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DETERMINANTS OF LABOUR MARKET EXIT OF OLDER WORKERS IN THE SLOVAK REPUBLIC

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ABSTRACT / RESUME

Determinants of labour market exit of older workers in the Slovak Republic

The Slovak population is set to age rapidly in the next decades, with significant impacts on economic growth and the sustainability of public finances. At the same time, the labour market exit age in Slovakia is among the lowest in the OECD. We use administrative data for Slovakia between 2013 and 2020 to analyse what factors influence the probability of employment exit of older workers. We find that statutory retirement ages have an important influence on the decision to leave employment. Higher educational attainment is associated with later employment exit, suggesting that the employment rate of older workers is likely to increase in the future as younger generations have higher educational attainment. We also find evidence that workers in sectors that are physically more demanding are exiting employment earlier. Impaired health also leads to significantly earlier employment exits. Finally living in a rural area or in areas with high unemployment is associated with earlier exit from the labour market.

JEL Classification: J21, J26

Keywords: ageing, older workers, labour supply, statutory retirement ages

This Working Paper relates to the 2022 OECD Economic Survey of the Slovak Republic (https://oe.cd/svk).

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Facteurs de la sortie du marché du travail des travailleurs âgés en République Slovaque

La population slovaque est amenée à vieillir rapidement au cours des prochaines décennies, ce qui aura des répercussions importantes sur la croissance économique et la viabilité des finances publiques. Par ailleurs, l'âge de sortie du marché du travail en Slovaquie est parmi les plus bas de l'OCDE. Nous avons utilisé des données administratives de la Slovaquie, comprises entre 2013 et 2020, afin d'analyser quels sont les facteurs qui ont une influence sur la probabilité de sortie de l'emploi des travailleurs âgés. Nous avons constaté que l'âge légal de la retraite a un impact important sur la décision de quitter l'emploi. Un niveau d'éducation plus élevé est associé à une sortie de l'emploi plus tardive, ce qui suggère que le taux d'emploi des travailleurs âgés est susceptible d'augmenter à l'avenir, les jeunes générations ayant un niveau d'éducation plus élevé. Nous avons également constaté que les travailleurs des secteurs physiquement plus exigeants quittent l'emploi plus tôt. Les problèmes de santé entraînent aussi des sorties d'emploi beaucoup plus précoces. Enfin, le fait de vivre dans une zone rurale ou dans une zone à fort taux de chômage se traduit par une sortie plus précoce du marché du travail.

Classification JEL: J21, J26

Mots clés: vieillissement, travailleurs âgés, offre de travail, âge légal de la retraite

Ce Document de travail a trait à l'Étude économique de l'OCDE de la République Slovaque (https://oe.cd/svk)

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Determinants of labour market exit of older workers in the Slovak Republic

By Jakub Fodor, Oliver Roehn, and Hyunjeong Hwang[1]

Introduction

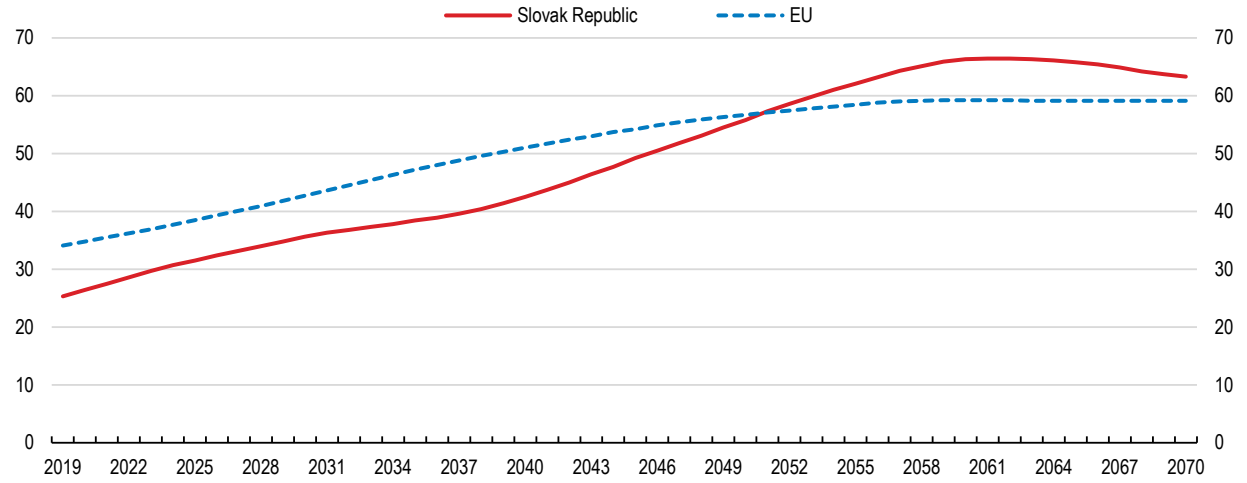
Slovakia's population is ageing rapidly. As larger cohorts move into retirement, smaller cohorts will replace them in the labour market. According to Eurostat, life expectancy in Slovakia is projected to increase faster than in other EU countries in the next 50 years (EC, 2021), given the currently low life expectancy and assumed convergence of mortality rates across EU countries in the long-term. Increasing life expectancy and low fertility rates will cause the share of economically inactive population to rise substantially. According to the most recent Eurostat projection the ratio of people aged 65+ to 20-64 will increase from 25.9 % in 2019 to 63.1 % in 2070, which is the second highest projected increase within the EU (Figure 1).

The growing share of the elderly will increase pressure on public finances. In 2019, the pension expenditures in Slovakia amounted to 8.3 % of GDP, well below the EU average of 11.6 % of GDP (EC, 2021). This is largely due to the currently younger population in Slovakia, while replacement rates and time spent in retirement are close to the EU average (EC, 2021). However, public expenditure on pensions is projected to increase by around 6 percentage points to 14.2 % GDP in 2070 as the population ages (Figure 2; EC, 2021). The projected increase in pension expenditures is the third highest among EU countries.

[1] Jakub Fodor was a secondee at the OECD and analyst at the Slovak Ministry of Finance when the paper was written. Hyunjeong Hwang and Oliver Roehn are members of the OECD Economics Department. The authors would like to thank Alexandra Salamonová, Peter Martiška, Eduard Hagara, Juraj Cenker, Daniel Dujava, Slavomír Hidas (Ministry of Finance of the Slovak Republic), Michael Koelle, Mame Fatou Diagne, Cyrille Schwellnus, Yvan Guillemette, Hermes Morgavi (OECD Economics Department), Hervé Boulhol, Andrew Reilly and Christian Geppert (OECD Directorate for Employment, Labour and Social Affairs) for their valuable comments and feedback. Special thanks to Federico Giovannelli for statistical assistance, Gemma Martinez and Alexandra Guerrero for editorial assistance (OECD Economics Department).

Figure 1. The population is ageing rapidly

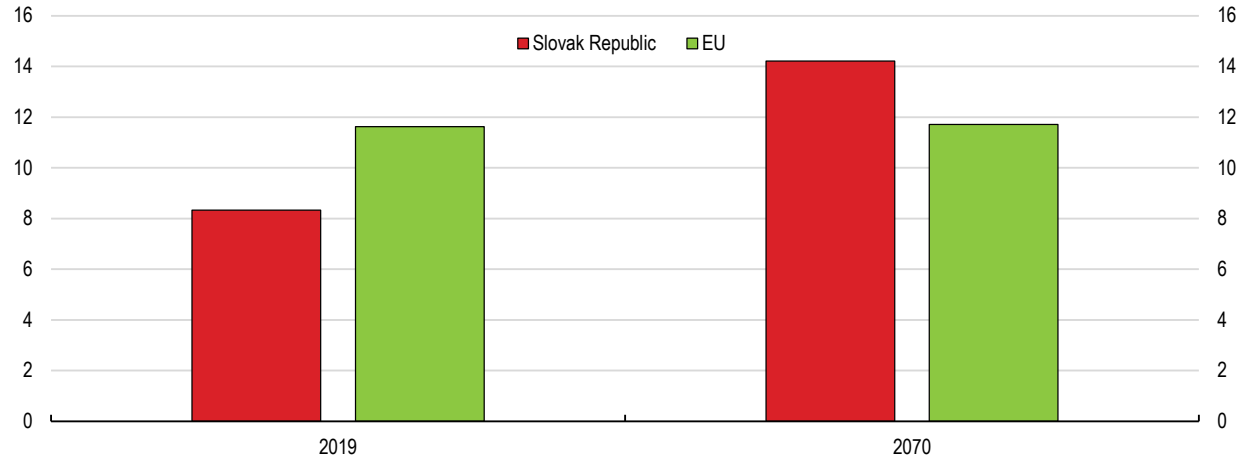
Population aged 65 and over as % of population aged 20-64, projections



Source: Eurostat (demo_pjan).

Figure 2. Pension expenditure is projected to increase strongly

Pension expenditure as a % of GDP



Source: European Commission (2021), "The 2021 Ageing Report: Economic and Budgetary Projections for the EU Member States (2019-2070)", Directorate-General for Economic and Financial Affairs, Institutional Paper 079, Luxembourg.

The cap on retirement age is expected to significantly contribute to the rise in pension expenditures. Under current rules, the retirement age is set to increase gradually until 2030 and remain unchanged at 64 years thereafter. The projections assume that with constant retirement age, the labour market exit age will remain unchanged as well. Pensioners retiring in 2070 are therefore projected to spend more than five extra years in retirement compared to those retiring in 2030 (EC, 2021).

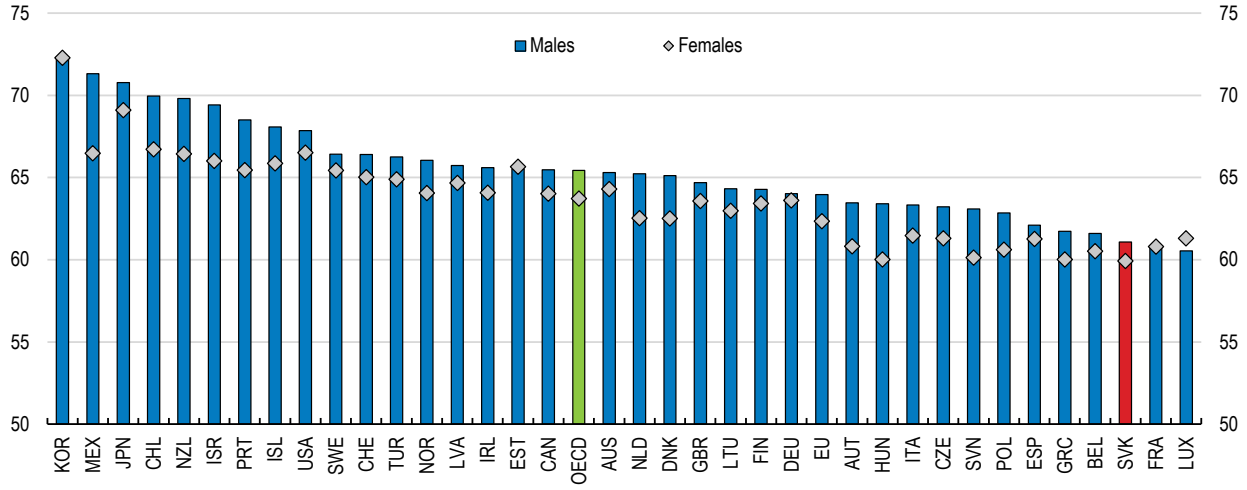
Population ageing can lower living standards in the future. As smaller, younger cohorts replace larger retiring cohorts, the labour force is set to shrink. If the age of labour force exit remains unchanged in the future, the share of the economically inactive population will increase. Real GDP per capita could decrease

by as much as 19 % between 2018 and 2050 if employment rates remained unchanged (OECD, 2020a)[2]. This decrease would be the highest among OECD countries, and significantly higher than OECD and EU27 averages (10 % and 12 %, respectively).

Longer careers can significantly improve long-term sustainability of public finance and living standards in the future. The average effective labour market exit age in Slovakia is among the lowest in the OECD (Figure 3). If the employment rate of older workers increased to the highest values observed in other countries, the real GDP in 2050 could increase by 32 % compared to the scenario with unchanged employment rates (OECD, 2020a)[3]. Longer careers can therefore more than compensate for the loss in living standards from population ageing. A higher employment rate of older workers would also increase public revenues and therefore improve the long-term sustainability of public finances.

Figure 3. The effective labour market exit age is low

Effective labour market exit age, 5-year period average 2013-2018



Source: OECD (2019), Pensions at a Glance 2019: OECD and G20 Indicators, OECD Publishing, Paris, https://doi.org/10.1787/b6d3dcfc-en.

This paper analyses the determinants of labour market exit age in Slovakia. There is a vast international literature about the determinants of labour market participation of older workers. However, there is very little evidence for Slovakia. We first discuss possible determinants of labour market exit and their relevance in the Slovak context. We then use administrative microdata from various sources to econometrically analyse the effects of various determinants on the employment exit age.

Determinants of employment exit

In this section we review the empirical evidence on determinants of employment exit. The most common determinants found in the literature can be categorised into four areas: institutional, socioeconomic, health and labour market determinants. A more complete review of the literature can be found for example in Sharn et al. (2018).

[2] Calculation abstracts from productivity gains due to technological progress or other factors.

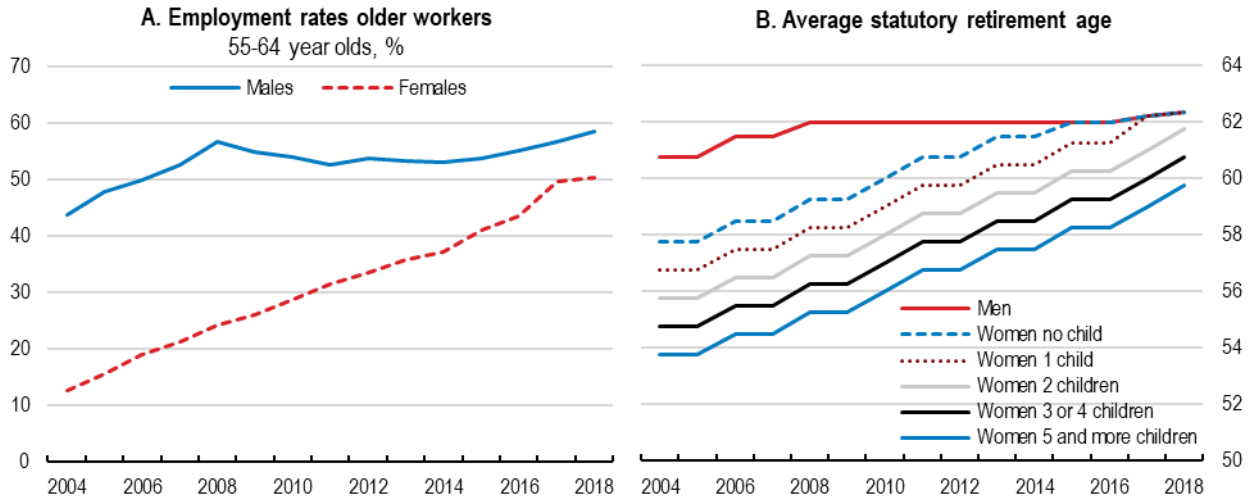
[3] The calculation assumes an increase in employment rates for people aged 50 or more in each 5-year age group and for both genders in line with countries such as New Zealand and Iceland, which have the highest rates in 2018.

Institutional determinants: the role of pension rules and parameters

The parameters of the public pension system are important determinants of employment exit. Generous pension benefits, a low statutory retirement age or the availability of early retirement options can motivate people to leave the workforce early. On the other hand, low replacement rates or a high statutory retirement age induces people to work longer.

Early and statutory retirement ages have been found to affect employment rates of older workers. For example, Geppert et al. (2019) find in a cross country study that reaching the early retirement age decreases the participation rate by 5 percentage points, and reaching the statutory retirement age by an additional 5 percentage points. Turner and Morgavi (2020) review estimates of the effect of increases in statutory retirement ages from cross country studies. They show that an increase in statutory retirement ages by one year typically implies an increase in the average effective retirement age by 1½ to 2½ months. Van Erp et al. (2014) show that for the Netherlands and the US, the probability to retire shows two peaks - one at the early retirement age and another at the standard retirement age. Individuals may stop working upon reaching the retirement age because withdrawing an early or old-age pension benefit makes it financially possible to stop working. However, van Erp et al. (2014) note that people might also opt to retire at the minimum or statutory retirement age for non-financial reasons (see discussion below). Workers may be unable to evaluate the optimal timing of retirement and therefore choose the standard retirement age. The default retirement age might therefore be an important psychological factor in explaining retirement behaviour. Slovakia's low statutory retirement age (e.g. 62.2 years for men, compared to the OECD average of 64.2 years in 2018) may therefore contribute to the low effective labour market exit age. At the same time, data also suggests a correlation between changes in the retirement age and employment rates of older workers. Employment rates for older workers increased at the same time as the statutory retirement age increased, in particular for women (Figure 4).

Figure 4. The employment rates of older workers rose as the average statutory retirement age increased

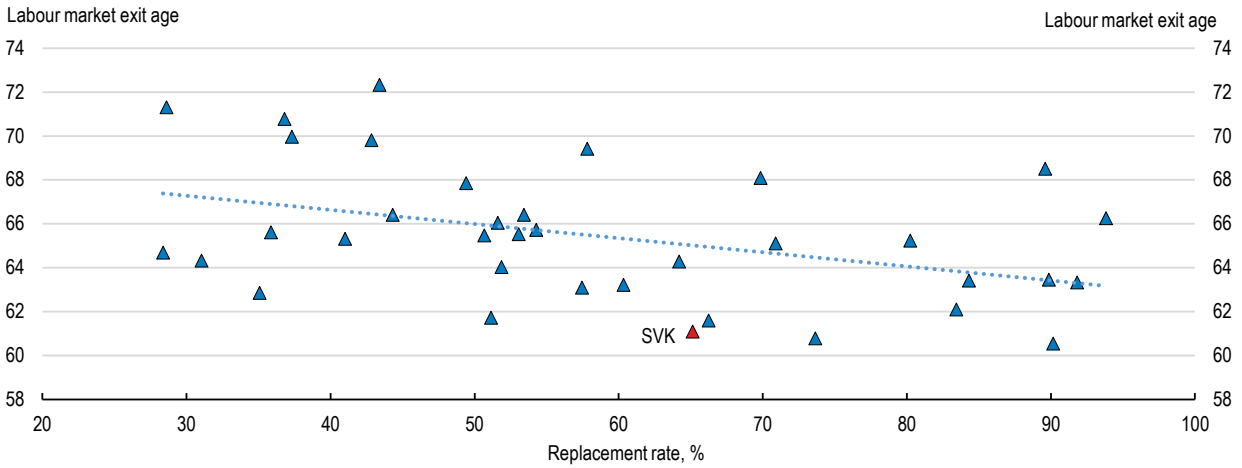


Note: In Panel B, the retirement age is defined on an age-cohort basis. Individuals are divided into groups by year and month of births. The graph reports the arithmetic average of retirement ages of the groups reaching retirement age in the given calendar year.
Source: Eurostat [lfsi_emp_a]; and Act No. 461/2003 on Social Insurance; and authors' calculations.

Replacement rates can affect the retirement decision. Using microdata for Italy, Miniaci (1998) finds that a 20 % decrease in the replacement rate delays the effective retirement age by 2 to 6 months. In addition, Geppert et al. (2019) find a strong negative correlation between replacement rates and participation of older workers in a cross-country study. The net replacement rate in Slovakia (65 %) is higher than the OECD average of 58 % (Figure 5). The relative generosity of the pension system may therefore explain at least part of the low labour market exit age in Slovakia.

Figure 5. The labour market exit age tends to fall with higher replacement rates

Effective labour market exit age (men, 2013-2018) and net replacement rate at average wage (2018)



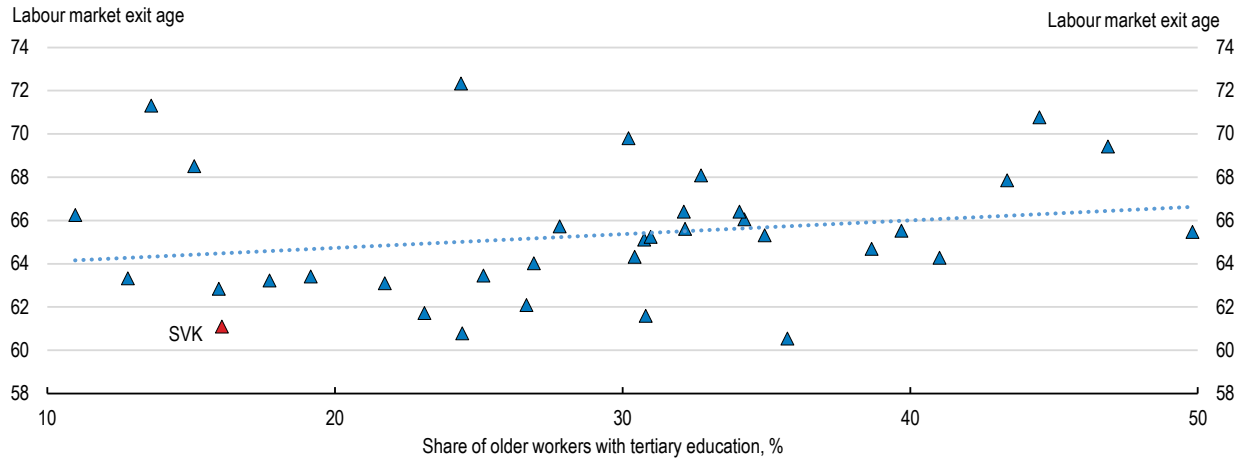
Source: OECD (2019), Pensions at a Glance 2019: OECD and G20 Indicators, OECD Publishing, Paris, https://doi.org/10.1787/b6d3dcfc-en.

Socioeconomic factors

Educational attainment, marital status and ethnicity may influence the retirement decision. Fisher et al. (2016) show that higher educational attainment is positively correlated with the age of retirement. Possible explanations are the later labour market entry of people with higher education and better working conditions. Additionally, higher income makes leisure more expensive, possibly motivating them to remain in work longer. In Slovakia, the share of workers aged 55-64 with tertiary education is only 16 %, significantly below the OECD average of 28 % (Figure 6). The relatively lower share of highly educated workers may therefore help explain the low effective age of retirement in Slovakia. Moreover, the decision to exit employment is often made jointly among partners (Finch, 2013). This suggests a role of the marital status on the labour market exit age. Finally, In Slovakia, the employment rate of the Roma is 25 % compared to 68 % in the general population (Bednarik et al., 2019). The share of unemployed Roma participating in active labour market policies is only half that of the non-Roma. Additionally, the Roma participate in programs that do not provide them with relevant skills nor increase their chances to participate in the labour market (Hidas et al., 2018). The lower chance to participate in the labour market is likely to cause an earlier exit from employment.

Figure 6. The labour market exit age tends to increase with higher education

Share of older workers (55-64, 2019) with tertiary education and effective labour market exit age (men, 2013-2018)



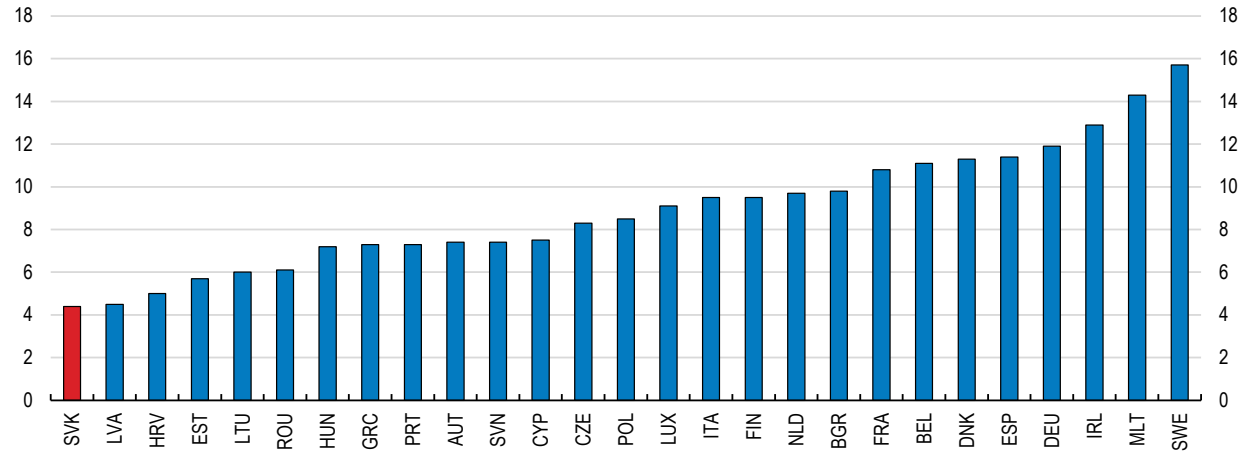
Source: OECD Pension database; and OECD Education database.

Health factors

Health and job strain play important roles in retirement timing. Van Rijn et al. (2014) find that poor health, particularly self-perceived health, is a risk factor for exit from paid employment through disability pension, unemployment and, to a lesser extent, early retirement. A similar result was found by a study across eleven European countries (van den Berg et al. 2010b). For individuals aged 50 and 63, poor self-perceived health was strongly associated with exit from paid employment to retirement, unemployment or disability pension. Slovakia has the lowest healthy life expectancy at age 65 among EU countries (Figure 7), which may contribute to early labour market exit. Furthermore, the quality of the working environment has a significant impact on workers' physical and mental health (OECD, 2014). A literature review by van den Berg et al. (2010) shows that poor health as well as high physical work demands are important determinants of early retirement.

Figure 7. The healthy life expectancy is low

Healthy life expectancy at 65, years



Source: Eurostat [hlth_hlye, demo_mlexpec].

Labour market factors

Macroeconomic factors and the number of job opportunities influence an individual's motivation to remain in the labour market. For example, Coile et al. (2011) find that a 5 percentage point increase in the unemployment rate increases the probability of retiring by about 10 %. This finding could due to several reasons. With a weak labour market, individuals might be unable to find a job or keep the one they have and retire instead of continuing to look for jobs especially at an older age. In a downturn, firms may reduce working hours or downsize by offering early retirement to workers (van Dalen and Henkens, 2013) instead of laying off workers. This may be particularly true in countries with strict employment protection legislation. Firms may also not wish to prolong employment of older workers due to lower productivity and higher wages (van Erp et al., 2014). This might induce them to leave the labour market. The unemployment rate in Slovakia has been on a declining trend between 2004 and the onset of the COVID-19 crisis, only interrupted in the aftermath of the global financial crisis between 2009 and 2012. This may have contributed to the increased labour force participation of older workers. Moreover, the place where a person lives may also influence the retirement decision. Based on anecdotal evidence from regional labour offices in Slovakia, many job-seekers refuse job offers only because of commuting and costly relocation to a more distant place of work (IFP, 2014). This factor is likely to push older workers withdrawing pension benefits out of employment, as costs of commuting may offset the additional work income.

Other control variables

We additionally control for the effect of age, gender, number of children and year of observation. Age has been repeatedly demonstrated to be one of the strongest predictors of individuals' decisions to retire (Wang et al., 2014). It serves as a proxy for factors like subjective health or psychological factors, e.g. motivation to work (Fisher, 2016). Women are more likely to be caring for older or disabled family members than men. According to the Ministry of Finance, more than three quarters of the carers receiving care allowance recipients between ages 50 and 65 in Slovakia are women[4]. Other unobserved factors, specific to the year of observation, are accounted for by including year-fixed effects.

Methodology and data

The dependent variable

We analyse the timing of employment exit, rather than labour market exit age or pension take-up. Labour market participants include employed workers as well as unemployed persons (searching for a job). As we use administrative microdata on social insurance paid by individuals, we observe if a person is employed but not whether one is unemployed (and therefore do not observe all labour market participants). In Slovakia, it is possible to continue to work while withdrawing a pension benefit. Most individuals start withdrawing old-age pension as soon as they are entitled to it, and some continue to work (Box 1). Pension take-up therefore does not denote career end. For these reasons, we use employment exit as the dependent variable, i.e. the age at which an individual stopped working.

To analyse the determinants of employment exit of older workers we employ a social insurance micro dataset between 2013 and 2020. As social insurance is compulsory for employees in Slovakia, the dataset contains all employees. We exclude the self-employed from the analysis in the baseline, as only about one-half pay social insurance contributions. The sample of self-employed is hence not representative in

[4] An individual can receive a care allowance, if they care for a handicapped family member. If a person opts to take care of a family member, their work income cannot be higher than twice the subsistence minimum. Otherwise, the benefit is decreased.

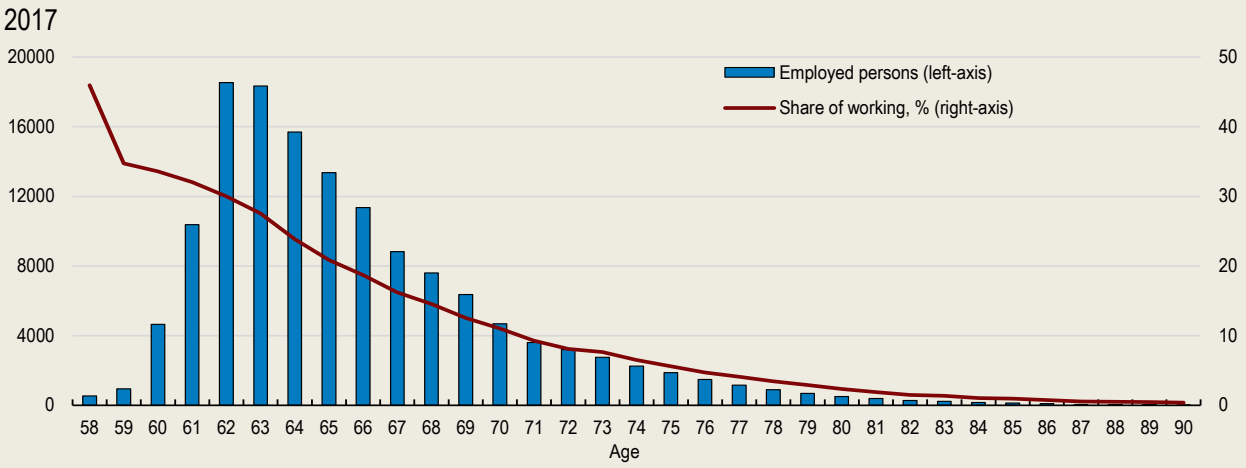
the dataset and including them may bias the results. However, in the sensitivity analysis, we include the self-employed paying social insurance contributions to gain some insight into the difference between employees and self-employed workers.

Box 1. Working past the statutory retirement age in Slovakia

Nearly everyone starts withdrawing old-age pension once eligible in Slovakia but many continue to work. In 2019, 97 % of men who started to withdraw an old-age pension had just reached the retirement age. As the benefit is not reduced if an individual continues to work, many continue to do so. Nearly 30 % of old-age pensioners aged 63 in 2017 were still working (Figure 8). The share is likely to be higher if the self-employed were included. However, the share of pensioners working drops sharply with age. For example only around 15% of pensioners aged 68 have income from work.

However, old-age pensioners have relatively low income from work. Pensioners' income from work decreases with age (Figure 9). Nearly 52 % of old-age pensioners aged 60-69 with income from employment in 2017 earned less than half of the yearly minimum wage[5]. This is likely because old-age pensioners tend to opt for non-standard forms of employment, which limit the number of hours they can work. While 88 % of workers not receiving an old-age pension are employed under a standard contract, this figure is only 49 % for employees receiving an old-age pension. Pensioners employed using non-standard types of work contracts pay significantly lower social and healthcare insurance contributions (23.8 % in case of non-standard contracts compared to 40.6 % in case of standard contracts)[6]. The number of working hours for an individual on a non-standard contract is limited to 10 hours per week or 350 hours per year.

Figure 8. Employed old-age pensioners by age



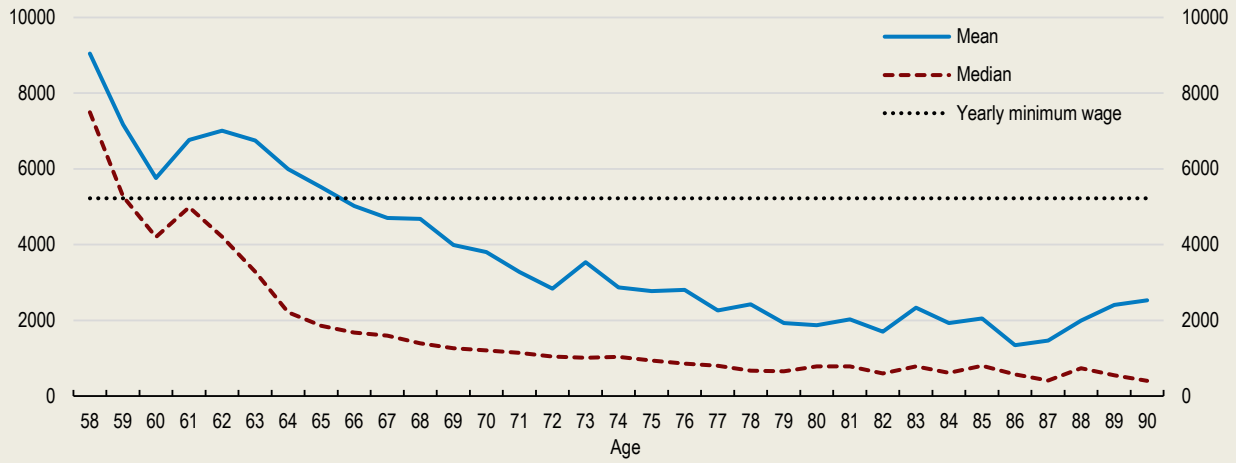
Note: The graph shows individuals withdrawing old-age pension in January 2017. They are denoted as working, if they earned any positive income in 2017. Income from self-employment is excluded from the calculation. Age is measured at the beginning of the year 2017.
Source: Social Insurance Company; and authors' calculations.

[5] The minimum wage in Slovakia is defined on monthly basis. Yearly minimum wage in this paper denotes twelve times the monthly minimum wage, 5 220 euros in 2017.

[6] Additionally, from 2018, pensioners pay only 1.05 % of their gross wage in social and healthcare contributions for the first 200 euros per month earned from non-standard contracts.

Figure 9. Yearly earned employment income of old-age pensioners by age

Euro, 2017



Note: The graph shows individuals withdrawing old-age pension in January 2017. Considered in the calculation are only those who earned any positive income in 2017. The self-employed are excluded from the calculation. Age is measured at the beginning of the year 2017. The yearly minimum wage is calculated as 12 times the monthly minimum wage.
Source: Social Insurance Company; and authors' calculations.

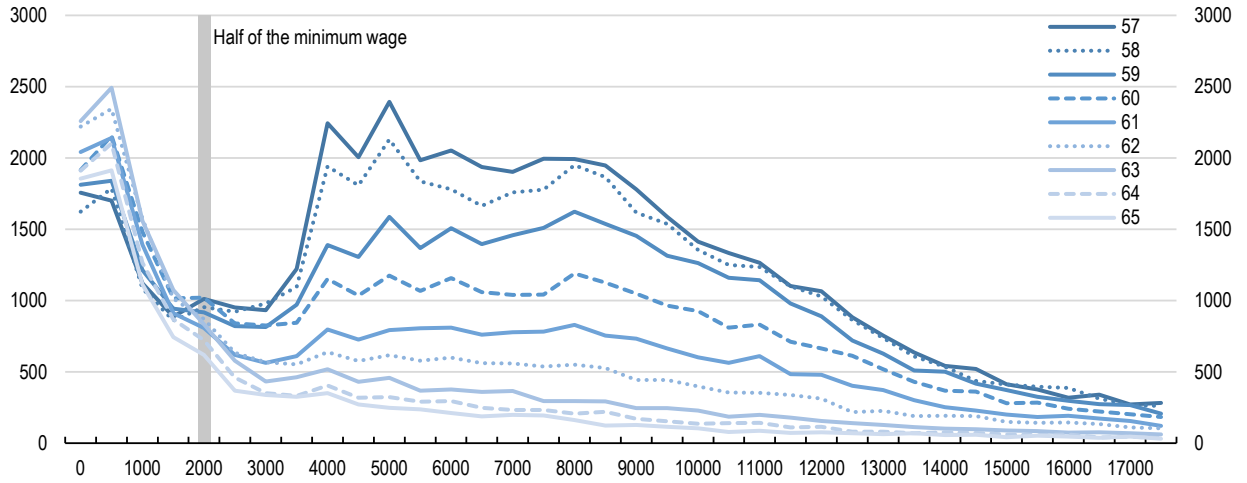
The baseline specification defines employment as working full- or part-time and excludes marginally employed people. Due to changes in reporting since 2018, individuals working for up to EUR 200 per month are not reported in the data from 2018[7]. Requiring a minimum income to consider an individual as working solves this reporting issue. Additionally, as the objective is to find determinants of longer careers, including marginal part-time work might influence the results. We therefore define employment as having a yearly work income of more than half the minimum wage. The majority of older employees earned more than 4000 euros per year in 2013, which was the minimum wage (Figure 10). On the other hand, nearly 20% of older employees make less than 1000 euros per year. In the sensitivity analysis, we relax the minimum income threshold, and include anyone earning a positive income from employment.

The dependent variable is defined as the probability that a person exits employment in a given year, if he worked in that year. We define employment exit as being employed in year *t* and not being employed in years *t+1* or *t+2*. The definition of employment exit potentially allows people who exited employment to return to work. Requiring more years of inactivity would, however, limit our sample to observations from a small number of years. We require sufficient time variation in our sample to obtain more robust estimates of the effect of early and statutory retirement ages. In the sensitivity analysis, we also apply a stricter definition, requiring five years of inactivity after the initial employment exit.

[7] Since July 2018, individuals working for up to EUR 200 are exempt from paying most of their social security contributions. This created a new category of social security contributors, which is not yet reported by the Social insurance Company in the standardized reports.

Figure 10. Number of employed by income and age

2013

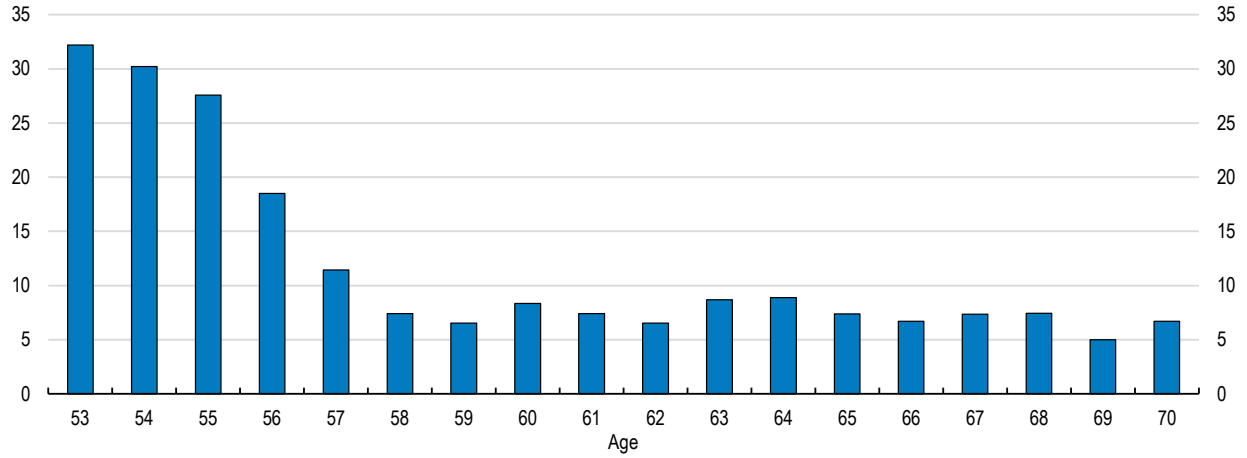


Source: Social Insurance Company; and authors' calculations.

We focus on employees aged between 57 and 70 years, as this is the age range when most people exit employment in Slovakia. Figure 11 shows that the probability of an individual returning to work after two years of inactivity drops sharply between the ages of 53 and 57 and remains low thereafter. Hence our focus on individuals aged 57 and over together with our definition of employment exit ensures that we largely focus on people permanently leaving the workforce.

Figure 11. Probability of returning to work after two years of inactivity

Probability of returning to work until 2020 if one worked in 2013 and did not work in 2014 or 2015, %



Source: Social Insurance Company; and authors' calculations.

The independent variables

We regress the employment exit indicator on institutional, socioeconomic, health, labour market variables and other control factors. All data come from administrative datasets. The variables used in this analysis are described in detail in Annex A. We first create a cross-sectional dataset for each year (2013 to 2018) by combining the dependent variable with the independent variables. In the next step, we append the respective datasets for the years 2013 – 2018 to create the baseline sample containing 450 859 individuals and 1 420 662 individual-year observations. Summary statistics of the baseline estimation sample are available in Annex B. We employ logistic regressions to analyse the age of employment exit. Additional details on the data and methodology can be found in Annex C.

To examine the effect of early or old-age pension benefit eligibility on the age of employment exit, we include indicators for reaching the retirement age. The period of possible employment exit is split into four parts:

- No benefit entitlement
- Early pension
- Old-age pension at the statutory retirement age
- Old-age pension past the statutory retirement age

Early pensions cannot be combined with work, unlike old-age pensions in Slovakia. We therefore measure the effect of the early pension separately from the old-age benefit. We also allow the effect of eligibility for the old-age benefit to differ between the first year a person becomes eligible and subsequent years. Ideally, we would also control for the replacement rate. However, the pension benefit level for an individual is not observable in our dataset, unless the person withdraws it. Therefore the replacement rates have to be estimated. As estimating an independent variable may introduce a bias in the coefficients for the other variables, we do not include the replacement rate in the baseline analysis but report results in the sensitivity analysis below.

To proxy for health status, we include variables indicating if a person is handicapped or withdraws a disability pension. Working with administrative data, an individual's health status is not available. However, indicators of whether a person is handicapped or withdraws a full or partial disability pension are available. For instance, 10% of older people aged 60 receive full disability pensions. There are different assessment criteria for being handicapped and for being eligible for disability pensions in Slovakia. Both statuses, however, imply health impairment, which can affect labour market participation. We also allow the effect to differ depending on whether the person becomes handicapped or disabled in a given year, or was already handicapped or disabled before. Finally, as data on occupation is not available, we proxy job strain by the industry an individual works in.

Results

Table 1 displays the baseline results. Estimates are reported as odds ratios, which can be interpreted as how much more likely an individual is to exit employment compared to the reference class. The reference is an individual not entitled to any benefits, with secondary education, working in manufacturing, living in a city, not Roma, without health impairment, married, aged 57, with two children, working in 2013 and male. If the value of an estimate is above one, an individual with that particular characteristic is more likely to exit employment than the reference person and vice versa.

Table 1. Baseline estimation results

Odds ratios, reference class in parenthesis for categorical variables

	Estimate and significance				Estimate and significance	
Benefit (No eligibility)				**Family status (Married)**		
Early pension	2.92	**		Unknown	0.95	
Old-age pension (at SRA)	8.01	**		Single	0.92	**
Old-age pension (past SRA)	4.39	**		Divorced	0.94	**
Education (Secondary)				Widowed	0.96	**
Unknown	0.72	**		**Age (57)**		
None	1.38	**		58	1.26	**
Elementary	2.58	**		59	1.80	**
Secondary with diploma	0.65	**		60	2.09	**
University	0.53	**		61	1.95	**
Industry (Manufacturing)				62	2.07	**
Construction	1.05	**		63	2.13	**
Mining	1.03			64	2.06	**
Accommodation and Restaurants	1.03			65	2.18	**
Unknown	1.00			66	2.04	**
Sales and Repair	0.89	**		67	2.21	**
Agriculture	0.87	**		68	2.20	**
Services	0.85	**		69	2.53	**
Transport	0.84	**		70	2.76	**
Other	0.72	**		**Children (2)**		
Public service and defence	0.72	**		0	1.18	**
Education	0.62	**		1	1.01	
Healthcare and long-term care	0.53	**		3	1.02	*
Health (No impairment)				4	1.03	*
Handicapped	1.26	**		5 or more	1.06	**
Became handicapped	2.18	**		**Year effects (2013)**		
Partial disability	1.25	**		2014	0.95	**
Became partially disabled	4.83	**		2015	0.88	**
Full disability	1.59	**		2016	0.91	**
Became fully disabled	13.62	**		2017	0.85	**
Living in a city	0.87	**		2018	0.88	**
Unemployment	1.02	**		**Women**	1.14	**
Roma	1.19	**		**Constant**	0.05	**
Number of observations	1 420 662					
Pseudo R2	0.123					
AUC	0.75					

Estimates marked * are statistically significant on 5 % level, ** on 1 % level. Standard errors are clustered at the individual level.

As expected, being entitled to early or old-age pension significantly increases the likelihood of exiting employment. For example, a person is 8 times more likely to exit employment if the person reaches the statutory retirement age than a person not eligible for a pension benefit. Higher education is associated with a smaller likelihood of exiting employment. For example, a person with elementary education is 2.6-times more likely to exit employment in a given year than a person with secondary education. Variation by industry likely captures the effect of job strain as people in mining and construction are more likely to exit employment than workers in the public sector, education or healthcare. Not living in a city, being Roma or having impaired health increases the likelihood of employment exit. Lastly, employment exit is 1.02 times as likely if the unemployment rate increases by 1 percentage point.

Simulations

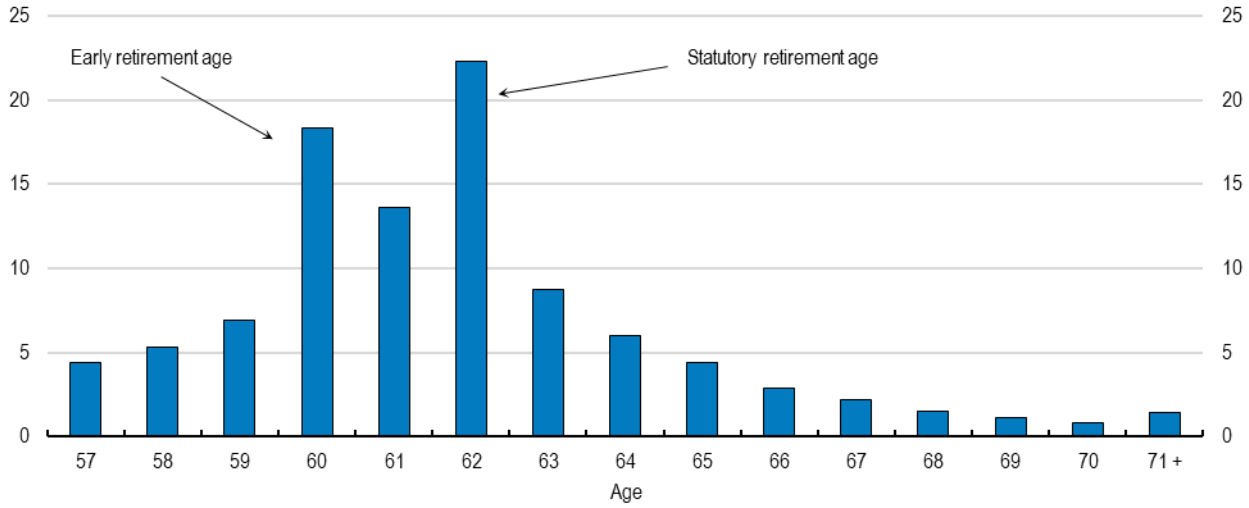
Using the estimation results, we can simulate how the age of employment exit varies with individual characteristics or the institutional setting. In all simulations, we assume that the individual worked at age 56 and calculate his projected employment exit age based on probabilities to exit employment between the ages 57 and 70 (Annex 4). We first compute the projected employment exit age for the reference individual, which is constructed by using the most common characteristics (the median characteristic is used for the unemployment rate and the year of observation):

- Early retirement age 60 years
- Statutory retirement age 62 years
- Manufacturing
- Secondary education
- Married
- Living in a city
- Unemployment 6.7 %
- Non-Roma
- No health limitations
- Two children
- Year 2016
- Male

Figure 12 shows the probability of the reference individual to exit the labour market at a given age. For the reference person employed at age 56, the probability to exit employment is highest between the ages 60 and 62 which coincides with reaching the early and statutory retirement age in the reference year 2016. The probability to exit employment before reaching the early retirement age is only 17 %, and the probability to exit employment past the statutory retirement age 29 %. Based on these probabilities we can calculate the projected employment exit age by simply multiplying the probabilities to exit at a given age by the age. The reference individual's projected employment exit age is 61.8 years. In the following, we show the projected changes in the employment exit age if one variable is changed. For example changing the statutory retirement age by one year, other variables remaining unchanged. Such a comparison makes it easier to compare the effects of various factors on the age of employment exit.

Figure 12. Probability to exit employment at a given age

Probability of a reference individual who worked at age 56 to exit employment at a given age

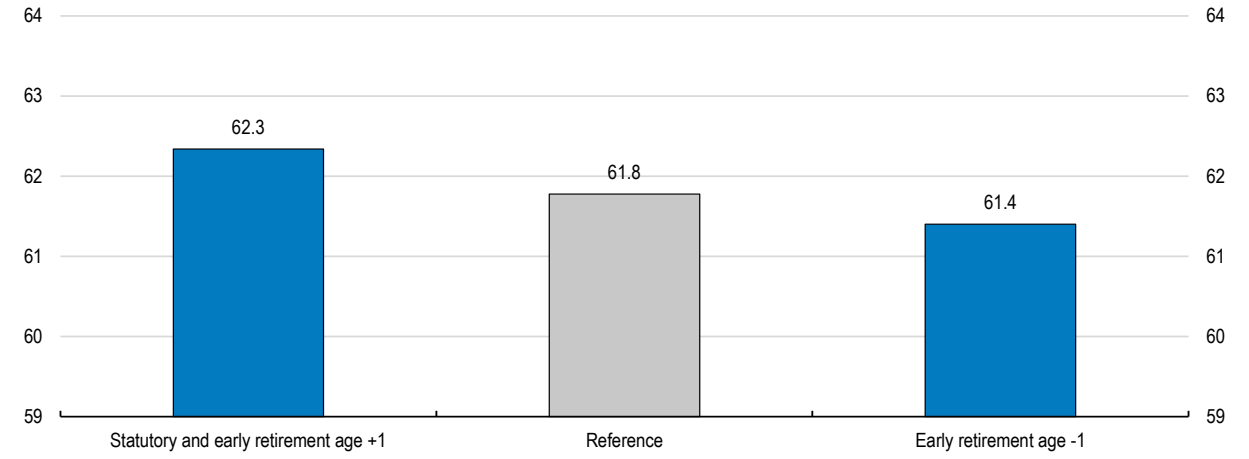


Source: Authors' calculations.

Increasing both the early and the statutory retirement age by one year would increase the projected employment exit age by 7 months (Figure 13). Using the results of the estimation, we can calculate the effect of increasing the retirement ages by one year, other things remaining equal. This would imply an early pension age of 61 years and the statutory retirement age of 63 years. The employment exit age increases by more than half of the increase in the early and the statutory retirement age. Hence, increasing retirement ages would have a significant effect on the employment rate of older workers. In contrast, allowing earlier retirement than under current policies would have significant negative employment effects. In particular, the results suggest that decreasing the early retirement age by one year would result in a 5 months earlier projected employment exit age. Given that most of the variation in the retirement ages in our sample stems from changes in the retirement age for women (Figure 4), we also estimate the effect for both genders separately (see Table A E.1 in Annex E). While the effect of the statutory retirement age is stronger for women, it remains highly significant for men.

Figure 13. Effect of change in retirement age on projected employment exit age

Years



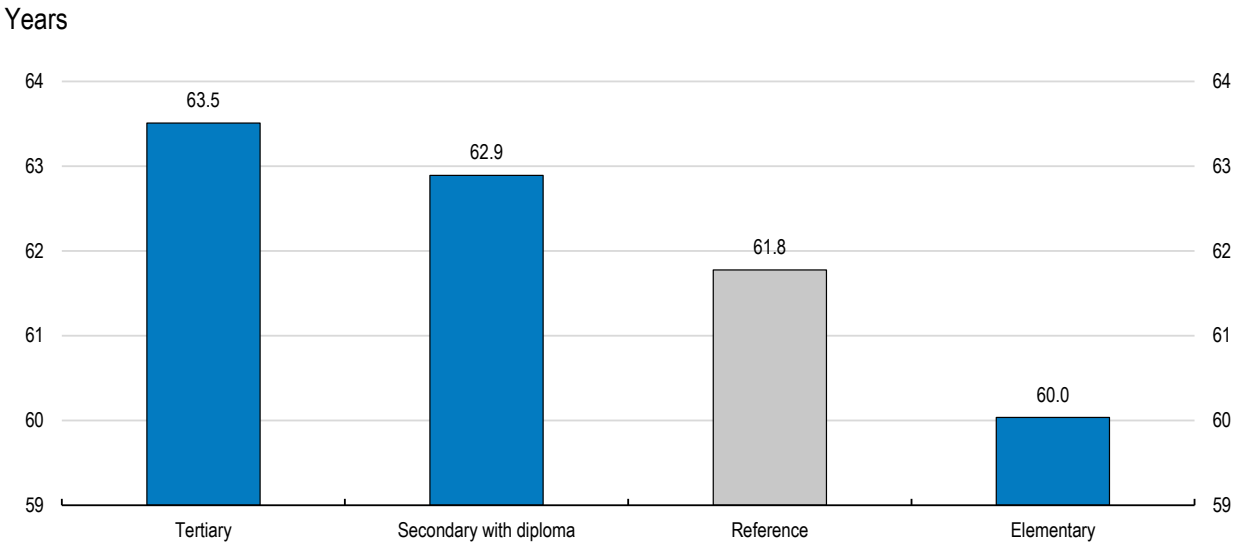
Source: Authors' calculations.

The impact of changes in the statutory retirement age on the effective retirement age in our study is somewhat higher than estimates found in the literature. Turner and Morgavi (2020) review cross country studies and find that increasing the statutory retirement age by 1 year leads to an increase in labour market exit age by 1½ to 2½ months. However, the authors find that this effect is much higher (4 to 5 months) in countries without early retirement pathways and in countries, where voluntary private pensions are underdeveloped, such as in Slovakia. Single country studies often find the effect to be even higher. For example, Manoli and Weber (2016) find that increasing the statutory retirement age by 1 year leads to an increase in labour market exit age by 5 months in Austria, while Lalive and Staubli (2015) find an increase of 7.9 months for women in Switzerland. An additional reason why our estimate is higher compared to other studies is that we restrict our sample to people employed at age 56. Atav et al. (2021) find that when focusing on such a subgroup, the effect in the Netherlands increased from 2 to 4 months. Our results are therefore more applicable to the population working at higher ages than for the entire population.

Higher education increases the projected employment exit age. The difference in the projected employment exit age between persons with elementary and secondary education is 1.8 years (Figure 14). Individuals with tertiary education work an additional 1.7 years compared to those with secondary education. The education structure is set to change in the next decades. While the share of people with tertiary education is only 16 % for people aged 55-64, it is more than 39 % for people aged 25-34 (OECD Database[8]). This shift towards a more educated workforce should therefore increase employment rates of older workers in the future.

The projected employment exit age varies significantly across sectors (Figure 15). The difference in the projected employment exit age between manufacturing (reference class) and construction or mining is small. However, comparing manufacturing with services, notably public services, reveals more significant differences. This is likely at least partially due to differences in job strain. The large difference between manufacturing and health care (almost 2 years) is likely due to the fact that there are labour shortages in the health care sector, in particular for doctors and nurses (see OECD, 2022), that induce people in health care to work past the retirement age.

Figure 14. Projected employment exit age by educational attainment

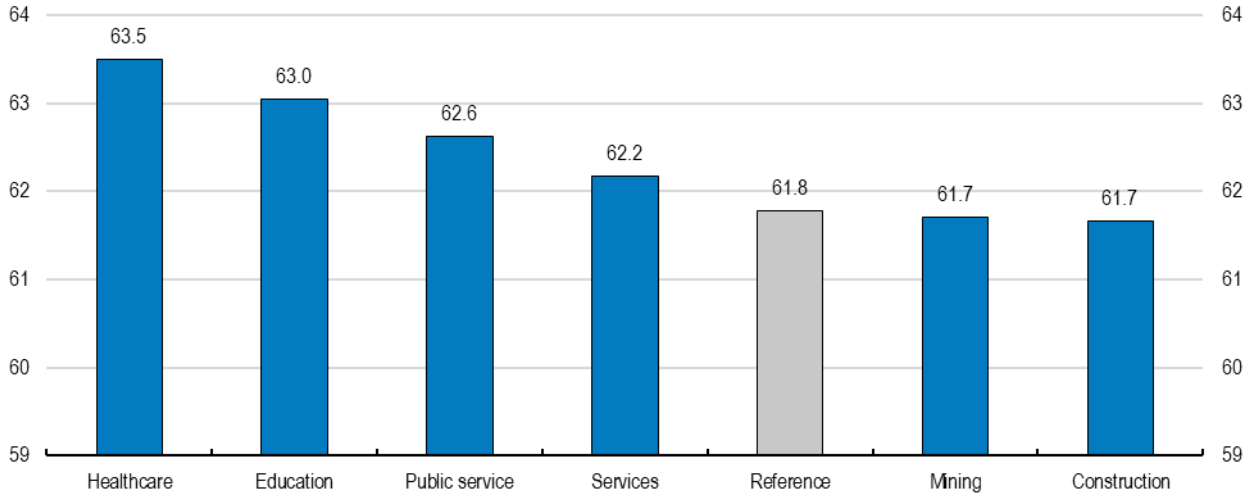


Source: Authors' calculations.

[8] Available here: https://data.oecd.org/eduatt/population-with-tertiary-education.htm.

Figure 15. Projected employment exit age in selected industries

Years



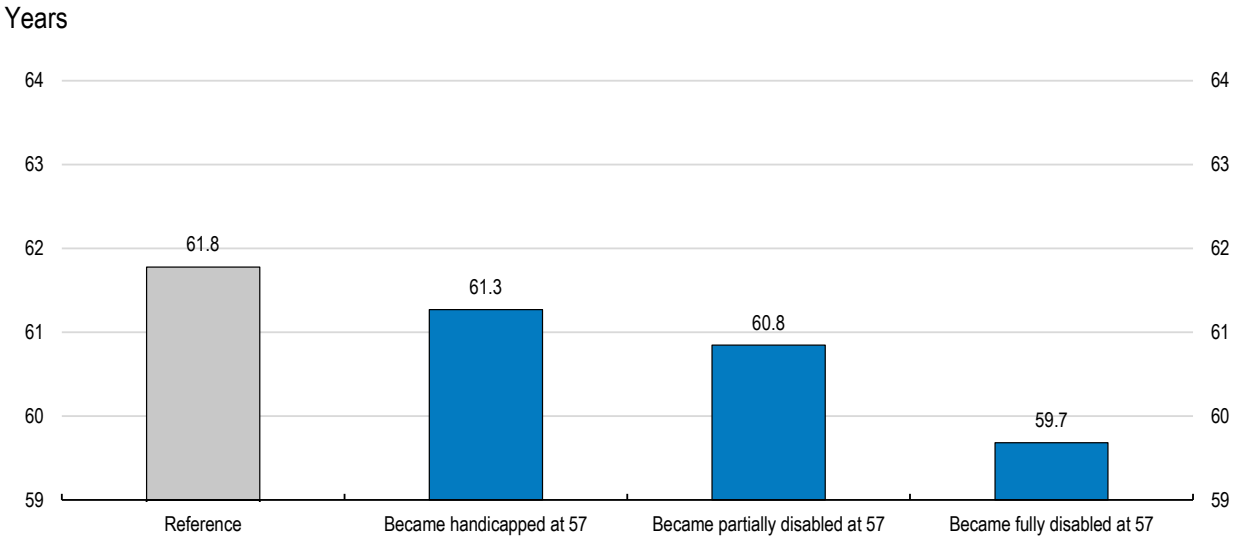
Source: Authors' calculations.

Becoming handicapped or disabled substantially decreases the projected employment exit age (Figure 16). If an individual worked at 56 and became handicapped at 57, the career is 6 months shorter compared to the reference individual. The differences are higher if an individual becomes partially disabled (11 months) and fully disabled (25 months). The benefit level is highest for the fully disabled and usually higher for the partially disabled than for the handicapped. The results also show that the effect is highest in the year when the individual became handicapped or disabled, suggesting that policies should aim to keep the handicapped and disabled in employment.

People living in rural areas and in districts with higher unemployment rates have lower projected employment exit ages (Figure 17). If an individual lives outside of the city, the projected employment exit age decreases by 4 months compared to the reference individual. Residing in a city might provide additional job opportunities compared to rural areas. Additionally, the costs and time spent commuting to work might offset the additional benefits from continuing to work. People living in a district with a higher unemployment rate have fewer job opportunities and may be discouraged from looking for work once laid off, especially at older ages. In addition, firms in structurally weak regions may lay-off older workers earlier due to their lower productivity and higher wages. We find that workers in urban areas with high unemployment (13.7% compared to 6.7% in the reference scenario)[9] leave the labour market around 4 months earlier. Workers in rural areas with a high unemployment rate leave the labour market around 7 months earlier.

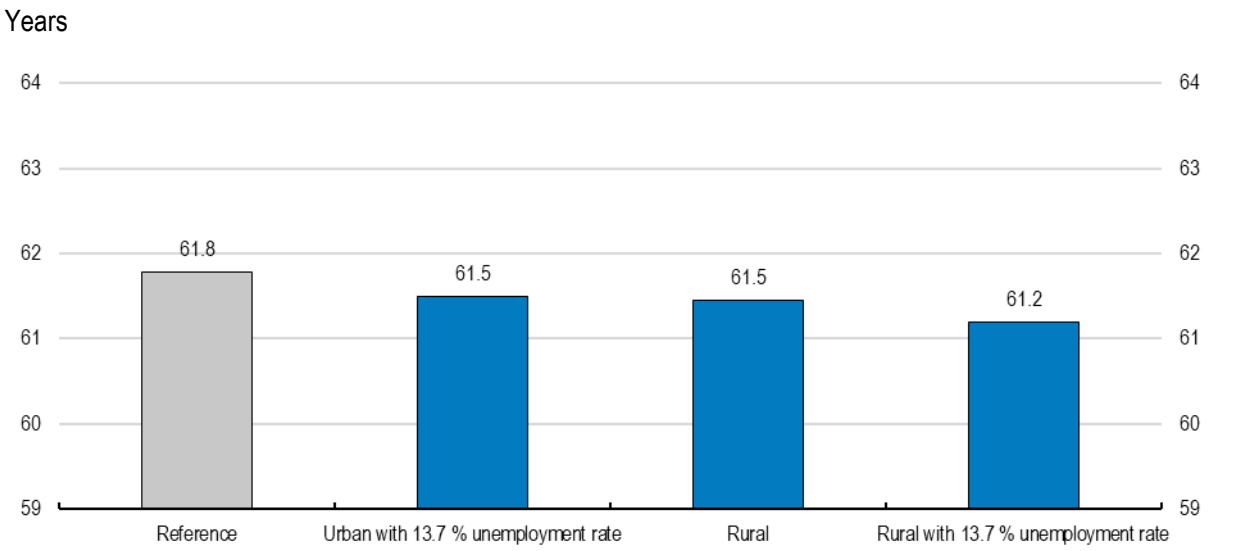
[9] In 2020, 10 out of 79 districts had an unemployment rate over 13.7%.

Figure 16. Projected employment exit age by health impairment



Source: Authors' calculations.

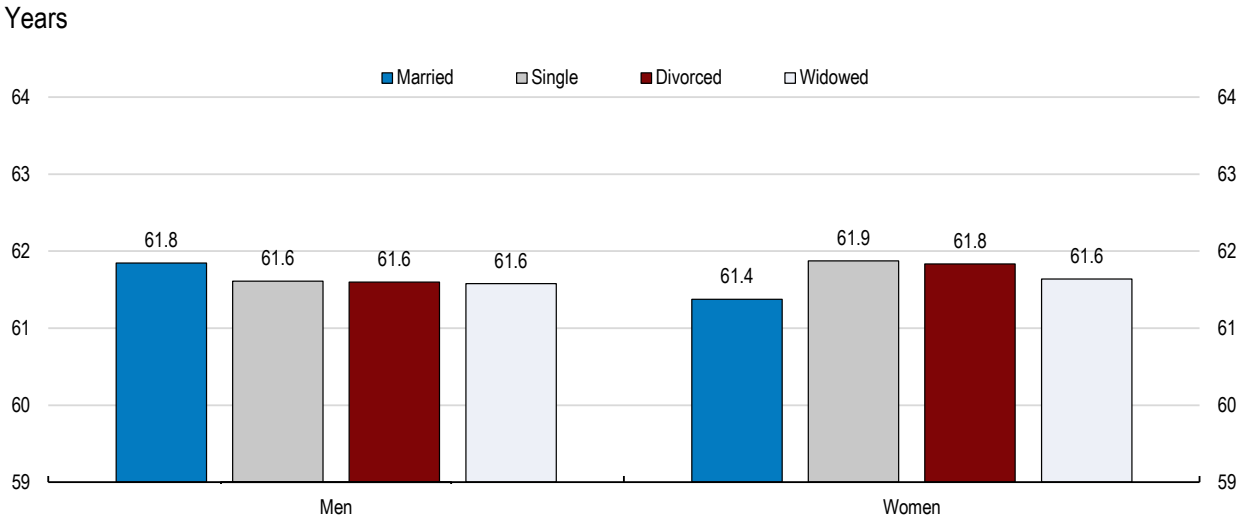
Figure 17. Projected employment exit age by place of residence and rate of unemployment



Source: Authors' calculations.

Married women exit employment first, married men last. In the simulations we analyse additional interactions between family status and gender (Table A E.2 in Annex E). Men who are single, divorced or widowed exit employment three months earlier than married men (Figure 18). On the other hand, married women exit employment sooner than single, divorced or widowed women. This suggests that in the case of a married couple, women exit employment sooner while men carry on working. As women are the ones usually caring for old or handicapped family members (see above), improving the long-term care system and creating opportunities for longer careers for women may increase the employment exit age of married women.

Figure 18. Projected employment exit age by gender and marital status



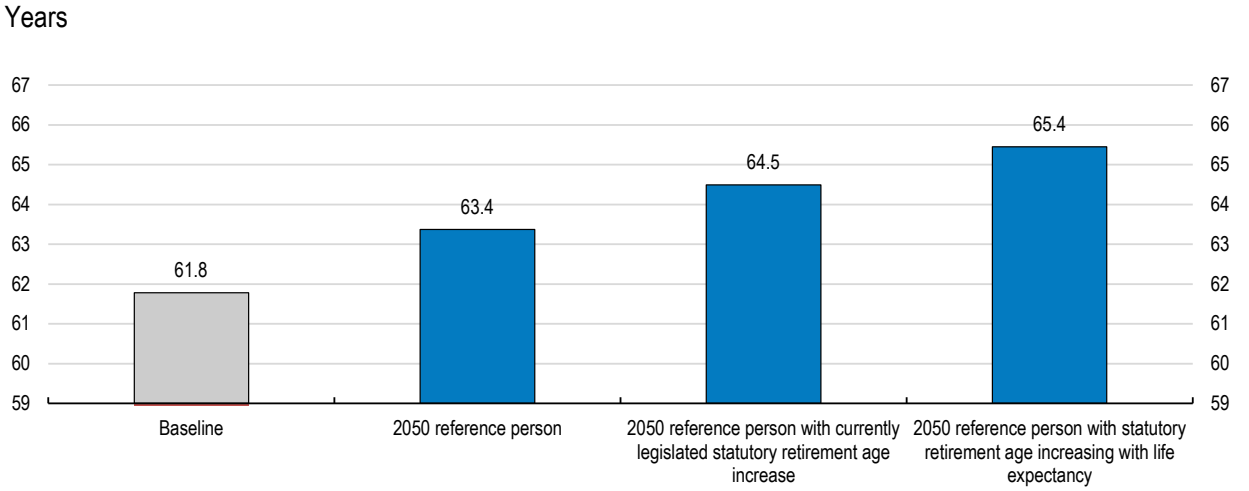
Source: Authors' calculations.

Finally, we simulate in a highly stylised way the projected employment exit age in the future (in 2050) by taking into account plausible changes in the education level of the population, sectoral changes and changes in the statutory retirement age. The education level of the population and the sector composition in Slovakia are set to change in the future. In 2019, the share of people aged 55-64 years with tertiary education was 16 %, compared to 39 % for people aged 25-34 years (OECD, 2020b). The value added share of industry (including construction) in GDP peaked in Slovakia in 2007 at 34 % and has been on a steady decline since, reaching 27 % in 2020[10]. We simulate these changes by setting the education level of the reference person from secondary education to secondary education with a diploma and changing the reference sector from manufacturing to services. We also simulate two possible settings of statutory retirement ages in 2050. The first scenario assumes that the statutory retirement age increases to 64 years in 2030 and remains at this age until 2050, in line with current legislation. The second scenario assumes that the statutory retirement age increases with gains in life expectancy at age 65, implying a statutory retirement age of 66 years in 2050[11].

[10] World Bank and OECD national accounts data.

[11] According to Eurostat, life expectancy at age 65 will increase by 4.4 years for men and 4.2 years for women between 2016 and 2050. For simplicity, we use a conservative estimate of 4 years.

Figure 19. Projected employment exit age in 2050



Note: For the 2050 reference person the education level is set to secondary education with diploma (from secondary education in baseline) and the reference person is employed in the services sector (from manufacturing in baseline).
Source: Authors' calculations.

The simulated employment exit age for year 2050 is significantly higher than for year 2016. The expected increase in the education level and change in sector composition alone increases the projected employment exit age by 1.6 years. An increase in the statutory retirement age to 64 years (according to current legislation) would lead to an additional rise in the projected employment exit age by 1.1 years. Finally, if the statutory retirement age increased in line with life expectancy the projected employment exit age would increase by one extra year compared to scenario with current legislation for year 2050 (Figure 19). Given the simplistic nature of the simulation, which only takes into account plausible changes in the educational level and sector of employment of the reference person in the future, and does not for example account for health developments of the population, the results should be interpreted with caution and not taken at face value. Nevertheless, the results highlight that the future projected employment exit age is likely to increase and changes in the statutory retirement age exert a strong influence on the decision to exit the labour market.

Sensitivity analysis

In this section, we consider four sensitivity scenarios. The first sensitivity scenario relaxes the assumption on the minimum earnings threshold for individuals to be considered employed. The second scenario extends the length of the required inactivity period for individuals to be accounted for as having exited employment. In the third scenario, we also consider the self-employed, who pay at least the minimum social insurance contributions.[12] The results of the estimations are displayed in Table A E.3 in Annex E. Lastly, we estimate the impact of replacement rates on employment exit (Annex F).

When including marginally employed workers in the analysis, the results are similar but the effect of retirement age and health factors decreases. In the baseline, we defined employment as having a yearly work income of more than half the minimum wage. In this scenario, we include all workers with positive income. The effect of the statutory retirement age decreases (Table A E.3). This is likely because people withdrawing an old-age pension often continue to work in marginal part-time jobs (Box 1). The estimates

[12] Approximately half of the self-employed do not pay any social security contributions due to low reported revenues.

for the effect of health factors also decrease compared to the baseline estimates, in particular for people receiving disability benefits. This indicates that the disabled are more likely to continue working in marginal jobs.

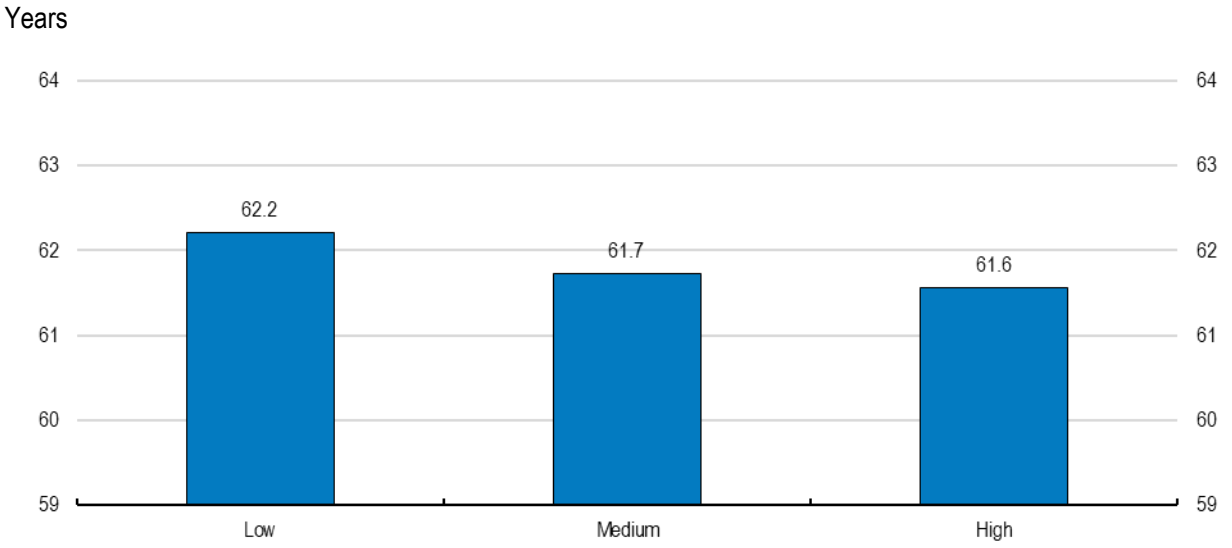
Restricting the definition of employment exit to a longer period of inactivity does not significantly change the results. In the baseline, we define employment exit as being employed in year *t* and not being employed for the next two years. In this scenario, we require five years of inactivity after leaving the workforce in order to characterize one as having exited employment. This assumption restricts our sample to observations from the years 2013 to 2015. The results for the sensitivity scenario are very similar to those of the baseline estimation (Table 1). The only notable difference in this scenario is that Roma are not significantly more likely to exit employment compared to the non-Roma population.

The self-employed work longer than employees. In the last sensitivity scenario, we include the self-employed in the sample. We add an additional indicator variable for the self-employed to compare the projected employment exit age between the self-employed and an employee. The dataset only includes those self-employed who pay social insurance, i.e. their gross revenue exceeded 50 % of the average wage from two years ago. Again, the results are not significantly different from the baseline estimation. The coefficient estimate of the indicator variable implies that the self-employed work about one year longer, with a projected employment exit age of 62.8 years for the self-employed compared to 61.8 years for employees. The impact of the early and statutory retirement ages on employment exit is somewhat lower than the baseline, suggesting that retirement ages play less of a role in the employment exit decision of the self-employed.

Finally, we investigate the impact of replacement rates on employment exit. The replacement rate is the ratio of a person's pension benefit level relative to his or her pre-retirement income. A person's benefit level is not observable in our dataset unless the person withdraws a pension and hence replacement rates cannot be calculated for all individuals in the dataset. To overcome this issue, we regress pension benefits for individuals, for which benefits are observable, on age, gender and pre-retirement income (Annex F). Based on the regression results we impute hypothetical benefit levels for all individuals. Because the replacement rates are estimated with errors, including the estimated values in the regression may bias the regression results. To mitigate this issue, we cluster the replacement rates in three categories of roughly equal number of observations. The three categories are low (up to 52%), medium (52% to 72%) and high (above 72%) replacement rates.

The results suggest that individuals with low replacement rates work longer than individuals with medium or high replacement rates. The results are reported in Table A F.2, The difference between the estimates for low and medium replacement rates is statistically significantly different in all stages of pension eligibility (early, at SRA and past SRA). The difference between the estimate for high and medium replacement rates is only statistically significant for early pension eligibility. Using the estimation results to simulate the employment exit age, we find that a person with a low replacement rate (below 52%) works around 6 months longer than a person with a medium or high replacement rate (Figure 20).

Figure 20. Projected employment exit age by replacement rate level



Source: Authors' calculations.

Conclusion

The Slovak population is set to age rapidly in the next decades. This will have a significant impact on economic growth and the sustainability of public finances. At the same time, the labour market exit age in Slovakia is among the lowest in OECD countries. We use administrative data for Slovakia between 2013 and 2020 to analyse what factors influence the probability of employment exit for workers above the age of 56 years. The results can inform future policy debates about increasing the participation of older workers in the labour market.

We find that pension age, socioeconomic, health and labour market factors influence the employment exit age in Slovakia. Increasing both early and statutory retirement by one year increases the projected employment exit age by seven months, indicating that retirement ages have an important influence on the decision to leave employment. Having tertiary instead of secondary education increases the projected employment exit age by 1.7 years. This implies that the employment rate of older workers is likely to increase in the future as younger generations have higher educational attainment. We also find evidence that workers in sectors that are physically more demanding are exiting employment earlier. Impaired health also leads to significantly earlier employment exits. Hence, improving work conditions, the health and rehabilitation of workers and labour market policies targeted at the disabled and handicapped would enable people to work longer. Finally living in a rural area or in areas with high unemployment is also associated with earlier exit from the labour market.

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Annex A. Description of variables

Table A A.1. Independent variables

Name	Type	Description
Benefit	Categorical	The variable *benefit* has four categories. The reference class is not being entitled to any benefit. Individuals entitled to early pension create the second class. The third class consists of people who reached the statutory retirement age in the given year. The last class is people who are past the statutory retirement age.
Education	Categorical	Includes four levels of education and an additional category "unknown" in case the value for education is missing.
Industry	Categorical	Includes twelve industries based on SK-NACE classification and an additional category "unknown" in case the value for industry is missing. The value is determined as the mode of the industries, in which an individual worked in the 10 years prior to the observation.
Living in a city	Dummy	Takes a value of one in case that the individual lives in a city, zero otherwise.
Unemployment	Continuous	Denotes the unemployment rate in the district of residence in the given year. The values are reported as 100-times the unemployment rate for better interpretation. This means that an unemployment rate of 5 % is reported as 5, rather than 0.05.
Roma	Dummy	Takes a value of one in case that the individual is identified as a Roma. The dataset of Roma was created based on the Atlas of Roma communities and used in other studies (e.g. Bednarik et al., 2019).
Health	Categorical	Based on administrative data, we can distinguish three classes of health impairment: • Handicapped: Person is assessed as handicapped, if the degree of functional disorder is 50 % or more. • Withdraws partial disability pension: Individual is eligible to a partial disability pension if his ability to work decreased by more than 40 % but no more than 70 % due to poor health. The assessment is independent from the assessment for being handicapped. • Withdraws full disability pension: Individual is eligible to full disability pension if his ability to work decreased by more than 70 % due to poor health. The assessment is independent from the assessment for being handicapped. For each class, two separate variables are created (*being* and *becoming*) to allow for different effect of health impairment in the first year and subsequent years. Because the assessments for handicapped status and disability pension are different and mutually independent, one can be both handicapped and withdraw disability pension. In such case, we include the individual only in category disabled for simplicity reason, i.e. to avoid creating additional categories for people who are both handicapped and disabled. We do this, because the disability benefit is directly tied to a decrease in work ability and so should be more limiting in ability to continue working. The variable handicapped therefore accounts for people who are handicapped but not disabled. If an individual is in category (fully or partially) disabled, he can be either both handicapped and disabled or only disabled.
Family status	Categorical	Family status with five categories.
Age	Categorical	Single category for each age between 57 and 70.
Number of children	Categorical	Number of children, capped at 5 children.
Year of observation	Categorical	Separate category for each year.
Women	Dummy	Takes the value of one for women, zero for men.
Self-employed	Dummy	Included in the sensitivity analysis. Takes the value of one, if an individual was self-employed in the given year.

Annex B. Summary statistics of the baseline estimation sample

Table A B.1. Summary statistics of categorical and dummy variables

	Probability of employment exit	Number of observations		Probability of employment exit	Number of observations
Benefit			**Family status**		
No eligibility	5.5%	643 210	Unknown	14.6%	8 138
Early pension	18.0%	329 640	Single	13.5%	95 927
Old-age pension (at SRA)	35.4%	110 120	Married	14.7%	1 048 768
Old-age pension (past SRA)	22.1%	337 692	Divorced	13.6%	153 928
Education			Widowed	17.0%	113 901
Unknown	14.5%	193 860	**Age**		
None	22.9%	63 048	57	4.5%	247 783
Elementary	26.5%	6 655	58	6.4%	241 937
Secondary	16.9%	546 525	59	10.5%	225 986
Secondary with diploma	13.1%	252 237	60	20.3%	195 750
University	10.7%	358 337	61	19.9%	144 819
Industry			62	30.2%	107 342
Construction	17.4%	69 749	63	22.9%	70 387
Mining	16.6%	7 721	64	21.5%	51 974
Accommodation and Restaurants	18.3%	23 209	65	22.1%	39 682
Unknown	18.4%	19 510	66	20.7%	30 240
Manufacturing	16.2%	307 770	67	21.6%	23 422
Sales and Repair	15.5%	139 083	68	21.3%	17 684
Agriculture	17.4%	58 748	69	23.2%	13 452
Services	15.1%	155 704	70	24.3%	10 204
Transport	14.4%	85 397	**Children**		
Other	14.3%	71 377	0	14.5%	136 747
Public service and defence	13.3%	161 472	1	13.6%	225 285
Education	12.0%	188 539	2	14.1%	711 300
Healthcare and long-term care	11.4%	132 383	3	16.4%	263 080
Health			4	17.0%	63 335
No impairment	14.1%	1 274 098	5 or more	18.1%	20 915
Handicapped	23.5%	27 507	**Year**		
Became handicapped	31.3%	3 305	2013	16.6%	206 083
Partial disability	13.8%	75 644	2014	15.5%	218 012
Became partially disabled	25.6%	14 303	2015	15.1%	230 878
Full disability	19.3%	20 076	2016	14.4%	242 748
Became fully disabled	49.2%	5 729	2017	13.7%	255 335
Living in a city			2018	13.3%	267 606
No	16.2%	501 211	**Gender**		
Yes	13.8%	919 451	Men	15.0%	730 261
Roma			Women	14.3%	690 401
No	14.6%	1 404 806			
Yes	18.7%	15 856			

Table A B.2. Distribution characteristics of the continuous variable unemployment by employment exit

	10th percentile	Median	Mean	90th percentile	Number of observations
Exited	2.9%	7.3%	8.6%	16.4%	208 021
Remained	2.8%	6.5%	8.1%	15.4%	1 212 461

Annex C. Dataset creation and methodology

We append observations across years to receive estimates that are more robust. For each year, the dependent variable is one if an individual retired in the given year and zero otherwise. Subsequently the independent variables for the given individual and year are assigned to the dependent variable. This way, we receive six individual datasets for each year separately (2013 to 2018). We then include the year for each observation and append the datasets. The scheme for appending the observation across years is displayed in Table A C.1.

Table A C.1. Scheme for creating the baseline sample

Employment exit	Year	Covariates
0	2013	XXX
.	.	.
1	2013	XXX

Employment exit	Year	Covariates
0	2014	XXX
.	.	.
0	2014	XXX

. . .

Employment exit	Year	Covariates
1	2018	XXX
.	.	.
0	2018	XXX

Employment exit	Year	Covariates
0	2013	XXX
.	.	.
1	2013	XXX
0	2014	XXX
.	.	.
0	2014	XXX
1	2018	XXX
.	.	.
0	2018	XXX

We use logistic regression to estimate the effect of independent variables on the timing of employment exit. The dataset described above is used to estimate the model of the following form:

$$log\left(\frac{p\left(E_{i,t+2}=0 \wedge E_{i,t+1}=0 \,\middle|\, E_{i,t}=1\right)}{p\left(E_{i,t+2}=1 \vee E_{i,t+1}=1 \,\middle|\, E_{i,t}=1\right)}\right)=\alpha+X_{i,t}\beta,$$

where $E_{i,t}$ denotes if individual *i* was employed in year *t* and the vector $X_{i,t}$ includes all individuals' covariates described above, including the year effects. On the left side, the probability is modelled using the logit function to make sure it remains between zero and one. The ratio of the probabilities shows the odds of exiting employment if an individual worked in year *t*. Odds are a helpful way of displaying the estimation results. Comparing odds of employment exit for a person with a characteristic and without it displays the effect of this characteristic on the employment exit decision. As an individual may appear in the dataset multiple times (for multiple years), we estimate the model using a robust estimation method that allows for intragroup correlation. We therefore cluster the observations based on the individual ID.

Annex D. Simulation specification

We first define the probability of employment exit at age a conditional on working at age a-*1*. This is precisely the estimated probability given in Table 1. The conditional probability to exit employment is defined as:

$$h(x_{i,a}) = \frac{\exp\{x_{i,a} * \beta\}}{1 + \exp\{x_{i,a} * \beta\}}$$

where $x_{i,a}$ is a vector of independent variables for individual i aged a, and β is the vector of estimated parameters including the constant term.

The probability to remain employed given individual's i characteristics and age a is then computed as:

$$p(W_{i,a} = 1 | x = x_{i,a}) = \begin{cases} 1 & for\ a = 56 \\ p(W_{i,a-1} = 1 | x = x_{i,a-1}) * h(x_{i,a}) & for\ a \in \{57, \dots, 70\} \\ 0 & for\ a = 71 \end{cases}$$

where $W_{i,a}$ denotes if individual *i* worked at age a, $x_{i,a}$ is a vector of independent variables for individual i, and β is the vector of estimated parameters. We assume that all individuals exit employment by age 71.

Subsequently we can compute the probability of employment exit at age a as:

$$p(R_{i,a} = 1 | x = x_{i,a}) = p(W_{i,a-1} = 1 | x = x_{i,a-1}) - p(W_{i,a} = 1 | x = x_{i,a})$$

where $R_{i,a}$ indicates whether individual *i* exited employment at age a. By multiplying the probability to exit employment with age, we obtain the projected age of employment exit. When interpreting the projected age of employment exit, one must bear in mind that the scenario assumes all individuals working at age 56.

Annex E. Additional estimation results

Table A E.1. Estimation results by gender

Odd ratios, reference class in parenthesis for categorical variables

	Baseline		Women		Men	
Benefit (No eligibility)						
Early pension	2.92	**	2.93	**	2.52	**
Old-age pension at SRA	8.01	**	8.25	**	5.96	**
Old-age pension past SRA	4.39	**	4.44	**	3.46	**
Number of observations	1 420 662		690 401		730 261	
Pseudo R2	0.123		0.122		0.126	
AUC	0.75		0.75		0.75	

Estimates marked * are statistically significant on 5 % level, ** on 1 % level. The estimations include the same set of control variables as the baseline (Table 1), but results for the control variables are not reported. Standard errors are clustered at the individual level.

Table A E.2. Interaction between family status and gender

Odd ratios, reference class in parenthesis for categorical variables

	Estimate	z-value
Family status (Married)		
Unknown	0.97	0.57
Single	1.11	0.00
Divorced	1.11	0.00
Widowed	1.12	0.00

	Estimate	z-value
Women	1.23	0.00
Family status (Married) x Women		
Unknown	0.97	0.66
Single	0.73	0.00
Divorced	0.73	0.00
Widowed	0.79	0.00

Table A E.3. Estimation of sensitivity scenarios

Odd ratios, reference class in parenthesis for categorical variables

	Baseline		Any income		Longer inactivity		With self-employed	
Benefit (No eligibility)								
Early pension	2.92	**	2.87	**	2.86	**	2.79	**
Old-age pension at SRA	8.01	**	6.21	**	7.67	**	7.31	**
Old-age pension past SRA	4.39	**	3.93	**	3.86	**	4.07	**
Education (Secondary)								
Unknown	0.72	**	0.82	**	0.67	**	0.72	**
None	1.38	**	1.25	**	1.35	**	1.40	**
Elementary	2.58	**	2.07	**	3.65	**	2.61	**
Secondary with diploma	0.65	**	0.75	**	0.61	**	0.64	**
University	0.53	**	0.63	**	0.51	**	0.52	**
Industry (Manufacturing)								
Construction	1.05	**	1.06	**	1.03	**	1.06	**
Mining	1.03		1.38	**	1.00	**	1.04	

	Baseline		Any income		Longer inactivity		With self-employed	
Accommodation and Restaurants	1.03		0.83	**	0.98	**	1.00	
Unknown	1.00		1.13	**	0.99	**	1.05	**
Sales and Repair	0.89	**	0.85	**	0.85	**	0.89	**
Agriculture	0.87	**	0.83	**	0.80	**	0.88	**
Services	0.85	**	0.79	**	0.77	**	0.86	**
Transport	0.84	**	0.85	**	0.84	**	0.84	**
Other	0.72	**	0.77	**	0.69	**	0.73	**
Public service and defence	0.72	**	0.85	**	0.70	**	0.74	**
Education	0.62	**	0.72	**	0.60	**	0.65	**
Healthcare and long-term care	0.53	**	0.61	**	0.50	**	0.55	**
Health (No impairment)								
Handicapped	1.26	**	1.27	**	1.24	**	1.24	**
Became handicapped	2.18	**	2.09	**	2.14	**	2.11	**
Partial disability	1.25	**	1.21	**	1.20	**	1.25	**
Became partially disabled	4.83	**	3.83	**	4.33	**	4.67	**
Full disability	1.59	**	1.68	**	1.43	**	1.55	**
Became fully disabled	13.62	**	8.86	**	13.11	**	12.19	**
Living in a city	0.87	**	0.87	**	0.87	**	0.88	**
Unemployment	1.02	**	1.02	**	1.02	**	1.02	**
Roma	1.19	**	1.29	**	1.07	**	1.17	**
Family status (Married)								
Unknown	0.95		1.01		0.90	**	1.00	
Single	0.92	**	0.98		0.86	**	0.93	**
Divorced	0.94	**	0.94	**	0.88	**	0.95	**
Widowed	0.96	**	0.97	**	0.94	**	0.96	**
Age (57)								
58	1.26	**	1.19	**	1.44	**	1.24	**
59	1.80	**	1.52	**	2.11	**	1.79	**
60	2.09	**	1.88	**	2.34	**	2.09	**
61	1.95	**	1.59	**	2.25	**	1.94	**
62	2.07	**	1.60	**	2.41	**	2.05	**
63	2.13	**	1.72	**	2.50	**	2.10	**
64	2.06	**	1.68	**	2.41	**	2.03	**
65	2.18	**	1.75	**	2.51	**	2.14	**
66	2.04	**	1.74	**	2.50	**	2.01	**
67	2.21	**	1.79	**	2.66	**	2.14	**
68	2.20	**	1.88	**	2.64	**	2.12	**
69	2.53	**	2.04	**	3.03	**	2.44	**
70	2.76	**	2.24	**	3.21	**	2.64	**
Children (2)								
0	1.18	**	1.21	**	1.20	**	1.19	**
1	1.01		1.04	**	1.03	**	1.02	*
3	1.02	*	1.00		1.04	**	1.02	**
4	1.03	*	1.00		1.06	**	1.04	**
5 or more	1.06	**	1.06	**	1.06	**	1.08	**

	Baseline		Any income		Longer inactivity		With self-employed	
Year effects (2013)								
2014	0.95	**	0.91	**	0.96	**	0.91	**
2015	0.88	**	0.87	**	0.89	**	0.84	**
2016	0.91	**	0.91	**			0.86	**
2017	0.85	**	0.87	**			0.83	**
2018	0.88	**	1.00				0.83	**
Women	1.14	**	1.03	**	1.23	**	1.12	**
Self-employed							0.68	**
Constant	0.05	**	0.04	**	0.05	**	0.06	**
Number of observations	1 420 662		1 946 585		634 453		1 620 927	
Pseudo R2	0.123		0.086		0.122		0.116	
AUC	0.75		0.71		0.75		0.74	

Estimates marked * are statistically significant on 5 % level, ** on 1 % level. Standard errors are clustered at the individual level.

Annex F. Replacement rate estimation

We first regress the value of the pension benefits on age, gender and work income. We therefore estimate the following regression:

$$Benefit = \alpha + \beta_1 * Age + \beta_2 * Women + \beta_3 * Income,$$

where $Benefit$ is an early or old-age pension that an individual withdrew in year 2012 divided by the average wage in 2012. Without this transformation, we would receive only the nominal value of benefit in 2012, which could not be used to estimate benefit value in subsequent years. Variable $Women$ is a dummy. To calculate the variable $Income$ we first calculate individual's work income to the average wage for years 2007 to 2011. This transformation allows to compare values across years because the average wage increased. We then take the average of these values to create the variable $Income$. Because our analysis only considers individuals working if they earned at least half the minimum wage, we keep this assumption in this regression. This means, that only individuals who earned at least half the minimum wage in year 2011 are included in the estimation.

Table A F.1. Estimation results for benefit calculation

	Estimate	p-value	95 % Confidence interval	
Age	0.019	0.00	0.019	0.019
Women	-0.055	0.00	-0.057	-0.053
Income	0.212	0.00	0.211	0.213
Constant	-0.802	0.00	-0.818	-0.786

The sample consists of 126 677 observations. The R-squared of this estimation is 0.56

The results are in line with expectations. The benefit increases with age, as older workers are able to earn more contribution years hence being eligible for higher benefit. Women have on average lower benefits because of lower lifelong income and possible shorter careers. Higher pre-retirement income implies higher pension because it proxies lifelong income which is part of benefit calculation.

To calculate the replacement rate of the income by pension benefit, we divide the estimated benefit level by the work income. Both variables are expressed as a ratio to the average wage. We can therefore obtain an estimated replacement rate for each individual in the sample.

Table A F.2. Estimation results including replacement rates

Odds ratios, reference class in parenthesis for categorical variables

Benefit (No eligibility)	**Estimate**	
Early pension (low RR)	2.26	**
Early pension (medium RR)	3.07	**
Early pension (high RR)	3.69	**
Old-age pension at SRA (low RR)	6.62	**
Old-age pension at SRA (medium RR)	8.91	**
Old-age pension at SRA (high RR)	8.98	**
Old-age pension past SRA (low RR)	3.82	**
Old-age pension past SRA (medium RR)	4.64	**
Old-age pension past SRA (high RR)	4.89	**
Number of observations	1 420 662	
Pseudo R2	0.125	
AUC	0.75	

Note: Estimates marked * are statistically significant on 5 % level, ** on 1 % level. The estimations include the same set of control variables as the baseline (Table 1), but results for the control variables are not reported.