Ageing Europe – An Application of National Transfer Accounts for Explaining and Projecting Trends in Public Finances

Project Acronym: AGENTA

Full Title: Ageing Europe: An application of National Transfer Accounts (NTA) for explaining and projecting trends in public finances

Grant Agreement: 613247

Duration: 01/01/2014-31/12/2017

Deliverable 3.1: Explaining retirement decisions for Sweden

Submission date: 17.12.2015

Project month: 10

Dissemination Level: PU

Authors: LUND; Haodong Qi, Haodong.Qi@ekh.lu.se; Tommy Bengtsson, Tommy.Bengtsson@ekh.lu.se; Jonas Helgertz, Jonas.Helgertz@ekh.lu.se

Coordinator: OEAW-VID

Funded by the Seventh Framework Programme of the European Union

The aim of Work Package 3 is to examine the importance of life-course factors (education, health, work history, and family situation) and institutional conditions (labour market, pension and tax policies) on older workers labour supply and retirement behaviour. For such a purpose, the research team has completed four research reports, which all provided evidence of how life-course factors affecting retirement and employment decisions. In addition, two of our research reports extended the analysis further to examine the impact of pension reform on retirement behaviour.

Our research reports all applied econometrics to analyse the life-course factors with some variation in model specification across studies due to different data sources used. For example, the Swedish study was able to investigate the old-age employment differences across a number of immigrant groups, thanks to the detailed information on individuals' country of origin given in the Swedish administrative data which covers the entire population, while the SHARE is only possible to disentangle the differences in retirement between natives and immigrants due to its small sample size. On the other hand, the empirical models specified across four studies share many common features. For instance, models all analyse effects of age, gender, and education. However, the importance of education on retirement behaviour appears considerably different across studies. The two Swedish studies both documented university education has a positive and significant effect on prolonging working life, whereas the opposite effects were found in the Spanish and SHARE study. The Swedish study also found distinct differences between males and females regarding the effects of education on age of retirement, females much more depending on education for age at retirement than males.

In addition to analysing the life-course factors for retirement decisions, the Swedish and Spanish studies took a step further to assess the effects of pension reform. The Swedish study focused on the impact of the 1994 pension reform on retirement age. The empirical results showed that the reform had a positive and significant effect on retirement age for men, but not women. The Spanish study, on the other hand, conducted simulation analysis to examine the impact of the

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reform approved in 2011 on pension expenditure, and found that the reform was not sufficient to ensure sustainability.

Deliverable 3.1 consists of the following two research reports:

Analysis of long term life course factors affecting retirement decisions, using administrative data

A: Old-age Employment in Sweden: the Reversing Cohort Trend

B: Prolonged Working Life in Sweden - A Result of the Great Pension Reform?

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Analysis of long term life course factors affecting retirement decisions, using administrative data

A: Prolonged Working Life in Sweden - A Result of the Great Pension Reform?

Authors: Haodong Qi, Haodong.Qi@ekh.lu.se;
Tommy Bengtsson, Tommy.Bengtsson@ekh.lu.se;
Jonas Helgertz, Jonas.Helgertz@ekh.lu.se

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Contents

Abstract

The mean age at retirement in Sweden increased roughly one month per year between 2000 and 2011 (Karlsson and Olsson, 2012). Empirical studies mostly relate this increase to eligibility requirement changes in the Swedish disability pension, which became increasingly stringent during the 1990s. Few, however, have attributed this increase to the 1994 old-age pension reform, which affected a broad spectrum of older workers. This paper specifically examines whether the rising retirement age was driven by the 1994 pension reform. The key finding is that the reform exerted a significant positive effect on the mean age at retirement for men, yet had little effect for women. For example, the reform raised de facto retirement age by 2.4 months for men, but merely 0.6 months for women, among those born in 1944.

1 Introduction

The share of the Swedish population aged 65+ doubled over the twentieth century. This demographic development has evolved via declines in both fertility and mortality, as described by the stable population theory (Preston et al., 1989, 2001). However, the initial reduction in deaths, when mortality levels remained high, actually rejuvenated the population, as the individual ageing effect (changes in the life-cycle survival schedule) were outweighed by the growth rate effect (Lee, 1994). Hence, previous population ageing in Sweden was mainly driven by the fertility decline, at least until the late twentieth century (Bengtsson and Scott, 2011; Coale, 1957). The ageing process was beneficial to economic development and the creation of welfare services, as survivors were concentrated at young ages, which, together with fewer children being born, increased the ratio of productive to non-productive population (the demographic support ratio). This phenomenon is commonly referred to as ”the first demographic dividend” (Bloom and Canning, 2009; Mason, 2005; Mason and Lee, 2007; United Nations, 2013). However, this dividend has now been turned into a deficit, because continuous improvements in human survival, particularly after age 65, have made the individual ageing effect dominate the rate of growth effect, and, therefore, contribute to a declining support ratio.

The declining support ratio creates challenges for welfare states. One challenge is the potential threat to the sustainability of public old-age pension system, particularly Defined Benefit Pay As You Go (DB PAYG) systems. The average pension expenditure is expected to grow from 9% to 12% of total GDP between 2010 and 2050 across OECD countries (OECD, 2013). Such growth in pension provision, in a context of population ageing, will result in rising costs per worker to provide benefits to a given age vector of retirees, assuming the length of working life (e.g. between 20 and 65) is fixed (Lee and Edwards, 2001). To counteract this threat, many governments across OECD countries have prioritized pension reform, with the goal of creating incentives for postponing retirement. Recent OECD statistics showed that the average labor market exit age across OECD countries has gradually increased since the early 2000s (OECD, 2013). Some argue that this increase is indeed the result of government interventions, such as restricting early retirement schemes, and/or raising statutory retirement ages (Buchholz et al., 2013; Komp et al., 2010).

Sweden, without exception, has gone through several reforms of the public pension system. In 1991, the government abolished the retirement pathway, whereby disability insurance (hereafter DI) could be utilized for labor market reasons (e.g.

due to unemployment). Six years later, DI was further restricted by eliminating favorable rules for workers aged 60-64 (Hagen, 2013). A major reform on the public pension system was introduced in 1994, when the parliament passed legislation of a new pension system. This legislation was to phase out the defined-benefit pay as you go pension system (ATP) with a Notional Defined Contribution pay as you go system (NDC). After these reforms, Sweden, like many other OECD countries, also witnessed an increase in effective mean retirement age after a long-term trend towards early retirement. The average exit age from the labor market conditional on working at age 50 grew from 63 to 64 years old between 2000 and 2011, an increase of about one month per year (Karlsson and Olsson, 2012).

Whilst the majority of retirement studies for Sweden have focused on the effects of disability insurance on retirement (e.g. Johansson et al. (2014); Karlström et al. (2008)), much less attention has been paid to the 1994 old-age pension reform which affected a broader spectrum of older workers. The only study to date which specifically evaluated the impact of the 1994 Swedish old-age pension reform is Glans (2008), who documented a remarkable decline in the retirement hazard over ages 60-64 among the cohorts most affected by the reform. However, the reduced form estimation on the time to retirement event only captures the differences in hazards between those who are unaffected and those who are more affected by the reform (i.e. cohort differences), which might potentially confound behavioral modifications incentivized by the reform, and preference changes that are independent of the pension reform. This paper contributes to the literature by explicitly incorporating financial incentives in the retirement model in order to distinguish between these two types of behavioral change. Doing this allows us to evaluate the true effect of the Swedish old-age pension reform on labor market exit age. Another advantage of our study is that we use the latest updated register data which covers cohorts younger than those in Glans (2008). This is crucial for understanding the behavioral response to this policy change, as younger cohorts were more affected by the reform.

Our overall aim is to examine the effects of phasing in the NDC pension scheme on the prolongation of working life. The key research question is whether, and to what extent, the rising mean retirement age is a result of the 1994 public pension reform. To address this central question, we first examine the differences in pension entitlements before and after the reform, and quantify the benefit difference between the observed and the counterfactual pension income that older workers would have otherwise been entitled to had the reform not been implemented. Secondly, we incorporate the benefit changes into the retirement model

and make inferences regarding the effect of labor and pension income on retirement probabilities. Finally, we evaluate the effects of the reform on working life extension by examining the differences between the observed and the counterfactual average retirement age, assuming the post-reform pension benefit is the same as the pre-reform level.

2 The Great Reform in the Swedish Pension System

Sweden followed a long-term trend towards early retirement until the late-1990s. Some argue that this trend is attributable to the generosity of disability insurance (DI) since the early 1970s. Over the period 1970 to 1991, workers aged 60+ could retire through DI with labor market reasons, such as unemployment, which largely explains the declining labor force participation among the older workers during the period (Hagen, 2013). During the 1990s, the Swedish government implemented two major reforms concerning DI; first by abolishing the utilization of DI for labor market reasons in 1991, and secondly, by eliminating the favorable rules for workers aged 60-64 in 1997.

The labor supply effects of these DI reforms have been studied by Karlström et al. (2008), who found a positive impact on the labor force participation rate. Moreover, this study also showed large anticipation effects of the reform, due to the fact that the reform was announced two years prior to its implementation. As a result, the transition from unemployment to DI almost doubled, corresponding to about 2% of the labor force between ages 60 and 64, during the year before the reform was implemented. Karlström et al. (2008) argued those who transitioned were mainly the DI applicants aged 60-64 in 1996 (born 1932 to 1936), who believed that they would be eligible for DI under the pre-reform regime, but not under the post-reform regulation. Furthermore, according to Karlström et al. (2008), the application had to be filed before January 1, 1997, meaning the last group who benefited from the favorable rule of DI were those aged 60 on December 31, 1996, the 1936 cohort.

However, the period of investigation in Karlström et al. (2008) ended in 2001, thus further developments in old-age labor supply remain unclear. Some have shown that the average exit age from labor market increased approximately one month per year between 2000 and 2011 (Karlsson and Olsson, 2012). Was such an increase a response to the changes in stringency of DI admission? This question is difficult to answer because the post-DI reform period overlapped with the reform on the general old-age pension system. The new pension system (NDC) proposed in the 1994 old-age pension reform was implemented in 1999 and star-

ted paying out benefits in 2001 (Hagen, 2013).

The reformed old-age pension system comprises three main pillars: the universal covered guarantee part, Notional Defined-Contribution Pay-As-You-Go (NDC PAYG) and privately managed fully funded accounts (Palmer, 2000; Hagen, 2013). For the income related PAYG pillar, there was a gradual transition from the ATP to NDC, which was implemented over 16 years. The first recipient of NDC were those born in 1938, whereby one-fifth of their pension was calculated based on the NDC rule, and the remaining four-fifths based on the ATP rule. The NDC part, as a share of the total income related benefit from the public old-age pension, increased by 5 percentage points for each successive cohort up to those born in 1953. Hence, the pension entitlements for those born in 1954 or later are accounted by a complete conversion of the accumulated pension credits from the ATP into the NDC (Palmer, 2000; Settergren, 2001; Konberg et al., 2006; Hagen, 2013). All benefits will be completely paid from the NDC system by the year 2040 (Sunden, 2006).

The ATP and NDC pension schemes are different in many aspects. The former has a defined benefit feature which has been proven to be unsustainable given the context of demographic ageing, whereas the latter is in the defined contribution spirit, which has the potential for ensuring long-term sustainability. From the individual's perspective, the two systems can be mainly distinguished by two features, the importance of earning history and the divisor for calculating pension benefits. These two factors create the differences between ATP and NDC as they lead to differences in the rate of return.

Under the ATP, only the best 15 years of earnings during the working life are used to calculate one's pension entitlements, whereas, under the NDC, the entire life earnings are taken into account for calculating benefits. This fundamental difference between the two schemes creates stronger incentives for workers to postpone retirement under the NDC system. This is because under the best-15-year rule, workers would not expect any increase in their final pension benefits as the highest earning over the life cycle tends to occur before age 50 (Laun and Wallenius, 2015). However, NDC implies that the entirety of pre-retirement labor income will be relevant for calculating entitlements, thus additional years of earnings at old ages will increase expected benefits. It is also noteworthy that the best-15-year rule in ATP generates significant redistribution from low- to high-income earners and from women to men, simply because the peak of the labor income over the life cycle is typically higher for men and high-income earners. This potentially treats workers with equivalent lifetime earnings, but with inequivalent life-cycle earning profiles, unequally (Laun and Wallenius, 2015). Therefore, NDC

addresses this equity issue inherent to ATP by taking full life time earnings into account.

The second important feature that distinguishes NDC from ATP is the divisor to calculate the annuity. The divisor is a function of remaining life expectancy, which is determined by age and cohort, and not by gender and previous earning history. This divisor, however, implies benefit reduction for those participating in the NDC system (i.e. for those born in 1938 or later). As long as life expectancy continues to increase, the younger generation will receive ever decreasing monthly pension benefits, since the divisor is an increasing function of remaining years of living (Hagen, 2013). Such a mechanism also creates incentives for delaying retirement, because an additional year of working not only gives a one more year contribution to the pension assets, but it also deducts one year of remaining life expectancy from the divisor. This is particularly important for retirement income between ages 60 and 64, since from age 65 workers will be able to claim a guaranteed pension which can potentially top up the monthly pension benefits. Hence, as some have pointed out, the lifetime pension income as a function of retirement age is very flat in ATP, whereas it increases steeply under NDC (Laun and Wallenius, 2015; Palmer, 2000). The effect of retiring at age 66 will be an increase in monthly pensions of about 9 percent, and the effect of retiring at age 67 will result in a nearly 20 percent increase, compared to retiring at age 65 (Konberg et al., 2006).

Having briefly summarized the historical reforms of the DI and old-age pension system, our first conclusion is that to identify the labor supply effects of DI reform and/or the 1994 pension reform is challenging, as these reforms took place simultaneously. Furthermore, as we stressed earlier, previous studies have focused on the effects of disability insurance on retirement (Johansson et al., 2014; Karlström et al., 2008), but much less attention has been paid to the 1994 old-age pension reform which covers a broader spectrum of older workers. Our emphasis in this paper is, therefore, on the effects of the 1994 pension reform on retirement.

To eliminate the effect of DI reform, we condition our sample on those born from 1937 onward, because, as we formerly discussed, the 1937 cohort are identical to all later born in terms of facing the same stringency of the DI eligibility rule. However, they differ from those born in 1938 or later since their old-age pension benefits were completely calculated by ATP rules. Therefore, the remainder of the paper will examine the difference in retirement between the 1937 cohort who were unaffected by the 1994 pension reform, and those born in 1938 or later who were affected.

3 A Simple Retirement Model

We assume that the time horizon for each individual to choose between work and retirement starts from age 60. This is because income-related pension benefits are payable from age 60 onwards in the ATP system, and from age 61 onwards in the NDC system. Moreover, the last year of possible employment is assumed to be age 67. This is motivated by the fact that the 2001 Employment Act allows workers to be fully engaged in labor activity up to and including age 67.

Our retirement model is a simplified version of a dynamic programming model. The main assumption we impose is the zero discounting factor. The reason for such simplification is that our analysis is based on the entire population, and the challenge of recursive computation in dynamic programming using such a large sample would be too burdensome. One might argue that this is a strong assumption, as it eliminates forward looking behavior. However, previous empirical evidence has shown that there is no difference in the estimated coefficient signs between the static and dynamic models, only in coefficient sizes. For example, the coefficient estimates in Berkovec and Stern (1991) differed only in magnitudes, and not in signs, across the model with 0 and 0.95 discounting factors. Moreover, empirical evidence in Qi (2015) showed that the inter-temporal substitution behavior was largely outweighed by the intra-temporal substitution behavior among older workers (aged 60+) in Sweden. Such evidence implies that the static assumption in the simplified retirement model might not be so strong, as older workers might become myopic once approaching the end of the life-cycle. Hence, we model individuals' work history as a static choice problem between work and retirement over a discrete and finite time horizon between ages 60 and 67.

3.1 Values of Working and Retirement

The choices of work and retirement are modelled in a random utility set up, which conventionally comprises two components, the observed part of the utility and the remaining unobserved proportion of the utility. Hence, in the context of deciding whether to continue working or retire, the utility of the two choices may be expressed by the following two equations, respectively:

$$U_W = V_W + \epsilon_W \tag{1}$$

$$U_R = V_R + \epsilon_R \tag{2}$$

where, V denotes the observed utility, and ϵ is the unobserved part. Subscripts W and R refer to the choices of working and retiring.

It is important to stress that the salient difference between this paper and earlier work with a similar focus (Glans 2008) is that we explicitly distinguished working-retiring choice as a function of financial incentives and non-financial preferences. Such a distinction is crucial for policy evaluations. As mentioned earlier, one of the key goals for pension reforms across many OECD countries is to create incentives for working longer (OECD, 2013). These incentives can only be mediated through the pecuniary value of retirement, but not through the non-pecuniary part. This is because financial incentives to work longer can only be created through adjusting workers' budget constraint (i.e. the pecuniary value), yet seldom by altering individuals' pure preferences. For this, we define the observed value, V in (1) and (2), as:

$$V_W = V(Y_W, B_W) + V_W(X) \tag{3}$$

$$V_R = V(Y_R, B_R) + V_R(X) \tag{4}$$

where, Y and B are labor and pension income, respectively. X is a set of exogenous individual characteristics.

The first term on the right hand side of (3) and (4) corresponds to the pecuniary value of being in the labor force and retirement, respectively, which is solely determined by labor and pension income. The second term of both equations (3) and (4) refers to the non-pecuniary value of being in either state. One might interpret this term as the non-financial utility flow.

The value functions in (3) and (4) are assumed to be a linear combination of all the covariates and the associated parameters. Therefore, (3) and (4) may be explicitly written as:

$$V_W = \alpha Y_W + \beta B_W + \gamma_W X \tag{5}$$

$$V_R = \alpha Y_R + \beta B_R + \gamma_R X \tag{6}$$

The first two terms on the right hand side of equations (5) and (6) constitute the pecuniary values in (3) and (4). As the covariates in the pecuniary value function vary across choices, the two parameters, α and β, thus distinguish the marginal utility of labor income from the marginal utility of pension income. The last term on the right hand side of equations (5) and (6) corresponds to the non-pecuniary values in (3) and (4). Non-pecuniary value is determined by a set of exogenous socio-demographic individual characteristics, which are constant across the two choices, work and retirement.

3.2 Probability of Retiring

The probability of choosing to retire may be simply defined as:

$$\begin{aligned}\text{Pr}(R) &= \text{Pr}(U_R > U_W) \\ &= \text{Pr}(V_R + \epsilon_R > V_W + \epsilon_W) \\ &= \text{Pr}(V_R - V_W > \epsilon_W - \epsilon_R)\end{aligned} \tag{7}$$

From (7), it is clear that the probability of retiring is the cumulative distribution of the density function of $\epsilon_W - \epsilon_R$ that is below a certain threshold (i.e. the difference between the value of retiring and working ($V_R - V_W$)). Let ξ_V be the value difference $V_R - V_W$ and ξ_ϵ be the difference of two random errors $\epsilon_W - \epsilon_R$, thus the probability in (7) may be re-written as:

$$\text{Pr}(R) = \int I(\xi_V > \xi_\epsilon) f(\xi_\epsilon) d\xi_\epsilon \tag{8}$$

where, $I(*)$ indicates whether the argument, $\xi_V > \xi_\epsilon$, is true. $f(*)$ is a density function of ξ_ϵ.

Since we have discussed the observed part of utility, V, the remaining issue to be addressed in order to calculate the probability of retirement is the assumption on the distributions of ϵ_W, ϵ_R, as well as ξ_ϵ. Because ϵ_W, ϵ_R, and ξ_ϵ are unobserved, to compute the probability of retiring requires the integration of $\text{Pr}(R)|\xi_\epsilon$ over all values of ξ_ϵ weighted by the density function, $f(\xi_\epsilon)$. The integral in (8) may be evaluated either by numerical solution or closed form solution. It is well known that the former method is much more computationally intensive than the latter. Therefore, we choose the closed form solution to proceed with our retirement model.

To derive the closed form solution for computing the probabilities of retiring, three assumptions on ϵ_W and ϵ_R are needed. First, the two errors are independent of each other. Second, both errors are identically distributed. Third, each of the errors follows a Gumbel distribution (Type-I extreme value distribution). The last assumption is motivated by the fact that the difference between the two Gumbel distributed variables follows a logistic distribution. More explicitly, if ϵ_W and ϵ_R are independently and identically distributed extreme values, then $f(\xi_\epsilon)$ is a logistic distribution.

Having imposed the above three assumptions on the ϵ's, the probabilities of retiring have closed form corresponding to the logit transformation of the pecuniary and non-pecuniary part of the value functions, as in (5) and (6). Therefore, the

probability of retiring can be expressed as:

$$\text{Pr}(R) = \frac{\exp(V_R)}{\exp(V_W) + \exp(V_R)} \tag{9}$$

3.3 Model Interpretation

It is well known that, for discrete choice data, the value of each of the choices can only be identified relative to some reference. In the present context, we are only interested in the difference between the values of being retired and remaining in the labor force. We choose the alternative, working, as the base, and therefore, (9) may be re-written as:

$$\text{Pr}(R) = \frac{\exp(V_R - V_W)}{1 + \exp(V_R - V_W)} \tag{10}$$

From (5) and (6), the value difference between retiring and working is:

$$V_R - V_W = \alpha(Y_R - Y_W) + \beta(B_R - B_W) + (\gamma_R - \gamma_W)X \tag{11}$$

The interpretation for the non-pecuniary value is straightforward, since the exogenous individual characteristics in X are constant across choices. Thus the term $\gamma_R - \gamma_W$ may be interpreted as the value of retiring relative to the value of working for fixed values of X.

The α and β are coefficients for the alternative specific variables. The ratio of the two coefficients can be interpreted as the marginal rate of substitution. To be more explicit, assuming the level of utility is a constant (or equivalently $dV = 0$), the total differential of the value function can be written as:

$$dV = \alpha dY + \beta dB = 0 \tag{12}$$

Rearranging (12) yields:

$$\frac{\alpha}{\beta} = -\frac{dB}{dY}_{|dV=0} \tag{13}$$

Hence, the ratio of α to β in (13) can be interpreted as the marginal rate of substitution of labor income while working in terms of pension income while retiring. For instance, if $\frac{\alpha}{\beta} = 0.6$, and suppose that the expected annual labor income is 100,000 SEK, a worker would choose to retire with the same level of utility if he/she is compensated with at least 60,000 SEK as pension income. In other words, the worker would be willing to forego at most 40,000 SEK of labor income to re-

tire.

4 Data

Our analysis relies on data from the Swedish Interdisciplinary Panel (SIP), which contains ample information on individual labor market outcomes, such as income and occupational attainment, as well as socio-demographic and health characteristics. SIP consists of individual level data from several different administrative registers, including the income and taxation registers, the inpatient register and the total population register (RTB). These multiple registers are merged to create a longitudinal database covering roughly 12 million unique individuals born between 1930 and 1980 who resided in Sweden sometime during the period 1968-2013. The database allows for studies examining individuals behavior towards the end of their labor market careers, from a life course perspective.

As we discussed, the DI reform was implemented in 1997. This may have created incentives for early retirement among those who were under the favorable rules of DI. To isolate this potential effect from the old-age pension reform, one needs to ensure the observations in the sample were exposed to identical policy settings, except the old-age pension reform. For this, we extracted data on the cohorts born between 1937 and 1944 from SIP. This is because the oldest cohort born in 1937 was no longer under favorable rule of DI, but were under the identical DI policy setting to all the later born cohorts. Furthermore, this cohort was not affected by the old-age pension reform, thus an ideal reference group.

Another sample selection criterion is that all the individuals are working at age 59 (i.e. they receive only positive labor income, but not any sorts of pension income). Hence, our sample excluded those who claim DI before age 60, but included those who retired on DI between age 60-64. We followed all individuals from age 60 to 67, assuming the entire population is retired at age 67. This is because the 2001 Employment Act implemented in September of the same year allows workers to be fully engaged in labor activity up to and including age 67.

We use labor and pension income information to define retirement. The labor income comprises wages, salaries, sickness benefits, parental benefits, and unemployment benefits. The pension income includes payments received from old-age pension and disability insurance. The retirement age is defined as when the sum of any sorts of pension income exceeds the labor income. This implies that partial retirement is counted as working if the associated retirement income does not exceed income from labor. Furthermore, workers who are unemployed and/or on sick leave are treated as being in the working state, since they are still part of the

labor force.

The following two figures describe the basic patterns in our sample. Figure 1 compares the survival probability of being in the labor force for the oldest cohort unaffected by the 1994 reform, and for the youngest cohort whose pension benefits were calculated by both ATP and NDC. More specifically, for the youngest cohort, half of their total old-age pension income was derived based on the ATP system, and the remaining half was calculated by NDC rules. The difference between the two survival curves in each panel in Figure 1 suggests that the younger cohort remained in the labor market longer than the older cohort. Another important feature is that around 10% of the population remained in the labor force at age 67 for the 1944 birth cohort, while close to 0% were active in the labor market for the 1937 cohort.

To summarize the age patterns of retirement shown in Figure 1, we calculated the average effective labor market exit age for each consecutive cohort born between 1937 and 1944, which is illustrated in Figure 2. The mean exit age from the labor market exhibits a clear upward trend for each successive cohort for both sexes. This cohort trend coincides with what was shown in Karlsson and Olsson (2012). However, our calculated retirement ages are higher than in Karlsson and Olsson (2012), because our sample conditioned on still being in the labor force at age 59, whereas their sample conditioned on age 50. The difference between the oldest and youngest cohort in average retirement age is 0.47 for men and 0.56 for women. In other words, the shifting age pattern shown in Figure 1 implies that those born in 1944 retired on average 5.7 months for men and 6.7 months for women later than those born in 1937 who were unaffected by the pension reform, and whose benefits were entirely calculated based on the ATP rule.

5 Method

5.1 Missing Data: Labor and Pension Income

To incorporate pecuniary value into the retirement model, as shown in (5) and (6), we need information of both labor and pension income. However, one problem arises due to missing income data, as some retirees had missing labor income, and alternatively, some workers lacked pension income. To estimate our previously specified retirement model requires imputation of the missing income data. The following briefly illustrates how we overcame this challenge in our analysis.

Labor income was observed for each individual only up to the age prior to the first

Figure 1: Age pattern of probability of remaining in the labor force conditioning on working at age 59

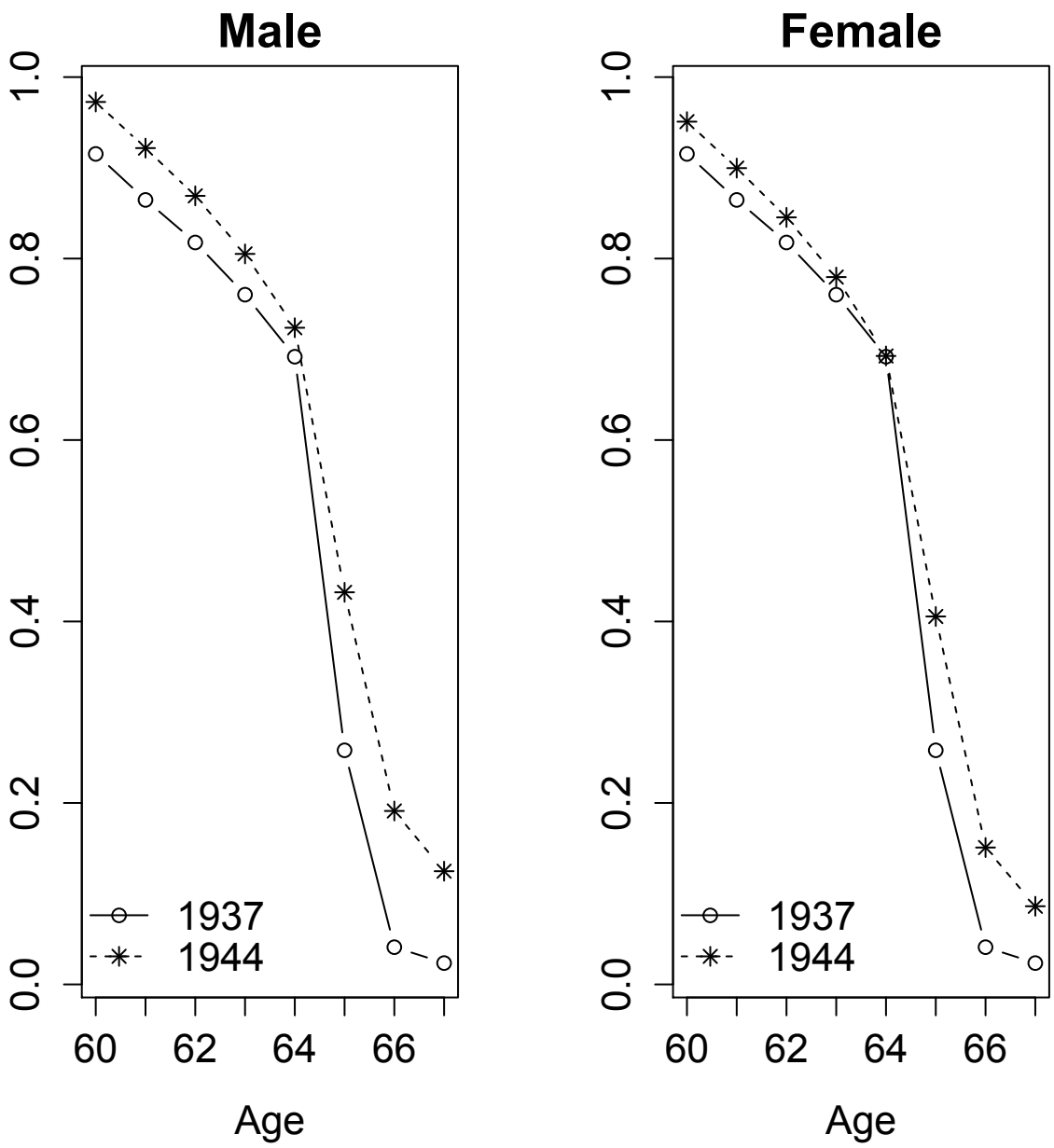
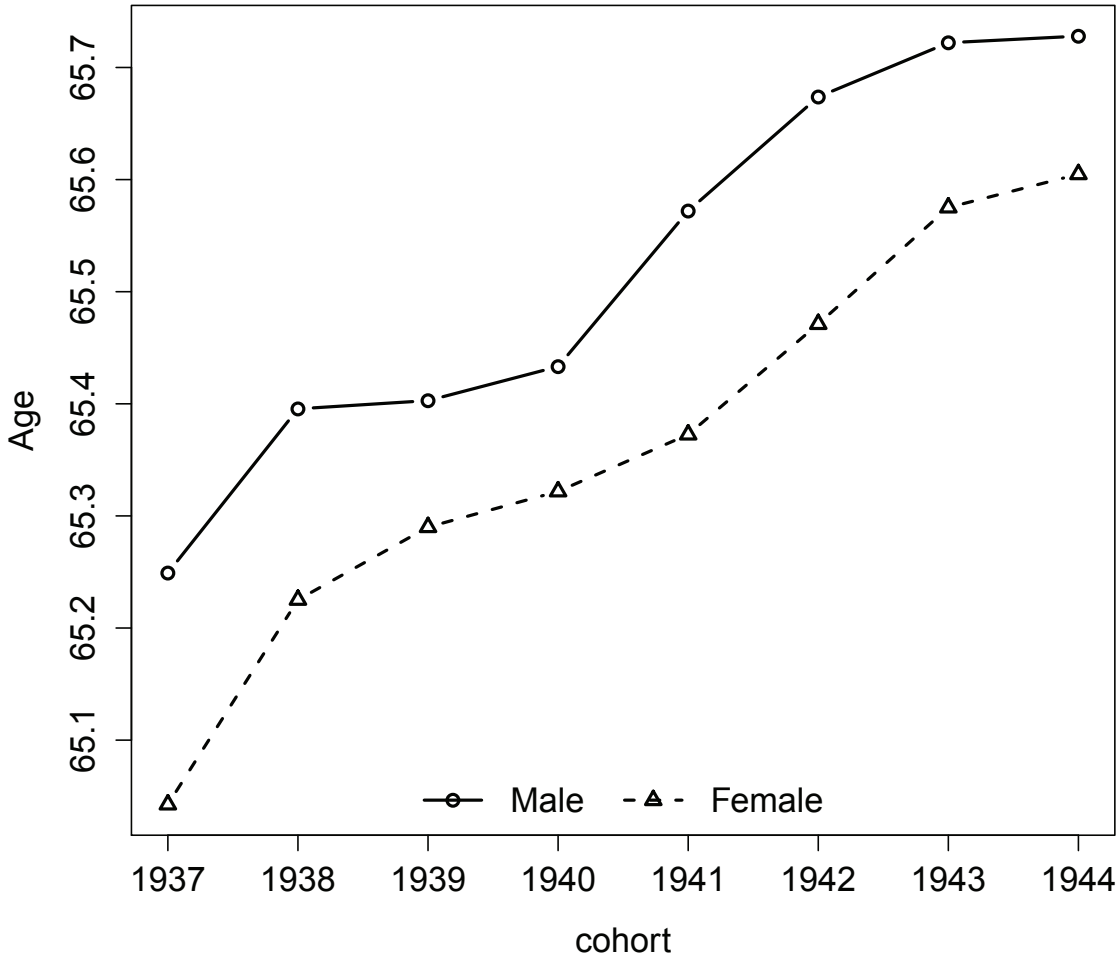


Figure 2: Cohort trends in retirement age conditional on working at age 59



year of retirement, as workers are assumed to receive no labor income upon exiting the labor force. Hence, the missing labor income during the first year of retirement was imputed by the labor income received during the year before retirement. There is no need to impute missing labor income after the first year of retirement, as observed individuals are censored after the retirement event occurred.

As we mentioned in the data section, pension income came mainly from two sources, disability pension and old-age pension. We did not impute the disability pension if it is missing, and simply replaced missing values with zero. The old-age pension (OA) was imputed by a pension forecasting equation, which was estimated by regressing the observed old-age pension benefits on a number of time-varying and time-constant covariates. The implicit specification may be written as:

$$OA_{i,t} = f(t, c, Z_i, S_{i,t}, \theta) \tag{14}$$

where, t is age. c is the dummy indicator for each of the birth cohorts. Z_i is a set of time-constant covariates: sex, education, and country of origin. $S_{i,t}$ is a set of time-varying covariates: marital status, occupation, and accumulated labor income since age 55 ($\sum_{i=55}^{t-1} Y(t)$). θ is a vector of parameters.

We used the estimated coefficients and the observed values of all covariates in equation (14) to predict the expected pension (i.e. $E(OA_{i,t}|t, c, Z_i, S_{i,t}, \theta)$). The counter-factual pension was predicted by imposing the cohort variable equal to 1937 (i.e. $E(OA_{i,t}|t, c = 1937, Z_i, S_{i,t}, \theta)$). This essentially eliminated the cohort difference in benefit accounting in order to generate a counter-factual scenario that the 1994 pension reform did not take place.

5.2 Estimating Retirement Model

The theoretical retirement model derived previously forms the basis for estimating retirement probabilities. The empirical model corresponding to the theoretical model may be explicitly specified as follows:

$$V_{W,i,t} = \alpha Y_{i,t} + \gamma_W X_{i,t} \tag{15}$$

$$V_{R,i,t} = \beta[E(OA_{i,t}|t, c, Z_i, S_{i,t}, \theta) + DI_{i,t}] + \gamma_R X_{i,t} \tag{16}$$

where, $Y_{i,t}$ is observed labor income (for the first year of retirement, we replace $Y_{i,t} = Y_{i,t-1}$). $E(OA_{i,t}|t, c, Z_i, S_{i,t}, \theta)$ is expected old-age pension income predicted by (14). $DI_{i,t}$ is observed pension income from disability insurance. $X_{i,t}$ is a set of covariates: age, cohort, sex, education, marital status, occupation, and country

of origin.

The retirement model was estimated by logistic regression with maximum likelihood estimation. Given the value functions of working and retiring in (15) and (16), the probability of retiring is therefore:

$$\text{Pr}(R_{i,t}) = \frac{\exp(V_{R,i,t} - V_{W,i,t})}{1 + \exp(V_{R,i,t} - V_{W,i,t})} \tag{17}$$

5.3 Predicting Retirement Probability

To evaluate the effects of pension reform on prolonging working life, we predicted the potential retirement outcomes based on our estimated retirement model, given the two scenarios of pension benefits (with and without reform), respectively. The scenario with the reform is essentially the predicted probability given the values of retiring and working determined by all the covariates as observed. Let $\hat{p}$ be such a predicted probability, thus:

$$\begin{aligned}\hat{p}_{i,t} = \text{Pr}\{&R_{i,t}|V_{W,i,t}(Y_{i,t}, X_{i,t}, \alpha, \gamma_W),\\ &V_{R,i,t}(E(OA_{i,t}|t, c, Z_i, S_{i,t}, \theta), DI_{i,t}, X_{i,t}, \beta, \gamma_R)\}\end{aligned} \tag{18}$$

The scenario of without reform is the probability conditional on the values of retiring and working determined by all the covariates as observed except the expected old-age pension benefits. The cohort variable in (16) in this scenario is imposed by $c = 1937$. Doing this allows for estimating what the value of retiring, as well as the retirement probability, would have been had the pension income for all cohorts been calculated based on the pre-reform accounting rule, ATP. Let p^* be such a probability, therefore:

$$\begin{aligned}p^*_{i,t} = \text{Pr}\{&R_{i,t}|V_{W,i,t}(Y_{i,t}, X_{i,t}, \alpha, \gamma_W),\\ &V_{R,i,t}(E(OA_{i,t}|t, c = 1937, Z_i, S_{i,t}, \theta), DI_{i,t}, X_{i,t}, \beta, \gamma_R)\}\end{aligned} \tag{19}$$

To examine the statistical significance of the effects of pension reform on retirement, we also calculated the confidence intervals associated with $\hat{p}_{i,t}$ and $p^*_{i,t}$. These intervals were calculated by:

$$CI_{\text{Pr}(R_{i,t})} = \frac{\exp(\hat{\xi_{V_{i,t}}} \pm 1.96\sigma_{\xi_{V_{i,t}}})}{1 + \exp(\hat{\xi_{V_{i,t}}} \pm 1.96\sigma_{\xi_{V_{i,t}}})} \tag{20}$$

where, $\hat{\xi_{V_{i,t}}} = \hat{V_{R,i,t}} - \hat{V_{W,i,t}}$. $\hat{V_{R,i,t}}$ and $\hat{V_{W,i,t}}$ are the linear prediction of value of re-

tiring and working using (16) and (15), respectively. $\sigma_{\xi_{V_{i,t}}}$ is the standard errors of $\xi_{V_{i,t}}$.

The standard errors of $\xi_{V_{i,t}}$ were estimated by:

$$\sigma_{\xi_{V_{i,t}}} = \sqrt{g'_{i,t}(-H)^{-1}g_{i,t}} \tag{21}$$

where, $g_{i,t}$ is the gradient and H is the Hessian matrix; they were retrieved from the maximum likelihood estimation.

5.4 Calculating Mean Retirement Age

We used the potential retirement probabilities, $\hat{p}$ and p^*, as well as their confidence intervals to calculate the average effective age of labor market exit in the economy with and without the old-age pension reform, respectively. The two mean retirement ages were calculated using the method of dynamic exit age indicator in Vogler-Ludwig and Dull (2008). The derivation is briefly presented as the following. Let $\hat{p}_{i,t}$ be the probability of retiring for an individual at age t, which is predicted by our retirement model, equation (17). The probability of remaining in the labor force at age t is defined as the overall probability of staying in the labor force from some starting age t_0 up to age $t-1$ (Vogler-Ludwig and Dull, 2008). In the present context, we assume $t_0 = 59$, and this probability may be written as:

$$p^s_{i,t} = \prod_{i=59}^{t-1}(1-\hat{p}_{i,t}) \tag{22}$$

The probability of exiting the labor force at age t is then the probability of retiring at age t (i.e. $\hat{p}_{i,t}$), given the overall probability of remaining in the labor force up to age $t-1$ (i.e. $p^s_{i,t}$). The average effective labor market exit age is then computed as the sum of ages weighted by the probability of exiting the labor force. The age range in our case is assumed to be between 59 and 67. Therefore, the average exit age may be explicitly written as:

$$e_i = \sum_{i=59}^{67}\hat{p}_{i,t} \times p^s_{i,t} \times t \tag{23}$$

Equation (23) was applied to calculate the predicted and counter-factual mean exit age with 95% confidence intervals using $\hat{p}_{i,t}$, $p^*_{i,t}$, and the corresponding confidence intervals of the two probabilities. The effect of the gradual phasing in of NDC on prolongation of working life is therefore the difference between the aver-

age retirement age calculated by $\hat{p}_{i,t}$ and $p^*_{i,t}$. More explicitly:

$$dE(e) = E(e|\hat{p}_{i,t}) - E(e|p^*_{i,t}) \tag{24}$$

6 Results

This section reports and discusses our major findings of the analysis. We start by showing the differences in the age profiles of pension income across cohorts, both observed ($OA_{i,t}$) and predicted pension ($E(OA_{i,t}|t, c, Z_i, S_{i,t}, \theta)$) using equation (14). We then show the simulated counter-factual pension income assuming all cohorts belonging to the ATP system, which is computed by imposing $c = 1937$ in (14). More explicitly, the counter-factual pension income is $E(OA_{i,t}|t, c = 1937, Z_i, S_{i,t}, \theta)$. The predicted pension income $E(OA_{i,t}|t, c, Z_i, S_{i,t}, \theta)$ is used for estimating the retirement model, and the coefficient estimates and model fit are illustrated in the later part of this section. Finally, the effects of the pension reform on retirement age are quantified and reported.

6.1 Predicted and Counter-factual Pension

Figure 3 depicts the cohort differences in pension income. All the data on pension benefits were adjusted for inflation to 2011 price levels. The black lines in Figure 3 are the observed and predicted pension incomes for men, and the dark grey lines are for women. The first thing to note is that our pension equation fits the observed age profiles of benefits extremely well. This is not surprising as we controlled for age and cohort dummies, as well as their interaction, in the pension equation.

The second important note is that, within each cohort, gender differences in pension entitlements are considerable, as indicated by the discrepancies between the black and grey lines. However, such discrepancies are much more profound within the 1937 cohort than all younger ones. This is mainly due to the differences in the benefit accounting between the ATP and NDC system. The 1937 cohort was the last birth cohort who fully belonged to the ATP system, thus the best-15-year rule applied to calculate their full benefits. As we mentioned earlier, the 15-best-year rule generated significant redistribution from low- to high-income earners and from women to men, because the peak of the life-cycle earning profile is higher for men and high-income earners. Therefore, the benefit differences are the greatest for the 1937 cohort in Figure 3. As the younger cohorts became more attached to the NDC system, such gender differences diminished.

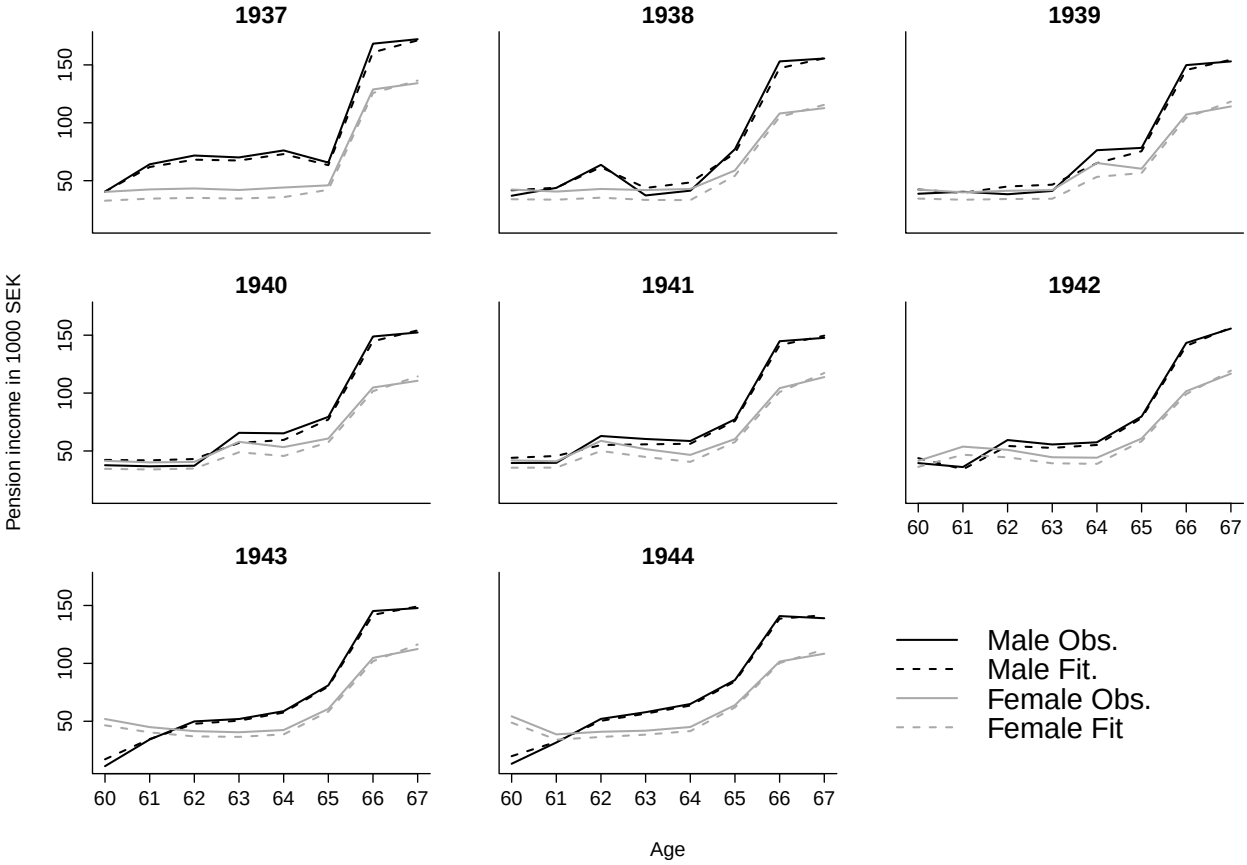
The third noteworthy feature in Figure 3 is that the benefits between age 60 and 65 were nearly flat for the 1937 cohort who belonged to the ATP system, but became a steeper increasing function of age for later born, particularly among the last two birth cohorts, whose benefits were 45% and 50% derived from NDC, respectively. This is in line with Laun and Wallenius (2015) who argued that the pension benefits over age were very flat in the old system, but increased much more steeply as a function of age in the new system. The steep growth curve of pension income for younger cohorts is also associated with the divisor in benefit accounting in NDC.

As we stressed earlier, one important feature distinguishing NDC from ATP is the divisor to calculate the annuity. The divisor is a function of remaining life expectancy which is determined by age and cohort, not by gender and previous earning history. This divisor, however, implies benefit reduction for those who participated in the NDC system (for those born in 1938 or later). As long as life expectancy increases, the younger generation will receive ever decreasing monthly pension benefits since the divisor is an increasing function of remaining years of living (Hagen, 2013). This is particularly important for retirement income between ages 60 and 64, since from age 65 workers will be able to claim guaranteed pension, which can potentially top up monthly pension benefits. Therefore, the growth curves in pension income between age 60 and 65 for the two youngest cohorts are much steeper than for their older counterparts.

Figure 4 shows the difference between the predicted and counter-factual pension incomes. For the counter-factual, shown by the dash lines in Figure 4, it is assumed that all later born cohorts expected to receive the same benefit level as the 1937 cohort. That is every one received 100% ATP pension, and thus the benefits over age would be flat compared to the NDC pension. The difference between the dash lines and the solid lines reflects the amount of pension reduction due to the 1994 pension reform.

Two features are worth noting in Figure 4. First, the reform resulted in much greater benefit reduction for men than women, as the difference between the dash and solid lines is larger for men. In fact, over age 60-65, women gained somewhat in benefits from the reform. Such differences in benefit reduction reflect the difference between ATP and NDC in benefit accounting. As discussed earlier, the best-15-year rule in ATP generated the redistribution from women to men, whereas NDC mitigated such unequal redistribution. The consequence is, as shown in Figure 4, that men lost more in pension entitlements than women over the reform. This is because NDC reversed the redistribution flow from low- to high-income earners compared to the old system.

Figure 3: Observed and predicted pension income in 1000 SEK



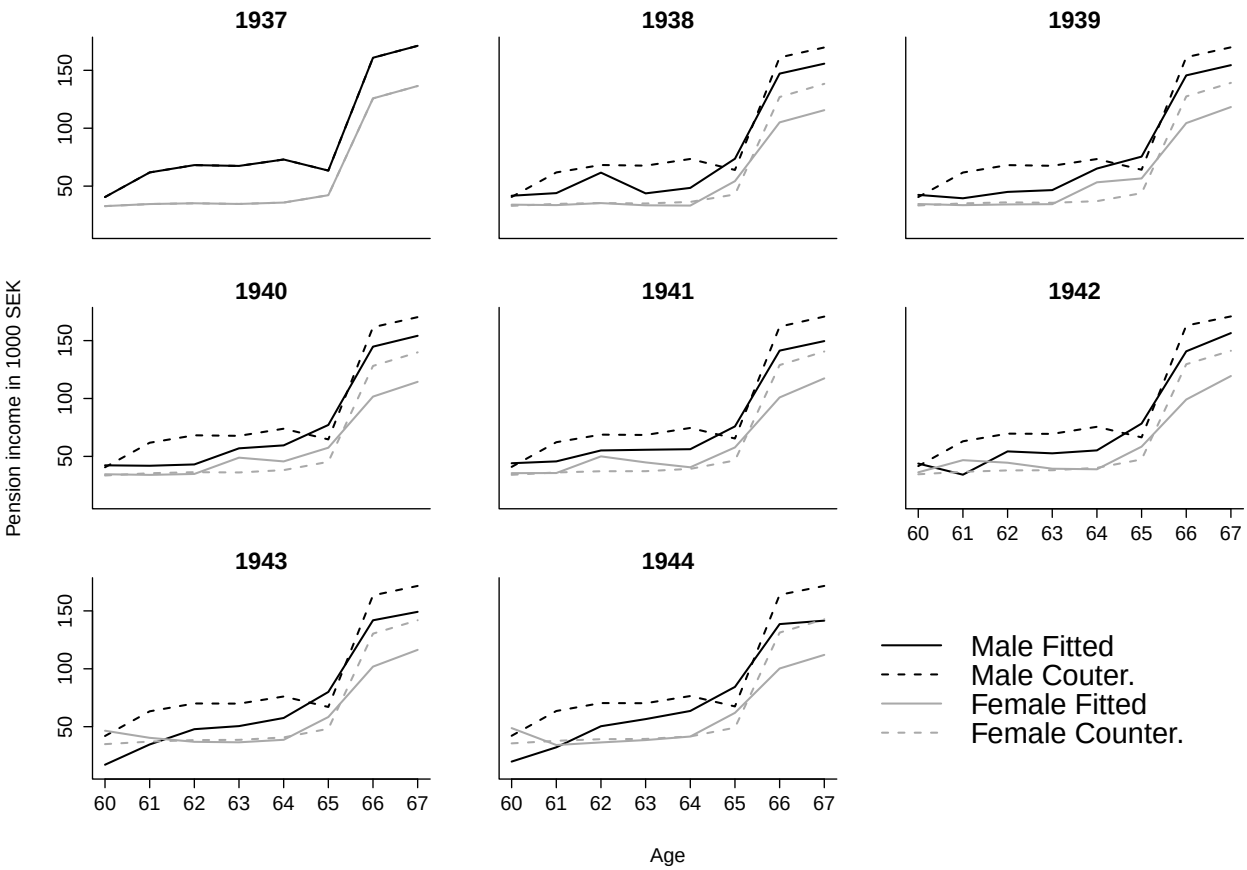
Note: observed is the mean of $OA_{i,t}$, and predicted is the mean of $E(OA_{i,t}|t, c, Z_i, S_{i,t}, \theta)$

The second important note from Figure 4 is that the benefit reduction for men, depicted by the black dash and solid lines, implies that for those more attached to NDC, were they to have retired at the same age under the ATP system, the implied pension income would have been much lower, a finding in line with the argument in Laun and Wallenius (2015).

6.2 Retirement Model Estimates

We estimated the retirement model by alternative-specific logistic regression. The estimation is a two-step process. In the first step, we only included individual-specific covariates, the $X_{i,t}$ in (15) and (16). Therefore, the model is a reduced form estimation of retirement probabilities, which can be estimated by standard logistic regression. This model is similar to the one in another contribution to work package 3 by Divenyi and Kezdi (2015), who estimated a reduced-form equation to examine the life-course factors for retirement hazard across 13 European

Figure 4: Predicted and counter-factual pension income in 1000 SEK



Note: Predicted is the mean of $E(OA_{i,t}|t, c, Z_i, S_{i,t}, \theta)$, and counter-factual is the mean of $E(OA_{i,t}|t, c = 1937, Z_i, S_{i,t}, \theta)$

countries.

We added pecuniary variables, both labor and pension, into the model in the second step. That is the model specification as shown in (15) and (16), which is also comparable with the behavioral model estimated by Patxot et al. (2015) in their study on the effects of Spanish pension reform on retirement decisions. The labor and pension income coefficients correspond to α and β, respectively. They represent the pecuniary value change with respect to the change in each unit of labor income while working and in each unit of pension benefits while retiring. For example, the coefficients reported in the third and fourth columns in Table 1 can be interpreted as an increase in 100,000 SEK from labor income would increase the pecuniary value of working by 1.3 SEK for men and 2.2 SEK for women. The same amount increase in pension income would raise the value of retiring by 3.9 and 4.3 SEK for men and women, respectively.

By taking the ratio of the two coefficients, as shown in (13), we get the estimate of the marginal rate of substitution between labor and pension income. The implied marginal rate of substitution by α and β is 0.33 for men and 0.51 for women. This means that men would choose to retire if their pension entitlement exceeded 33% of the expected labor income, while the respective figure for women was 51%. In other words, men were willing to forego 18% more labor income than women to exit the labor market.

All the coefficient estimates for the individual-specific covariates, X in (15) and (16), may be interpreted as the relative non-pecuniary value of retirement to working. It is noteworthy that the estimates of the individual-specific covariates in the reduced-form estimation (the first and second columns) are substantially different than in the model with income variables (the third and fourth columns), in terms of the direction and/or the magnitude of the coefficients. For example, highly educated workers have substantially lower relative value of retiring to working, compared to those with secondary and primary education, in the reduced-form model. This relationship, however, was reversed in the model that controls for labor and pension income, whereby workers with university or higher degrees were more prone to retirement than those who only attained secondary and primary education. Low-skilled service and manual workers tended to be more likely to retire than high-skilled management and white-collar workers in the reduced form, whereas this relation was reversed for women when pecuniary values were taken into account. Women with low-skilled occupations became more reluctant to retire than high-skilled workers. The only individual-specific covariate whose sign was persistently in line with expectations across models are marital status, and number of hospital admissions during the previous year.

Discrepancies in coefficients between the reduced-form and income model estimates, particularly for education and occupation, highlight the difference between this study and Glans (2008). We distinguished between pecuniary and non-pecuniary values of retirement. The socio-economic differences in retirement probabilities estimated by reduced form models do not necessarily reflect the differences in pure preferences for work and retirement, the preference that is independent of financial incentives. For instance, many studies have documented that the highly educated are less likely to retire than those with lower education levels. Our results provide new insights, showing that these educational differences are not necessarily due to the differences in pure preferences, but rather driven by differences in pecuniary values of retirement. This lends support to some theoretical reasoning for why higher-educated retire later. For example, educated people work more years because their skill premium might result in higher pay (Maestas and Zissimopoulos, 2010; Peracchi and Welch, 1994). Such a premium may, in turn, increase the opportunity cost of retirement, and therefore retain older workers in the labor force. The highly educated may also start their career later than the lesser-educated, and thus more working years may compensate the loss of pension entitlements due to years spent in education (McDaniel, 2003). Thus the main conclusion from our regression results is that the decision to retire was mostly being driven by money, the pecuniary value of prolonging working life.

A final note relating to Table 1 regards the explanatory power of the variation in income to the variation in retirement probabilities. As both the McFadden R-square and the log-likelihood values indicate, the income model fits the data much better than the reduced-form model.

6.3 Model Fit

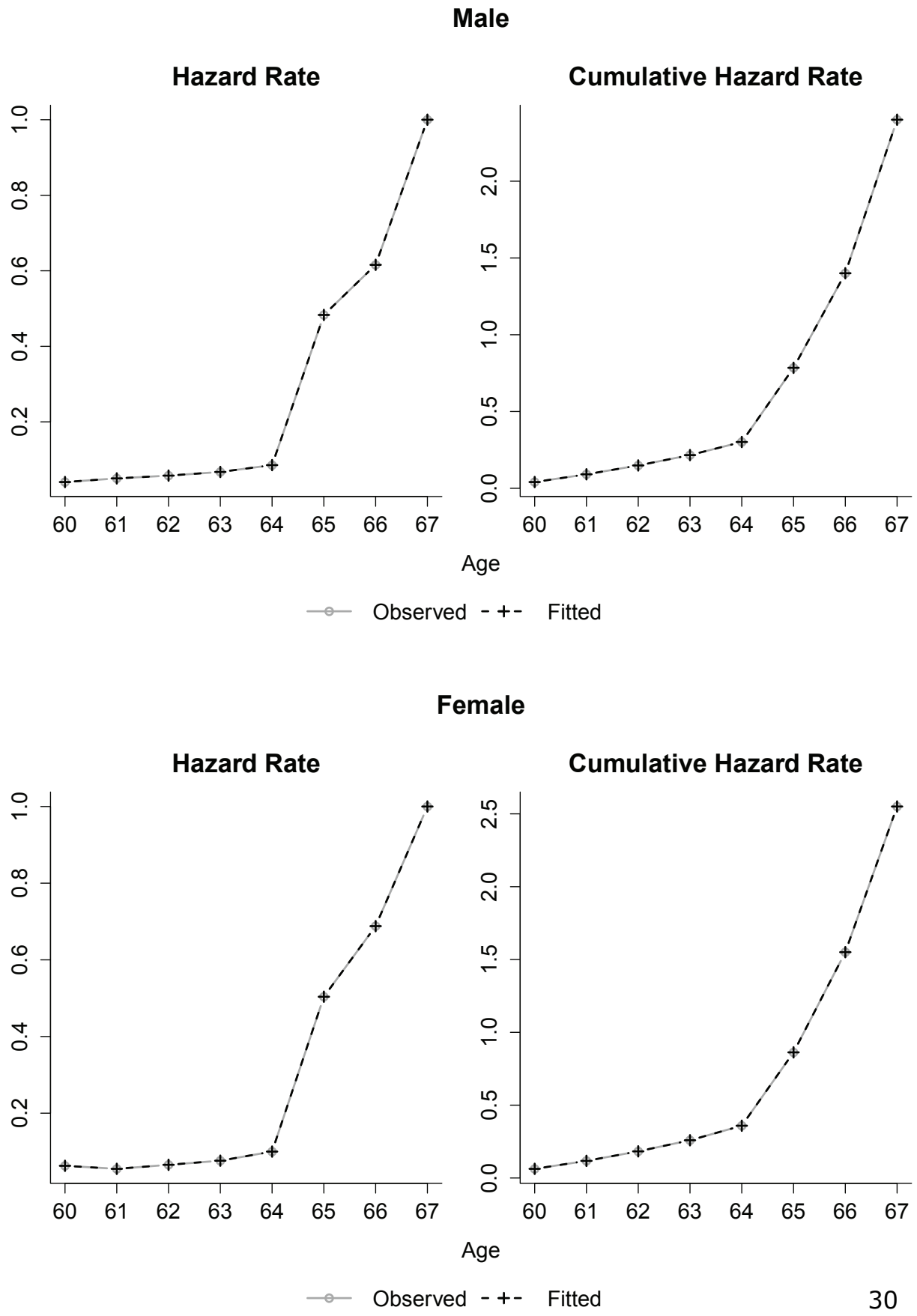
As we stressed earlier, our main purpose in this paper is to evaluate the effects of the 1994 pension reform on labor market exits. This requires comparing the retirement patterns conditional on the pension income as it was observed and on the counterfactual pension income if ATP was not phased out by NDC. For this, the model fit of the retirement probabilities is extremely important, as the valid comparison relies on good replication of the retirement patterns by the model we specified. Figure 5 presents the observed and the predicted retirement hazard based on the model estimates in the third and fourth columns in Table 1. The Figure suggests that the model fits the observed age pattern of retirement hazard extremely well for both men and women. Such good fit is mainly due to the control for age dummies.

Table 1: Model Estimates for Equation (17) by Logistic Regression

	Choice: Retire			
VARIABLES	Men	Women	Men	Women
Constant	-2.717***	-2.907***	-1.762***	-2.359***
Labor			0.000013***	0.000022***
Pension			0.000039***	0.000043***
Primary		Reference		
Secondary	-0.019***	-0.049***	-0.064***	0.012
University+	-0.341***	-0.338***	0.011	0.055***
Managerial		Reference		
Service	0.217***	0.099***	0.209***	-0.115***
Manual	0.196***	0.333***	0.162***	-0.043***
Marital	-0.095***	0.026***	-0.253***	0.564***
0 Hosp		Reference		
1 Hosp	0.282***	0.321***	0.110***	0.102***
2 Hosp	0.644***	0.810***	0.402***	0.354***
Age	yes	yes	yes	yes
Cohort	yes	yes	yes	yes
Age-cohort	yes	yes	yes	yes
Country of Origin	yes	yes	yes	yes
Observations	1,781,701	1,661,793	1,781,701	1,661,793
R2	0.275	0.269	0.540	0.575
Log Likelihood	-561,960	-552,564	-356,571	-321,700

Significance: *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Figure 5: Observed and predicted retirement hazard



6.4 The Effects of NDC on Retirement Hazard

Figure 6 compares the predicted hazard and cumulative hazard rates of retirement (shown by the black solid line) with the counter-factual assuming there were no cohort differences in pension benefit accounting (shown by the dark grey solid line). The dash lines along with the solid lines are 95% confidence intervals.

The difference between the dark grey line and the black line in Figure 6 reflects the effects of phasing out the ATP by NDC in the 1994 pension reform on the retirement hazard. The most important feature in Figure 6 is that the reform effect was stronger for men than women. In particular, the switch from ATP to NDC gave no difference in retirement hazard rates for women aged 60-64, but a statistically significant difference for men. The reform lowered the retirement hazard rate at age 66 for both sexes.

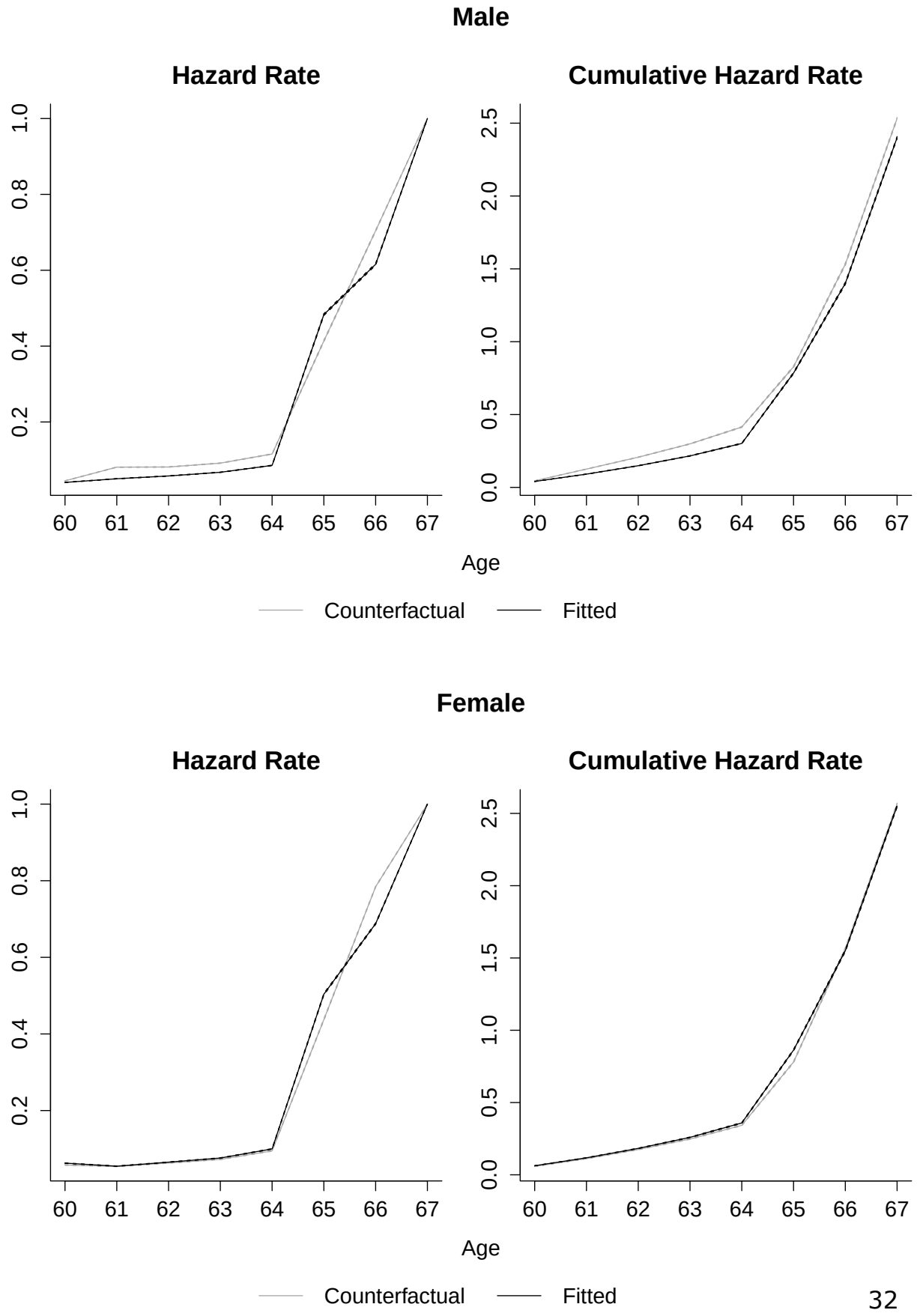
The overall effect of the reform on the retirement hazard between ages 60-67 is more clearly revealed by the cumulative hazard rate, on the right hand side panels in Figure 6. The counter-factual cumulative hazard rate of retirement is constantly higher than the predicted rate for men, while essentially no difference exists for women. Most importantly, the effects on male retirement risk are statistically significant at 95% confidence level, as the confidence bands barely overlap one other.

The reason for such differences between men and women is straightforward. As we already illustrated in Figure 4, there were profound benefit reductions for men due to switching from ATP to NDC, but slight gains for women, at least between ages 60-65. This, as one might expect, may translate into disproportional effects on the retirement behavior between men and women. As it clearly stands out in the left panel of Figure 6, the effect was more or less equally distributed between men and women aged 65-67, whereas it was unevenly distributed prior to age 65.

6.5 The Effect of NDC on Retirement Age

We calculated the mean effective labor market exit age using (23) as a summary of the age-specific retirement rates shown in Figure 6. We did this for each of the cohorts and calculated the exit age with 95% confidence intervals associated with the predicted and counterfactual retirement probabilities, $\hat{p}$ and p^*, respectively. The effect of pension reform on retirement age is the difference between the mean age at labor market exit implied by the predicted and counterfactual retirement probabilities, as per equation (24). Figure 7 illustrates the difference

Figure 6: Predicted and counterfactual retirement hazard



in average retirement age between the actual and the counterfactual scenarios. The solid line represents the retirement age implied by the predicted probabilities ($\hat{p}$) and the dash line represents the retirement age implied by the counterfactual probabilities (p^*).

The retirement age for men and women exhibits an upward cohort trend in Figure 2, as was the case in Karlsson and Olsson (2012); however, the underlying causes appear to be different between sexes in Figure 7. For men, the growth in labor market exit age across cohorts seems largely driven by the 1994 pension reform, as the difference between the predicted solid line and the counterfactual dash line is large. The difference also increases over cohorts, which makes intuitive sense because NDC was gradually phased in across these transitional cohorts. As discussed earlier, the transition from ATP to NDC was implemented over 16 years. The first recipients from NDC were those born in 1938, one-fifth of whose pension was calculated based on the NDC rule, and four-fifths based on the ATP rule. The NDC part, as a share of the total income-related benefit from the public old-age pension, increased by 5 percent for each successive cohort up to those born in 1953. Hence, as we can see from the upper panel in Figure 7, the effects of the reform on the retirement age was greater for younger cohorts because they were more attached to the NDC pension system, which created stronger incentives to work longer. For example, the mean labor market exit age for the 1944 cohort was 65.73, while it would have been 65.52 if they fully belonged to ATP. This implies that, for this particular cohort, their working lives were prolonged by 0.2 years (or equivalently 2.4 months) on average solely due to the pension reform.

For women, however, the reform effect on the retirement age was much less profound than for men. Taking the youngest female cohort as an example, the mean retirement age was 65.6, while the counterfactual exit age is 65.55. That means the effect of the reform on the retirement age for women born in 1944 was merely 0.05 years, or 0.6 month. In fact, the positive effect of the reform emerged only among those born in 1942 and later. For earlier born cohorts, the reform actually exerted a negative effect on the mean retirement age, and such an adverse impact was statistically significant for the 1939 and 1940 cohorts. However, this negative effect might not be unexpected. As shown in Figure 4, the expected pension benefits for women born in 1939 and 1940 prior to age 65 were substantially higher than the counter-factual benefits, which accordingly elevated the value of retirement relative to work, as well as the probability of retiring. As a result, the average age at retirement was lower than it otherwise would have been had the reform not occurred.

In general, the small and opposite effect of reform on female mean retirement age suggests that the upward cohort trend may have been driven by other factors which are independent of economic incentives. In other words, women's average labor market exit age would have been increasing anyway even though the reform was not in place. For men, however, the increasing mean retirement age across cohorts was largely due to the changing financial incentives mediated by the gradual phasing in of NDC.

6.6 The Effect of NDC on the "New Labor Market"

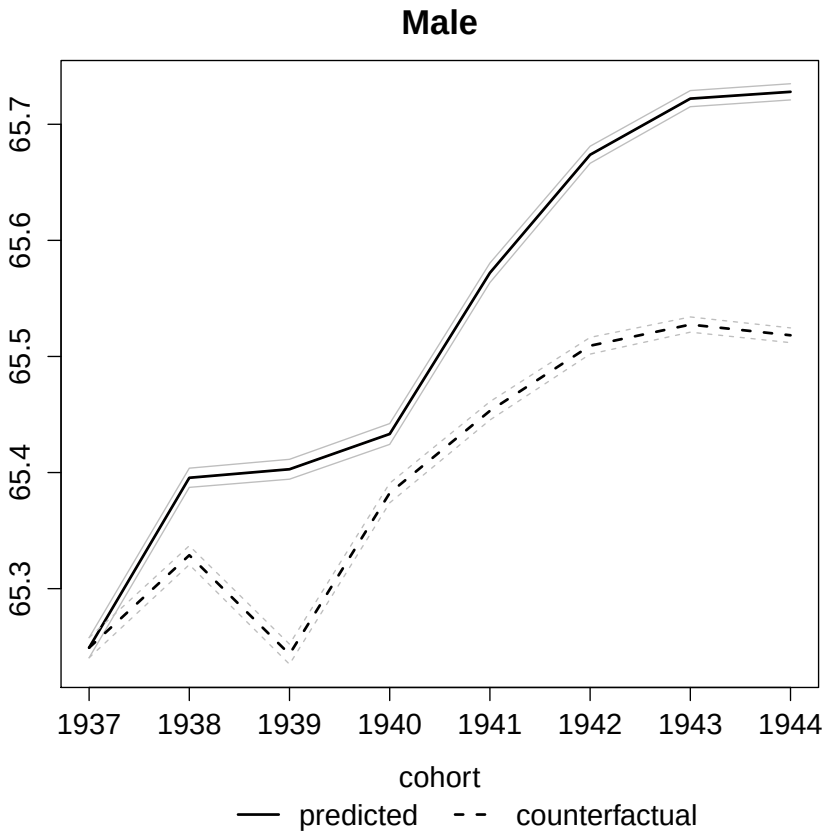
To date, we have presented our results in terms of the average impact of the 1994 pension reform on retirement age. The effects of policy change on potentially vulnerable groups (the so-called "new labor market") are currently of great interest to researchers and policy makers. To contribute to this discussion, we decompose the average impact of the reform by education and occupation, and address the question of whether various socio-economic groups responded differently to the gradual phasing in of NDC.

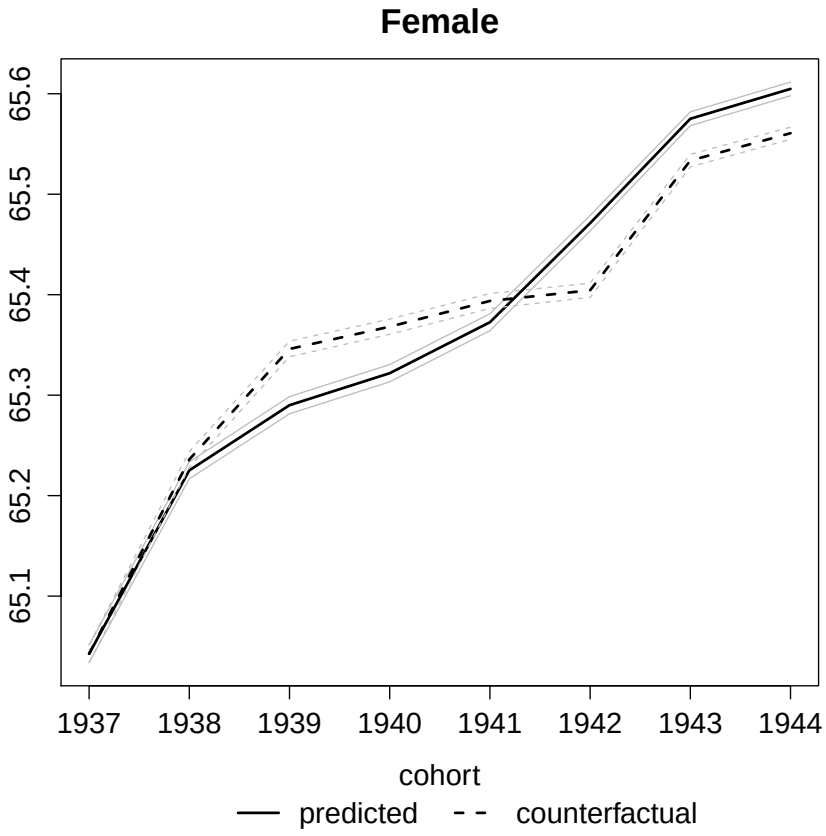
Figure 8 illustrates the effect of the pension reform on the retirement age by educational attainment. The first insight from Figure 8 is that those with a university or higher degree retired at higher ages than those who only finished primary and secondary education. As shown by the predicted cohort trend in retirement age (the solid lines), the average labor market exit age for workers with university+ education was higher than with primary and secondary education, for both genders.

The second insight from Figure 8 is that the cohort trend was largely explained by the gradual phasing in of NDC for men, as the difference between the predicted and counterfactual retirement age (the solid vs. dash lines) is profound. This difference persists across all educational groups, meaning that the pension reform created incentives for working more years to more or less the same extent, among all male workers, regardless of educational attainment.

However, the overall reform effect appears much more moderate among women, as the differences between the solid and the dash lines are smaller in the lower panel than the upper panel of Figure 8. As just discussed for the cohort trend illustrated in Figure 7, the reform did not exert any significant effect on retirement age until the 1942 cohort for women. This appears to be true across all the three educational groups. However, the incentives for late retirement were stronger among those with university+ than with primary and secondary education, as the difference between the predicted and counter-factual mean retirement age is lar-

Figure 7: Effect of NDC on Average Labor Market Exit Age over Cohorts





ger for the highest educated, compared to the other education groups among those born in 1942 and later.

Figure 9 distinguishes the reform effects on the retirement age by high- and low-skilled occupation. The picture is similar to the educational differences shown in Figure 8. Male workers were more responsive to the gradual phasing in of NDC than female workers. Among women, high-skilled management and white-collar workers were incentivized the most by the reform across all three occupational groups.

The last, but not least, note from Figures 8 and 9 is that the negative effect of the reform on retirement age for women, as shown in the lower panel of Figure 7, was mainly driven by female workers with primary and secondary education, and with low-skilled occupations. This finding helps us to identify the new labor market effects of the policy amendments with greater precision. There are two explanations for such different responses to the reform among the vulnerable population. First, as discussed earlier, NDC reversed the redistribution of income from low- to high-income earners, which originally existed in ATP. This, in turn, increased the benefits for those low-income earners who were less educated and worked in low-skill occupations. As a result, the reform actually elevated their value and probability of retiring, and reduced their mean retirement age. The second reason might arise from the demand side of the labor market. It might be that the lesser-educated and low-skilled had limited opportunities to prolong their working lives, and therefore responded unexpectedly to the pension reform. However, the second explanation is speculative as our model was not designed for examining any demand-side impact on retirement age.

7 Conclusion

Sweden has witnessed an increase in the average age at labor market exit for more than a decade. Many have attributed this increase to the government's efforts in reforming disability insurance (DI) over the 1990s (Karlström et al., 2008; Johansson et al., 2014). Our aim in this paper is to complement the relatively scarce literature on the effects of the 1994 general old-age public pension reform on retirement age.

The only previous study examining this reform effect conducted reduced-form survival analysis on time to retirement. Our analysis, by incorporating financial incentives, distinguished between pecuniary and non-pecuniary values of retirement. Such a distinction is of great importance for evaluating the impact of policy amendments, because government interventions aimed at promoting longer work-

Figure 8: Effect of NDC on Average Labor Market Exit Age by Educational Attainment

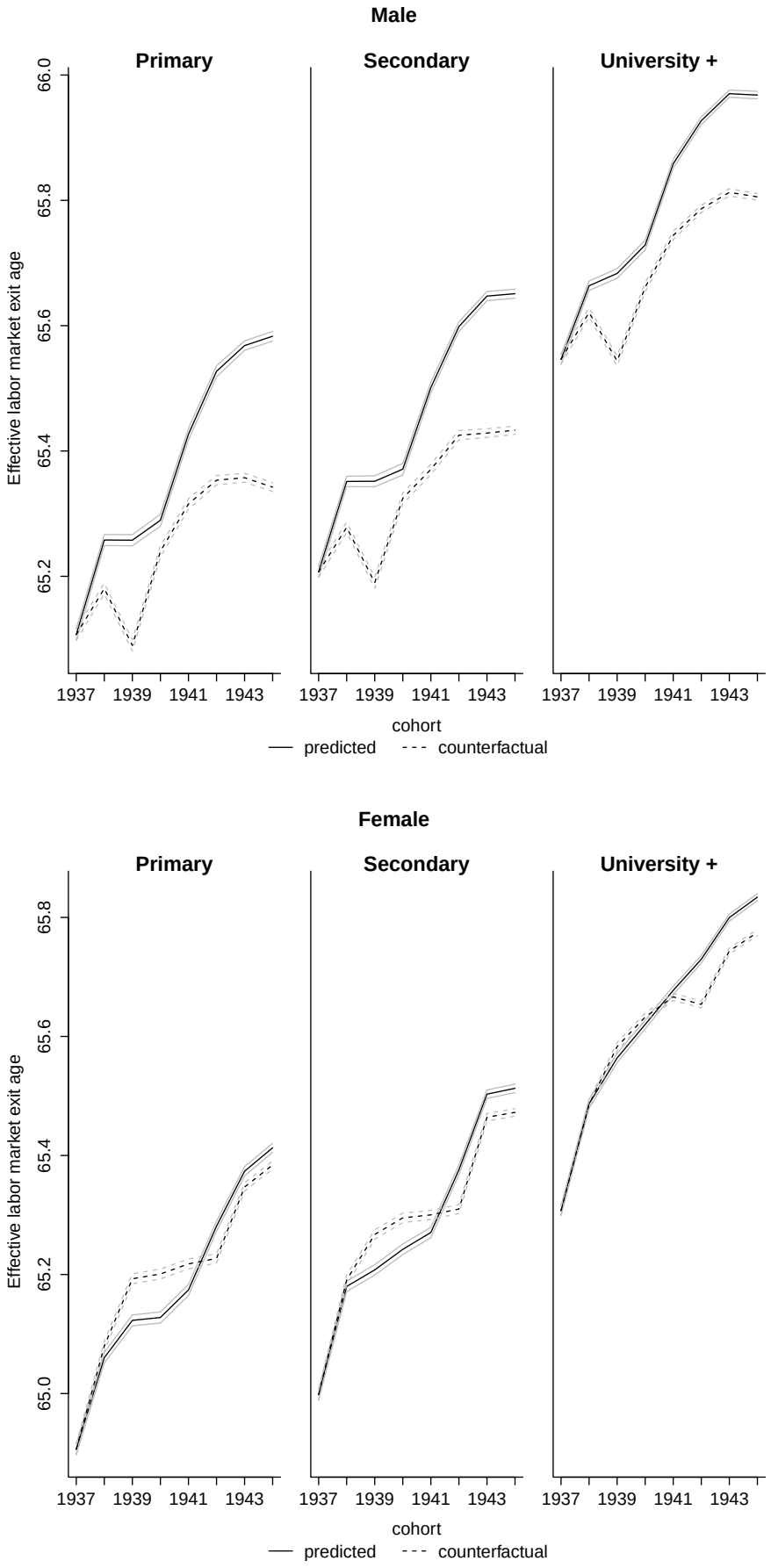


Figure 9: Effect of NDC on Average Labor Market Exit Age by Occupation

ing lives can only be accomplished by altering workers' pecuniary value of retirement by adjusting their budget constraints. Non-pecuniary values, such as pure preferences for work and retirement, are hardly influenced by policy. The central question is, therefore, whether the observed increase in retirement age is a result of the gradual phasing in of the NDC pension scheme introduced by the 1994 pension reform.

The 1994 reform imposed a substantial benefit reduction for older male workers, but to a much less extent for female workers, at least among those aged 60-65. This is because of the difference in benefit accounting rules between the pre-reform and post-reform pension schemes. The NDC system replaced the best-15-year rule in the old ATP system by lifetime earnings history as an accounting method for calculating the monthly pension income, which reversed the redistribution flow from low- to high-income earners, as well as from women to men in the old system.

Our alternative-specific logistic regression estimates showed that men were willing to forego more labor income than women in order to retire. This implies that the opportunity cost for men to receive pension while not working was greater, as men's potential labor earnings were higher. Our regression analysis further showed that the pure preference on retirement, independent of pension income, was very different than what one might expect from reduced-form estimations. In particular, we found highly educated and high-skilled female workers were more willing to retire after controlling for financial incentives.

Using information on the benefit difference between the NDC and ATP pension schemes, as well as the estimated pure preference and financial incentives for retirement, we examined the effects of the 1994 pension reform on retirement age. Our main finding is that older male workers were more responsive to the policy amendment than female. The mean exit age from the labor market for the 1944 cohort (the most affected group by the reform in our study sample) increased by 2.4 months as a result of the phased in NDC pension system. However, for women who born in 1944, the effect of the reform on the average retirement age was merely 0.6 months. In other words, women's observed retirement age across cohorts increased regardless of the switch from ATP to NDC.

Finally, our analysis also showed socio-economic differences in response to the gradual phasing in of NDC. The responsiveness to the reform was large for men regardless of their educational attainment and their occupational skill level. For women, however, the response to the pension reform was only statistically significant among those born in 1942 or later. In addition, the effects on the mean re-

tirement age were greatest among those with a university or higher degree, and who worked in a high-skilled occupation, while negative effects emerged among women who were less educated and skilled.

Acknowledgments

We are grateful to Anna Amilon, Kerstin Enflo, Alexia Fürnkranz-Prskawetz, Jan Lanke, and Jeff Neilson for their helpful comments.

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Analysis of long term life course factors affecting retirement decisions, using administrative data

B: Old-age Employment in Sweden: the Reversing Cohort Trend

Authors: Haodong Qi, Haodong.Qi@ekh.lu.se;
Tommy Bengtsson, Tommy.Bengtsson@ekh.lu.se;
Jonas Helgertz, Jonas.Helgertz@ekh.lu.se

Funded by the Seventh Framework Programme
of the European Union

Contents

Abstract

Sweden, like many OECD countries, has witnessed a reversal of old-age labor supply, from a trend toward early retirement to a steady increase in the age at labor market exit. This change is widely believed to be a consequence of pension reforms in the 1990s, which increased the stringency of eligibility for disability insurance, while providing financial incentives for postponing retirement. Previous literature on this topic has paid little attention to the possible impact of population compositional change on the reversing old-age labor supply. This paper examines the role of the variation in population characteristics on the changing old-age employment over time. Decomposition analyses show that population structural change explains little of the reversed old-age labor supply trend among men, but one fourth among women, due mainly to the variation in the share of educated female workers.

1 Introduction

The effective labor market exit age declined across most OECD countries for several decades until the early 2000s, before gradually increasing thereafter (OECD, 2013). Some empirical studies have shown that this type of trend reversal might be a result of policy interventions, such as raising statutory retirement age, restricting early retirement schemes, and/or embedding stronger economic incentives in the pension system to delay retirement (Buchholz et al., 2013; Komp et al., 2010).

Sweden, like other OECD nations, experienced a reversal in old-age labor supply, from a trend towards early retirement to a steady growth in the number of active workers aged 60+. This reversal, however, occurred earlier than in other OECD countries. The average exit age for men dropped from around 66 in 1970 to 62 in 1994, and then gradually increased to approximately 64 in 2011, while for women, it gradually increased from roughly 61 in 1980 to 63 in 2011 (Karlsson and Olsson, 2012). Is this increase, at least since the mid-1990s in Sweden for both men and women, a result of policy amendments, particularly the public pension reform in 1994? This is an important question because how older workers respond to such policy changes has implications for future labor supply in an ageing economy; a better understanding of such implications are necessary for assessing the long-term welfare consequences of demographic deficits driven by the process of population ageing.

The relationship between pension and retirement behavior has been extensively investigated in economic literature. One of the most common research findings is that retirement age strongly corresponds to the pension age at which benefits are available, and thus the most important cause of the spiking retirement rate at age 65 is economic incentives embedded in the social security system (Berkovec and Stern, 1991; Gruber and Wise, 1999, 2004; Heyma, 2004; Johansson et al., 2014; Karlstrom et al., 2004; Lumsdaine et al., 1992; Stock and Wise, 1990). If this causal relation holds, one might argue that the rising mean retirement age in Sweden, as well as in many other OECD nations, might be a result of pension reforms that generally create financial incentives for working longer.

Previous literature also shows important social, economic, and demographic gradients on retirement outcome. For example, the importance of education, health, occupation, marital status, and gender on labor market departure rates has been documented by Börsch-Supan et al. (2009); Buchholz et al. (2013); Glans (2008); Klevmarken (2010); Komp et al. (2010); Larsen and Pedersen (2013); Stenberg and Westerlund (2013). These life-course factors for retirement decisions were

also examined by Patxot et al. (2015) based on Spanish Social Security Administrative Data (Muestra Continua de Vidas Laborales), as well as by Divenyi and Kezdi (2015) using retrospective life history data from 13 European countries (SHARELIFE). This body of work implies that a possible explanation for the changing retirement age may arise from variation in population composition over time, such as the changes in the share of population completed tertiary education. For example, the aged 60+ population today may be on average healthier, more educated, and/or better skilled than the same-aged cohorts from previous decades, which, given that healthy, educated, and/or skilled workers are more likely to prolong working life, may also lead to increases in the mean retirement age.

This mechanism, however, has been seldom investigated in retirement literature, and therefore motivates the present paper, which examines the importance of population compositional change on later-life employment dynamics. More explicitly, this study decomposes the reversing trend in old-age labor supply into two types of effects; population structural change, and a residual that captures the effects of pension policy amendments, as well as changes in behavior, culture, social norms, and/or labor demand. We are particularly interested in whether developments in education, immigration, and/or health are important in this regard. Our analysis relies on data from the Swedish Interdisciplinary Panel (SIP), which covers the entire population born between 1930 and 1980, and living in Sweden sometime during the time period 1968-2013.

2 Research Background

2.1 Population Ageing and Its Consequences

Population ageing has been an ongoing process in Sweden over the past century, with the share of the elderly (age 65+) more than doubling during the period between 1900-2000. Conventional wisdom on the causes of population ageing are changing demograhic conditions, such as declining mortality and fertility, as formulated by stable population theory (Preston et al., 1989, 2001). While the net effect of fertility decline is clear, that of mortality decline is ambiguous on population ageing; whether it exerts a positive or negative impact depends on changes in the life-cycle survival schedule (the individual ageing effect) and the initial level of mortality (Lee, 1994).

The initial mortality decline in Sweden occurred around mid-19th century, and actually made the population grow younger as the individual ageing effect was outweighed by the rate of population growth effect. Hence, the process of popula-

tion ageing in Sweden from the late-nineteenth to the late-twentieth century was mainly driven by the fertility decline (Coale, 1957; Bengtsson and Scott, 2011), a so-called ”first stage of population ageing”. However, human survival, particularly after age 65, has been continuously increasing over the past decades, propelling further increases in life expectancy. This has made the individual ageing effect dominate the rate of growth effect, which in turn shifted the determinants of population ageing from fertility to mortality decline, a so-called ”second stage of population ageing”.

The first stage of population ageing actually exerted a positive effect on economic development and provision of welfare services, as falling fertility, coupled with the reduction in premature death, resulted in a greater number of workers relative to the number of dependants (an increase in the demographic support ratio). This phenomenon is often referred to as ”the first demographic dividend” (Bloom and Canning, 2009; Mason, 2005; Mason and Lee, 2007; United Nations, 2013). The second stage of population ageing, however, will lead to rapid growth in the share of the elderly, and, therefore, a declining support ratio, which may adversely influence the economy and the welfare state. In other words, the ”demographic dividend” first created by population ageing is now or will soon be transformed into a ”demographic deficit”.

One major economic concern which arises from the demographic deficit is the rising per worker cost of transferring per capita resources to a given age vector of non-workers (i.e. children and elderly), assuming working life duration is fixed between ages 20 and 65 (Lee and Edwards, 2001). Transfers may be mediated by public and/or private institutions. In Sweden, these transfers are entirely funded through public channels (Hallberg et al., 2011; Mason and Lee, 2011; United Nations, 2013), raising the question: can the public finance system be sustained at a level that maintains the standards of living given the demographic deficit?

In addition, the life-cycle consumption pattern in Sweden exhibits a strong tilt towards older ages, roughly doubling for those aged 80 to 100, compared to the working-age population. This pattern is in sharp contrast to the classical pattern implied by the life-cycle hypothesis, whereby consumption stays constant throughout the entire life-cycle (Jappelli and Modigliani, 2005). The sharp increase in old-age consumption in Sweden is strikingly similar to the U.S. pattern, and is mainly driven by health expenditures (Lee et al., 2011). However, the financing of such expenditure is fundamentally different; it is predominately reliant on public transfers in Sweden, whereas paid through private spending in the U.S. Similarly, pension provisions will naturally grow when the share of the population reaching retirement age expands. The pension system in Sweden relies entirely on the public

transfer system, placing increased fiscal pressure on Swedish public finances in light of demographic deficits.

2.2 Policy Options for Tackling Demographic Deficit

The looming demographic deficit may be tackled by policy measures. Cutting benefits is one approach, which may however lead to welfare loss. This approach simply shifts responsibility from the public to the private sector, and therefore in no way addresses the problem of demographic deficits. Cutting benefits may also deteriorate overall economic efficiency, as some welfare services are shifted to households forcing family members to leave the labor market. Issuing national debt might be an alternative solution; however, this measure tends to be repaid by future generations, and thus raises the issue of inter-generational equity. Public debt might also crowd out private capital, which could erode productive investment, unless a Ricardian equivalence proposition holds (Barro, 1974). The recent debt crisis felt throughout Europe may create additional obstacles for further debt issuance.

Demographic policies, such as promoting childbearing and migration, might be effective policy measures (Harper, 2014). Rising fertility, however, would take 2-3 decades before newborns age into the labor market and exert a positive effect on the working population, and the number of immigrants needed to offset the declining support ratio will be very large (Bengtsson and Scott, 2011). Additionally, the extent to which immigration might mitigate the demographic deficit further depends on whether foreign workers integrate into the labor market and fill demand. Hence, recent policy discussions put particular emphasis on extending the length of working life, which might be helpful towards expanding the tax base and provide financial support necessary to offset the adverse impact of the demographic deficit.

One of the measures for working life prolongation is to reform the defined benefit pension system. Many governments have committed to such a reform strategy in recent decades, through raising statutory retirement ages, restricting early retirement schemes, and/or creating financial incentives to prolong working life (OECD, 2013). Sweden, without exception, has undergone three major reforms on the pension system during the 1990s. Stringency of eligibility for disability insurance (DI) was raised twice, in 1991 and 1997, respectively (Hagen, 2013). In 1994, the Swedish parliament passed legislation that the former old-age pension system (ATP) would be phased out by a new one - notional defined contribution (NDC).

2.3 Institutions and old-age employment

Although the 1994 pension reform in Sweden was implemented in a specific year, it affected different birth cohorts disproportionally due to some transitional rules embedded in the reform process. Hence, the observed trend reversal in retirement age shall also be visible with a cohort perspective, if the pattern reflects the effect of policy amendments. Indeed, as shown in Figure 1, the cohort pattern of mean effective retirement age follows a downward trend up to the 1937 cohort, and dramatically increased from the 1938 cohort onwards. Some have argued that such a reversal might be attributable to the 1994 pension reform (Glans, 2008; Karlsson and Olsson, 2012). However, it may also be associated with other reforms, such as changes within the disability pension program from the early 1960s to late 1990s.

The disability pension system, since the 1963 reform through the early 1990s, can be considered generous, as it was unrestrictive on eligibility and allowed workers to retire for labor market reasons, which explains the downward trend in labor force participation among older workers during this period (Hagen, 2013). One might argue that the downward trend would be reversed, once disability pension became more restrictive on eligibility and less generous. Indeed, Karlström et al. (2008) have shown that the 1997 DI reform, which abolished the special eligibility rules and prohibited utilizing disability insurance for labor market reasons among those aged 60-64, had a positive impact on older workers' labor force participation rate.

However, Karlström et al. (2008) have also shown that this reform did not instantly increase the de facto employment rate, due to the "communicating vessel effect" (increased utilization of unemployment insurance and sickness benefits). In addition, they argue that the employment effect might take about 2 or 3 years to exert itself, as employees, employers, and unions need time to adjust to the post-reform rules. Unfortunately, the data in their study extended only until 2001, thus further development in old-age employment, as a response to the disability pension reform, remains unclear. Although Karlsson and Olsson (2012) showed that the effective labor market exit age gradually increased up until 2011 since the mid-1990s, it is still difficult to fully attribute such an increase, particularly after 2001, to the disability pension reform, because the 1994 public pension reform was implemented at about the same time.

The major change in the 1994 public pension reform was to replace the Defined-Benefit Pay-As-You-Go system (Allman tillaggspension, hereafter ATP) with the Notional Defined-Contribution Pay-As-You-Go system (hereafter NDC). The former

has been proven to be unsustainable given an ageing population, whereas the latter is designed to ensure long-term solvency of the pension system. The key difference between the two systems is how they calculate benefits. ATP relates individual's pension entitlement to the best-15-year earning history throughout the working life, while NDC takes the entire lifetime labor income into account. The major implication for such a difference is that NDC creates greater incentives for postponing retirement than ATP. The reason is that workers would expect an increase in pension benefits with additional years of gaining labor income under the NDC system, but no such an increase in pension income would be expected under ATP, as the best-15-year earnings usually occur before age 50 (Laun and Wallenius, 2015). In other words, NDC participants would receive proportionally higher benefits if their lifetime earnings were greater (Palmer, 2000).

In addition to the earning history, NDC further incentivizes workers to postpone retirement by introducing the remaining life expectancy as a divisor for calculating monthly entitlements. In practice, this means the pension benefit in NDC is a steep increasing function of age because the life expectancy divisor decreases with age. These two features imply that, compared to retiring at age 65, retiring at 66 will increase monthly pensions by about 9 percent, which increases further to roughly 20 percent if retiring at age 67 (Konberg et al., 2006). The divisor in NDC benefit accounting also implies benefit reduction for future generations if the retirement age remains unchanged. This is because the divisor will be increasingly greater across future generations, as long as the expected years of living continues to increase for younger cohorts (Hagen, 2013).

The phasing in of NDC would be gradually implemented over 16 years, according to the legislation of the 1994 pension reform. All benefits will be completely paid from the NDC system by the year 2040 (Sunden, 2006). The 1938-born cohort was the first to have their pension calculated under both systems, with one-fifth calculated based on new rules, and four-fifths based on the old rules. These proportions changed by 5 percent for each successive cohort up to those born in 1953, meaning that from the 1954 cohort onwards, benefits are accounted by a complete conversion of the accumulated pension credits from the old system into the new system (Konberg et al., 2006; Palmer, 2000; Settergren, 2001). One implication of the gradual phasing in of NDC for those born between 1938 and 1953 is that the later-born cohorts are more attached to the NDC system, and therefore need longer working lives to maintain the same level of pension entitlements. Such financial incentives might also explain the reversal of retirement age as we just described.

Given that the DI and public pension reforms were implemented at roughly the

same time (in 1997 and 1999, respectively), it is difficult to isolate the employment effect of one reform from another, particularly in the post-2001 period. Therefore, we consider reforms which occurred over the last decade of the 20th century as an institutional explanation for the reversal, and examine whether there are other factors which may be more or less important than the reforms. More specifically, we are interested in whether compositional population changes in education, health, and immigrants may be relevant factors for the reversing cohort trend of mean retirement age, as shown in Figure 1. Our motivation for paying particular attention to these three factors follows.

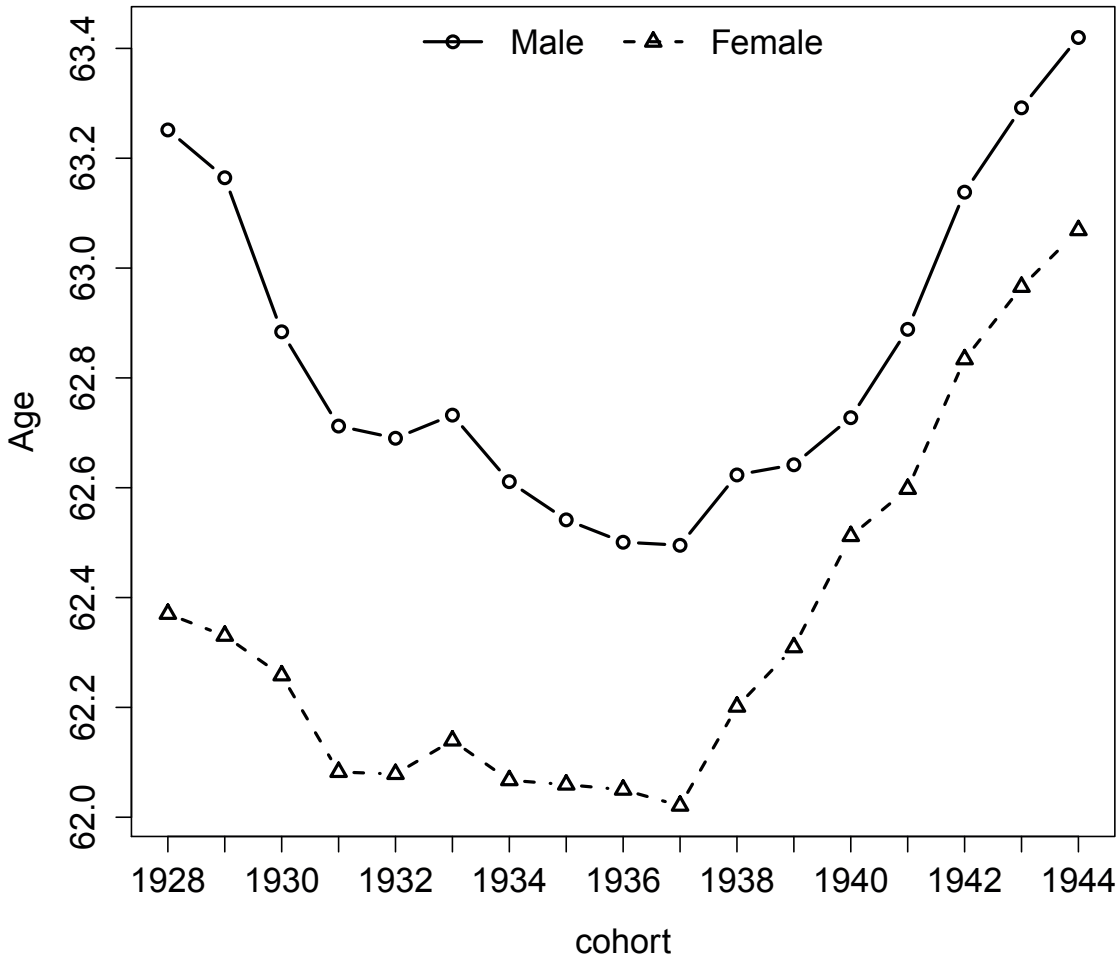
2.4 Education and old-age employment

Education and old-age employment might be positively associated for several reasons. From a labor supply perspective, educated people tend to work more because they are paid more, have more fulfilling jobs, and face fewer physical demands (Maestas and Zissimopoulos, 2010). Highly educated persons may also enter the labor market later, therefore extending working life may be compensating for the loss of pension entitlements due to years spent in school (McDaniel, 2003).

More years in employment for educated older workers may also attribute to demand-side factors. As argued by Peracchi and Welch (1994), changes in technology and increasing openness of the economy may not only increase the return to skills, but they may also have implications for the allocation of skills across and/or within industries, and consequently induce skill-related employment differentials. For example, firms are increasingly reliant on technical advancement to remain competitive in the global economy, which may create more job opportunities and higher demand for educated and skilled older workers.

Recent empirical work has consistently reported a strong and positive relationship between education and old-age work participation in Sweden. Karlsson and Olsson (2012) documented large differences in retirement age by education; the mean exit age ranged from 61.7 for those who only finished compulsory school (Frgymnasial utbildning) to 65 for post-graduates (Forskarutbildning). Johansson et al. (2014) showed significant and positive effects of education on late retirement, even after controlling for health, demographic characteristics, as well as financial incentives measured by option value. Stenberg and Westerlund (2013) argue that educational attainment at young ages, as well as later in life, matters for labor market outcomes among older workers. They showed that university education at mid-age (42-55) improved labor market survival rates over ages 61-66 by 5 percent in Sweden. Klevmarken (2010) conducted an analysis of the

Figure 1: Mean age at retirement by cohort, conditioning on population who are still in the labor force at age 50



Data Source: Swedish Inter-disciplinary Panel (SIP). Note: Retirement age defined by the first calendar year with no labor income.

probability of gainful employment over age 50-69 based on a random sample of over 280,000 individuals born between 1938 and 1940 from the Swedish income register (LISA). He found that the employment effect of education was large and significantly positive. More importantly, the effect for women was more than double that of men.

Having briefly summarized theoretical and empirical literature in terms of the positive association between education and old-age employment, one might suspect that the reversal in retirement age may be attributable to cohort differences in education attainment, skills, as well as job opportunities, if later-born generations are better-educated and/or skilled than their earlier-born counterparts. Hence, we address this particular relationship in this paper, namely the effect of educational composition change on the cohort difference in old-age employment.

2.5 Health and old-age employment

Health is a form of human capital (Becker, 1964; Grossman, 1972), making it an obvious candidate for explaining old-age employment. Impaired health is one of the most common reasons for departure from the labor market in Sweden, the reported cause of 41 percent of men and 47 percent of women (Albin et al., 2015). Examining the relationship between health and older workers' labor decisions is of great importance for policy. As argued by Börsch-Supan et al. (2009), if workers are physically and mentally worn out, the costs of early retirement and strain on the pay-as-you-go pension system may be large, but worth it. However, those who are healthy but inactive may be regarded as unused capacity[1]. Relevant policies targeting this "unused capacity" and facilitating late-life employment are needed, as scholars believe that such unused capacity does exist (Gruber and Wise, 1999, 2004).

Studies for Sweden based on register data generally find better health is associated with delayed retirement and higher work participation. For instance, Klevmarken (2010) found workers who received sickness benefits for 2-4 days a year were less likely to be in gainful employment compared to those without any sick days. Johansson et al. (2014) showed that workers in the highest health quintile were 1.6 percent less likely to exit the labor force than those in the lowest health quintile. If health variation explains old-age employment differentials, one could argue that the cohort trends in retirement age may be associated with improved average health across cohorts. Therefore, in the present study, we also examine the cross-cohort variation in health composition, as well as its relation to the

[1]The unused capacity is defined as a suboptimal usage of human capital, leading to a level of output below the first-best equilibrium (Börsch-Supan et al., 2009).

overall cohort trend in old-age employment.

2.6 Foreign born and old-age employment

The study of labor supply behavior of older workers has generally neglected the implications that foreign-born individuals may have for an ageing society. Immigrants may potentially maintain the size of labor force as well as the tax base, and could possibly improve competitiveness and productivity, ultimately boosting economic support for the ageing society (Harper, 2014). Nonetheless, whether the ageing economy may benefit from immigrant workers depends on the extent to which they integrate into the labor market and fill demand. Low levels of economic integration may become an additional burden on the society. Therefore, research on the employment of older foreign-born workers is of great importance.

Migrants to Sweden, particularly those from lesser developed countries, are generally perceived as a somewhat disadvantaged group, with poorer health, less education, and lower socio-economic position. Whether such factors further deteriorate their employment prospects during later life remains unclear, although immigrant-native wages, income, and wealth differentials have been examined extensively. Recent literature connects early life exposure to worse health conditions with an elevated risk of sickness absence over adulthood (Helgertz and Persson, 2014). Since immigrants from less-economically developed countries were likely born where the early life exposure to negative health conditions was higher than for Swedish born natives, their current health outcomes may accordingly differ. Therefore, we argue that migrants, particularly those from less developed countries, may be associated with lower employment rates at older ages.

Sweden has experienced different waves of immigration in recent decades, altering the composition of the foreign-born population based on country of origin. Hence the third question we address in this paper is whether the changing immigrant composition across cohorts matter in relation to the reversing cohort trend in old-age employment.

3 Data and method

The analysis relies on data from the Swedish Interdisciplinary Panel (SIP), which contains ample information on individual labor market outcomes, such as income and occupational attainment, as well as socio-demographic and health characteristics. SIP consists of individual level data from several different administrative registers, including the income and taxation registers, the inpatient register and the total population register (RTB). These multiple registers are merged to create

SIP-EXIT, a longitudinal database covering roughly 12 million unique individuals born between 1930 and 1980 who resided in Sweden sometime during the period 1968-2013. The database allows for studies examining individuals behavior towards the end of their labor market careers, from a life course perspective. For the present study, we extracted 13 cohorts born between 1935 and 1947 from SIP-EXIT and followed them from ages 55 to 64.

Our outcome variable is the individuals' employment status, which is defined as working if an individual received at least one basic amount (BA) as labor income during the year. Our main independent variables of interest are educational attainment, health, and country of birth. Education is categorized by primary, secondary, and university or higher educational attainment. Health is measured by the number of hospital admissions during the past year, recorded in the impatient care register since year 1990. It is categorized by never, once, and twice or more been hospitalized. The foreign-born population is categorized into 8 regions: Africa, Asia, Balkan, Europe outside the Nordic countries, Middle East, Nordic countries outside Sweden, North America, and South America.

Our analysis is comprised of two parts. The first is a descriptive analysis which graphically presents the old-age employment differentials with respect to demographic, socio-economic, and health strata. We also show the cohort differences in education, health, and the migrants' composition, in order to verify if there are any cohort trends in these covariates. Second, we conduct a decomposition analysis to examine if the cohort reversal in old-age employment is attributable to population compositional change across cohorts. This is important for addressing the question of whether the cross-cohort variation in old-age employment is a result of the pension reforms during the 1990s, as if it was driven by reforms, we might expect little impact due to population structural change.

The decomposition analysis was conducted in three steps. We first estimated an econometric model based on the pooled sample, which includes all individuals born between 1935 and 1947 (aged 60-64), and who are observed between 1990-2011. Second, we estimate cohort-specific models to obtain estimates for each birth cohort. Finally, we conduct a Blinder-Oaxaca decomposition to quantify the contribution of population structural change and the institutional reforms to the cross-cohort variation in old-age employment.

In the first step, the data is treated as a pooled cross-section with the observation period from 1990 to 2011. The coefficient estimates were obtained using logistic regression with robust standard errors. The general specification of the eco-

nometric model may be written as:

$$y_i = \alpha + Z_i'\beta + \epsilon_i \tag{1}$$

where, y_i is the dichotomous outcome variable for each individual in the pooled sample, which equals 1 if employed, and zero otherwise. Z is a set of covariates including dummy indicators for each birth cohort, age, marital status, education level, health condition, and country of birth.

In the second step, we estimated the model for each birth cohort separately with the same specification as in (1), but excluded the cohort dummies in Z. The cohort-specific model may be simply modified as:

$$y_{i,c} = \alpha_c + X_{i,c}'\beta_c + \epsilon_{i,c} \tag{2}$$

where, c denotes each cohort born between 1935 and 1947, and X is a set of covariates: dummy indicators for age, marital status, education level, health condition, and country of birth.

The decomposition analysis in the third step is based on the obtained estimates for $\alpha, \beta, \alpha_c, \beta_c$ in (1) and (2), together with the observed population characteristics $X_{i,c}$. As stressed earlier, our central interest is to examine the effect of cross-cohort compositional differences in education, health, and native-foreign born population on the reversing cohort trend of old-age employment. Hence we set the 1935 birth cohort as the reference category and make pair-wise comparisons with each later-born cohort. The average difference between the reference cohort and each later born in the outcome variable y_i can be expressed as:

$$dY = E(Y_c) - E(Y_{1935}) = \alpha_c - \alpha_{1935} + E(X_c)'\beta_c + E(X_{1935})'\beta_{1935} \tag{3}$$

where, c denotes each cohort born between year 1936 and 1947.

Following Jann (2008), we apply a two-fold decomposition by including a "nondiscriminatory" coefficient vector to determine the contribution of X. Thus letting α^* and β^* be such vectors for the constants and coefficients, (3) can be rewritten as:

$$\begin{aligned} dY = (\alpha_c - \alpha^*) - (\alpha_{1935} - \alpha^*) + [E(X_c) - E(X_{1935})]'\beta^* \\ +[E(X_c)'(\beta_c - \beta^*) - E(X_{1935})'(\beta_{1935} - \beta^*)] \end{aligned} \tag{4}$$

The term $[E(X_c) - E(X_{1935})]'\beta^*$ in (4) is the differences in the outcome variable attributable to the changing mean value in covariates (differences in the employment rate that is explained by differences in the composition of covariates). The

sum of the remaining terms on the right hand side of (4) is the difference in outcome due to coefficient change (the unexplained differences in the employment rate). In the present context, we interpret the explained part as the contribution of compositional change in population to the overall cohort differences in old-age employment. The unexplained part is therefore the effects of non-compositional change. Hence, (4) can be simplified as:

$$dY = dX + dB \tag{5}$$

where, dX refers to the impact of compositional change and dB refers to the influence of institutional change, mainly the pension reforms.

One might argue that dB is essentially the consequence of pension reforms, as the cross-cohort variation in old-age employment corresponds to the disproportional effect of policy change on the expected pension entitlements. However, dB can also arise from preference changes which are independent of the reforms. For instance, later-born cohorts may work more simply because of different work-leisure preferences compared with earlier-born cohorts. We realize this limitation of our decomposition analysis, and argue that our estimates on the dB merely reflect the residual effect of old-age employment variation, while the relative importance due to pension reforms, behavioral modification, changes in working culture and norms, as well as demand for old-age labor remain unknown.

One final note concerning the decomposition analysis regards the unknown parameters α^* and β^*. Some argue that the nondiscriminatory parameters should be determined by imposing weights, either by averaging the coefficient estimates obtained from each pair-wise regression or by groups sizes (Cotton, 1988; Reimers, 1983). However, since our decomposition relies on pair-wise comparison, imposing weights would induce variation in α^* and β^* across cohorts. This, as can be seen from (4), might alter the contribution of dX. Thus, we choose to follow the approach by Neumark (1988) and Oaxaca and Ransom (1994), using the coefficients from a pooled regression. Their methods rely on the pooled regression over each of the paired groups, which can still result in variations in the nondiscriminatory parameters across cohorts. Hence, in order to hold α^* and β^* not only constant, but representative for all cohorts, we determine the parameter vectors by using the estimates obtained from (1), which is the pooled regression for the whole sample born 1935-47. Therefore, $\alpha^* = \alpha$ and $\beta^* = \beta$.

4 General old-age employment pattern

Figure 2 depicts the general pattern of employment over the later life-cycle, exhibiting a downward trend. The employment rate dropped from around 80% at age 55 down to below 50% at age 64. The rate of decline is essentially identical between men and women. The downward slope is by no means a surprising phenomenon. It exemplifies the age-earning profile that typically peaks around age 50, and gradually declines thereafter; a pattern which has been uncovered in 17 out of 19 OECD countries (Skirbekk, 2003). As predicted by the inter-temporal substitution hypothesis, workers are assumed to anticipate a wage drop over the course of their later careers, and in response to such evolutionary wage declines, rational agents would demand more leisure (and thus supply less labor) when wages are low (Macurdy, 1981).

However, an important feature from Figure 2 is that the relationship between employment rate and age is non-linear, as the downward slope gets steeper after age 60. Such a drop might be too steep to be explained by decreasing wages at older ages, casting doubt on the explanatory power of the inter-temporal substitution hypothesis for the employment pattern over this particular segment of the life cycle. In fact, Qi (2015) showed that the employment response to wage change at ages 60-64 tends to be dominated by income effects rather than substitution effects (neither intra-, nor inter-temporal), and therefore, lends support to the backward-bending labor supply curve. Nonetheless, the macro data used in Qi (2015) does not allow incorporating financial incentives into the empirical estimation, which is an important factor, since benefits from the public earnings-related pensions are payable from age 60 in ATP and 61 in NDC in Sweden[2]. Thus the estimates possibly overstate the true income effect of wage changes on employment. One might expect the wage effect on labor supply to diminish once pension income is controlled for.

Moreover, the age-employment profile in the present study should differ by cohort if it reflects the impact of public pension reform. This is because our sample contains cohorts both completely covered by the ATP system (those born before 1938) and by the hybrid system (the transitional cohorts who were born in 1938 or later). Recalling from the previous discussion, those born later require longer working lives in order to maintain the same level of pension entitlements, thus we expect the employment decline after age 60 to be less steep for the younger generation.

[2]ATP is the public earnings-related pension prior to the 1994 pension reform and NDC is the post-reform scheme.

Indeed, as shown in Figure 3, there are large differences across cohorts in the age pattern of employment. The overall pattern exhibits a downward trend, similar to Figure 2. However, comparing the older cohorts with the younger ones, the age-profile of employment shifts towards older age. The cohort employment differential accentuates with increased age, and is partiluarly profound from age 60 onwards. Hence, the apparent interactive effect between cohort and age might be supporting evidence for the employment effects of the old-age pension reform in 1994. This reform effect also seems equally distributed between genders, as the shifting pattern towards older age is similar for both sexes.

Evidence in Figure 3 is also in line with the institutional explanation for the reversing cohort trend in retirement age by Karlsson and Olsson (2012). To illustrate the cohort differences in old-age employment rates, we plot the cohort trend in employment rates in Figure 4. As we just discussed, the age pattern, as well as the cohort differences, are quite distinguishable between ages 55-59 and 60-64, thus the cohort trend is further disaggregated into two age groups in Figure 4.

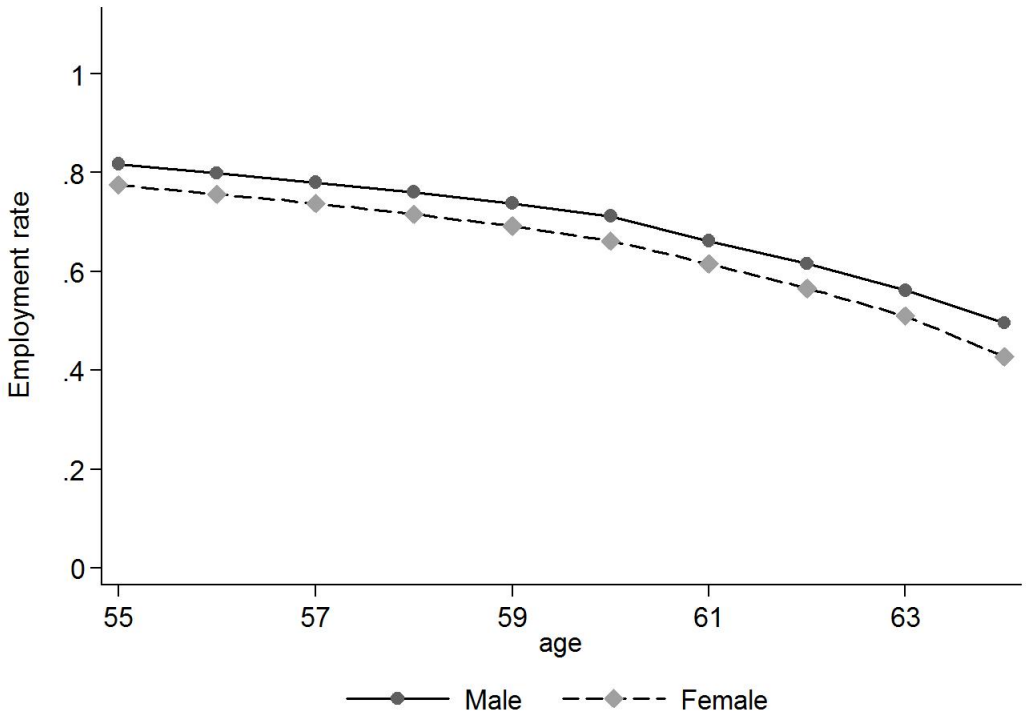
The overall cohort-specific employment rate for the entire sample (aged 55-64) is trending upward for both sexes, as shown by the middle connected line in both panels in Figure 4. However, by disaggregating this trend into two sub-groups, it becomes evident that the upward trend is mainly driven by the older age group, those aged 60-64. There is essentially no trend among those aged 55-59, but steep growth for those aged 60-64. Together with the pattern in Figure 3, which shows the shift of the age profile of employment is more profound between ages 60-64 than 55-60, this graphical evidence implies that the reversing cohort trend in old age employment is attributable to pension reforms, as it appears to only affect the older age group.

Since our main interest in this paper is the reversing cohort trend in old-age employment, and the major change occurs within the 60-64 age group, the remainder of the paper will focus its analysis on the cross-cohort variation in aged 60-64 employment.

5 Cohort trends in population composition and old-age employment

The key question of this paper is whether the reversing cohort trend is associated with population compositional change, such as education, health, and/or immigrants. Therefore, in this section, we describe some feature of each of the covariates. We primarily focus on the cohort differences in the composition of the pop-

Figure 2: Age pattern of employment by gender, sample cohort 1935-47 for years 1990-2011



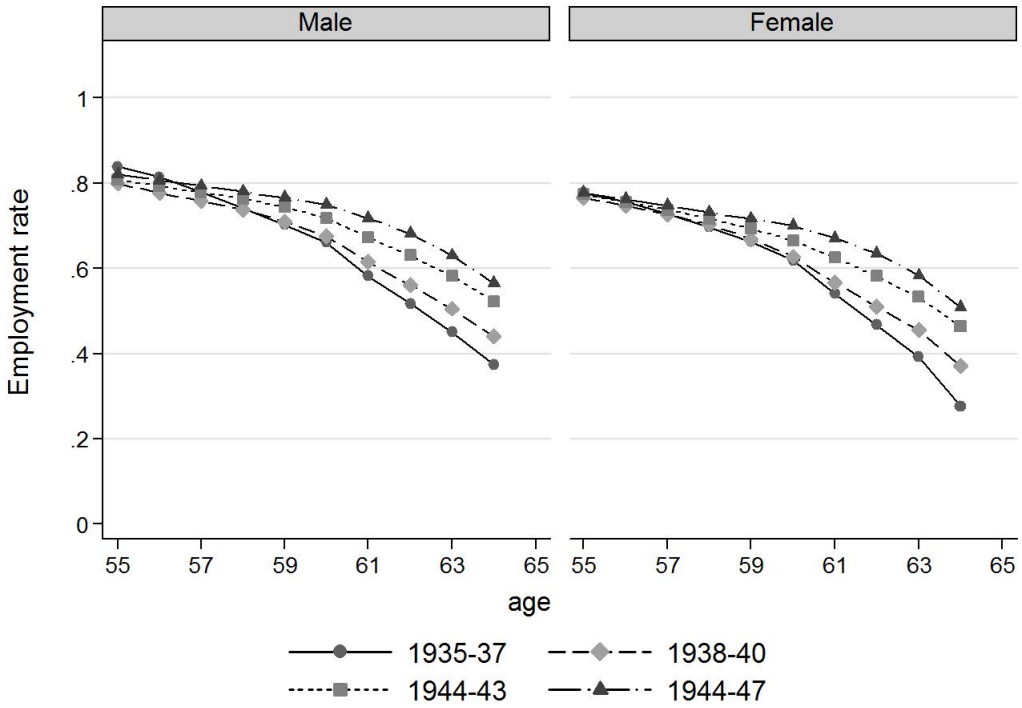
ulation and the old age employment differentials with respect to demographic, socio-economic, and health strata.

5.1 Education and late-life employment

Figure 5 illustrates the cross-cohort differences in educational composition. The shifting educational composition across cohorts is clearly evident, a compositional change that is more profound among women than men. Among those born between 1935 and 1947, the share with primary education declined from roughly 50 to 30 percent for men and from 50 to 23 percent for women, while those with university education grew to 28 percent for men and 30 percent for women.

Recalling our earlier discussion on the theoretical prediction that educated workers are more likely to be in employment at older ages (Maestas and Zissimopoulos, 2010; McDaniel, 2003; Peracchi and Welch, 1994), if this holds, the growing share of highly educated across cohorts may translate into an overall increase in employment. However, whether the changing educational composition matters for the cohort trend in old-age employment would also depend on changes in the employment differentials across educational groups. This is illustrated by Figure 6,

Figure 3: Age pattern of employment by cohort and gender, sample cohort 1935-47 for years 1990-2011



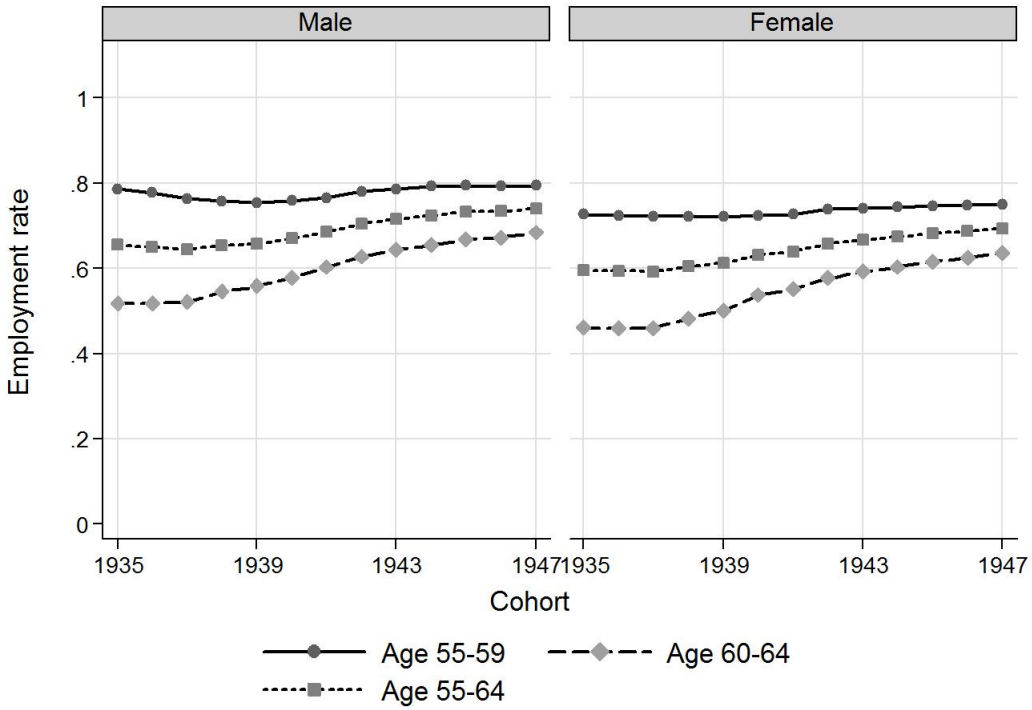
which shows the cohort trends of employment rate by education and sex among those aged 60-64.

The first insight from Figure 6 is that the growth of employment rate across cohorts occurred at all levels of education. The implication of such a parallel trend among educational groups is that the employment differentials do not vary across cohorts. This evidence is in stark contrast to the reversing early retirement in Germany, where pension policy reform led to a growing gap between low and medium educated groups for the timing of employment exit (Buchholz et al., 2013).

Despite employment differentials with respect to education not increasing, it did persist to the same magnitude across cohorts. The differences in cohort trends across education levels suggest that education and old-age employment are positively associated, lending support to the above-mentioned theoretical assumptions. This positive relationship is in line with previous empirical findings based on a similar data source (Johansson et al., 2014; Klevmarken, 2010; Stenberg and Westerlund, 2013).

However, the overall educational differences in cohort trends are greater among women than men. The difference between those with primary and secondary edu-

Figure 4: Cohort trends in employment by age and gender, sample cohort 1935-47 for years 1990-2011



cation is much smaller for men than women, with the gender difference noticeably smaller amongst the university+ educated, compared to those with primary and secondary education.

Given the consistent high employment rate among the highly educated and the increasing share of the population with tertiary education across cohorts, one might expect a positive relationship between the changes in education composition and old-age employment across cohorts. This relationship will be explicitly examined in the decomposition analysis.

5.2 Health and later-life employment

As previously mentioned, impaired health is one of the most common reasons for departure from the labor market (Albin et al., 2015). One might expect poor health to be associated with lower probability of working. This section describes whether such association might exist in Sweden based on our data. Moreover, cross-cohort variation in health is also presented due to its relevance for addressing our key question; whether the health composition of the older-aged labor force varied by cohort, and whether such change led to old-age employment growth.

Figure 5: Educational composition over cohort, 1935-47

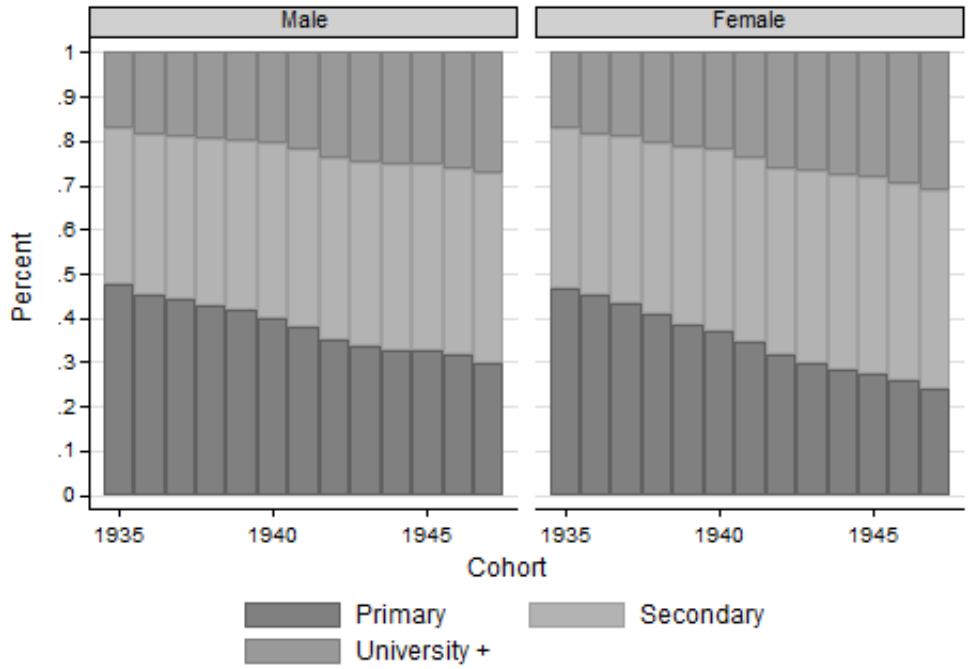
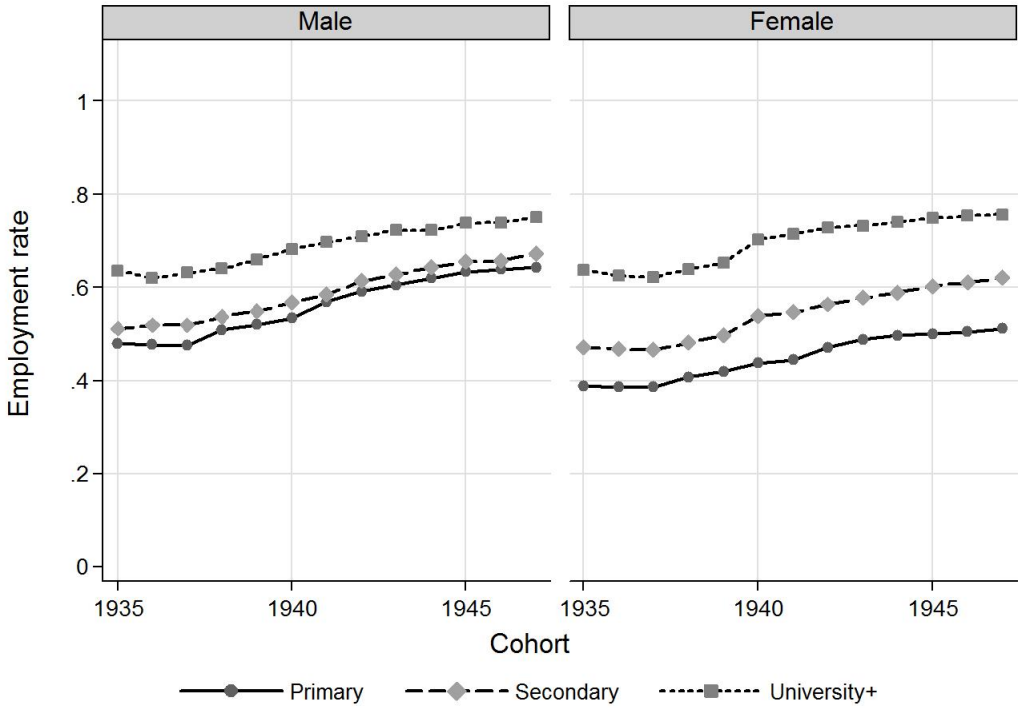


Figure 6: Cohort trend in age 60-64 employment by education and sex



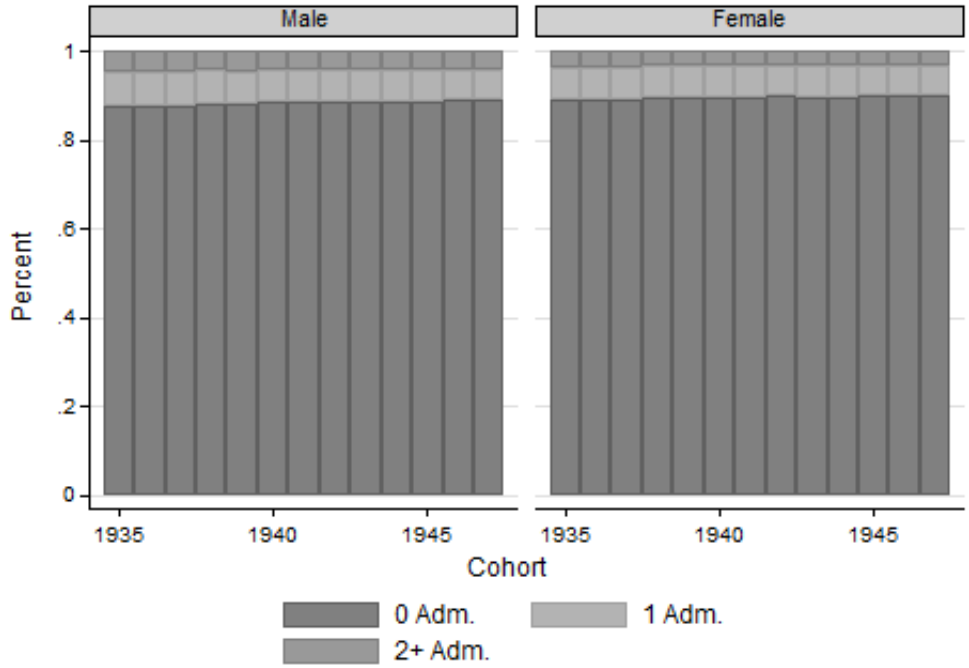
Health is measured by number of hospital admissions during the past observation year. We further categorize the variable into: 1) no admissions 2) one admission and 3) two or more admissions. Figure 7 shows the cohort trend in health composition. Unlike educational composition, the cohort differences in health composition are much less profound, although a small improvement in health over time can be seen. The share with no hospital admissions was 88% for the 1935 cohort, and increased to 89% for men and 90% for women born in 1947. Conversely, both the share of 1 admission and 2+ admissions were lowered by one percentage point.

Figure 8 shows the cohort trends of employment rate by health and sex among those aged 60-64. The overall relation between health and old-age employment is positive. The employment rate was the highest for those never hospitalized, whereas those who were admitted twice or more was the lowest. This implies that better health (or less hospital admissions) was associated with higher employment, and conversely impaired health reduced the probability of working. Such evidence is in line with previous empirical findings using the Swedish register data (Johansson et al., 2014; Klevmarken, 2010). Moreover, the health-employment relationship appears linear for both genders, as the difference between the 0 and 1 admission equals the difference between 1 and 2+ admissions, more or less. Such differentials persist over all cohorts, and are common for both men and women.

As stressed earlier, those who are healthy, but inactive in the labor market may be regarded as "unused capacity" (Börsch-Supan et al., 2009). Such "unused capacity" seems to exist in Sweden, more so among the older cohorts, and among women. The employment rate for healthy workers grew from 53% to 70% for men and from 48% to 65% for women between the 1935 and 1947 cohorts. However, Figure 7 shows that around 90% of the population aged 60-64 has never been hospitalized, a proportion which is constant for men and women over the cohorts. This has two implications. First, the difference in the employment rate among healthy workers between the oldest and youngest cohorts implies that unused capacity was reduced by 17 percentage points in employment for both sexes. Second, despite this unused capacity reducing substantially across cohorts, it still remained at 20% for men and 25% for women, respectively. In other words, 20% of men and 25% of women aged 60-64, who were born in 1947, were healthy but inactive in the labor market. This lends support for the argument that such unused capacity does exist (Gruber and Wise, 1999, 2004).

Given the little variation in health composition across cohorts (as shown in Figure 7), the upturn trend in employment is likely not attributable to health develop-

Figure 7: Health composition over cohort, 1935-47



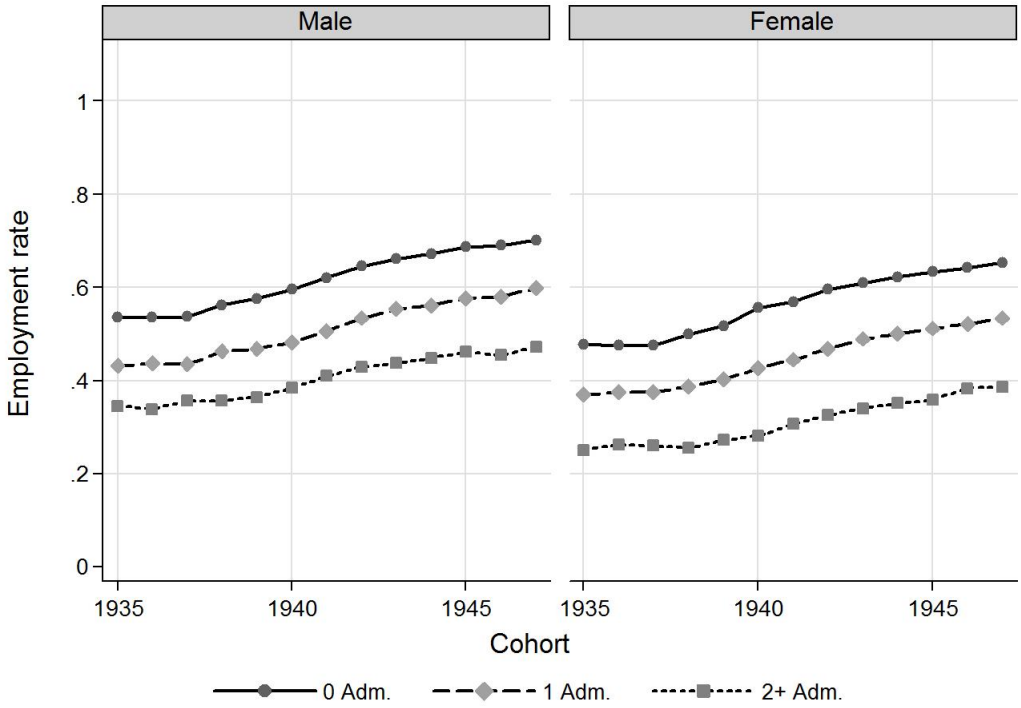
ment across cohorts, even though a general health-employment relationship exists. This point will be more explicitly examined in our decomposition analysis.

5.3 Foreign born and late-life employment

The labor market exit behavior among foreign-born older workers has been studied to a minimal extent in the retirement literature. This is partially due to the fact that the share of foreign-born population is much smaller than for natives. Random samples of the population typically do not have a sufficient number of observations of foreign workers. Quite often, native-immigrant differences in labor market outcomes are captured by including a dummy indicator, but detailed analysis by country of birth is rare. The SIP-EXIT covers the entire population in Sweden, thus we are able to examine the native-immigrant employment differentials in a detailed manner.

Figure 9 shows the size of each migrant group aged 60-64 as a share of the total population. The majority of the foreign-born population within each cohort came from the Nordic region (Denmark, Finland, Norway, and Iceland). European immigrants outside the Nordic region were the second largest group. The third largest group were the Balkans, and the fourth largest group came from the Middle East, including Turkey, Iran, Iraq, and Lebanon. The remaining and smallest portion of

Figure 8: Cohort trend in age 60-64 employment by health and sex



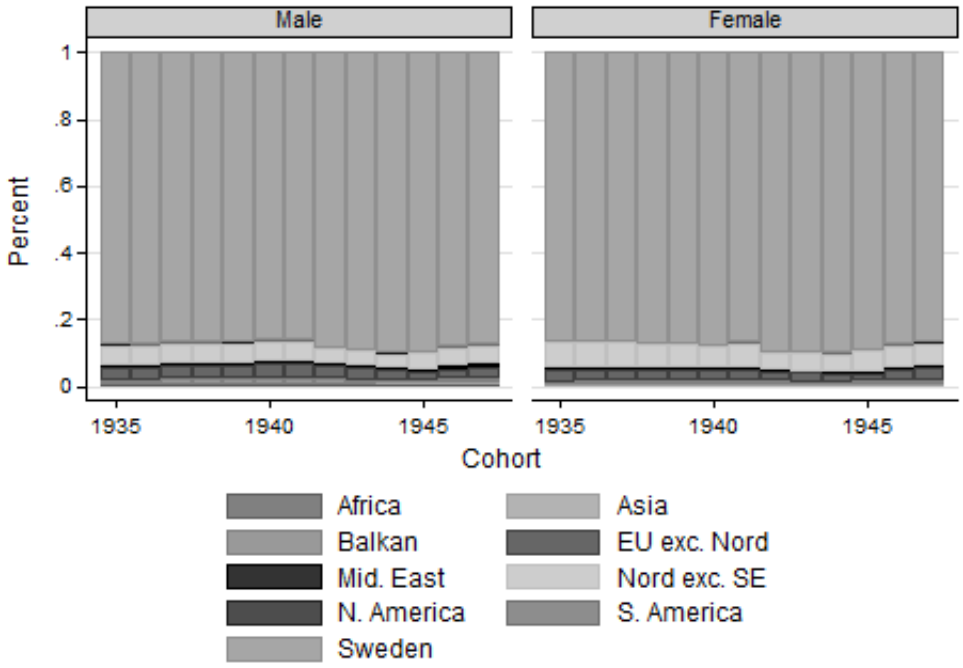
the foreign-born population originate from Africa, Asia, North America and South America.

Although the foreign composition does vary slightly across cohorts, the population is still dominated by the Swedish native-born, who comprised nearly 90% across all the cohorts. Hence, the overall compositional change in native-immigrant population appears to be negligible.

Figure 10 shows the cohort trends of employment rate by the foreign-born categories and sex. It is evident that the variation in old-age employment is large across the native- and foreign-born populations. Not only do employment levels differ, but also across the cohort trend. The groups who most closely resemble natives are: Nordic, European, North American men and women, and South American men. The most striking feature in Figure 10 is that the employment rates for those from the Balkan and Middle East countries were, on average, 35% lower for men and 43-45% lower for women, compared to natives.

Since the cohort differences in the ethnic composition of the population are small, mainly dominated by the native-born. Additionally, the cohort trends in employment across various immigrant groups are much more complex than education and health strata; it is, therefore, hard to say a priori whether these cross-cohort

Figure 9: Native and foreign-born population composition over cohort, 1935-47



variations matter for the old-age employment reversal. We thus address this question explicitly in our decomposition analysis.

5.4 Descriptive Summary

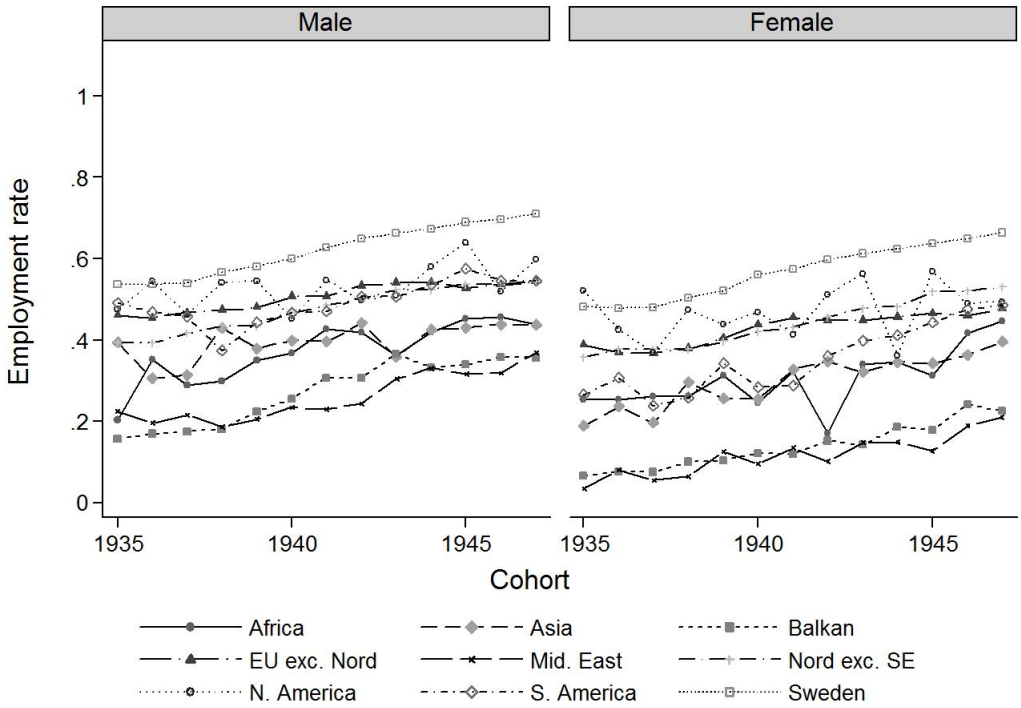
Table 1 highlights what has been discussed so far regarding the cohort change in old-age employment by socio-economic, demographic and health strata. Between the oldest and youngest birth cohorts, the overall employment change for women was 2 percentage points higher than for men.

Across three levels of educational attainment, the cohort trend among men was steepest for those who only completed primary and secondary education. However, for women, the sharpest growth occurred among those with secondary education. Health does seem to matter for the employment change across cohorts, as those who had been hospitalized no times, or once, during the past year, had a higher increase than those with a worse health condition. The cohort employment curve varies substantially across foreign-born and native populations. Despite that employment differentials based on country of origin do exist among the later born, some minority groups are catching up in old-age employment (African and Balkan men, and African, Asian, and South American women).

Table 1: Summary of cohort differences in age 60-64 employment rates by sex

	Employment Rate					
	Male			Female		
Variable	1935	1947	Diff.	1935	1947	Diff.
Overall	0.52	0.68	0.16	0.46	0.64	0.18
Education						
Primary	0.48	0.64	0.16	0.39	0.51	0.12
Secondary	0.51	0.67	0.16	0.47	0.62	0.15
University+	0.64	0.75	0.11	0.64	0.76	0.12
Health						
0 admission	0.53	0.7	0.17	0.48	0.65	0.17
1 admission	0.43	0.6	0.17	0.37	0.53	0.16
2+ admission	0.35	0.47	0.12	0.25	0.39	0.14
Birth Country						
Africa	0.2	0.44	0.24	0.25	0.45	0.2
Asia	0.39	0.44	0.05	0.19	0.4	0.21
Balkan	0.16	0.36	0.2	0.07	0.23	0.16
Europe outside Nordic	0.46	0.54	0.08	0.39	0.48	0.09
Middle East	0.22	0.37	0.15	0.03	0.21	0.18
Nordic outside Sweden	0.39	0.54	0.15	0.36	0.53	0.17
North America	0.48	0.6	0.12	0.52	0.5	-0.02
South America	0.49	0.55	0.06	0.27	0.48	0.21
Sweden	0.54	0.71	0.17	0.48	0.66	0.18

Figure 10: Cohort trend in age 60-64 employment by country of origin and sex



6 Decomposition Analysis

The decomposition analysis is based on econometric models (1) and (2), where the probability of working is written as a function of the covariates in Z for the whole sample and X for the cohort-specific estimation. We conduct the decomposition for both genders separately. The regression results are presented in Table 2 for men and Table 3 for women. We begin our discussion with the first columns of Table 2 and Table 3, which corresponds to the estimation based on the pooled sample including all individuals born from 1935-47 (aged 60-64), and observed over the period 1990-2011.

All coefficients in the pooled model are with expected signs and statistically significant at conventional levels. Education was positively associated with the probability of working for both men and women in all age groups. However, it is important to note that the educational differences in employment were much larger among women than men. This coincides with the cohort trend shown in Figure 6, in which the employment gap between the highly educated and lower educated was consistently wider for women than men.

Health does seem to matter for old-age employment for both sexes. However, hospital admission during the past year seems to have affected women slightly more than men. For example, among those being admitted to hospital more than twice, the probability of working was reduced 57% for men, and 66% for women, compared to those who were never hospitalized.

Another important observation in our regression results is the large employment differences across the native and foreign born populations. The probability of working for all immigrants was substantially lower than for native-born, with the estimated odds ratios ranging from over 0.18 to 0.58 for men and 0.11 to 0.62 for women. Considering the gender dimension, native-immigrant differentials were more profound for women than men among those from Balkan, European other than Nordic, Middle East, North and South American countries, while equally large for men and women born in Africa and Asia. Most interestingly, native-immigrant differentials were smaller for women than men among the immigrants from other Nordic countries. As shown in Figure 10, the most striking differences in employment rates were between the native-born population and immigrants from the Balkans and the Middle East. These differences corresponded to about 80% for men and nearly 90% for women based on our regression results.

The second through the last column of Table 2 and Table 3 present coefficient estimates for each cohort-specific model. We uncovered cross-cohort variation in some estimates. The most important feature is the increasing odds ratios within each age category across birth cohorts. This implies the age-employment profile shifted towards older ages, the pattern we have already shown in Figure 3.

Regarding education, coefficients for men show a pattern of increasing odds ratios, suggesting that educational differences in employment diminish over cohorts. However, this pattern did not occur among female workers. On the other hand, impaired health appears to have increasingly affected the odds of employment negatively for men, as the odds ratios for 2+ admissions decreased across the cohorts. The same coefficients for women, however, remained fairly constant across cohorts. Finally, the native-immigrant differentials widened among men from Asia, Europe, and South America, while diminished among those from Balkan countries. For female foreign-born workers, most groups have increasingly closed the native-immigrant gap (or holding constant), except the European and North American immigrants.

We used the estimates from Tables 2 and 3 to implement the Blinder-Oaxaca decomposition analysis. The results for men and women are graphically presented in the following figures (See Table 4 and Table 5 for detailed results).

The circled line in Figure 11 illustrates the total difference in employment rate between cohort 1935 and each of the successive later-born cohorts. The growing differences indicated by the circled line across cohorts reflect the cohort trend in old-age employment, that we showed and discussed in Figure 4 for ages 60-64. The circled line is overlapped with the diamond line for men, suggesting that the cohort trend of old-age employment was entirely driven by coefficient change, dB in equation (5). This implies that the residual effect dominated the compositional change on the old-age employment. For women, however, there was some effect of population structural change, as shown by the squared line in the right panel of Figure 11. For example, out of the 17.6% overall difference in employment rate between the 1935 and 1947 cohorts, 4% was explained by the changes in population composition between the two generations (dX in equation (5)), while 13.6% was due to the non-compositional effects, dB.

Figure 12 further decomposes the total compositional change (dX in equation (5)) into each of the covariates included in the model. None of the changing means of covariates contributed to the cohort employment differentials for men. This is not surprising, as we just discussed that the effects of compositional change on the overall cohort trend of employment rate (shown by the squared line in the left panel of Figure 11) was essentially zero. However, there were slightly more profound compositional effects for women (shown by the squared line in the right panel of Figure 11) which were mainly due to the changing educational composition. This is shown by the black squared line in the right panel of Figure 12, which most closely matches the total compositional change (the circled line).

We further decompose the effect of educational composition change on old-age employment by levels of educational attainment. The results are presented in Figure 13. The effect of compositional change in education on employment was mainly attributable to two groups; the least educated (shown by the dotted line), and highly educated (shown by the circled line).

Table 6 provides a summary of the decomposition results illustrated in Figures 11, 12, and 13. The summary statistics are calculated by taking the average of the dY and dX in equation (5) across cohorts 1936-1947. In other words, the averages over the rows of Table 4 and Table 5. The first row in Table 6 shows that the average difference in the age 60-64 employment rate between the 1935 and each later-born cohort was 8.9% for men and 9.3% for women. The second row of Table 6 suggests that the average effect of the compositional difference on the employment difference between the 1935 and each of the 1936-47 cohorts was negligible for men. However the average employment difference for women was explained more than one-fourth by the average compositional change in the pop-

ulation (2.5% out of 9.3%). Of the 2.5% average contribution of population structural change to the overall employment trend, 2.2% was driven by educational composition change.

Table 2: Logit estimates of probability of working, pooled and cohort samples for men

VARIABLES	Pooled	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945	1946	1947
							Age							
60	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref
61	0.782***	0.736***	0.697***	0.679***	0.734***	0.742***	0.800***	0.788***	0.792***	0.809***	0.833***	0.853***	0.843***	0.841***
62	0.631***	0.554***	0.504***	0.541***	0.562***	0.595***	0.636***	0.636***	0.646***	0.683***	0.709***	0.725***	0.709***	0.669***
63	0.498***	0.395***	0.393***	0.416***	0.447***	0.475***	0.499***	0.516***	0.520***	0.562***	0.578***	0.581***	0.541***	0.520***
64	0.377***	0.280***	0.283***	0.307***	0.341***	0.362***	0.386***	0.396***	0.405***	0.439***	0.447***	0.421***	0.401***	0.398***
							Marital Status							
Unmarried	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref
Married	1.772***	1.768***	1.705***	1.807***	1.709***	1.743***	1.733***	1.760***	1.731***	1.760***	1.766***	1.812***	1.815***	1.880***
							Education							
Primary	0.604***	0.539***	0.574***	0.547***	0.609***	0.576***	0.546***	0.600***	0.615***	0.612***	0.653***	0.646***	0.648***	0.633***
Secondary	0.663***	0.607***	0.671***	0.640***	0.669***	0.642***	0.619***	0.630***	0.661***	0.659***	0.704***	0.684***	0.679***	0.692***
University+	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref
							Health							
0 Admission	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref
1 Admission	0.657***	0.676***	0.687***	0.676***	0.678***	0.667***	0.648***	0.644***	0.645***	0.655***	0.635***	0.640***	0.643***	0.659***
2+ Admission	0.436***	0.476***	0.463***	0.504***	0.455***	0.445***	0.445***	0.442***	0.438***	0.418***	0.421***	0.418***	0.395***	0.411***
							Country of Origin							
Sweden	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref
Africa	0.321***	0.190***	0.430***	0.314***	0.307***	0.351***	0.350***	0.410***	0.375***	0.253***	0.306***	0.336***	0.324***	0.286***
Asia	0.317***	0.446***	0.314***	0.323***	0.472***	0.365***	0.376***	0.324***	0.368***	0.240***	0.315***	0.291***	0.289***	0.271***
Balkan	0.203***	0.136***	0.153***	0.160***	0.152***	0.193***	0.211***	0.251***	0.221***	0.275***	0.221***	0.205***	0.212***	0.202***
Europe outside Nordic	0.570***	0.662***	0.651***	0.690***	0.648***	0.611***	0.633***	0.577***	0.586***	0.558***	0.530***	0.468***	0.461***	0.442***
Middle East	0.176***	0.210***	0.176***	0.194***	0.152***	0.159***	0.171***	0.145***	0.147***	0.190***	0.202***	0.173***	0.166***	0.195***
Nordic outside Sweden	0.579***	0.576***	0.582***	0.645***	0.616***	0.589***	0.624***	0.595***	0.582***	0.601***	0.565***	0.566***	0.521***	0.513***
North America	0.560***	0.647***	0.909	0.654***	0.774*	0.658***	0.475***	0.606***	0.465***	0.455***	0.591***	0.678***	0.381***	0.494***
South America	0.545***	0.746***	0.698***	0.689***	0.433***	0.540***	0.566***	0.509***	0.525***	0.518***	0.544***	0.585***	0.513***	0.498***
Observations	3,386,543	199,661	205,851	212,391	221,648	231,480	230,480	240,997	273,321	295,839	316,620	320,591	321,793	315,871
Pseudo R-squared	0.0701	0.0711	0.0672	0.0656	0.0602	0.0602	0.0595	0.0581	0.0562	0.0531	0.0521	0.0579	0.0633	0.0673

Significance: *** p<0.01, ** p<0.05, * p<0.1

Table 3: Logit estimates of probability of working, pooled and cohort samples for women

VARIABLES	Pooled	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945	1946	1947
							Age							
60	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref
61	0.802***	0.758***	0.708***	0.671***	0.745***	0.722***	0.817***	0.820***	0.831***	0.841***	0.847***	0.876***	0.883***	0.874***
62	0.643***	0.555***	0.496***	0.516***	0.549***	0.591***	0.651***	0.663***	0.684***	0.698***	0.724***	0.752***	0.739***	0.717***
63	0.505***	0.375***	0.367***	0.383***	0.430***	0.477***	0.514***	0.540***	0.544***	0.575***	0.584***	0.600***	0.573***	0.579***
64	0.352***	0.204***	0.211***	0.231***	0.283***	0.313***	0.391***	0.394***	0.410***	0.435***	0.436***	0.429***	0.412***	0.416***
							Marital Status							
Unmarried	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref
Married	1.074***	0.982*	0.973***	0.977**	1.023**	1.023**	1.057***	1.106***	1.097***	1.112***	1.107***	1.113***	1.129***	1.154***
							Education							
Primary	0.347***	0.347***	0.361***	0.367***	0.381***	0.380***	0.326***	0.319***	0.332***	0.346***	0.345***	0.337***	0.334***	0.345***
Secondary	0.495***	0.486***	0.509***	0.509***	0.509***	0.514***	0.481***	0.469***	0.469***	0.487***	0.490***	0.497***	0.494***	0.514***
University+	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref
							Health							
0 Admission	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref
1 Admission	0.618***	0.640***	0.646***	0.652***	0.624***	0.617***	0.590***	0.606***	0.605***	0.611***	0.612***	0.613***	0.612***	0.616***
2+ Admission	0.342***	0.362***	0.386***	0.373***	0.345***	0.345***	0.315***	0.336***	0.328***	0.338***	0.334***	0.328***	0.350***	0.335***
							Country of Origin							
Sweden	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref
Africa	0.327***	0.372***	0.327***	0.331***	0.310***	0.340***	0.204***	0.327***	0.135***	0.336***	0.330***	0.261***	0.410***	0.432***
Asia	0.313***	0.233***	0.328***	0.237***	0.397***	0.304***	0.246***	0.354***	0.368***	0.303***	0.318***	0.300***	0.304***	0.343***
Balkan	0.130***	0.074***	0.089***	0.087***	0.113***	0.111***	0.118***	0.108***	0.135***	0.112***	0.153***	0.136***	0.193***	0.165***
Europé outside Nordic	0.494***	0.617***	0.565***	0.563***	0.534***	0.558***	0.536***	0.542***	0.491***	0.443***	0.441***	0.439***	0.403***	0.418***
Middle East	0.105***	0.041***	0.105***	0.068***	0.075***	0.142***	0.091***	0.123***	0.080***	0.112***	0.107***	0.083***	0.126***	0.134***
Nordic outside Sweden	0.621***	0.612***	0.674***	0.675***	0.615***	0.622***	0.591***	0.597***	0.594***	0.618***	0.590***	0.650***	0.621***	0.614***
North America	0.476***	0.887	0.666***	0.525***	0.706**	0.527***	0.488***	0.352***	0.504***	0.660***	0.250***	0.540***	0.383***	0.347***
South America	0.402***	0.370***	0.456***	0.314***	0.327***	0.469***	0.278***	0.268***	0.357***	0.400***	0.391***	0.454***	0.471***	0.491***
Observations	3,371,820	203,022	211,939	214,647	224,308	231,781	227,470	238,869	266,754	292,153	309,752	315,186	319,505	316,434
Pseudo R-squared	0.0812	0.0911	0.0849	0.0793	0.0721	0.0663	0.0723	0.0715	0.0693	0.0644	0.0642	0.0680	0.0695	0.0712

Significance: *** p<0.01, ** p<0.05, * p<0.1

Table 4: Decomposition results, men

	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945	1946	1947
							Overall					
Y	0.518***	0.521***	0.545***	0.559***	0.578***	0.603***	0.628***	0.644***	0.655***	0.669***	0.673***	0.685***
dY	-0.000	0.003	0.027***	0.041***	0.060***	0.085***	0.110***	0.126***	0.137***	0.151***	0.155***	0.167***
dX	0.002***	0.001	0.001**	0.000	-0.001**	0.000	0.006***	0.008***	0.008***	0.007***	0.003***	0.003***
dB	-0.002	0.002	0.026***	0.041***	0.061***	0.085***	0.104***	0.118***	0.129***	0.144***	0.152***	0.164***
							dX					
Age	0.000	0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
Marital	0.000	-0.001***	-0.002***	0.001	-0.003***	-0.008	-0.004***	-0.005***	-0.006***	-0.008***	-0.010***	-0.010***
Education	0.002***	0.003***	0.004***	-0.001	0.004***	0.011	0.009***	0.010***	0.011***	0.011***	0.012***	0.014***
Hospital	0.000	0.000**	0.001***	-0.000	0.001***	0.002	0.001***	0.001***	0.001***	0.002***	0.002***	0.002***
Birth Country	-0.000	-0.001***	-0.001***	0.000	-0.003***	-0.005	0.000	0.002***	0.003***	0.002***	-0.000*	-0.003***
							dB					
Age	-0.000	-0.000*	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.001***	-0.001***	-0.000***	-0.000***	-0.000***
Marital	-0.002*	0.001	-0.001*	-0.001	-0.001	-0.000	-0.001	-0.000	0.000	0.001	0.001	0.002***
Education	0.003***	0.001*	0.004***	0.003***	0.001*	0.003***	0.004***	0.004***	0.005***	0.004***	0.004***	0.004***
Hospital	0.001	-0.003	0.003	0.005*	0.007**	0.008**	0.008**	0.010***	0.012***	0.012***	0.015***	0.011***
Birth Country	-0.019	-0.006	0.001	-0.003	-0.001	-0.003	0.005	0.015*	0.001	0.003	0.023***	0.019**
constant	0.015	0.009	0.020*	0.036***	0.055***	0.077***	0.089***	0.090***	0.111***	0.125***	0.110***	0.128***
N	405,512	412,052	421,309	431,141	430,141	440,658	472,982	495,500	516,281	520,252	521,454	515,532
N cohort 1936-47	205,851	212,391	221,648	231,480	230,480	240,997	273,321	295,839	316,620	320,591	321,793	315,871
N cohort 1935	199,661	199,661	199,661	199,661	199,661	199,661	199,661	199,661	199,661	199,661	199,661	199,661

Significance: *** p<0.01, ** p<0.05, * p<0.1

Table 5: Decomposition results, women

	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945	1946	1947
							Overall					
Y	0.460***	0.461***	0.483***	0.501***	0.537***	0.551***	0.577***	0.593***	0.604***	0.616***	0.625***	0.636***
dY	-0.001	-0.000	0.022***	0.040***	0.077***	0.090***	0.116***	0.132***	0.143***	0.155***	0.164***	0.176***
dX	0.004***	0.007***	0.012***	0.016***	0.017***	0.022***	0.031***	0.034***	0.037***	0.038***	0.038***	0.040***
dB	-0.005***	-0.007***	0.010***	0.024***	0.059***	0.068***	0.085***	0.097***	0.106***	0.117***	0.126***	0.136***
							dX					
Age	0.000	0.000	0.000	-0.000	-0.000	0.000	-0.000	0.000	-0.000	-0.000	-0.000	-0.000
Marital	-0.000**	-0.000***	-0.000***	-0.000***	-0.000***	-0.001***	-0.000***	-0.000***	-0.001***	-0.001***	-0.001***	-0.001***
Education	0.003***	0.006***	0.010***	0.014***	0.016***	0.021***	0.026***	0.029***	0.032***	0.034***	0.037***	0.041***
Hospital	0.001**	0.001***	0.001***	0.001***	0.001***	0.001***	0.002***	0.001***	0.001***	0.002***	0.002***	0.002***
Birth Country	0.000	0.000	0.001***	0.001***	0.000*	0.000*	0.004***	0.004***	0.005***	0.003***	0.000	-0.003***
							dB					
Age	0.000	-0.000	-0.000*	-0.000**	-0.000***	-0.000***	-0.000***	-0.001***	-0.001***	-0.000***	-0.000***	-0.000***
Marital	-0.000	-0.000	0.001***	0.001***	0.002***	0.004***	0.003***	0.004***	0.004***	0.004***	0.004***	0.004***
Education	0.002	0.002*	0.002***	0.002**	-0.001	-0.001*	-0.001	-0.000	-0.000	0.001	0.001	0.001*
Hospital	-0.008	-0.005	0.004	0.005	0.013***	0.008**	0.009***	0.007*	0.008**	0.009**	0.005	0.007**
Birth Country	-0.049*	0.006	-0.017	-0.030**	0.008	-0.008	0.004	-0.025*	-0.007	-0.015	-0.033***	-0.034***
constant	0.050	-0.011	0.021*	0.047***	0.037***	0.067***	0.070***	0.113***	0.103***	0.119***	0.150***	0.158***
N	414,961	417,669	427,330	434,803	430,492	441,891	469,776	495,175	512,774	518,208	522,527	519,456
N cohort 1936-47	211,939	214,647	224,308	231,781	227,470	238,869	266,754	292,153	309,752	315,186	319,505	316,434
N cohort 1935	203,022	203,022	203,022	203,022	203,022	203,022	203,022	203,022	203,022	203,022	203,022	203,022

Significance: *** p<0.01, ** p<0.05, * p<0.1

Table 6: Summary of average effects of compositional change on old-age employment

	Male	Female
Avg. dY	0.089	0.093
Avg. dX	0.003	0.025
Age	0.000	0.000
Marital	-0.005	0.000
Education	0.008	0.022
Hospital	0.001	0.001
Birth Country	-0.001	0.001

7 Summary and Discussion

Over the past decades, a number of OECD countries have seen their old age population exhibit a reversal pattern of employment, from a greater proportion of early retirees to a greater proportion who remain active workers at age 60+, although the magnitude and the tempo of these changes vary across countries (OECD, 2013). Many argue that the observed reversal was attributable to pension reforms which facilitated the prolongation of working life (Börsch-Supan et al., 2009; Buchholz et al., 2013; Karlström et al., 2008; Komp et al., 2010). The present study contributes to this literature by considering the importance of changes in population composition in the reversing old-age employment, a relation that has seldom been explored in the retirement literature. Our argument is that if highly educated, skilled and healthy workers are more likely to retire later, as shown in previous studies (Börsch-Supan et al., 2009; Buchholz et al., 2013; Glans, 2008; Klevmarken, 2010; Komp et al., 2010; Larsen and Pedersen, 2013; Stenberg and Westerlund, 2013), then the changes in retirement age may have risen due to changes in the population's composition, because the old age workforce might be increasingly better educated and skilled over time.

Our main focus is on the variation in old-age employment across cohorts rather than over time. This is because the major institutional reform in Sweden, the 1994 public pension reform, was implemented during a specific year, but affected different birth cohorts disproportionally. Hence, we presume the cohort differences, as shown in Figure 1, partly identifies the employment effect of the reform. However, we also argue that cross-cohort differences in old-age employment may be driven by changes in other factors, such as culture, behavior, norms, as well as

Figure 11: Effects of compositional and behavioral change on employment differences across cohorts

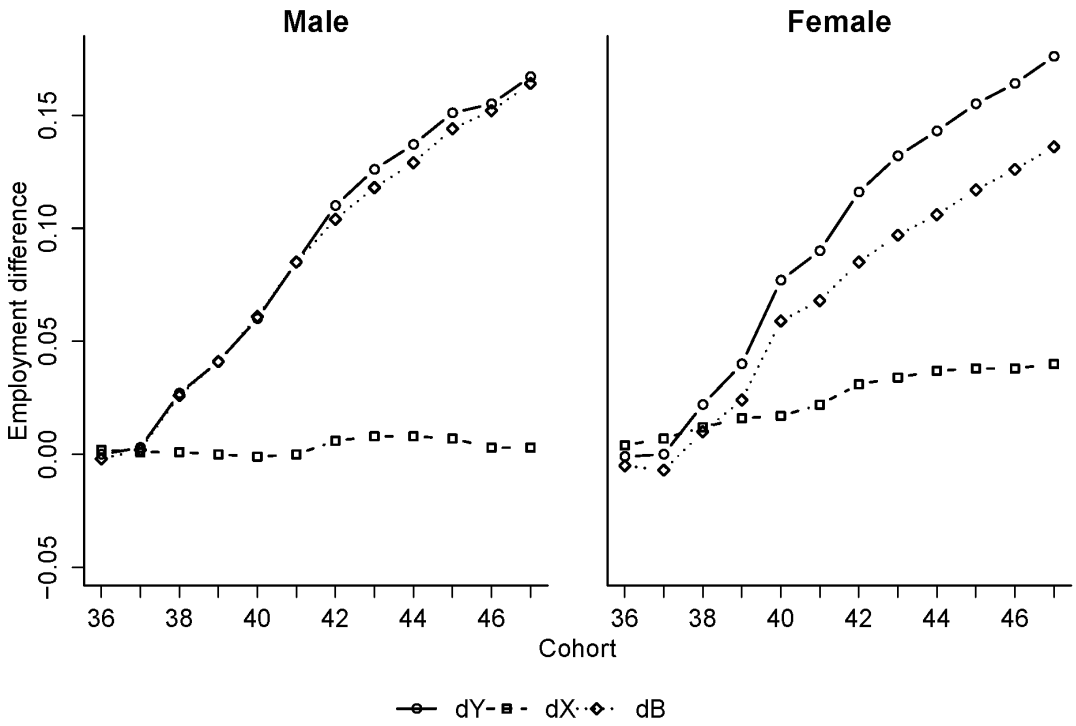


Figure 12: Decomposing effect of total compositional change on cross-cohort employment differences by covariates

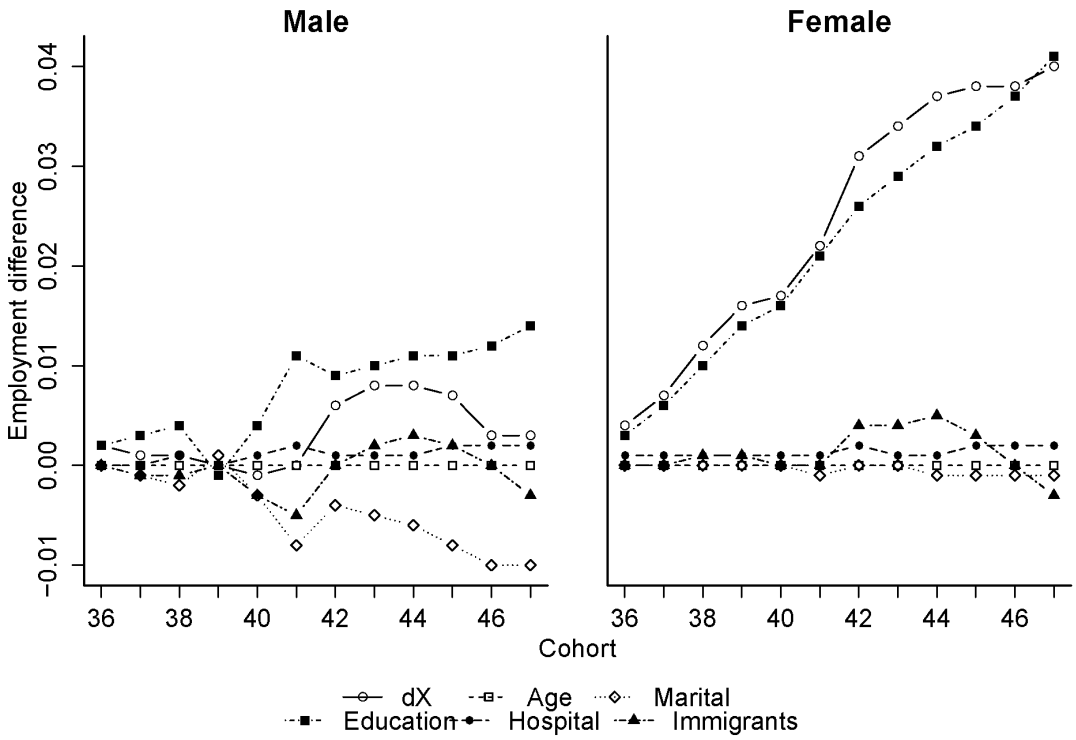
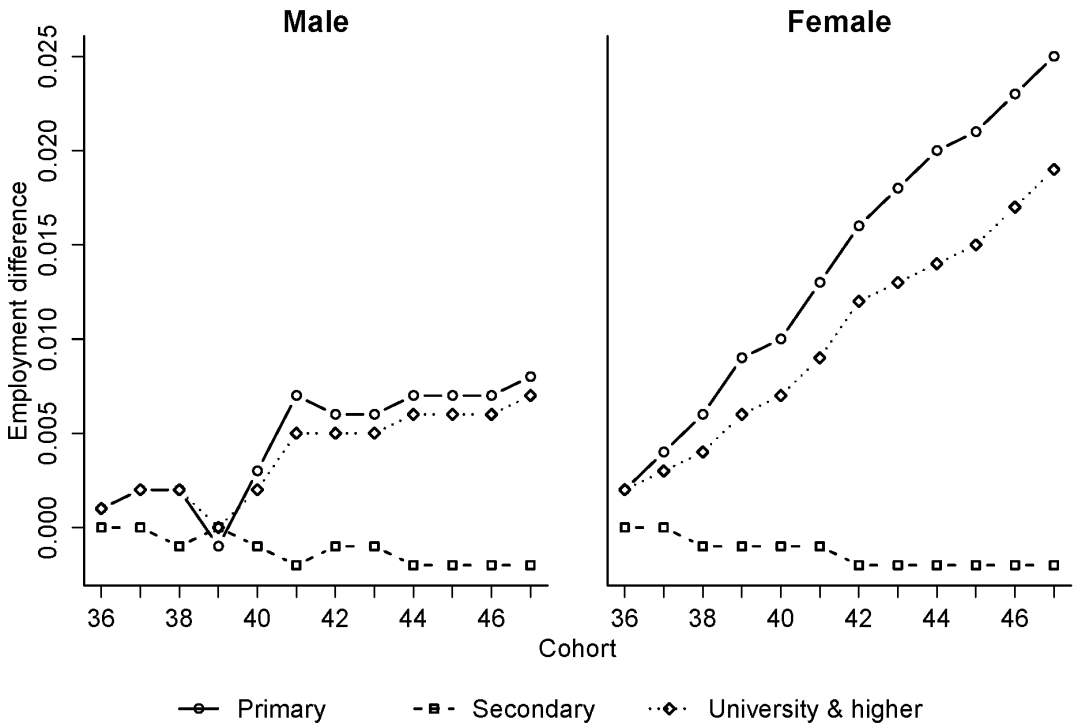


Figure 13: Decomposing effect of compositional change in education on cross-cohort employment differences by educational attainment



labor demand. Thus our decomposition analysis essentially examines the relative importance of the changing distribution of the population characteristics and the residual that captures all kinds of non-compositional changes.

The descriptive analysis shows considerable variation in the composition of education across cohorts, but little change in the share of population with good and poor health. The composition of native-immigrant populations do vary across cohorts, but the foreign-born's relative share of the population is small. Therefore, one might expect the changing educational composition of workers might play an important role in determining the reversing cohort trend in old-age employment. Our main findings are summarized as follows:

1. For men, the reversing cohort trend in old-age employment was unaffected by any compositional changes in education, health, and foreign born across cohorts, despite considerable variation in population characteristics, particularly in the share of educational attainment.
2. For women, the changing population structure played a bigger role than for men in shaping the old-age employment trend, although it was not dominant (the compositional change explained 2.5% out of 9.3% average increase in employment rate across cohorts). Out of this 2.5%, the educational composition change accounted for 2.2%, of which about 1% was due to the growing share of the population who had attained university or higher education. The remaining 1.2% of the effect from education came from the declining fraction with primary education.

The regression analyses further suggest that education, health, and country of origin are all important determinants of late-life employment within each cohort. This implies that more coherent and integrated policies are necessary, since the employment differentials across social, demographic, and health strata are large in both economic and statistical terms.

As argued by Harper (2014), public policy in light of population ageing should enable prolonging working life through lifelong training, education, and skills updating, as well as providing improved working conditions for older workers. Such a view is also mildly supported by our investigation, as our regression analysis shows that higher education elevates the probability of working, and the decomposition analysis suggests that the growing share of university educated, and declining share of primary educated, matter for cross-cohort employment differentials, at least for women. In addition, recent evidence also suggests that education, not only at young ages, but also at mid-age, is important for retaining work-

ers in the labor force (Stenberg and Westerlund, 2013). Therefore, providing education and promoting life-long training programmes are relevant to reduce the inequality in old-age employment.

The last, but not least, note from our analysis is that a considerable share of the older workforce is still available as ”unused capacity”. Although the employment rate among healthy workers in the youngest cohort increased to 70% for men and 65% for women, about 20-25% of healthy workers are inactive in the labor market. Such an ”unused capacity” deserves further research attention.

One might argue that the amount of ”unused capacity” may be driven by our crude measure of health; we treat all individuals not being hospitalized in the previous year as healthy. This measure might not necessarily reflect the true health condition, and, as a result, the ”unused capacity” might be exaggerated. This specification may also have led to little cross-cohort variation in health composition, as shown in Figure 7, which consequently contributes nothing to the increase in old-age employment. There are two alternative health measures, the length of sickness absence and the use of out-patient care, which may give more variation in the health composition.

However, the former may lead to an endogenous relationship between health and employment, particularly for the older population. For example, individuals with strong pure preference for leisure may have greater incentive to live on sickness benefits, given the generous provision for sick leaves in Sweden. One previous study found that the employment effect of the disability pension reform appears to be crowded out by the increase in the utilization of sick leave benefits (the so-called ”communicating vessel effect”) (Karlström et al., 2008). In this case, the duration of sickness might be a subjective measure of health, and the employment effects of health might be exaggerated, a mechanism similar to people who use poor health to justify non-participation in labor activities, the justification hypothesis. Using out-patient care might give more variation in health composition, simply because the use of this service is more frequent than inpatient care. Unfortunately, the corresponding data in the outpatient care register in Sweden starts from year 2001, which only covers half of the study period. Hence, we used the inpatient care register, mainly the number of days in hospital, as the source of an objective health measure.

We would like to conclude this paper by mentioning some caveats in our analysis and possible extension for future research. Our decomposition analysis is unable to disentangle the relative importance of pension reforms, changes in working norms, preferences, behavior, and/or labor demand in shaping the reversal of

old-age employment. These factors are captured by a single residual. Thus, a more comprehensive retirement model and empirical estimation are needed to address the question in more detail.

Furthermore, as mentioned, to understand the existence of the remaining "unused capacity", one might need to look into the "communicating vessel effect". That is to quantify the extent to which these healthy, but inactive, workers are bridging the work-retirement transitions through unemployment benefits, sickness benefits, and/or early withdraw of pension benefits.

Finally, our analysis showed large late-life employment differentials across foreign born populations. This sheds light on the importance of investigating older foreign workers and their responses to policy intervention, an area which deserves further research, particularly during an era when a large share of first-generation labor migrants are about to reach pensionable age.

Acknowledgments

We are grateful to Anna Amilon, Kerstin Enflo, Ronald Lee, and Jeff Neilson for their helpful comments.

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