5,080	5,048
1945	5,438	5,377	5,320	5,256	5,198	5,141
1946	6,731	6,678	6,616	6,558	6,484	6,423
1947	7,130	7,072	7,006	6,955	6,902	6,836
1948	7,161	7,106	7,046	6,989	6,937	6,873
1949	7,617	7,538	7,478	7,413	7,340	7,291
1950	7,176	7,120	7,066	7,012	6,970	3,604
1951	8,300	8,296	8,293	8,278	4,273	
1952	8,358	8,348	8,327	4,237		

Note: The cells contain the number of women observed by cohort and age in June of each calendar year of the study, from 2001 to 2011. Women who were granted pensions on favourable conditions are excluded. The dark shading indicates women below the NRA; the light shading indicates cohorts of women who are partly below and partly above the NRA; no shading indicates women past the NRA.
Source: Authors calculations, ENSIB register

Table A3. Number of individuals in the study population by age and birth cohort in the treatment and control groups in the models estimating the effect of the ERA rise

	Age (completed years)					
Birth cohort	56	57	58	59	60	61
1943		2,525	5,111	5,064	5,019	4,979
1944	2,574	5,244	5,189	5,135	5,080	5,048
1945	5,438	5,377	5,320	5,256	5,198	5,141
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Source: Authors calculations, ENSIB register

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