Is it worth raising the normal retirement age? A new model to estimate the employment effects

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Article**
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Abstract

Pension reforms, that raise the normal retirement ages, are crucial yet controversial in ageing developed countries. While cross-country studies confirm positive significant effects, their estimated effects are modest compared to those from country-specific studies using micro data. This study attempts to reconcile these differences by introducing greater heterogeneity into the cross-country approach. Starting from a standard cross-country panel error correction model, several empirical innovations are introduced to better capture the influence of the demographic composition of countries, the possibility of retiring at an earlier age, and the importance of private pension funds and early exit pathways. These changes result in larger and more heterogeneous predicted effects of changes in the normal retirement ages on the older-age employment rate and average age of labour market exit across countries. The proposed model, allows for simulations on the effects of pension policy reforms.

Keywords: normal retirement ages, employment rate, labour market policy, older workers

1 INTRODUCTION AND SUMMARY OF RESULTS

Pension reforms, especially those increasing the normal retirement age, play an important and controversial role in many developed and ageing countries. The rising fiscal costs of public pensions and the strong opposition often faced by governments contemplating such interventions make evident the importance of reliable quantifications of their effects, especially on the labour market. As shown by IMF (2024), the frequency of protests related to pension reforms has significantly increased over the years, particularly since 2010. This underscores the contentious nature of pension reforms and the need for evidence-based policy design to address both fiscal sustainability and public concerns. Many empirical papers, using cross-country macro models, have estimated the impact of raising the normal retirement age on aggregate older-age employment. The estimates from such studies unequivocally point towards a positive and statistically significant effect on labour force participation and the employment rate. However, the magnitude of this effect is surprisingly modest when expressed in terms of *average age of labour market exit*: most studies suggest that a 1-year increase in the *normal* retirement age only raises the *average age of labour market exit*[1] by 1-2½ months (see table 1).

[1] The average age of labour market exit is the average age of all persons withdrawing from the labour force in a given period, whether during any particular year or over any five-year period. The average age of labour market exit (AALME) is thus simply the sum of each year of age weighted by the proportion of all withdrawals from the labour force occurring in that year of age (see Boulhol and Keese, 2021).

Empirical research using microdata from individual countries often suggests much stronger effects, for instance:

- Mastrobuoni (2009), using U.S. microdata, finds that a 2-month increase in the normal retirement age raises the effective retirement age[2] by approximately 1 month;
- Fehr, Kallweit and Kindermann (2012), using a calibrated general equilibrium model, estimate that the 2007 pension reform in Germany, which increased the normal retirement age by 2 years, delayed retirement by an average of 9 to 12 months;
- Etgeton (2018), instead, by estimating a dynamic discrete choice model from the biographical data of social insurance agencies in Germany, quantified that the effect of the same 2-year increase in the normal retirement age delayed, in the years 2012-13, the average age of labour market exit by 8.4 months;
- Hanel and Riphahn (2012), using data from the Swiss Labour Force Survey, analysed a two-step pension reform in Switzerland that raised the normal retirement age for women from 62 to 63 in 2001 and then to 64 in 2005, finding that the combined reform delayed retirement entry by 7.7 months;
- Lalive and Staubli (2015), by contrast, using data from the Swiss social security database, found that the 2001 rise in the retirement age only delayed labour market exit by 7.9 months;
- Morris (2021) estimated that the 1994 Australian pension reform, which raised the normal retirement age for women from 60 to 65, increased the average age of labour market exit by 9 months;
- Fodor, Roehn and Hwang (2022) found that an increase in the minimum and normal retirement age by one year in Slovakia would lead to a 7-month rise in the average age of labour market exit.

The results in Turner and Morgavi (2021) show that, when heterogeneity across pension systems and demographics are adequately modelled, the cross-country panel estimates align more closely with the country-specific effects. However, that study relies on a database that is difficult to update[3], as it includes the labour force participation rate computed by single year of age and is limited to a restricted group of mainly EU countries. The objective of this paper is to examine whether these results can be replicated at a more aggregate level; using a broader definition of the older age employment rate (defined on the population aged 55-74) as the dependent variable; and with a wider set of countries on a dataset which is both more up-to-date and can be replicated using recent datasets.

[2] For the purpose of this paper, the terms "average age of labour market exit" and "effective retirement age" are used interchangeably.

[3] Turner and Morgavi (2021), in fact, used a dataset collecting the labour market variables by education, sex and single year of age from the Eurostat Labour Force Surveys for the European countries, the Current Population Survey for the United States and the Statistics Canada Labour Force Survey for Canada. Most of the European countries instead provide data in 5-year age bands.

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Table 1
The effect of raising the normal retirement age in previous OECD and IMF studies

	Effect of raising the normal retirement age by 12 months on average age of labour market exit (months)
Blöndal and Scarpetta (1999)	1.1 to 1.4
Gal and Theising (2015)	1.4
Égert and Gal (2017)	1.4
Grigoli, Koczan and Tapalova (2018)	2.3
Geppert et al. (2019)	2.4
Turner and Morgavi (2021)	2.7-4.7

Note: The original studies reported their findings in terms of an effect on the employment rate or labour force participation rate. The figures reported here are the result of the author's calculations, which are detailed in Turner and Morgavi (2021) and the appendix, and are made both to provide all estimations on a comparable basis and provide an estimate of the absolute effect on the average age of labour market exit to compare with an increase in the normal retirement age of 12 months. The calculations are based on estimated parameters reported in the respective studies, but also involve some additional assumptions. Hence, the figures in the table should be regarded as approximate, although they are robust to reasonable variations in these assumptions.

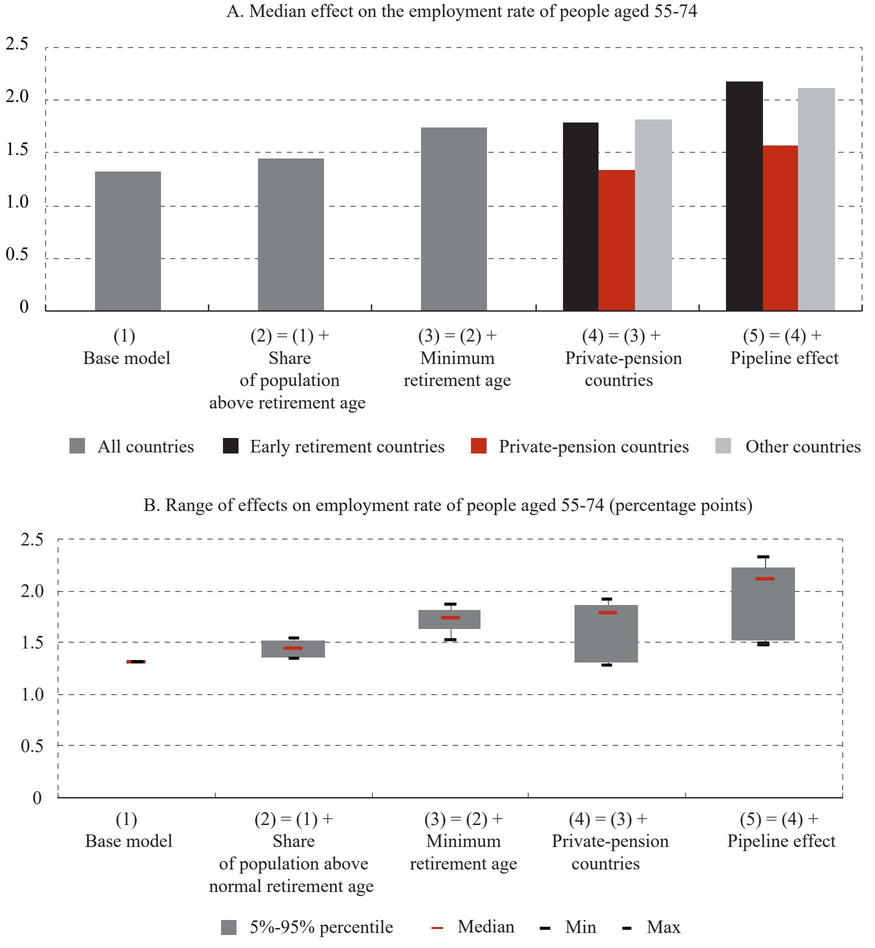
Source: Author's calculations described in the appendix.

The present work proposes several innovations to the empirical model used to quantify the effects of pension reforms. To give a sense of the importance of each modification, a standard cross-country panel error correction model (ECM) is estimated as a base model and innovations are introduced incrementally. The base model includes the normal retirement age as the main variable capturing the retirement policies, as in most of the cross-country empirical papers, as well as a set of other labour market polices and control variables. According to the base model, a 1-year increase in the normal retirement age has an estimated effect on the employment rate of those aged 55-74, equal to 1.3 percentage points. This implies a median estimated effect on the average age of labour market exit of 3.2 months, from a 1-year increase in the normal retirement age (see the appendix for the underlying calculation). The present work proceeds by incrementally introducing a number of features. The effect of each feature on quantifying the impact on old age employment age of an increase in normal retirement ages by 12 months are summarised below and in figure 1.

The innovations introduced by the present work produce much higher effects on the employment rate than implied by previous pooled country estimations, so that raising the normal retirement age is a much more worthwhile proposition for policymakers. The flexibility of the model better captures country-specificities of demography and pension systems, resulting in more heterogeneous predicted effects both across countries and through time. The model proposed, which distinguishes between minimum and normal retirement ages, enables simulations to be made on the impact of raising normal retirement ages and reducing the gap between normal and minimum retirement ages. In some countries with the lowest employment rates closing these gaps could lead to significant increases in employment rates. A few countries, in contrast, could reap substantial benefits by harmonising normal retirement ages between genders.

Figure 1

Model innovations give larger employment effects from raising the retirement age



Note: The figures compare the effect on the old age employment rate of a rise of the normal retirement age by 1 year among the models expressed in percentage points. On the x-axis the modelling innovation introduced with respect to the previous model is shown. The model specifications reported in the figure correspond to the one shown in table 3 where the results of each innovation are compared. For the models including the effects of minimum retirement age and of the pipeline effects, these are also assumed to move by 1 year in line with the change in the normal retirement age. The effects are calculated using the data for year 2020 or latest year available to compute the long-term effects. The data cover 27 countries, mostly in the European Union, but also Switzerland, Canada and the United States.

Source: Author's calculations.

The remainder of the paper is organised as follows: section 2 presents the base model, which is used as a term of comparison to measure the effects of each innovation; sections 3 to 6 introduce each innovation to the model and quantify the effects in term of goodness of fit, median effect on the older age employment rate of a 1-year increase in the normal retirement age, and heterogeneity of the estimated effects; section 7 compares the model predictions with those coming from empirical research using microdata from individual countries; section 8 shows how the model can be used for policy simulation and in particular to quantify the effects of the minimum retirement age on old age employment rates; finally, section 9 concludes.

2 THE BASE MODEL

The base model that is the starting point of the present analysis uses the employment rate for those aged 55-74 as the dependent variable and the normal retirement age as the main policy instrument. The normal retirement age is calculated as the weighted average of the normal retirement ages for men and women, using the respective population shares as weights. The normal retirement age is here defined as the age at which an individual, who entered the labour market at age 25 and had a full career, becomes eligible for a full pension from all mandatory pension schemes.[4] The model is estimated using the two-steps Engle-Granger procedure, where the long-term relationship is estimated using the dynamic OLS methodology with one lead and one lag and robust standard errors. The model can be written as follows:

$$\begin{aligned} ER_{c,t} &= \alpha_c + \alpha_P \cdot RA_{c,t} + \sum_j \alpha_j X_{j,c,t} + \varepsilon_{c,t} \\ \Delta ER_{c,t} &= \beta_c + \beta_t + \pi \cdot \hat{\varepsilon}_{c,t-1} + \beta_P \cdot \Delta RA_{c,t} + \sum_j \beta_j \cdot \Delta X_{j,c,t} + \eta_{c,t} \end{aligned} \quad (1)$$

where $ER_{c,t}$ is the employment rate of people aged 55-74; $RA_{c,t}$ is the normal retirement age of country c at time t; α_c and β_c are a set of country fixed effects; β_t are a set of time fixed effects; $X_{j,c,t}$ is a set of labour market policy variables and control variables also used to capture differences among countries in the labour and product market regulation (see table 2).

The labour and product market variables are the gross unemployment benefit replacement rate (UBGR); the detrended spending on active labour market policies per employed person, expressed as a share of GDP per capita (ALMP); the average tax wedge on the mean income; the excess coverage[5]; the EPL indicator for regular contracts[6]; and the OECD indicator of product market competition on the network industries (ETCR).[7] In addition, the life expectancy at 65 and the prime age employment rate, defined on the age group 25-54, are also included as control variables. Consistently with the overall approach to capturing the age composition of the population, life expectancy at 65 is computed by multiplying the life

[4] The retirement ages are taken from the country notes of past editions of the OECD publication *Pensions at a Glance* for both men and women separately. For the base model, the two retirement ages are then aggregated using a weighted average, with the share of population by sex as weights.

[5] The excess coverage variable is defined as the difference between the coverage of wage bargaining agreement and the share of covered workers who are represented by unions. This variable is computed from the data in the ICTWSS database.

[6] The OECD indicators of employment protection legislation (EPL) evaluate the regulations on the dismissal of workers on regular contracts and the hiring of workers on temporary contracts. For the present work the indicator for regular contracts is used. They cover both individual and collective dismissals.

[7] The OECD indicators of regulation in energy, transport and communications (ETCR) summarise regulatory provisions in seven sectors: telecoms, electricity, gas, post, rail, air passenger transport, and road freight.

expectancy at 65 for women and for men by the share of men and women aged 65+ in the population aged 55-74 expressed as a percentage. The first one captures the effect of health and longevity of the workforce and the long-term demographic trends. The latter captures overall trends in the labour markets; the impact of labour market policies not included in the model whose effects on older workers are not different than those that affect prime age workers; it also accounts for the importance of early career patterns, and of labour market attachment. The data cover 27 countries, mostly in the European Union, but also Switzerland, Canada and the United States. The panel is unbalanced. The data coverage of the estimation sample is summarized in table 2.

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Table 2
Summary table of the variables

	Minimum	Median	Mean	Maximum	Standard deviation
ER 55-74	13.3	32.0	32.7	57.5	9.7
UBGR	1.9	26.7	23.5	55.5	12.7
ALMP	2.3	27.7	31.2	97.5	21.4
Average tax wedge	1.9	31.0	30.0	48.3	9.2
Excess coverage	-4.7	20.7	29.6	87.3	26.7
EPL	0.1	2.3	2.1	4.6	0.9
ETCR	0.5	1.8	2.1	5.4	1.0
ER 25-54	58.4	80.2	79.0	88.6	5.4
LE 65	74.4	93.4	92.9	115.0	8.1

Note: ER 55-74 is the employment rate of people aged 55-74 expressed in percentage; UBGR is the gross unemployment benefit levels expressed in percentage of the previous gross earning; ALMP is the detrended active labour market policy spending on employment as a share of GDP per capita; Average tax wedge is the average tax wedge for a couple with 2 children and prime earner at 100% and second earner at 67% of the average wage; Excess coverage is the difference between the coverage of wage bargaining agreement, expressed in percentage, and the share of workers who are represented by unions covered; EPL is the OECD Strictness of employment protection for regular contract from individual and collective dismissals, the indicator, which measures the strictness of employment protection on a scale from 0 to 6, where higher values indicate more stringent regulations; ETCR is the component on regulation of network industries of the OECD PMR indicator, which measures the pro-competitive regulatory settings on a scale from 0 to 6, where higher values indicate more restrictive regulations; ER 25-54 is the employment rate of people aged 25-54 expressed in percentage; LE 65 is the life expectancy at 65. This last variable is computed by multiplying the life expectancy in years for women and for men by the share of men and women aged 65+ on the population aged 55-74 expressed as percentage. These statistics are calculated on the estimation sample, which starts from 1992 and ends in 2019, with different coverage among countries.

Source: For ER 55-74, OECD Employment database; for UBGR, OECD Social Protection and Well-being database; for ALMP, OECD Labour database; for Average tax wedge, OECD Tax statistics database; for Excess coverage, ICTWSS database; for EPL, OECD Labour database; for ETCR, OECD PMR indicator database; for ER 25-54, OECD Employment database; for LE 65, OECD Health database; and OECD Employment database.

To better compare the effects of each innovation, we kept the same set of policy and control variables constant for the long-term equation across all models. Only variables that were statistically significant in all the models were retained. Based on this criterion, the only variable included in the model was the EPL indicator. However, other labour market policies, which affect the prime age employment rate, were also included as control variables. Hence the inclusion of a labour market policy in the model is to be interpreted as the differential effect of this policy on the old age group employment rate, with respect to the prime age group. Thus, the estimated models suggest that the labour market policies affect the old age employment rate in a similar way as the prime age employment rate, except for the stricter EPL, which tends to favour older age employment age. For the short-term equation, instead, a stepwise regression was performed to select the dependent variables. Only the pension policy variables were excluded from the stepwise procedure and were always included in the short-term equations.

3 INNOVATION 1: INTRODUCING DEMOGRAPHICS

While the normal retirement age has been a common choice as a policy variable in empirical pooled-country studies on old-age labour market choices, it has limitations. This choice is equivalent to estimating the average effect among the countries in the sample or to assuming a uniform effect on the old-age employment rate of a rise in the normal retirement age, regardless of the current normal retirement age or the demographic composition[8].

A better alternative is to use the share of population aged above the normal retirement age as a pension policy variable. This is estimated as the sum of the share of men whose age is above the normal retirement age for men on the total population aged 55-74 and the share of women whose age is similarly above the normal retirement age for women on the total population aged 55-74. This approach addresses two aspects of the heterogeneity of pension systems: the differences in the normal retirement ages by sex, and the demographic compositions. It creates a direct link between normal retirement ages, demographic composition of the country and the aggregate employment rate.

Introducing the share of the population above the retirement age as an alternative pension policy variable, the proposed model fits the data better than the base model (compare models (1) and (2) in table 3), while the estimates for the common variables are similar.

[8] For further discussion on the subject, see the appendix.

Table 3
Long term equations explaining the older age employment rate

Explanatory variables	Dependent variable: employment rate of the 55-74 age group				
	Variant equations				
	(1) Base model	(2) (1) + % pop. above normal ret. age	(3) (2) + Minimum retirement age	(4) (3) + Private-pension countries	(5) (4) + Pipeline effect
Labour and product market regulations					
EPL regular contracts	5.863**	6.283**	7.932**	8.138**	8.448**
Pension policies					
Normal retirement age	1.320**				
Pipeline effect					-0.087
% pop. above minimum ret. age			-0.098	-0.095	-0.132
% pop. above normal ret. age		-0.286**	-0.243**		
% pop. above normal ret. age (private pensions countries)				-0.172	-0.176
% pop. above normal ret. age (non-private pensions countries)				-0.256**	
% pop. above normal ret. age (early exit countries)					-0.265**
% pop. above normal ret. age (other countries)					-0.275***
Other variables					
ER 25-54	0.615***	0.608***	0.586***	0.583***	0.606***
Life expectancy 65+	0.561***	0.538***	0.506***	0.516***	0.493***

Explanatory variables	Dependent variable: employment rate of the 55-74 age group				
	Variant equations				
	(1) Base model	**(2) (1) + % pop. above normal ret. age**	**(3) (2) + Minimum retirement age**	**(4) (3) + Private-pension countries**	**(5) (4) + Pipeline effect**
RMSE	2.66	2.60	2.61	2.60	2.60
Adjusted R^2 (%)	91.8	92.2	92.1	92.1	92.1
Obs.	522	522	522	522	522
Countries	27	27	27	27	27
Time coverage	1992-2019	1992 - 2019	1992-2019	1992-2019	1992-2019

Note: The table shows the estimated coefficients of the long-term equation of the model. Model (1) corresponds to the base model. Model (2) is the same as model (1) but instead of using the normal retirement age for pensions as pension policy variable, the share of population above the normal retirement age is used. Model (3) uses the database created by Geppert et al. (2019) integrated with the data from OECD (2021, 2023), which distinguish between minimum retirement age and normal retirement age. Model (4) introduces the distinction between countries where the private pension funds are important. Model (5) is equivalent to model (4), but the pipeline effect for early exit countries is added. The RMSE and the adjusted R^2 *shown in the table refer to the long-term equation only and hence are computed excluding the lagged and leading variables used in the Dynamic OLS methodology to estimate it.*

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Source: Author's calculation.

4 INNOVATION 2: DISTINGUISHING BETWEEN THE MINIMUM AND NORMAL RETIREMENT AGE

Most countries' pension schemes allow workers to retire some years before the normal retirement age, with benefits often reduced for each year taken before the normal retirement age (see OECD, 2023).

Providing an early retirement option within the old age pension system allows greater flexibility in accounting for differences in individual circumstances, including underlying health. However, such early retirement possibilities may have a negative impact on the older age employment rate. It also undermines the effects of increasing the normal retirement age if the rise is not accompanied by a correspondent rise in the minimum retirement age.

Taking advantage of the database put in place by Geppert et al. (2019), it is possible to refine the estimates and isolate the effects of the early retirement possibilities. Analysing the retirement conditions of the OECD countries, they built a database where the minimum retirement ages and the normal retirement ages are collected for the countries of the European Union plus Japan, United States, Switzerland, and Canada for the period 1990 to 2017. This database was updated with the last data available from OECD (2021, 2023). The definition of normal retirement age, accepted in the present work, is the age at which an individual, who entered the labour market at age 25 and had a full career, becomes eligible for a full pension from all mandatory pension schemes. The minimum retirement age, instead, is the age at which an individual, who entered the labour market at age 25 and had a full career, becomes eligible for a reduced pension from a mandatory pension scheme at an earlier age than the normal one[9]. In many countries a significant fall in the employment rate at these earlier ages can be observed, especially for less-educated individuals[10].

Distinguishing both ages adds the variable "Share of population above the minimum retirement age" as well as "Share of population above the normal retirement age". Incorporating these variables enables the model to account for both the minimum and normal retirement ages for men and women efficiently. Model (3) in table 3 and figure 1 shows that the presence of such possibilities of retiring before the normal retirement age dampens the employment rate of older workers. Moreover, isolating the effect of the minimum retirement age, the median estimated effect of a rise of the normal retirement age by 1 year, assuming both the minimum and normal retirement ages move in parallel, is slightly higher by around 0.30 percentage points and the range of estimates rises by 0.15 percentage points with respect to the previous model, varying between 1.53 and 1.87 percentage points (see figure 1, panel B).

This approach reduces multicollinearity issues, as the four retirement ages are highly correlated (see table 4). By using only two variables with a correlation of 0.37, the model remains parsimonious.

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[9] These variables are calculated based on the country notes of the past editions of *Pensions at a Glance* for both men and women separately.

[10] Manoli and Weber (2016) using Austrian administrative data on the 2000 and 2004 pension reform estimated that, a 1-year increase in the minimum retirement age led to a 4.8-month increase in the average job-exiting age and a 6-month increase in the average retirement age.

Table 4
Correlation among retirement ages

	Minimum retirement age		Normal retirement age	
	Men	**Women**	**Men**	**Women**
Minimum retirement age (men)	1.00			
Minimum retirement age (women)	0.73	1.00		
Normal retirement age (men)	0.28	0.41	1.00	
Normal retirement age (women)	-0.10	0.52	0.59	1.00

Note: The table shows the correlation among the retirement age variables.
Source: Author's calculation.

5 INNOVATION 3: DISTINGUISHING COUNTRIES WITH IMPORTANT PRIVATE PENSION FUNDS

The importance of private pension funds reduces the relevance of the public normal retirement age in favour of the rules and the incentives set by the private pension funds. Private pension funds often allow individuals to customise their retirement planning based on their financial situation preferences. Some private pension funds offer incentives for delaying retirement, such as increased benefits or bonuses. This can incentivise working longer, even beyond the public normal retirement age, to maximise their private pension benefits. Workers with lower salaries may have little room for financial commitments such as contributions to voluntary private pension schemes and may be forced to withdraw funds from their private pension accounts to meet more pressing short-term financial challenges. As a result, individuals may prioritise the rules and incentives offered by private pension funds over the fixed public retirement age and sometimes may be forced by necessity to work even after the normal retirement age to achieve a dignified retirement.

Following the approach in Turner and Morgavi (2021) it is possible to differentiate for countries where private pension funds are important (henceforth "private pension countries"[11]). They find that these groups of countries are less responsive to changes in the normal retirement age. For the present work, countries are considered as having an important voluntary private pension system (private pension countries) if voluntary private pensions cover a large share of the working population and the replacement rate from such schemes is at least 60% of that in the public mandatory pension scheme.

[11] For the purposes of the current estimation, countries are characterised as having an important voluntary private pension system if voluntary private pensions cover a large share of the working population and the replacement rate from such schemes is at least 60% of that in the public mandatory pension scheme. Using data from tables 5.3 and 9.1 in OECD (2019), this includes Canada, Ireland, Israel, Japan, Mexico, the United Kingdom, and the United States.

The estimated parameters confirm the lower responsiveness of the private pension countries[12]. The estimated coefficient for private pension countries, in fact, is equal to -0.172, even if the parameter is not statistically significant, to be compared with -0.256 for the other countries, see model (4) in table 3. Thus, a 1-year increase in the normal retirement age in the median private pension country raises the older age employment rate by 1.3 percentage points, compared to 1.8 for the median country among the other ones, see model (4) in figure 1, panel A. Differentiating the effect of changes in the normal retirement age of private pension countries, slightly increases the estimated effects on the other countries. Consequently, the median estimated effect of a rise of the normal retirement age by 1 year on the older age employment rate is 0.04 percentage points higher and the range of estimates is 0.29 percentage points greater with respect to model (3), varying between 1.29 and 1.92 percentage points (see figure 1, panel B).

6 INNOVATION 4: DISTINGUISHING COUNTRIES WITH ALTERNATIVE EARLY EXIT PATHWAYS

The concept of early exit pathways, as developed by Kohli (1991), refers to institutional arrangements linked to managing the transition between work exit and entry into the regular old-age pension system. Early exit pathways, shaped by economic challenges like the high unemployment in the late 1970s and early 1980s, take the form of early retirement pensions, disability benefits, and extended unemployment benefits. These pathways provide easily accessible and relatively generous benefits, influencing older workers to withdraw from the labour market. Despite the initial economic rationale fading, early exit pathways persisted, becoming ingrained in workers' and employers' expectations, decoupled from the business cycle, often serving as pull factors for older workers to withdraw from the labour market, by offering easily accessible and relatively generous benefits.

In the countries where alternative early exit pathways are important, the labour force participation falls already 1 or 2 years before the minimum retirement age (a so-called "pipeline effect"), especially for less-educated individuals. This is captured in the model by the inclusion of an additional variable, called "the pipeline effect", which is defined as the share of the population aged 55-74 whose age is higher than one year below the minimum retirement age and who also have a "less educated"[13] background[14]. The importance of the early exit pathways reduces the importance of the normal retirement ages for individuals' labour market choices.

[12] The two coefficients are estimated separately by creating two variables: the first one is obtained by interacting the variable "share of population above the retirement age" with a dummy variable assuming value 1 if the country is a "private pension" one and zero otherwise; the second one is obtained by interacting the variable "share of population above the retirement age" with a dummy variable assuming value 1 if the country is not a "private pension" one and zero otherwise. This method reduces the power of the estimators but avoids problems of multicollinearity.

[13] For the purpose of this paper, "less-educated" corresponds to the levels 0-2 of the 2011 standard of the International Standard Classification of Education (ISCED).

[14] Staubli (2011) show that tighter eligibility criteria in the Austrian disability insurance program induced an increase in employment of 1.6 to 3.4 percentage points and brought important spillover effects into the unemployment and sickness insurance program. Borghans, Gielen and Luttmer (2014) show that more stringent criteria for accessing the disability insurance benefits induced in the Netherlands an increase in the employment rate by 2.9 percentage points and, at the same time, an increase in other social assistance programmes.

For the present work, countries are considered as having important early exit pathways ("early exit countries") if their effective retirement age is below its minimum retirement age in the current year and in the 4 previous ones. This implies that the list of early exit countries changes every year: for example, in 1997 only Luxembourg is considered an early exit country; in 2008, Austria, Belgium, France, Italy, the Netherlands, and Poland; in 2019, Belgium, France, Greece, Hungary, Italy, the Netherlands, Poland, and Spain. Model (5) distinguishes early exit countries and captures the effect of the presence of the pipeline effect for those countries. The estimated parameters confirm the lower responsiveness of the early exit countries and the presence of a pipeline effect, even if restricted to the first year before the minimum retirement age and for the less-educated individuals only[15]. Isolating the pipeline effect increases the estimated minimum retirement and normal retirement effects. Consequently, the median estimated effect of a rise of the normal retirement age by 1 year on the older age employment rate is 0.33 percentage points higher and the range of estimates is 0.52 percentage points greater than in model (4), varying between 1.49 and 2.35 percentage points (see figure 1, panel B).

7 COMPARISON WITH SINGLE-COUNTRY ESTIMATES

This section compares the estimated effects of historical pension reforms or of pension reform proposals, using the presented model, with quantifications from single-country studies analysing the same policy changes.

Discrepancies might be expected from the ability of single-country studies to account more accurately for the unique characteristics of each nation's pension system, other relevant policies, demographics, and economic conditions. Additionally, the use of microdata in these studies allows for a more granular analysis that cannot be captured by macro-level models. The capacity of micro-level models to include a wide range of variables, such as employment history, income distribution, health status, and retirement intentions, contributes to a more comprehensive understanding of how pension reforms impact different segments of the population.

Nevertheless, despite the differing methodologies, the estimated effects from the two approaches are remarkably similar, with the panel estimates of reform effects being within 20% of the country-specific estimates in 5 out of the 7 cases considered (table 5). Macro-models often fail to capture the complexity and the many differences among the countries pension systems and for this reason are frequently considered inferior to studies using micro data. However, the innovations proposed in the present study, which improve the capture of country-specific demographics and pension system characteristics, show that cross-country macro estimations can give results that are comparable to those derived from micro-level data. This approach can be particu-

[15] Staubli and Zweimüller (2013), using the social security data for Austria, estimate that the gradual rise in the minimum retirement age from 55 to 58.25 for women and from 60 to 62 for men between 2001 and 2010 resulted in an increase in the employment rate by 9.75 percentage points for men and 11 percentage points for women. They also estimated that, at the same time, unemployment increased by 12.5 percentage points among men and by 11.8 percentage points among women.

larly advantageous in situations where micro data are scarce or difficult to obtain, as it allows for meaningful analysis of retirement policies across different countries without requiring extensive individual-level data. This is particularly important in broad comparative studies or where access to granular data is limited.

Table 5

The predictions of the model are consistent with those of single-country studies

Study	(1) Country	(2) Year of reform[1]	(3) Increase in normal retirement age (months)	(4) Effect on average effective age of retirement (months): Original study	(5) Effect on average effective age of retirement (months): Proposed model
Mastrobuoni (2009)	USA	2000	2	1	0.6
Fehr, Kallweit and Kindermann (2012)	DEU	2008	24	9-12	8.4
Hanel and Riphahn (2012)	CHE	2001 & 2005	12	2.3-5.4	4.2-4.3
Lalive and Staubli (2015)	CHE	2001	12	7.9	4.2
Etgeton (2018)	DEU	2012	24	8.4	8.1
Fodor, Roehn and Hwang (2022)	SVK	2020	7	7	5.7

Note: (1) The year refers to the year of the pension reform analysed or to the year of reference of the quantification. (2) The quantification using the proposed model is made by estimating the effect of a 1-year increase in the country's normal retirement age for the specified year, using the estimates from model (5) in table 3 and the data on the demographic composition in the estimation sample for the specific year. The estimated impact for a 1-year increase was subsequently rescaled to the actual change.

Source: Author's calculations.

8 THE EFFECT OF CHANGING THE GAP BETWEEN MINIMUM AND FULL NORMAL RETIREMENT AGES

The quantifications considered above compute the effects on the older age employment rate of raising the normal retirement age by 1 year, assuming that the minimum retirement age also increases simultaneously by 1 year. However, the experience of past OECD pension reforms demonstrates that this is not always the case and that reforms sometimes increase the gap between the two pension ages[16]. The proposed model in section 6, by distinguishing between the normal age of retirement and a

[16] For example, in Belgium the normal retirement age for women in the period 1998-2007 was raised 5 times from 60 to 65 while the minimum retirement age remained constant at 60; in Switzerland the normal retirement age for women was raised twice, in 2001 and 2005 while the minimum retirement age remained constant at 62. In the Czech Republic, the normal retirement age was for both men and women raised twice, in 2019 and 2020 while the minimum retirement age remained constant; in Germany the normal retirement age for both men and women was raised in 2018 while the minimum retirement age remained constant; and in Portugal the normal retirement age for women was raised 3 times in the period 1994-8 while the minimum retirement age remained constant. Other countries instead raised the statutory retirement age while at the same time they lowered minimum retirement age: for example, Italy for male workers in 2012.

minimum age of retirement, permits simulation of the effects of closing the gap between these two ages rather than raising them both concomitantly. The presence of minimum retirement ages gives more freedom for the workers to choose to forego a part of their pension and retire at an earlier age than the normal age at which they are eligible for a full pension. If the reduced pension is correctly calibrated to account for the longer retirement period, no additional financial pressure is exerted on the pension system. Greater choice allows for differences in individual circumstances, in particular health, with potentially positive effects on wellbeing. This may be the case in occupations where the decline in physical or cognitive abilities of older workers pose a risk to themselves or others, such as those in public security and safety services or manual occupations characterised by challenging working conditions that, over extended periods, could lead to adverse health outcomes. However, as pointed out in OECD (2023), these cases can primarily be dealt with by policies outside the realm of old-age pensions such as health and safety regulations; reskilling and upskilling frameworks to facilitate career transitions; accessible, efficient and responsive long-term sickness benefits and disability insurances; and special pension schemes covering workers in hazardous or arduous jobs.

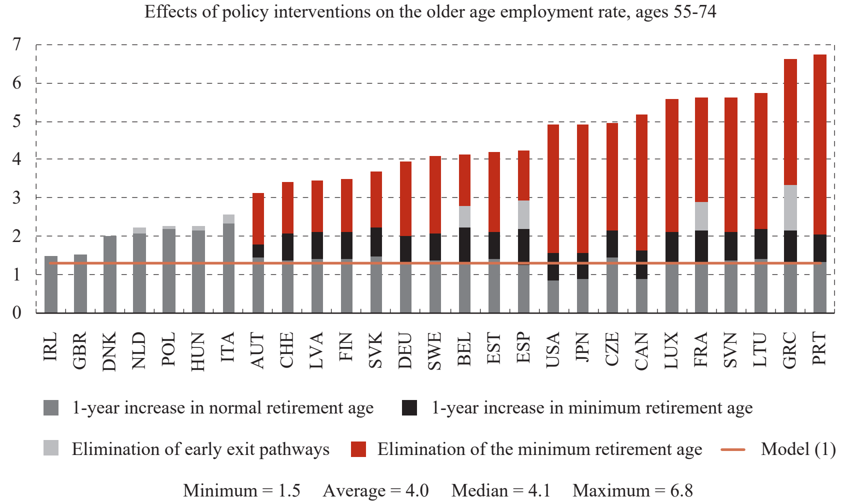
Four possible policy changes related to rises in the retirement ages are evaluated in figure 2 using the final model (5), incorporating all the modelling innovations[17]:

1) A 1-year increase in the normal retirement age, keeping the minimum retirement age unchanged.
2) A 1-year increase in the minimum retirement age, keeping the full normal retirement age unchanged after the previous one-year increase. This effect is only relevant for countries that offer a minimum retirement age option. It further assumes the corresponding "pipeline effect" introduced in section 6 also shifts by one year.
3) Elimination of the early exit pathway. This effect is positive only for the early exit countries.
4) Elimination of the minimum retirement ages, assuming that the minimum retirement age becomes equal to the normal retirement age. To better assess the scale of such effects the policy change is considered simultaneously with a 1-year increase in the normal retirement age and the elimination of the early exit pathways.

[17] The correspondent underlying model is described in the appendix while figure A1 visualise the effects of the four reforms using the underlying model.

Figure 2

Policy simulations changing the gap between the minimum and normal retirement ages (percentage points)



Note: This figure shows the effects of a set of policy changes by country based on the estimated model (5) using the data for the year 2020: the effects of raising the normal retirement ages by 1 year (without any changes in the minimum retirement ages), raising the minimum retirement ages by 1 year and correspondingly moving the pipeline effect by 1 year; eliminating the early exit pathways, if present, for all the countries in the sample, based on the estimated model. The elimination of the early exit pathways is equivalent to moving the correspondent effect to the minimum retirement age, incorporating the 1-year increase in the minimum retirement age. The elimination of the minimum retirement age is equivalent to raising the minimum retirement age, and the correspondent pipeline effect, to be equal to the normal retirement age, incorporating the 1-year increase in the normal retirement age and the elimination of the early retirement pathways. The estimated effects are compared with those obtained in the base model.

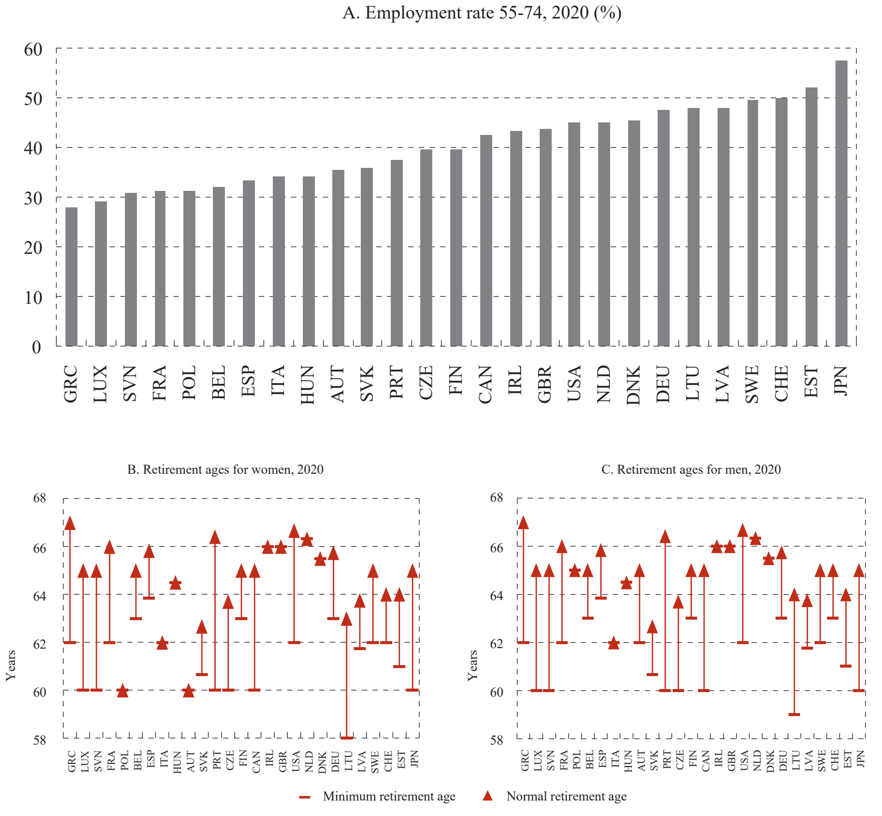
Source: Author's calculations.

The results presented in figure 2 show that the employment effect of raising the normal retirement age is much smaller if the minimum retirement age remains unchanged. The rise in the minimum retirement age impacts a younger, and therefore generally greater, share of the population. The elimination of early exit pathways ("pipeline" effects) can have substantial effects, as in the case of France, Spain, and Greece, which have a minimum retirement age between 2 and 5 years before the normal retirement age. Italy, the Netherlands, Poland, and Hungary by contrast did not have a distinct minimum retirement age in 2020, (so that the minimum retirement age is the same as the normal retirement age) hence, the elimination of the early exit pathway affects a much older, and therefore generally smaller, share of the population.

Many countries have recently (or are in the process of) reducing the distance between the two retirement ages, as for example, in Belgium, Spain, Finland, France, and Hungary (figure 3, panels B and C). Some of the countries with the lowest older age employment rates have significant scope for a reduction of the distance between the normal and the minimum retirement age; this includes Greece, Luxembourg, Slovenia, and France (figure 3, panel A). The normal retirement age of these countries is equal to or above the median normal retirement age of the sample, but the possibility to retire early on a reduced pension likely reduces their old age employment rate. Other countries like Poland and Austria can instead reduce the differences in the normal retirement ages between men and women.

Figure 3

The countries with the lowest old age employment rate also have big retirement age gaps



Source: OECD Employment database; and OECD Pension at a Glance database.

9 CONCLUSIONS

The employment rate at older ages is affected, as is any other age group, by fiscal and activation policies, wage setting institutions and labour and product market regulations. What is peculiar to this age group is the importance of the pension policies in conjunction with the demographic dynamics. Pension policies specifically affect the population approaching the retirement ages. Predicting the effects of changes in the retirement ages requires a model that effectively integrates two key aspects of pension policies: retirement rules and demography. Neglecting either pension policies or demographic considerations leads to ineffective analysis.

The proposed model introduces several innovations to the base model. Replacing the normal retirement age with the share of population above the normal retirement age as the main pension policy variable allows for different effects of policy reforms among countries. This variable efficiently combines policy and demographic information and is closely linked to the policy instruments to allow for policy simulations. Given its foundation on a single age year model, the model can be easily generalised to incorporate specific dynamics like education, gender, presence of early exit pathways, etc. Distinguishing between minimum and normal retirement ages allows inclusion of the undermining effect of the presence of minimum retirement ages in the model. Accounting for pension systems specificities allows quantification of the undermining effect of alternative early exit pathways and the reduced responsiveness to changes to normal retirement ages due to the importance of private pension systems.

The models estimated using this approach better fit the data and provide predictions of the effects of pension reforms that are closer to the estimates coming from country-specific studies. The quantifications are different among countries, based on both the pension policies put in place by the government and the demography of the country. The innovations to the model introduced by the present work, tend toward greater diversification of the estimated effects and closer predicted effects to those estimated in single-country studies, compared to the base model. This results in a higher median effect, compared to the base model: the median estimated effect of an increase in the normal retirement ages on employment rate by adopting model (5) is around 60% greater than the one estimated using the base model. The effects range between 1.49 and 2.35 percentage points, while it is the same for all countries in the base model, which estimates the average effect in the sample.

The proposed model, distinguishing between minimum and normal retirement ages, allows one to make policy simulations on the effects of raising the normal retirement ages and of reducing the distance between the normal retirement age and the minimum retirement age. Some of the countries with the lowest older age employment rate have significant retirement age gaps. Reducing this gap can have significant effects on the employment rate. Other countries can instead benefit from reducing the differences in the normal retirement ages between men and women. The adjusting horizon for changes in the retirement ages is quite long, probably due to grandfathering options. For this reason, it is important to anticipate the effects of demographic changes or to include automatic adjustment mechanism for the retirement ages.

Disclosure statement
The author has no conflicts of interest to declare.

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THE UNDERLYING MODEL

The employment rate at age 55-74 can be written in the following way:

$$ER_{55-74} = \frac{Empl_{55-74}}{POP_{55-74}} = \frac{\sum_{a=55}^{74} Empl_a}{POP_{55-74}} = \frac{\sum_{a=55}^{74} ER_a \cdot POP_a}{POP_{55-74}} = \sum_{a=55}^{74} P_a \cdot ER_a \quad \text{(A1)}$$

where:

$P_a = \frac{POP_a}{POP_{55-74}}$ is the share of population of age a on the total of population aged 55-74;

$ER_a = \frac{E_a}{POP_a}$ is the employment rate at age a.

The present model is based on the one estimated by Turner and Morgavi (2021) using single year age class data. The original model used the participation rate by age class while the present model uses the employment rate, as dependent variable. It assumes that there is a natural friction in the employment rate: the older is the worker the less likely he is to be working, independently of the retirement age. In the model proposed in the present work this assumption was dropped. It also assumes that the employment rate at the retirement ages falls by the same amount for all countries, independently of the retirement age. The employment rate for each country sex, age, year combination (c, s, a, t) can therefore be written as follows:

$$ER_{c,s,a,t} = \theta_c + \theta_t + \theta_r \cdot I\left(a \geq retirement\ age_{c,s,t}\right) + \sum_j \theta_j X_{j,c,t} \quad \text{(A2)}$$

where θ_c is a country fixed effect, θ_r is the retirement age effect, X_j are a set of control variable variables of interest and θ_j their associated coefficients. Consequently, the employment rate of population is assumed to remain constant at $\theta_c + \theta_t + \sum_j \theta_j X_{j,c,t}$ until the year before the retirement age when it falls by θ_r percentage points.

Aggregating equation (3) by age, becomes:

$$ER_{c,t} = \theta_c + \sum_s \theta_r \cdot P_{c,(a \geq retirement\ age_{c,s,t}),s,t} + \sum_j \theta_j X_{j,c,t}$$

Which is equivalent to the proposed model.

Grouping together the country and year fixed effects and the control variables $X_{j,c,t}$ in equation (3), which for a given country at a given year are constant, in the constant θ_0, the model can be rewritten in the following way:

$$ER_a = \theta_0 + \theta_r \cdot RET_a,\ where\ RET_a = \begin{cases} 1,\ if\ a \geq retirement\ age \\ 0,\ otherwise \end{cases}$$

Therefore, if the retirement age if equal to R_a

$$\begin{aligned} ER_{55-74}\left(R_a\right) &= \sum_{a=55}^{74} P_a \cdot ER_a = \sum_{a=55}^{74} P_a \cdot \left[\theta_0 + \theta_r \cdot RET_a\right] \\ &= \sum_{a=55}^{74} P_a \cdot \theta_0 + \theta_r \cdot \sum_{a=55}^{74} P_a \cdot RET_a = \theta_0 + \theta_r \cdot \sum_{a=R_a}^{74} P_a \end{aligned} \tag{A3}$$

If, instead, the retirement age is raised to $R_a + 1$, it can be written:

$$ER_{55-74}\left(R_a + 1\right) = \theta_0 + \theta_r \cdot \sum_{a=R_{a+1}}^{74} P_a$$

The effect on the employment rate of the raise of the retirement age from R_a to $R_a + 1$ is

$$ER_{55-74}\left(R_a + 1\right) - ER_{55-74}\left(R_a\right) = \left(\theta_0 + \theta_r \cdot \sum_{a=R_{a+1}}^{74} P_a\right) - \left(\theta_0 + \theta_r \cdot \sum_{a=R_a}^{74} P_a\right) = -\theta_r \cdot P_{R_a}$$

The effect is equal to the parameter θ_r multiplied by the share of population at the initial retirement age P_{R_a}.

In the same way, it can be demonstrated that the effect of a 1-year change in the minimum and in the normal retirement age is given by:

$$\begin{aligned} & ER_{55-74}\left(minR_a + 1, normR_a + 1\right) - ER_{55-74}\left(minR_a, normR_a\right) \\ & = -\theta_{minret} \cdot P_{minR_a} - \theta_{normret} \cdot P_{normR_a} \end{aligned}$$

While the effect of increasing the normal retirement age by 1 year and the eliminating of the early exit pathways, that is letting the minimum retirement age be equal to the normal retirement age, can be quantified as follows:

$$\begin{aligned} & ER_{55-74}\left(minR_a + 1, normR_a + 1\right) - ER_{55-74}\left(minR_a, normR_a\right) \\ & = -\theta_{pipeline} \cdot \sum_{a=\min R_a - 1}^{normR_a} P_a - \theta_{minret} \cdot \sum_{a=\min R_a}^{normR_a} P_a - \theta_{normret} \cdot P_{normR_a} \end{aligned}$$

Figure A1 shows the effect of a pension reform on the employment rate by age, according to the underlying model. The employment rate is assumed to remain constant until the age year before the retirement ages. A first fall in the employment rate occurs the year before the minimum retirement age due to the pipeline effect, for the early exit countries only. This fall is equal to the pipeline effect $\theta_{pipeline}$. The second additional reduction in employment rate occurs at the minimum retirement age (*minret*), if present, and it is equal to the early retirement age effect, θ_{minret}. A share of the population prefers to renounce to part of the full pension to retire some years before the normal retirement age normal retirement rate ($normR_a$). At this age workers eligible for a full pension from all mandatory pension schemes. This fall is equal to the normal retirement age effect, $\theta_{normret}$.

If one assumes that all the population shares P_a are constant, formula (A3) can be rewritten in the following way.

$$ER_{55-74}(R_a) = \theta_c + \theta_t + \theta_r \cdot \sum_{a=R_a}^{74} \frac{1}{20} = \theta_c + \theta_t + \theta_r \cdot \frac{74 - R_a}{20} \quad \text{(A4)}$$

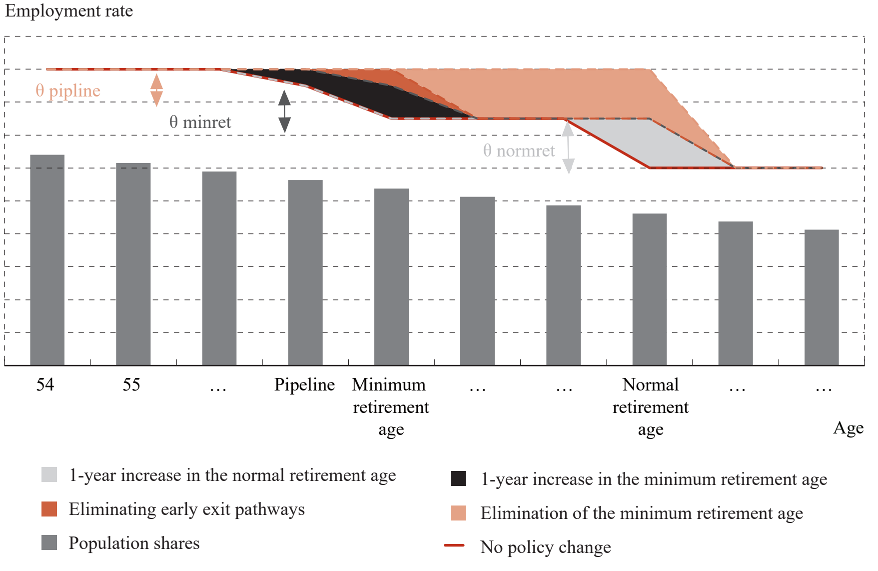
Hence

$$ER_{55-74}(R_{a+1}) - ER_{55-74}(R_a)$$
$$= \left(\theta_c + \theta_t + \theta_r \cdot \frac{74 - R_{a+1}}{20}\right) - \left(\theta_c + \theta_t + \theta_r \cdot \frac{74 - R_a}{20}\right) = -\frac{\theta_r}{20} R_a \quad \text{(A5)}$$

This shows that using the normal pension age in the regression model is equivalent to the proposed model, assuming that the population shares are constant and the parameter θ_r is -20 times the estimated parameter using the normal pension age variable, or -1/5 if, as it is the case in the present work, the shares are expressed in percentage.

Figure A1

Model visualisation



Note: The disaggregated model underlying model (5) is shown together with the effect of three possible pension reforms: a 1-year raise in the normal retirement age, a 1-year raise in the minimum retirement age, and the elimination of early exit pathways, consistent with the quantification in figure 2. An increase of 1 year in the minimum and in the normal retirement age has an effect that is proportional to the population shares at those ages. The effect of eliminating the early exit pathways, that is to move the minimum retirement age to the normal retirement age, instead is proportional to the share of population whose age is included between the age year before the initial minimum retirement age and the final normal retirement age.

Source: Author's illustration.

APPROXIMATED EFFECTS ON THE AVERAGE AGE OF LABOUR MARKET EXIT

The employment rate at age 55-74 can be written in the following way:

$$ER_{55-74} = \frac{Empl_{55-74}}{POP_{55-74}} = \frac{\sum_a Empl_a}{POP_{55-74}} = \frac{\sum_a ER_a \cdot POP_a}{POP_{55-74}} = \sum_a ER_a \cdot P_a \qquad \text{(A6)}$$

If, as it implicit in the proposed model, changes in the retirement age affect the labour market choices of the population whose age is equal at the initial retirement age and assuming no changes in the age composition of the population, the effect on the employment rate of a change in the retirement ages is given by:

$$\Delta ER_{55-74} = \sum_{a=55}^{74} \Delta ER_a \cdot P_a = \Delta ER_{R_a} \cdot P_{R_a} \qquad \text{(A7)}$$

Ignoring deaths, assuming the age structure is stable, that nobody retires before age 55 and everyone retires by age 75, the average age of labour market exit can be calculated as[18]:

$$AALME = \sum_{a=55}^{74} a \cdot \frac{A_{a-1} \cdot P_{a-1} - A_a \cdot P_a}{A_{54} \cdot P_{54}}$$

where:

$AALME$ is the average age of labour market exit;

A_a is the participation rate at age a.

The effect of a change in the retirement age on the average age of labour market exit is:

$$AALME(R_a+1) - AALME(R_a) = \Delta\, AALME = \sum_{a=55}^{74} a \cdot \frac{\Delta A_{a-1} \cdot P_{a-1} - \Delta A_a \cdot P_a}{A_{54} \cdot P_{54}} \qquad \text{(A8)}$$

Where the Δ express the difference between before and after the reform. Expanding the RHS of (A8) gives:

$$\Delta AALME = \frac{1}{A_{54} \cdot P_{54}} \qquad \text{(A9)}$$

$$\cdot \Big[\left(\Delta A_{54} \cdot P_{54} - \Delta A_{55} \cdot P_{55} \right) \cdot 55 + \ldots + \left(\Delta A_{R_a-1} \cdot P_{R_a-1} - \Delta A_{R_a} \cdot P_{R_a} \right) \cdot R_a$$

$$+ \left(\Delta A_{R_a} \cdot P_{R_a} - \Delta A_{R_{a+1}} \cdot P_{R_a+1} \right) \cdot \mathrm{R}_{a+1} + \ldots + \left(\Delta A_{73} \cdot P_{73} - \Delta A_{74} \cdot P_{74} \right) \cdot 74 \Big]$$

If one assumes that there is no unemployment and therefore all the active population is employed, the formula above can be rewritten in the following way.

[18] See: https://www.oecd.org/els/soc/Labour-Market-Exit-Age-Methodology.pdf.

$$\Delta AALME = \frac{1}{A_{54} \cdot P_{54}} \cdot \Big[\left(\Delta ER_{54} \cdot P_{54} - \Delta ER_{55} \cdot P_{55} \right) \cdot 55 + \ldots + \left(\Delta ER_{R_a - 1} \cdot P_{R_a - 1} - \Delta ER_{R_a} \cdot P_{R_a} \right) \cdot R_a + \left(\Delta ER_{R_a} \cdot P_{R_a} - \Delta ER_{R_{a+1}} \cdot P_{R_a + 1} \right) \cdot R_{a+1} + \ldots + \left(\Delta ER_{73} \cdot P_{73} - \Delta ER_{74} \cdot P_{74} \right) \cdot 74 \Big] \tag{A10}$$

If, as above, one assumes that changes in the retirement age affect the labour market choices of the population whose age is equal at the initial retirement age and that no changes in the age composition of the population occur, the equation above can be written in the following way:

$$\Delta AALME = \frac{1}{A_{54} \cdot P_{54}} \cdot \Big[\left(0 \cdot P_{54} - 0 \cdot P_{55} \right) \cdot 55 + \ldots + \left(0 \cdot P_{R_a - 1} + \Delta ER_{earR_a - 1} P_{R_a} \right) \cdot R_a + \left(\Delta ER_{R_a} \cdot P_{R_a} - 0 \cdot P_{R_a + 1} \right) \cdot \left(R_a + 1 \right) + \ldots + \left(0 \cdot P_{73} - 0 \cdot P_{74} \right) \cdot 74 \Big] = \frac{1}{A_{54} \cdot P_{54}} \cdot \Delta ER_{R_a} \cdot \left(R_{a+1} - R_a \right) \cdot P_{R_a} = \frac{\Delta ER_{R_a}}{A_{54} \cdot P_{54}} \cdot P_{R_a} = \frac{\Delta ER_{55-74}}{A_{54} \cdot P_{54}} \tag{A11}$$

Following the same logic, it can be demonstrated that the same result is valid for all the models.

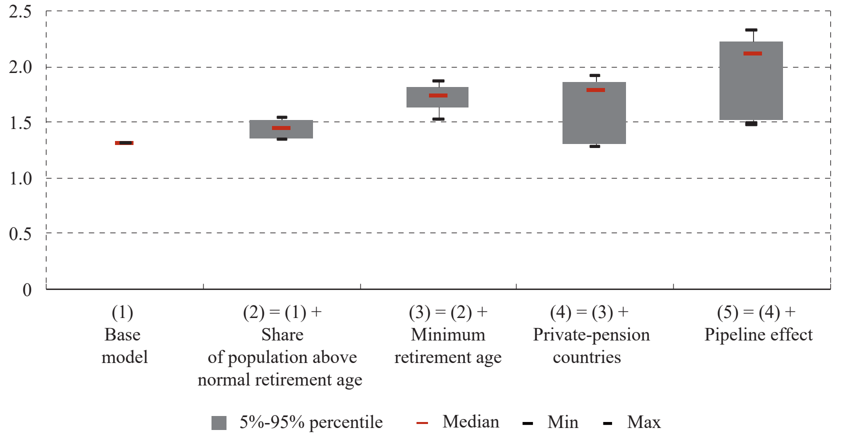
Equation (A11) can thus be used to have an order of magnitude of the correspondent effects on the average age of labour market exit of a 1-year increase in the normal retirement age for each model. Given the strong assumptions they are based on the resulting estimated effects have no ambition of precision. They can however give an order of magnitude.

This formula was used for the computations in table 1. Given the different set of countries included in the estimation samples of the different studies, the values of A_{54} and P_{54} are the correspondent OECD averages. The set of models in the present work are instead compared using the data of the estimation sample, which is the same for all the models. In the case of model (1) the effect on the employment rate is equal to 1.32 for all the countries. Hence the variability in entirely due to the variability in A_{54} and P_{54}. Thus, the estimated effects on the average age of labour market exit ranges between 2.53 and 4.22 months with a median of 3.17 months. The effects of pension reforms on the employment rate in the other models instead are more dispersed. The estimated effect on the average age of labour market exit is affected by the joint variation of A_{54}, P_{54} and the effects on the employment rate. The estimated effects on the average age of labour market exit consequent to model (2) range between 2.68 and 4.91 months, with a median of 3.47 months. The range of the estimated effects is thus 0.54 months greater than those consequent to the base model and the median is 0.30 months higher. The estimated effects on the average age of labour market exit consequent to model (3) range between 3.23 and 5.84 months, with a median of 4.26 months. The range of the estimated effects is thus 0.38 months greater than those consequent to model (2) and the median is 0.79 months higher. The estimated effects on the average age of labour market exit consequent to model (4) range between 3.06 and 6.00 months, with a median of 4.04 months. The range of the estimated effects is thus 0.33 months greater than those consequent to the base model and the median is 0.22 months lower. The estimated effects on the average age of labour market exit consequent to model (5) range between 3.52 and 7.14 months, with a median of 5.02 months. The range of the estimated effects is thus 0.67 months greater than those consequent to the base model and the median is 0.97 months lower. Figure A2 compares the models both in terms of the effects on the old age employment rate and on the average age of labour market exit.

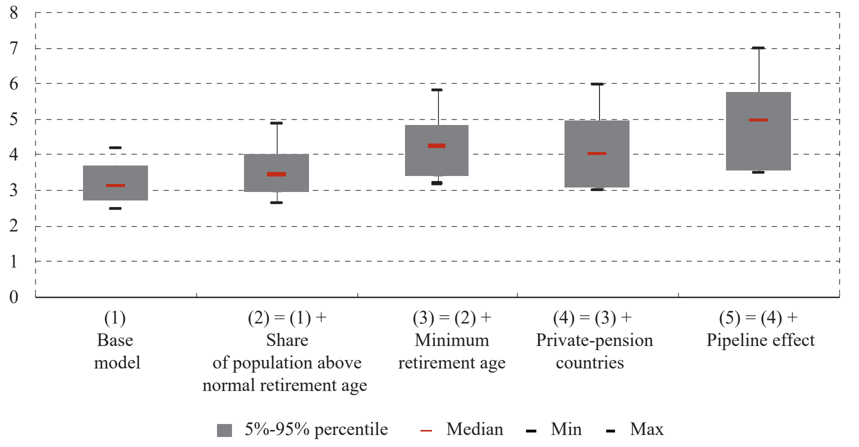
Figure A2

Comparing the effects on ER-55-74 and on AALME under the proposed model

A. Effects on old age employment rate (percentage points)



B. Effects on average effective age of labour market exit (months)



Note: The figure compares the long-term effect on the old age employment rate and on the average age of labour market exit of a raise of the normal retirement age by 1 year among the models expressed in percentage points and months, respectively. On the x-axis, for each model, the main innovation introduced with respect to the previous model is shown. For the models including the effects of minimum retirement age and of the pipeline effects, these are also assumed to move by 1 year. The red horizontal marks show the median of the distribution of the effects among the countries in the sample; the blue boxes show the distance between the fifth and the ninety-fifth percentile; and the whiskers show the minimum and the maximum values. The effects are calculated using the data for year 2020 or latest year available.

Source: Author's calculations.