UCLouvain

UNIVERSITÉ DE NAMUR

Economics School of Louvain - ESL

Economics School of Namur - ESN

Effects of Early Retirement Programs on Youth Unemployment

A Ranked Matching Model with Age Heterogeneity

Author : Guillermo Dominguez

Thesis Director : Mathias Hungerbühler

Thesis Reader : Vincent Vandenberghe

Academic Year 2023-2024

Master in Economics – 120 credits – Focus : Research focus (ECON2MA)

Université catholique de Louvain - Economics School of Louvain - Place Montesquieu 3, 1348 Louvain-La-Neuve
Université de Namur – Economics School of Namur – Rempart de la Vierge 8, 5000 Namur

Acknowledgments

I would like to express my profound gratitude to my supervisor from UNamur, professor Mathias Hungerbühler, for his invaluable guidance and relentless support, for his dedication and insightful feedback that made this work possible but most importantly for the knowledge and skills I have gained under his supervision that will serve me well in future endeavors. Additionally, I would like to acknowledge professor Vincent Vandenberghe to whom I am very grateful for the time spent reading my work.

Special thanks go to my loving family. To my father, Guillermo, for his unconditional support and wise words of advice that helped overcome every challenge. To my mother, Magalí, for her endless love and unwavering belief in me to reach this milestone. And to my sisters, Andrea and Mariana, for being my inspiration and for being by my side at every step of the way. Without the love all of you have given me, this work would not have been possible.

Last but not least, I want to extend my heartfelt thanks to my friends, both those who have been with me from the very beginning and those I have met along the way. You have been crucial part of this journey, and the motivation and joy that you provided significantly contributed to the realization of this achievement.

Effects of Early Retirement Programs on Youth Unemployment: A Ranked Matching Model with Age Heterogeneity

Guillermo Dominguez

August 2024

Abstract

This paper introduces age-heterogeneity and ranking in a static matching model as in Hungerbühler et al. (2012) and Landais et al. (2018). It does so by differentiating into three different age groups: young, middle and old. And ranking according to their productivity assuming middle-aged workers as the most productive group and older workers as the least productive. The proposed framework implies that firms prefer the most productive group and the matching rates depend on it and in the proportion of each group in the population. The work developed here aims to answer, from a theoretical perspective, the effects of early retirement programs on the young unemployment. We show the existence of a positive relation between the number of older workers in the labor force and the probability of finding a job for younger workers. Additionally, we find a negative relationship between young workers' job find rate and the reservation wage of older workers.

Contents

1 Introduction **2**

1.1 Background and context 2

1.2 Motivation, Research Question and Methodology 2

1.3 Structure 3

2 Related Literature **4**

2.1 Early Retirement Program 4

2.2 Substitutability 5

2.3 Unemployment for different age groups 6

3 The model **6**

3.1 Environment 7

3.2 Matching rates 9

3.3 Wage setting 10

3.4 Firms 12

3.5 Equilibrium 13

3.6 Analytical Results 13

4 Simulation **16**

4.1 Parameters values 16

4.2 Simulation results 17

5 Further Research **19**

5.1 Limitations 19

6 Conclusion **20**

1 Introduction

1.1 Background and context

According to Mirkin (1987), early retirement programs were put in place not to achieve a labor market equilibrium, but to fulfill broader social goals. Such programs date from the 1970s and early 1980s and were introduced to address problems such as labor market rigidities (leading to high unemployment rates), the introduction of new technologies and job search difficulties. Specifically, early retirement for the employed workers was pursued to provide greater employment opportunities for the young.

Nowadays, population trends by OECD (2023b), indicate that in the last decades old age population has doubled from 9% in the 1960s to 21% in 2021 and is projected to increase to 27% by 2050. Such aging, according to Aiyar and Ebeke (2016), impacts economic measures in two different ways: an increase in the dependency ratio and an aging workforce, both having significant effects on the total output. Combined with early retirement schemes, GDP per capita would be expected to fall with a higher dependency ratio.

In recent years, governments have turned into rising the retirement age and reserving early retirement for hazardous jobs, as mentioned in OECD (2023a). This aims to stabilize public finances of the governments where the fiscal pressure comes from the viability of pensions and healthcare expenses. Such policies may also indirectly alleviate youth unemployment.

1.2 Motivation, Research Question and Methodology

The motivation behind this paper comes from the need to look into the labor market dynamics in an aging society. In all the OECD countries, youth unemployment exceeds the rate of the overall population. The average youth unemployment rate in OECD countries is 8.9% compared to 4.8% for the total population. The challenges for policymakers, labor organizations and firms need to be focused on managing an age-diverse workforce,

as discussed in the work by Guest and Shacklock (2005).

Empirical literature shows the effects of early retirement programs and how they have not been an optimal approach for the labor market, older workers and the government, as illustrated in the works of Jousten (2001), Jousten et al. (2010), and Böheim and Nice (2019). Furthermore, there are few theoretical works that address the issue of retirement policies. Here, we can observe the work of Lefèbvre (2012), and in a broader aspect, the work Menzio et al. (2016), which addresses the problem of age-heterogeneity. However, with the work developed here, we hope to gain insights into the labor market when faced with age-heterogeneity and implicit preferences of the firms on the the age of the workers. We aim to provide a deeper understanding of the sources of labor market imperfections that arise from the assumptions of worker substitutability and the generosity of the social security.

We will explore how do early retirement programs affect the probability of finding a job for younger workers. To do such, we will consider a static matching model as in Hungerbühler et al. (2012) and Landais et al. (2018), while adding age heterogeneity and ranking between age groups to consider an intrinsic preference of firms over the age of workers and the productivity that they may bring with it. This approach should provide theoretical insights of how increasing the older working population is beneficial for younger workers.

1.3 Structure

The remainder of this paper proceeds as follows, section 2 provides a comprehensive literature review on early retirement programs and its effects on the labor market. Section 3 gives the detailed development of the extended matching model with age-heterogeneity and ranking, and provides the key results of it. In section 4, we provide the simulations of the model to back the key results. Finally, section 5 discusses further research and extensions on the model provided, while section 6 gives concluding remarks and the contributions to the literature and policy implications.

2 Related Literature

2.1 Early Retirement Program

As mentioned by Jousten (2001), for a long time, decision makers, when facing an aging population, opted to decrease retirement age or incentivize early retirement to loosen the labor market. The intuition behind these decisions was to diminish competition for jobs, by removing the older, more expensive workers from the market. However, this approach negatively affected the development of new skills for the older workers and governments had to face increasing costs in their social security budgets. Since then, governments have started to change such trends, and by 2020 the average retirement age in the OECD countries was of 64.2 years for men, according to OECD (2023a). The projection for those workers who entered the labor market in 2020, is an average retirement age closer to the 67 years of age.

Early retirement programs emerged in the 1970s as a solution to youth unemployment, gaining traction across many countries, Lefèbvre (2012). This policy approach seemed intuitive, aiming to reduce the workforce and thus increase the job openings and participation rates for younger workers. However, as Kapteyn et al. (2004) point out, this strategy would led to worksharing and the lump of labor fallacy. The lump of labor fallacy assumes a fixed amount of work available and then by reducing the number of workers, there will be an increased availability of vacancies for younger workers.

According to empirical research by Jousten et al. (2010), observe the case of Belgium, an economy characterized by its relatively high unemployment rate of the young and low participation rate of older workers. The authors show that incentivizing older workers to leave the labor force did not clearly increase youth employment.

Moreover, the idea of easing the exit of the labor force for the elderly relies on the assumption that young and old workers are perfect substitute. However, Böheim and Nice (2019) mention that even workers with similar skills but differing by five years are imperfect substitutes. Additionally, the authors emphasize that early retirement amounts

to higher labor costs and negatively affects labor demand for both young and old workers.

2.2 Substitutability

Many authors, such as Jousten (2001), Guest and Shacklock (2005) and Roger and Wasmer (2011) have found that age heterogeneity in the labor market has become a complex study in the field of labor economics. Policymakers, labor organizations and private firms struggle on finding the right proportions of old and young workers. For Jousten (2001), the analysis is mainly from the government's point of view and the budgetary challenges. However, leaving such implications aside, he highlights that governments failed to reduce unemployment and increase opportunities for young workers.

Guest and Shacklock (2005) look into the "optimal mix" of old and young workers from a management perspective. Focusing on the variability of productivity within age groups and wage differentials, they conclude that workers are not substitutes but complements. When it comes to the hiring decision, firms prefer younger workers due to their high productivity at lower hiring costs while maintaining and appreciating older workers' experience and low turnover. An aging workforce, in terms of aggregate productivity is most likely to bring benefits to firms. This can be supported by Ruzik-Sierdzinska et al. (2013), where it is mentioned that the ability to perform work tasks consistently rises through the first 10 years of working life, maxing out at 30-35 years old, remains steady until 50 years old when the declining in productivity starts.

Interestingly, van Ours and Stoeldraijer (2011) finds that many studies throughout the years have found contradicting conclusions on the relation of age and productivity. The differences arise due to factors related to the required skill levels of the different jobs. Some jobs may require a high level of expertise, where older worker developing the same functions through the years have a complete advantage over their younger counterparts. However, in jobs where constant adaptation and learning is required, the younger workers may show a higher productivity.

When revisiting the marginal productivity among age group and skill profiles, Roger

and Wasmer (2011) found that workers at any skill level are imperfect substitutes for one another. Additionally, they found that wages do not reflect actual productivity and that relative productivity-to-wage ratio is an important factor in employers' decisions. When looking into wages differentials, we should also consider Hellerstein et al. (1999), where the authors find that other exogenous factors affect wages and not only productivity measurements.

2.3 Unemployment for different age groups

Age significantly affects the unemployment rate for different age groups. While the middle-aged workers (also known as prime-aged) are the least affected by unemployment, younger and older workers face more barriers to employment. The study by Axelrad et al. (2018) looks into the conditions that different age groups face during unemployment and draws two important conclusions. First, youth unemployment is highly affected by the state of the labor market and the business cycle, and less by personal attributes. Secondly, the main difficulties faced by unemployed older worker when looking for a job emerge from their age rather than the state of the economy.

It is also important to consider the preferences of hiring firms. For this, Farber et al. (2019) conducted a study to observe callbacks from firms to unemployed workers. The study finds that, when considering the age of applicants, prime-aged workers have a higher probability of receiving a callback compared to younger and older workers. In their results, they can not conclude if there is a preference between young and old workers, but they do conclude a higher interest in hiring prime-aged workers among the three types.

3 The model

Let us introduce here a different extension to the matching models that have been developed previously with agents heterogeneity. For instance, Lefèbvre (2012) and Barnichon

and Figura (2015) explored the idea of worker heterogeneity in the labor market. The former focused specifically on age heterogeneity, adding retirement risks for older workers alongside the usual job destruction rate. The latter, created a generalized matching function that explicitly introduces labor market heterogeneities and nesting the standard matching function when constant heterogeneity in the labor market. However, our model introduces heterogeneity in the matching model with ranking in the matching function. Incorporating such mechanism will allow for a representation of the intrinsic preferences in the labor market over the type of workers. This extension acknowledges that even without discrimination, the firms prioritize certain attributes or qualification, in our case, the prioritization over age-productivity relation.

3.1 Environment

Consider an economy with a continuum of firms and three types of risk-neutral workers categorized by age: young, middle and old (indexed by y, m, o, respectively). The share of individuals in each group is given by σ_y, σ_m, σ_o we take them as given. The productivity level of each type is exogenous and follows $y_m > y_y > y_o$. We develop a static matching model similar to those in Hungerbühler et al. (2012) and Landais et al. (2018), incorporating ranking within matching functions to account for age-heterogeneity in the labor market. The matching function will be used with a Cobb-Douglas specification as in Blanchard and Diamond (1989). Firms produce a unique final good and employ only one worker.

Ranking, by definition, involves determining the relative position of agents. In our case, we assume that firms rank workers based on their age, prioritizing middle-aged workers over younger ones, and younger workers over older ones. Essentially, we want to capture the scenario where, when presented with applications from two or three from workers varying in age, firms will hire the highest-ranked worker. For example, if a firm receives an application from a middle-aged and a younger worker, it will choose the middle aged worker. Similar situation would happen when presented with a younger and

an older worker, but in this case, it will choose the younger worker.

Worker and firms meet according to the Cobb-Douglas matching function, which is increasing, concave and homogeneous of degree 1. The total number of matches in the economy is given by:

$$H = M(U, V) = AV^{1-\alpha}U^{\alpha}$$

where $U = U_m + U_y + U_o$ representing the total number of unemployed in the economy, $V \geq 0$ are the vacancies, the technology $A > 0$ and $\alpha \in (0, 1)$. For a match to occur, there should be at least one worker and one vacancy, else: $M(0, U) = M(V, 0) = 0$.

As mentioned before and with the assumption of productivity levels per age group, we propose that the preferred type is the middle-aged worker, then the young and finally the old. In order to integrate heterogeneity and ranking we obtain the following type-specific matching functions:

$$\text{Middle} = M(V, U_m) \tag{3.1}$$

$$\text{Young} = M(V, Um + U_y) - M(V, U_m) \tag{3.2}$$

$$\text{Old} = M(V, U_m + U_y + U_o) - M(V, Um + U_y) - M(V, U_m) \tag{3.3}$$

Such functions, allow us to give the preference to the middle-aged workers, which then will from the younger workers' function, and in such way, the young and the middle functions will be subtracted from the matching function of the old.

Now define labor market tightness as the ratio of vacancies to unemployed. Each group will face the same number of vacancies but the number of unemployed will be increasing according to the ranking, thus increasing the tightness to the next type, giving us the following expressions:

$$\theta_m \equiv \frac{V}{U_m}$$

$$\theta_y \equiv \frac{V}{U_m + U_y}$$

$$\theta_o \equiv \frac{V}{U_m + U_y + U_o}$$

Introducing ranking into the matching model allows us to characterize firms' preferences without introducing discrimination. This can be observed in the group specific matching functions and market tightness. These functions allow to observe the independence of the middle-aged group as the most preferred group, while the young is interdependent with the middle-aged, and the old group is interdependent with both the middle-aged and the young groups. Additionally, labor market tightness increases with the decrease in the ranks as well.

3.2 Matching rates

The firms fill a vacant job with a worker of each type at the rate $m(\theta_i)$ which reflect the ability of the firm to match with middle-aged (m), young (y) and old (o) workers. The matching rates are defined as follows:

$$m(\theta_m) = \frac{M(V, U_m)}{V} \tag{3.4}$$

$$m(\theta_y) = \frac{M(V, U_m + U_y)}{V} - m(\theta_m) \tag{3.5}$$

$$m(\theta_o) = \frac{M(V, U_m + U_y + U_o)}{V} - m(\theta_y) - m(\theta_m) \tag{3.6}$$

The matching rate for middle-aged workers depends only on the number vacancies and the number unemployed middle-aged workers. Then, for the next two groups we have to consider the group itself plus the population of the preceding, and subtract the matching rate of the preceding as well. It makes then, that for the younger workers, we have to consider that they have to compete among the middle and themselves, and then subtract the matching rate of the middle. For the older workers it follows the same procedure.

with $m'(\theta_i) < 0$ and following the Inada conditions below to support the existence of an equilibrium.

$$\lim_{\theta \to 0} m(\theta) = +\infty \quad \text{and} \quad \lim_{\theta \to +\infty} m(\theta) = 0$$

Inversely, define $p(\theta_i) = \frac{V}{U_i} * m(\theta_i)$ as the probability for worker of type i to match with a firm. We obtain the following expression for each type:

$$p(\theta_m) = \frac{V}{U_m} m(\theta_m) \tag{3.7}$$

$$p(\theta_y) = \frac{V}{U_y} m(\theta_y) \tag{3.8}$$

$$p(\theta_o) = \frac{V}{U_o} m(\theta_o) \tag{3.9}$$

To ensure the properties of the model, $p(\theta_i)$ follows similar Inada conditions (shown below). While vacant jobs are filled at a diminishing rate, workers match an increasing rate as θ increases.

$$\lim_{\theta \to 0} p(\theta) = 0 \quad \text{and} \quad \lim_{\theta \to +\infty} p(\theta) = +\infty$$

3.3 Wage setting

Our analysis will consider that only the older workers can opt for a reservation wage considering it as retirement. In the literature, it is common practice to use the Nash Bargaining solution, proposed by Binmore et al. (1986), for wage determination. This methodology implies that workers have a bargaining power γ which will be used to divide the surplus of their production with the firm. In the end, the worker payoff is a real wage w_i, that in fact is a fraction of their production y_i. In the case of the older workers, we shall also consider that their wage will need to account for some of their reservation wage z, since they will opt for retirement when $z > w_o$.

The solution for the wage setting problem is determined by:

For the young and middle workers:

$$[w_i]^{\gamma} * [y_i - w_i]^{1-\gamma} \quad \forall i \in y, m$$

Getting the First Order Condition of this expression with respect to w_i:

$$w_i^\star = \gamma * y_i \tag{3.10}$$

The expression for the surplus division that firms face with older workers:

$$[w_o - z]^\gamma * [y_o - w_o]^{1-\gamma}$$

And when getting the First Order Conditions with respect to w_o, we get that the wage for the old is:

$$w_o^\star = \gamma * y_o + (1 - \gamma) * z \tag{3.11}$$

For the wage setting we can determine that the of the old depends on their productivity and on their reservation wage. The following propositions will help to observe the wage setting for the older workers.

Proposition 1: *The positive relationship between the wage and the reservation wage, implies that the wage of the older workers, w_o, can be the highest, the middle, or the lowest wage among the different age groups. What will determine such positioning is the reservation wage. Meanwhile, the relationship of $w_m > w_y$ will remain constant as long as the productivity relations $y_m > y_y$ remains unchanged.*

Proof: Start by taking the partial derivative of w_o with respect to z.

$$\frac{\delta w_o}{\delta z} = 1 - \gamma > 0$$

Now, assume that $z = 0$, in such case we obtain the following relationship $w_m > w_y > w_o$.

When $z > 0$ we analyze three possible cases:

$$w_m > w_y > w_o \iff z < y_y - y_o$$
$$w_m > w_o > w_y \iff y_y - y_o < z < y_m - y_o$$
$$w_o > w_m > w_y \iff z > y_m - y_o$$

Thus, we observe that the wage of the older is related to the value of their reservation wage. □

3.4 Firms

Each firm has a single vacancy, once this vacancy it is filled, the firm produces a given amount of output y_i, since it will depend on the type of worker it hires. The firm's profit is $y_i - w_i - h$, where h is the fixed cost of opening a vacancy. If the firm does not fill the vacancy the profit will be equal to h.

There exist a free entry condition such that firms will open vacancies until the expected return becomes zero. Let $b_i = y_i - w_i$ be the expected benefit of a firm depending on the type of worker it hires. Then the free entry condition is given by:

$$m(\theta_m)b_m + m(\theta_y)b_y + m(\theta_o)b_o = h \tag{3.12}$$

Given the free entry condition equation 3.12 and the equations 3.4, 3.5, 3.6 we get the following expression for the supply of vacancies from the firms. Note that, since firms can not discriminate beforehand their preferred age group, there is a single supply of vacancies.

$$V = \frac{(1-\gamma)}{h}[M_m(y_m - y_y) + M_y(y_y - y_o) + M_o y_o + z(M_y - M_o)] \tag{3.13}$$

The supply of vacancies is then determined by the firms' bargaining power, the cost of opening vacancies, the matching functions of each group, their productivity and the

reservation wage of the old.

3.5 Equilibrium

The equilibrium of the model is given by the triple $(w_i^\star, \theta_i^\star, V^\star)$. For $w_i^\star$ and $V^\star$, the equilibrium is straightforward from the equations 3.10 and 3.11, for the wage and equation 3.13 for the vacancies. However, to find $\theta_i^\star$, we need to compute the following expressions:

$$\theta_m^\star = \frac{V^\star}{U_m^0 - (p(\theta_m)U_m)} \tag{3.14}$$

$$\theta_y^\star = \frac{V^\star}{(U_m + U_y)^0 - (p(\theta_y)(U_m + U_y))} \tag{3.15}$$

$$\theta_o^\star = \frac{V^\star}{(U_m + U_y + U_o)^0 - (p(\theta_o)(U_m + U_y + U_o))} \tag{3.16}$$

where the superscript 0 indicates initial value. The equilibrium market tightness is given by the division of the equilibrium number of vacancies over the subtraction of the initial unemployment values minus the value of the total number of workers that find a job.

3.6 Analytical Results

Proposition 2: *an increase in the number of older workers in the labor market (an increase in the early retirement age) increases the probability of younger workers to find a job.*

Proof: To examine the relationship between the probability of finding a job for the young workers ($p(\theta_y)$) with respect to the total number of old unemployed (U_o) we partially differentiate $p(\theta_y)$ with respect to U_o:

$$\frac{\delta p(\theta_y)}{\delta U_o} = \frac{\delta p(\theta_y)}{\delta V} * \frac{\delta V}{\delta U_o} \tag{3.17}$$

Take equations 3.8 and 3.13 under their Cobb-Douglas specification.

$$p(\theta_y) = \frac{AV^{1-\alpha}}{U_y}[(U_m + U_y)^\alpha - U_m^\alpha]$$

$$V = \left(\frac{(1-\gamma)A}{h}[U_m^\alpha(y_m - y_y) + (U_y + U_m)^\alpha(y_y - y_o) + (U_m + U_y + U_o)^\alpha y_o + z((U_y + U_m)^\alpha - (U_m + U_y + U_o)^\alpha)]\right)^{1/\alpha}$$

Calculate the partial derivative of $p(\theta_y)$ with respect to V:

$$\frac{\delta p(\theta_y)}{\delta V} = \frac{(1-\alpha)V^{-\alpha}A}{U_y}\left[(U_m + U_y)^\alpha - U_m^\alpha\right] \tag{3.18}$$

Next, compute the partial derivative of V with respect to U_o:

$$\frac{\delta V}{\delta U_o} = \frac{V}{\alpha W}\frac{(1-\gamma)A}{h}[\alpha(U_m U_y + U_o)^{\alpha-1}(y_o - z)] \tag{3.19}$$

where W is defined as:

$$W \equiv \frac{(1-\gamma)A}{h}\left[U_m^\alpha(y_m - y_y) + (U_y + U_m)^\alpha(y_y - y_o) + z\left((U_y + U_m)^\alpha - (U_m + U_y + U_o)^\alpha\right)\right]$$

Substituting equations 3.18 and 3.19 in the equation 3.17, we get:

$$\frac{\delta p(\theta_y)}{\delta U_o} = \underbrace{\frac{(1-\alpha)V^{-\alpha}A}{U_y}}_{>0}\underbrace{[(U_m + U_y)^\alpha - U_m^\alpha]}_{>0}\underbrace{\frac{(1-\gamma)VA}{\alpha W h}}_{>0}\underbrace{[\alpha(U_m + U_y + U_o)^{\alpha-1}]}_{>0}\underbrace{(y_o - z)}_{>0} > 0$$

Thus, it is demonstrated that an increase in the number of older workers in the labor market increases the probability of younger workers finding employment. □

The main intuition behind Proposition 2 is that, by decreasing the unemployed older workers, in this case by early retirement, would not improve the conditions for unemployed younger workers. To further understand the dynamics of this proposition let us refer to equations 3.18 and 3.19. Equation 3.18 shows that the probability of younger workers finding is positively related to the number of vacancies. Equation 3.19 shows

that there is a positive relation between the unemployed older workers and the supply of vacancies. By combining these two equations, we can observe a positive relationship between the probability of younger workers finding a job and the unemployed workers. The mechanism behind this is as follows: a decrease in the number of unemployed older workers (U_o) leads to a decrease in the supply of vacancies (V), which in turn, decreases the probability ($p(\theta_y)$) of younger workers finding a job.

Proposition 3: *The probability of younger workers finding a job is negatively related to the reservation wage of the old.*

Proof: To examine the relationship of the probability of finding a job for the young workers ($p(\theta_y)$) with respect to the reservation wage of the old (z), we need to get the following partial derivative:

$$\frac{\delta p(\theta_y)}{\delta z} = \frac{\delta p(\theta_y)}{\delta V} * \frac{\delta V}{\delta z} \tag{3.20}$$

Taking again equations 3.8 and 3.13 under their Cobb-Douglas specification, the first term of equation 3.20 is identical to the equation 3.18.

Next, compute the partial derivative of V with respect to z:

$$\frac{\delta V}{\delta z} = \frac{V(1-\gamma)A}{\alpha W h}((U_m + U_y)^\alpha - (U_m + U_y + U_o)^\alpha) \tag{3.21}$$

where W is defined as:

$$W \equiv \frac{(1-\gamma)A}{h}\left[U_m^\alpha(y_m - y_y) + (U_y + U_m)^\alpha(y_y - y_o) + z\left((U_y + U_m)^\alpha - (U_m + U_y + U_o)^\alpha\right)\right]$$

Substituting equations 3.18 and 3.21 into equation 3.20:

$$\frac{\delta p(\theta_y)}{\delta z} = \underbrace{\frac{V(1-\gamma)A}{\alpha W h}}_{>0}\underbrace{((U_m + U_y)^\alpha - (U_m + U_y + U_o)^\alpha)}_{<0}\underbrace{\frac{(1-\alpha)V^{-\alpha}A}{U_y}\left[(U_m + U_y)^\alpha - U_m^\alpha\right]}_{>0} < 0 \tag{3.22}$$

It is demonstrated that the probability of finding a job for the younger workers is negatively related to the reservation wage of the old. □

The intuition from Proposition 3 is that, by increasing the social security, such as pension payments, lead firms to supply fewer vacancies since the cost of providing them increases, affecting the probability of younger workers finding a job. To understand the dynamics of this proposition we need to analyze equations 3.18 and 3.21 separately. As before, equation 3.18 shows a positive relationship between the probability of younger workers finding a job and the supply of vacancies. Equation 3.21 indicates a negative relation between the supply of vacancies and the reservation wage. By combining both equations, as shown in equation 3.22, we observe a negative relationship between the reservation the probability of younger workers finding and the reservation wage. The underlying mechanism is as follows: an increase in the reservation wage (z) leads to a decrease in the supply of vacancies (V), which in turn, reduces the probability ($p(\theta_y)$) of younger workers finding a job.

4 Simulation

We conducted simulations to show the effects of increasing the retirement age and raising the reservation wage (pension payments). As in the model, we divide working age population into three groups; young workers, according the International Labor Organization, being between 15 to 24 years old, middle workers between 25 to 54 years old, and old workers being 55 to 69 years old. The age ranges for middle-aged and older workers were determined based on the earliest age at which workers can apply for early retirement programs in any OECD country, as referenced in OECD (2023a).

4.1 Parameters values

The calibration of the model will try to replicate the features of the labor market in a static version. We are going to set parameters to the common values used in the existing litera-

ture. Recall from the previous section that the matching function follows a Cobb-Douglas specification as in Blanchard and Diamond (1989). Following Mortensen and Pissarides (1994), we will set equal weights on unemployment and vacancies in our function, getting $\alpha = 0.5$, and for the bargaining power we will use $\gamma = 0.5$. To determine the thresholds for young, middle-aged and older workers, we use the data from OECD (2023c), and consider the whole population of OECD countries. This yields the following values for each group: $\sigma_y = 18\%$ for young workers, $\sigma_m = 57\%$ for middle-aged workers, and $\sigma_o = 25\%$ for older workers. We set the productivity of the middle-aged worker equal to 1 ($y_m = 1$) and use this as our baseline productivity for comparing younger and older workers. We assume that younger workers have higher productivity than older workers, with $y_y = 0.9 > y_o = 0.8$. Ensuring that the firms are acting rationally by preferring younger workers. The values for the reservation wage $z = 0.5$, the vacancy's fixed cost $h = 0.025$, and technology coefficient $A = 0.2$ were selected to align with the specific objectives of the research and to facilitate the exploration of the desired outcomes of the model.

4.2 Simulation results

The following table presents the result of the job finding rate $p(\theta)$ and matching rate $m(\theta)$ for the baseline scenario with the parameter values mentioned above. Table 1 summarizes the results of this case. It is observed that the middle-aged workers have a higher chance of matching, and firms have a higher probability of matching with them, indicating that they are the preferred group. When comparing the matching rates of older and younger workers, there's a higher rate for the older workers. Conversely, the probability of finding a job is higher for the younger workers.

	Middle (57%)	Young (18%)	Old (25%)
$y_m > y_y > y_o$, $z = 0.5$			
$p(\theta)$	94.86%	44.17%	38.37%
$m(\theta^\star)$	4.21%	0.62%	0.74%

Table 1: Simulation of key rates of study

Moreover, to extend on our analytical result in Section 3.6, Proposition 2, we ran simulations increasing σ_o by 5% from 25% to 30%, while keeping σ_y at the level of 18%, and decreasing σ_m from 57% to 52%.

	Middle (52%)	Young (18%)	Old (30%)
$y_m > y_y > y_o$; $z = 0.5$			
$p(\theta)$	96.98%	44.88%	38.07%
$m(\theta^\star)$	4.12%	0.66%	0.93%

Table 2: Simulation of key rates of study changing proportion of old workers

Table 2 summarizes the key results of increasing the proportion of older workers by 5%. This table again shows that middle-aged workers are the preferred group, and in comparison with the previous results, the probability of younger workers finding a job increases. These results are in line with Proposition 2, showing that increasing the retirement age would be beneficial for the younger workers.

Finally, we now extend our simulations to provide insights on the analytical result from Proposition 3 shown in Section 3.6. We maintain the initial proportions of each age group but now we increase the reservation wage z from 0.5 to 0.6.

	Middle (57%)	Young (18%)	Old (25%)
$y_m > y_y > y_o$, $z = 0.6$			
$p(\theta)$	93.45%	43.51%	37.80%
$m(\theta^\star)$	4.28%	0.63%	0.75%

Table 3: Simulation of key rates of study

Table 3 presents the results of increasing the reservations wage for older workers. As observed, an increase in z decreases the probability of younger workers finding a job. As noted in Proposition 3, the increase in the reservation wage raises the cost of supplying vacancies for firms. The reduction in the supply of vacancies then also affects the probabilities of middle-aged and older workers finding a job.

The results presented here highlight the relevance of understanding how the job finding rate interacts with the proportions of different age groups and the reservation wage. These findings suggest that younger workers benefit from a lower reservation wage (pension payments) and from an increased retirement age. The findings presented here should

be considered carefully due to the limitations of a static model, but they are valuable for further research on the subject.

5 Further Research

Potential extensions arise after the development of the model here presented. First, a dynamic model supports the idea of adding aging rates and different job destruction rates per type. A dynamic age-heterogeneity version (à la Menzio et al. (2016)) with a life-cycle specification and low and high skill labor division between age groups would provide relevant insights for labor market and retirement policies. Moreover, we would need to relax the assumptions and consider different productivity and different preferences for the firms. For the latter, it would be needed to allow for the existence of more than one type of firms, each preferring different composition of its workforce.

5.1 Limitations

This research, however, is subject to some limitations. The main limitation arises from the use of a static model. By ignoring the element of time, the model fails to capture changes that occur with the passage of time, such as entries and exits of the labor market, changes in technology and other economical shocks. Additionally, the model relies on two strong assumptions: firms' preferences and workers' age-specific productivity. In our case, we based firms' preferences exclusively on age, but in reality, preference may vary as firms may value other qualities in the hiring process, such as motivation and leadership. Similar case happens when we assume age-specific productivity, although literature does back that workers reach peak productivity when middle-aged, there is no clear evidence on the productivity differentials between young and old workers and this may vary on the job tasks.

6 Conclusion

In conclusion, the study here developed has examined the dynamics of early retirement programs, age-heterogeneity and labor market matching, exposing the complexity of the relationship between government policies, firm preferences and worker characteristics. Initially, early retirement programs were introduced to alleviate young unemployment by reducing competition for vacancies. However, this approach did not consider agent heterogeneity and fell into the *lump of labor* fallacy. Such policies relied on the assumption that early retirement would create job opening for younger workers, as if there were perfect substitutability between older and younger workers. This has been debunked by empirical studies showing that there is no clear link between the reduction of elderly participation and increased youth employment.

It has been studied empirically that substitutability between workers from different age groups is rather imperfect. Such studies show that an optimal workforce relies on the complementarity of age groups rather than their substitution. In terms of productivity, no clear relation has been found with age, since it depends greatly on the job characteristics. While older workers bring experience and stability, younger workers provide adaptability and learning capacity; thus, the optimal composition of the workforce varies according to the specific needs of firms.

Moreover, it has been observed that unemployment rates and hiring probabilities differ across age groups, with middle-aged workers being consistently the most favored group and young and old workers facing more significant barriers in comparison. Employment of the young is more sensitive to economic conditions, while for the old, such barriers are attributed to age-related biases.

The developed model incorporates age-heterogeneity and ranking in the matching function, allowing to observe the preferences of firms and the effects of productivity differentials. The first key result obtained was that increasing the number of older workers in the labor market improves the job-finding probabilities for younger workers. This

goes in line with our initial hypothesis that early retirement programs do not alleviate the young unemployment and even worsen it. Following this, another key result is the negative impact that the reservation wage of the old (retirement benefits) has on youth unemployment. This lead to a reconsideration of the generosity of social security programs and their implications on labor market dynamics. Also, linked to the reservation wage, it was observed that an increasing generosity of the social security for older workers, make it more expensive for firms to hire from this age group.

With this paper, we have contributed a novel approach to the design of matching models by introducing ranking between types of agents. First, the model was based on the assumption that middle-aged (also known as prime-aged) workers are the preferred age group for firms and the group with higher participation rates in the labor force, essentially just competing among themselves for the open vacancies. Then, it follows that the young-age group is the next preferred group by having the second-highest productivity, thus competing for vacancies against themselves and the middle-aged workers. Finally, it is assumed that older workers are the least preferred group, with the lowest productivity and competing for vacancies with all age groups. This methodology allowed us to obtain interesting insights, as mentioned above, and contribute to the literature on labor economics. However, as mentioned in Section 5, further research could be done to obtain more relevant results which could be applied into the study of public policy.

Finally, the policy implications from this paper is that policymakers and firms must revisit the impacts of age-heterogeneity in the labor market. For policymakers, it is important to find the balance between retirement age adjustments and social security generosity to optimize labor market outcomes. For the firms, recognizing the complementarity between age groups is optimal productivity.

References

S. Aiyar and C. Ebeke. The impact of workforce aging on european productivity. *IMF Working Papers*, 16:1, 01 2016. doi: 10.5089/9781475559729.001.

H. Axelrad, M. Malul, and I. Luski. Unemployment among younger and older individuals: does conventional data about unemployment tell us the whole story? *Journal for Labour Market Research*, 52, 2018. doi: 10.1186/s12651-018-0237-9.

R. Barnichon and A. Figura. Labor market heterogeneity and the aggregate matching function. *American Economic Journal: Macroeconomics*, 7(4):222–49, October 2015. doi: 10.1257/mac.20140116. URL https://www.aeaweb.org/articles?id=10.1257/mac.20140116.

K. Binmore, A. Rubinstein, and A. Wolinsky. The nash bargaining solution in economic modelling. *The RAND Journal of Economics*, 17(2):176–188, 1986. ISSN 07416261. URL http://www.jstor.org/stable/2555382.

O. J. Blanchard and P. A. Diamond. The aggregate matching function, November 1989. URL http://www.nber.org/papers/w3175.

R. Böheim and T. Nice. The effect of early retirement schemes on youth employment. *IZA World of Labor*, 2019. ISSN 2054-9571. doi: 10.15185/izawol.70.v2. URL https://hdl.handle.net/10419/206583.

H. S. Farber, C. M. Herbst, D. Silverman, and T. von Wachter. Whom do employers want? the role of recent employment and unemployment status and age. *Journal of Labor Economics*, 37(2):323–349, 2019. doi: 10.1086/700184. URL https://doi.org/10.1086/700184.

R. Guest and K. Shacklock. The impending shift to an older mix of workers: Perspectives from the management and economics literatures. *International journal of organisational behaviour*, 10(3):713–728, 2005.

J. K. Hellerstein, D. Neumark, and K. R. Troske. Wages, productivity, and worker characteristics: Evidence from plant-level production functions and wage equations. *Journal of labor economics*, 17(3):409–446, 1999.

M. Hungerbühler, E. Lehmann, A. Parmentier, and B. V. D. Linden. A simple theory of optimal redistributive taxation withequilibrium unemployment. *Economie publique/Public economics*, (22-23):203–18, 2012.

A. Jousten. Early retirement in europe: A call for action. *CESifo Forum*, 2001.

A. Jousten, M. Lefèbvre, S. Perelman, and P. Pestieau. *The Effects of Early Retirement on Youth Unemployment: The Case of Belgium*, pages 47–76. University of Chicago Press, February 2010. URL http://www.nber.org/chapters/c8251.

A. Kapteyn, A. Kalwij, and A. Zaidi. The myth of worksharing. *Labour Economics*, 11(3):293–313, 2004. ISSN 0927-5371. doi: https://doi.org/10.1016/j.labeco.2003.08.001. URL https://www.sciencedirect.com/science/article/pii/S0927537103000927.

C. Landais, P. Michaillat, and E. Saez. A macroeconomic approach to optimal unemployment insurance: Theory. *American Economic Journal: Economic Policy*, 10(2): 152–181, 2018.

M. Lefèbvre. Unemployment and retirement in a model with age-specific heterogeneity. *LABOUR*, 26(2):137–155, 2012. doi: https://doi.org/10.1111/j.1467-9914.2012.00543.x. URL https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1467-9914.2012.00543

G. Menzio, I. A. Telyukova, and L. Visschers. Directed search over the life cycle. *Review of Economic Dynamics*, 19:38–62, 2016. ISSN 1094-2025. doi: https://doi.org/10.1016/j.red.2015.03.002. URL https://www.sciencedirect.com/science/article/pii/S1094202515000241. Special Issue in Honor of Dale Mortensen.

B. A. Mirkin. Early retirement as a labor force policy: an international overview. *Monthly Labor Review*, 110(3):19–33, 1987.

D. T. Mortensen and C. A. Pissarides. Job creation and job destruction in the theory of unemployment. *The review of economic studies*, 61(3):397–415, 1994.

OECD. Pensions at a glance 2023: Oecd and g20 indicators. *OECD Publishing*, 2023a. URL https://doi.org/10.1787/678055dd-en.

OECD. Health at a glance 2023: Oecd indicators. *OECD Publishing*, 2023b. URL https://doi.org/10.1787/7a7afb35-en.

OECD. Historical population data, 2023c.

M. Roger and M. Wasmer. Heterogeneity matters: labour productivity differentiated by age and skills. *Institut National de la Statistique et des Études Économiques Working Paper*, (G2011/04), 2011.

A. Ruzik-Sierdzinska, M. Lis, M. Potoczna, M. Belloni, and C. Villosio. Age and productivity: Human capital accumulation and depreciation. Technical report, CASE Network Reports, 2013.

J. C. van Ours and L. Stoeldraijer. Age, wage and productivity in dutch manufacturing. *De Economist*, 159:113–137, 2011. doi: 10.1007/s10645-011-9159-4.