Retirement decisions in the presence of technological change: a theoretical and an empirical approach

Pierre-Jean Messe *  Eva Moreno - Galbis †  Francois-Charles Wolff ‡

Preliminary version

Abstract

The paper underlines the major role of productivity as a determinant of the worker’s retirement expectations. We propose an overlapping generation model with a continuum of heterogeneous ability workers. The labor market is endogenously segmented between worker’s having the required ability level to occupy jobs where the productivity is indexed to the technological state (complex jobs) and the rest of workers who are employed in positions whose productivity will be relatively deteriorated in case of technological change (simple jobs). We show that, for a given state of technology, workers in complex positions have a latter retirement date than those in simple positions. Furthermore, in case of a positive technological change, workers in complex positions delay retirement whereas those in simple jobs advance retirement. These findings are confirmed by our empirical approach, where we find that, after a technological change, workers who benefit from a skill upgrading training program have a higher expected retirement age.

Keywords: OLG, retirement, technological change, training

JEL: J14; J22; J24; J26

1 Introduction

The productivity of the worker results from a combination of psychological, physical and relational skills. All of them are modified along the life cycle. On the one hand they can get used by age, but on the other hand they can be improved by the effect of experience and training.

*University of Maine (GAINS-TEPP, Pres UNAM). Email: pierre-jean.messe@univ-lemans.fr
†University of Angers (GRANEM) and GAINS-TEPP. Email: Eva.morenogalbis@univ-angers.fr
‡University of Nantes (LEMNA). Email: Francois.Wolff@univ-nantes.fr
Traditionally, skill obsolescence has been cited as the main factor responsible for the lower attractiveness of senior workers in a context of technological change. However, recent studies, as the French survey ESSA, reveal that 45% of employers consider the better knowledge that seniors (50 years or more) have of the working world as a positive characteristic of older workers, 29% of employers considers the lower adaptability of seniors to technological and organizational changes as a negative factor and only 14% cites the lower dynamism of old workers as a negative characteristic. Moreover, Guignon and Pailhé (2004) find that seniors complaint less about the hardness of their job than young workers. More precisely, 26.6% of seniors declare having tight relationships with their chiefs, colleagues or the public, while this percentage attains 31.1% for young workers. Old workers are also more autonomous than young ones (37.7% against 35%), they solve more often problems found at work alone (62.9% against 54.8%), they prefer to deal alone with difficult situations (27.8% against 23.6%) and they complaint more often if there is no cooperation among them (18.2% against 12.9%). However, they seem to bear also more stress since 20.6% of them complaints about the cadence at work (against 19.5% of young workers).

In a context of technological change, senior workers combine some characteristics (such as autonomy, relational skills, wider human capital) that should favor their productivity (wage) and thus the pursuit of professional activity, and some characteristics (such as skill obsolescence, lower adaptability, health problems) promoting rather an early retirement from the labor market. Traditionally, the literature had only focused on skill obsolescence. More recent works underline though that senior workers may have a comparative advantage in terms of better relational and managing skills. In this context it may be in the interest of the firm to invest on human capital formation for senior workers (rather than for young workers not having the relational or managing skills) in case of technological change. Productivity, and thus wages, of older workers should be improved, which may affect the worker’s retirement decision.

The objective of this paper is to analyze from a theoretical and an empirical perspectives the impact of technological changes on the retirement choice. We underline the major role of productivity as a determinant of the worker’s retirement choice. Contrary to the previous literature, which has traditionally analyzed the relationship between productivity and senior’s employment from the demand side, we focus on this relationship exclusively from the supply side. From the empirical point of view, a simple way to disentangle supply-side from demand-side causes of retirement is to study retirement intentions, rather than effective transitions from work to retirement. Besides, as highlighted by Cobb-Clark and Stillman (2006), this type of analysis is
useful for policy makers to better grasp the causes that lead individuals to plan early retirement. In this paper, we exploit a unique cross-sectional French database drawn from the survey *Passage la retraite* conducted in 2006, that contains some information about the expected exit age of respondents aged between 50 and 69. To investigate the effect of technical progress and on-the-job training on retirement intentions, we use the COI (*Changements Organisationnels et Informatisation*) survey conducted in the same year and we compute aggregated variables within a local labour market, made up of a specific sector and occupation. Using such recent databases constitutes a great advantage with respect to the existing literature on the subject, since by 2006 we can claim that there was no incertitude concerning the diffusion process of new technologies among occupations. Each worker aged between 50 and 55 years old (our target population) could perfectly anticipate the required investment in human capital if she wanted to pursue her working activity.

From a theoretical point of view, we combine an overlapping generations model à la Michel and Pestieau (2000) with a technological diffusion process similar to that proposed in Ahituv and Zeira (2008). The individual lives for two periods. We assume that she works during the whole first period, whereas the worker must choose whether to work or not (early retirement) during the second period, and the number of years she works. This theoretical setup provides a rationale to our empirical results. Moreover, numerical simulations permit to better understand the retirement choices of people employed in heterogenous types of jobs depending on the state of technology.

There starts to be a non negligible amount of literature dealing with retirement decision issues. The most recent literature seems to focus on the demand side, and more precisely, on the impact of technological changes on hirings, firings/departures or the share of seniors in the workforce. Aubert, Caroli, and Roger (2006), using French data, conclude that the most innovative firms are the ones where the proportion of old workers is the lowest due to a reduction in the probability of hiring and an increase in the probability of exit. These results are mitigated when the possibility of training is considered (see Behaghel, Caroli, and Roger (2009)). More precisely, they show that even though training reduces turnover among older workers and increases their wage-bill share, it cannot attenuate the age bias associated to technical progress or new workplace practices.

On the basis of British data, Borghans and Weel (2002) also estimate a negative correlation between age and computer skills, which may favor an earlier retirement decision in case of technological adoption. Ljunqvist and Sargent (2008), Cheron, Hairault, and Langot (2007) and
Saint-Paul (2009), support the view that the shorter distance to retirement is the key feature to understanding the economics of older worker’s employment, since it is not in the interest of firms to invest in workers having a short working horizon. Langot and Moreno-Galbis (2008) find that the impact of technological change on the employment rate of age-heterogeneous workers is determined by the distance to retirement. In a context of rapid growth (technological change), it is in the interest of firms to renovate positions occupied by young workers (having a long working horizon) and destroy jobs occupied by seniors that will go soon on retirement. Results are modified when Langot and Moreno-Galbis (2008) consider heterogeneous productivity workers since it might be in the interest of the firm to update positions occupied by high productivity workers in spite of being old. Again, considering productivity issues allows the authors to account for heterogeneous situations within a given age cohort.

The literature has also analyzed the retirement decision from the supply side, particularly using empirical approaches. Using US data, Bartel and Sichermann (1993) conclude that workers in industries with higher average rates of technological change retire later than workers in industries with lower rates of technological progress, since they prefer to smooth the human capital investment they made. On the other hand, an unexpected increase in the rate of technological change induces earlier retirement, since workers do not have the required skills, and due to their short working horizon, they are not motivated to invest in human capital formation. Ahituv and Zeira (2011) suggest another interpretation. They consider that technical progress is made up of an aggregate part, that affects all sectors and a specific part that hits only one sector. They show that the specific part of technical progress has a positive and significant effect on the probability of not working among older workers. This first effect may correspond to the standard skill obsolescence effect. However, the aggregate technical progress implies an increase in wages, encouraging therefore older workers to delay their retirement age. Using also US data, Friedberg (2003) argues that age is not enough to explain why older workers use computers less. Impending retirement, which reduces the time horizon to recoup an investment in new skills, appears to play a major role. Actually, computer users are 25% more likely than non users to continue working. One possible explanation is that computer users have valuable skills that lead them to delay retirement; another explanation is that they already intend to retire later (for other reasons) and thus find it worthwhile to acquire skills. The author tests whether acquiring new skills induces the worker to delay retirement. She concludes that computer use raises the likelihood of continuing to work by up to 25-30%. The importance of the working horizon on
the retirement choices made by workers is also underlined by Hairault, Langot, and Sopraseuth (2010). They estimate that the shorter the distance to retirement (whatever the age of the worker), the lower the probability of being employed. This distance effect becomes active from the tenth year before retirement.

Our paper represents a contribution to this last stream of economic literature. We underline the role of productivity as a major determinant of the senior’s decision on retirement age. We argue in this paper that, for a given working horizon, high productivity seniors go on retirement latter. Our contribution is twofold. First, using an overlapping generation model with two types of jobs (complex and simple) where senior workers decide on their retirement date, we claim that technological change induces early retirement of older workers if and only if they bear skill obsolescence. If the senior worker’s productivity is improved together with the state of technology (the senior may be endowed with the appropriate skills or the firm may pay on-the-job training) the retirement age is delayed. Second, we provide empirical evidence for the French case, considering the expected exit age for workers aged 50-55 to disentangle the supply-side from the demand-side factors of retirement. Note that using recent data makes sense for our analysis. Indeed, we can consider that in 2006, there was no longer any incertitude concerning the diffusion of new technologies among occupations, which allows each senior worker in every profession to perfectly anticipate if an investment in new human capital is going to be required to pursue its activity.

The main findings of our paper can be summarized as follows. The worker’s productivity arises as the main determinant of the worker’s retirement expectations. The theoretical framework proposed in this paper predicts (theoretically and numerically) that worker’s whose productivity is improved together with the state of technology tend to retire later than workers who bear a skill obsolescence process (relative reduction in productivity) in case of technological change. These finding are confirmed by our empirical results. Using the French database COI 2006 and “Passage a la retraite” 2006, we find that, in case of technological change, workers employed in jobs displaying a high average training rate plan to retire later than those occupying jobs with a low average training rate. These results contrast with previous findings of Behaghel et al. (2011) that have shown that the interaction term between technical progress and the training rate was insignificant, when focussing on older workers’ flows. It could suggest that when considering only supply side determinants of retirement, on-the-job training may effectively dampen the age bias associated with technical progress. Our paper allows us to conclude that productivity of
the worker is not only a major determinant of the firm’s hiring and firing decisions concerning senior employees (demand side) but also a major factor of the worker’s retirement decisions. The paper is organized as follows. Section 2 presents the assumptions and the agent’s behavior of our theoretical model. Section 3 analyzes the model’s predictions by means of numerical simulations. Data and descriptive statistics are displayed in section 4. Section 5 describes the econometric methodology and the results. Section 6 concludes.

2 The model

2.1 Assumptions

2.1.1 The life cycle decisions

We consider an overlapping generations framework la Michel and Pestieau (2000), where individuals live for two periods. We assume that each period lasts 30 years, so that the young period will go from the age of 25 to 55 years old and the second period from 55 to 85 years old. During the first period of life individuals work and earn a wage that will be used for consumption and saving. During the second period of life individuals can decide to work for a while or not to work at all. Consumption during this second period is financed by savings made during the first period, by the wage earned during the second period if the individual works and by a retirement pension.

Expectations are rational, so that the worker chooses from the very beginning of life the optimal amount to save during the young period and the intended retirement date so as to maximize lifetime utility. Because we are mainly interested on the retirement decision we consider the second period of life as the reference period \( t \), whereas the first period corresponds to \( t - 1 \). Therefore, our reference cohort of workers entered the labor market in \( t - 1 \) and becomes old in \( t \).

2.1.2 The production process

Only one good is produced in the economy. Production only depends on labor, since capital is supposed to be supplied with an infinite elasticity (the interest rate is exogenous)\(^1\). Markets are assumed to be perfectly competitive.

\(^1\)This hypothesis corresponds well to the small open economy case.
We suppose a continuum of ability levels for workers $a_i^t$. As in Cheron, Langot, and Moreno-Galbis (2011), the economy includes two types of jobs: simple jobs, whose productivity is not affected by technological progress, and complex jobs, whose productivity depends on the state of technology. We assume that finding a suitable complex job, takes a longer time, so workers decide to search for a complex position if and only if, their expected gains of occupying a complex job overcome the search cost they bear. Complex positions will be then occupied by workers having a higher ability level, since they have higher expected gains. This search cost, allows us to introduce a kind of a filter allowing only the highest ability workers to have access to complex jobs.

During the first period of life (young period) productivity in simple and complex jobs is determined exclusively by the workers’ acquired ability. If between the first and the second period of life there is a change in the state of technology, productivity of young people becoming old employed in complex jobs is improved whereas that of simple jobs remains unaffected (biased technological change).

For young workers arriving in the labor market productivity equals their ability level. This hypothesis is realistic if we assume that education is indexed to the state of technology implying that the acquired ability distribution shifts together with the state of technology. The distribution of abilities acquired by young workers entering the labor market at date $t$ is defined by the interval $a_i^t \in [a_{i-1}^t, a_i^t]$, where $i$ stands for a particular ability level and $t$ is the time index. The distribution shifts along time together with the state of technology, $b_t$. The educational system is thus indexed to the state of technology from the very low education levels. At date $t$, the productivity of a complex or a simple job occupied by a young worker will then be given by $y^k_t = a_i^t = a_{i-1}^t \cdot b_t$ for $k = C, S$ and $a_i^t \in [a_{i-1}^t, a_i^t] = [a_{i-1}^t b_t, a_i^t b_t]$, that is, for every new generation arriving to the labor market the ability distribution is indexed to the technological change taking place between them and the previous generation.

In case of a biased change in technologies between $t - 1$ and $t$ two situations arise:

- Young employed workers becoming old and occupying a simple job, see their relative productivity deteriorated with respect to young workers entering simple positions. More precisely, an old worker that entered the labor market in $t - 1$ occupying a simple position, will have at date $t$ a productivity equal to: $y^{iS}_t = a_{i-1}^t$, since productivity in simple positions is not modified by $b_t$. In contrast, a young worker just coming out from the educational system, will have a productivity level $y^{iS}_t = a_i^t = a_{i-1}^t \cdot b_t$ for an identical $i$,
since education is assumed to be indexed to technological change.

- Employed workers becoming old and occupying a complex job, see their productivity level improved by $b_t$. More precisely, productivity in complex jobs is given by $y^C_t = a^C_t b_t$. For an identical $i-$ability level, a young worker entering the labor market at date $t$ and occupying a complex job, will have the same productivity $y^C_t = a^C_t = a^C_{t-1} b_t$.

### 2.2 The agent behavior

Pension arrangements provided by the state in most European countries are unfunded, with benefits paid directly from current workers’ contributions and taxes. Because our paper analyzes the impact of technological changes on the expected retirement date using French data and, since France has one of the most generous retirement systems in Europe, our theoretical framework focuses on the retirement decision in case of technological change in the presence of a pay-as-you-go system.

A young individual supplies one unit of labor that provides him a wage $w_{t-1}$. After paying taxes, the wage will be used either for consumption $(c_{t-1})$ or for saving $(s_{t-1})$. During the second period of life, the individual consumes $d_t$, which depends on savings made during the young period, on the retirement pension and on the net wage earned if he keeps working during the old age. Let’s denote by $\tau_t$ the social security tax rate paid over their wages by individuals, $\rho_t$ the replacement rate, $R = 1 + r$ the exogenous interest rate (rate of return to investment) and $z_t$ the amount of time worked by the individual during the second period of life (whose duration is normalized to 1). Consumption in the first and second life periods are given by:

$$c^k_{t-1} = (1 - \tau_{t-1}) w^k_{t-1} - s^k_{t-1} \quad \text{and} \quad d^k_t = R s^k_{t-1} + (1 - \tau_t) w^k_t z^k_t + \rho w^k_t (1 - z^k_t) \quad (1)$$

for $k = C, S$ (complex and simple jobs).

The individual chooses his saving and proportion of time he will work during his second period of life so as to maximize his lifetime utility:

$$\text{Max}_{\{s_{t-1}, z_t\}} \quad u_{t-1}(c_{t-1}, d_t, 1 - z_t) = \log c_{t-1} + \beta (\log d_t + \gamma \log (1 - z_t)) \quad (2)$$

$$\text{Max}_{\{s_{t-1}, z_t\}} \quad u_{t-1}(c_{t-1}, d_t, 1 - z_t) = \log \left((1 - \tau_{t-1}) w_{t-1} - s_{t-1}\right)$$

$$+ \beta (\log (R s_{t-1} + (1 - \tau_t) w_t z_t + \rho w_t (1 - z_t)) + \gamma \log (1 - z_t)) \quad (3)$$

where $\beta$ is the rate of time preference (for $\beta > 0$, utils are valued less the later they are received).
and $\gamma$ corresponds to preference for leisure\(^2\).

If the individual stops any working activity at the beginning of the second period of life, his retirement pension will equal $\rho w_t^k$ for $k = C, S$. Under the hypothesis that each generation is composed by the same number of people ($N_t = N_{t-1}$) and assuming that at every date the share of people employed in complex and simple jobs is respectively given by $a_t^{iR}$ and $(1 - a_t^{iR})$, the government budget constraint is given by:

$$
\rho [1 - z^S] W^{oS} + \rho [1 - z^C] W^{oC} = \tau_t [W^Y + W^O] \tag{4}
$$

where $\rho$ is assumed to be exogenously determined by the government, $W^Y$ stands for the wage bill of young workers, $W^O$ for the wage bill of old employed workers, $W^{oS}$ for the wage bill associated with old workers employed in simple jobs and $W^{oC}$ for the wage bill of old workers employed in complex jobs.

The left hand side corresponds to the amount of retirement pensions paid by the government. In a pay-as-you-go system, pensions paid in period $t$ must be financed from taxes paid by workers employed in period $t$. Therefore, the right hand side stands for taxation revenues coming from young employed workers at period $t$ and from old workers that keep working during their second period of life.

Because no dynamics is assumed concerning the evolution of $b_t$, our model can be understood as a sequence of independent stationary steady states, where each state is associated to a particular $b_t$ i.e. ... we analyze the impact of a shock in $b_t$ on the retirement decision. If the young and the senior period of life of the worker correspond to different state of technologies, then: $\tau_t \neq \tau_{t-1}$ and $w_t \neq w_{t-1}$, while if $b_t$ remains constant between periods we have: $\tau_t = \tau_{t-1}$ and $w_t = w_{t-1}$.

### 2.3 The equilibrium

The model’s equilibrium can be summarized by three sets of equations:

- Equality between wages and marginal productivity:

$$
\begin{align*}
\\text{Equality between wages and marginal productivity:} \\
&\quad w_{i-1}^t = a_{i-1}^t & \quad (5) \\
&\quad w_{iC}^t = a_{i-1}^t \cdot b_t \quad \text{where} \quad b_t > 1 & \quad (6) \\
&\quad w_{iS}^t = a_{i-1}^t & \quad (7)
\end{align*}
$$

\(^2\)This parameter includes all non monetary factors affecting the financial trade-off of the retirement decision. It covers socio-economic factors, working conditions or health status.
• The threshold ability level determining the segmentation of the labor market between ability levels qualifying for complex positions and ability levels not qualifying for them.

We assume that in order to have access to complex jobs, the individual needs to make an additional investment in terms of job search since it takes more time and resources to find a complex position suiting his own ability. In order to decide whether to make or not this investment on job search, the worker compares the expected gains and costs of occupying a complex position.

− Occupying a complex position allows the worker to benefit from an increasing gross wage in case of technological change along his life cycle: \( w_{it}^C - w_{it}^S = a_{it-1}^i \cdot b_t - a_{it-1}^i = a_{it-1}^i(b_t - 1) \).

− The search cost is assumed to be an exogenous constant equal to \( \varphi \).

The threshold ability level below which it is not in the interest of the young individual to pay for the search cost corresponds to:

\[
 a_{it-1}^i(b_t - 1) = \varphi \quad \Rightarrow \quad a_{it-1}^i = \frac{\varphi}{(b_t - 1)} \quad (8)
\]

All individuals having an acquired ability level above \( a_{it-1}^i \) decide to spend more time on searching for a complex position. A higher search costs reduces the number of abilities for which it is in the interest to search for a complex positions. Conversely, the higher the size of the anticipated technological change, \( b_t \), the larger the number of abilities that searches for a complex position.\(^3\)

• The FOC associated with the optimizing problem (3) are given by:

\[
\frac{\partial u_{it-1}}{\partial s_{it-1}} = 0 \Rightarrow s_{it-1} = \frac{\beta(1 - \tau_{it-1}) w_{it-1} - d_t}{\beta R_t} \quad (9)
\]

\[
\frac{\partial u_{it-1}}{\partial z_t} = 0 \Rightarrow z_t = \frac{(1 - \tau_t - \rho(1 + \gamma)) - R s_{it-1} \gamma / w_{it}}{(1 + \gamma)(1 - \tau_t - \rho)} \quad (10)
\]

If the individual does not work at all during the second period, \( i.e. \ z_t^k = 0 \ for \ k = C, S \), his savings will equal:

\[
s_{it-1}^S = \frac{\beta}{1 + \beta} (1 - \tau_{it-1}) w_{it-1} - \frac{\rho_t w_{it}}{R(1 + \beta)} = \frac{\beta}{1 + \beta} (1 - \tau_{it-1}) a_{it-1}^i - \frac{\rho_t a_{it-1}^i}{R(1 + \beta)} \quad (11)
\]

\[
s_{it-1}^C = \frac{\beta}{1 + \beta} (1 - \tau_{it-1}) w_{it-1} - \frac{\rho_t w_{it}}{R(1 + \beta)} = \frac{\beta}{1 + \beta} (1 - \tau_{it-1}) a_{it-1}^i - \frac{\rho_t a_{it-1}^i b_t}{R(1 + \beta)} \quad (12)
\]

\(^3\)If the individuals anticipate the absence of a technological shock, \( b_t \) equals unity and the threshold ability level would tend to infinity, that is, there is no segmentation of the labor market since the difference between complex and simple jobs disappears.
Future consumption is given by:

\[
d_t^S = \frac{\beta}{1 + \beta} (R(1 - \tau_t)w_{t-1}^i + \rho_tw_t^i) = \frac{\beta}{1 + \beta} (R(1 - \tau_t)a_{t-1}^i + \rho_ta_{t-1}^i)
\] (13)

\[
d_t^C = \frac{\beta}{1 + \beta} (R(1 - \tau_t)w_{t-1}^i + \rho_tw_t^i) = \frac{\beta}{1 + \beta} (R(1 - \tau_t)a_{t-1}^i + \rho_ta_{t-1}^i b_t)
\] (14)

If the individual decides to work during the second period of life, his optimal choices depend on the type of job we consider:

\[
z_t^R = \frac{1 - \tau_t - \rho + \beta(1 - \tau_t - \rho(1 + \gamma)) - \gamma R\beta(1 - \tau_{t-1})w_{t-1}/w_t}{(1 - \tau_t - \rho)(1 + \beta + \gamma\beta)}
\] (15)

which, depending on the type of job leads to

\[
z_t^C = \frac{1 - \tau_t - \rho + \beta(1 - \tau_t - \rho(1 + \gamma)) - \gamma R\beta(1 - \tau_{t-1})1/b_t}{(1 - \tau_t - \rho)(1 + \beta + \gamma\beta)}
\] (16)

\[
z_t^S = \frac{1 - \tau_t - \rho + \beta(1 - \tau_t - \rho(1 + \gamma)) - \gamma R\beta(1 - \tau_{t-1})}{(1 - \tau_t - \rho)(1 + \beta + \gamma\beta)}
\] (17)

The analysis of equation (15) allows us to distinguish between three different effects. The first effect corresponds to the term \((1 - \tau_t)(1 + \beta)\). The higher the tax individuals pay in the second period the shorter the time they decide to work, since their net wage will be lower. This effect can though be counterbalance by the time preference for the future. The second term \(-\rho(1 + \beta(1 + \gamma))\) tells us that the higher the replacement ration \((i.e.\ the\ higher\ the\ retirement\ pension)\) and the higher the preference for leisure, the less the individual is willing to work in the second period. Finally, the term \(-\gamma R\beta(1 - \tau_{t-1})w_{t-1}/w_t\) captures the trade-off between a wealth effect coming from past savings and a substitution effect coming from the current wage an old individual may earn if she keeps working. The higher the wage earned during the first period with respect to the wage earned during the second period the lower \(z_t\). While \(R\beta(1 - \tau_{t-1})w_{t-1}\) stands for the wealth effect, \(1/w_t\) represents the current wage effect (substitution effect). In simple jobs, the last effect is neutralized by the wealth effect. In contrast, in complex jobs, the wage effect is dominant. More precisely, since \(b_t > 1\) the negative term in equation (15) is smaller than in a simple position, leading to a higher \(z_t\). Individuals in complex positions work for a longer period of time.

Replacing in equation (9) yields:

\[
s_{t-1}^R = \frac{1}{R(1 + \beta + \gamma\beta)} [\beta R(1 - \tau_{t-1})(1 + \gamma)w_{t-1} - w_t(1 - \tau_t)]
\] (19)

which, depending on the type of job leads to

\[
s_{t-1}^C = \frac{1}{R(1 + \beta + \gamma\beta)} [\beta R(1 - \tau_{t-1})(1 + \gamma)a_{t-1}^i - a_{t-1}^i b_t(1 - \tau_t)]
\] (20)

\[
s_{t-1}^S = \frac{1}{R(1 + \beta + \gamma\beta)} [\beta R(1 - \tau_{t-1})(1 + \gamma)a_{t-1}^i - a_{t-1}^i(1 - \tau_t)]
\] (21)
In complex positions individuals save less since they anticipate a higher future wage.

Replacing in the expression for future consumption yields:

\[
d_{t}^{C} = R \left[ \frac{1}{R(1 + \beta + \gamma \beta)} [\beta R(1 - \tau_{t-1})(1 + \gamma) a_{t-1}^{i} - a_{t-1}^{i} b_{t}(1 - \tau_{t})] \right] \\
+ (1 - \tau_{t}) a_{t-1}^{i} b_{t} \left[ \frac{1 - \tau_{t} - \rho + \beta (1 - \tau_{t} - \rho(1 + \gamma))}{1 - \tau_{t} - \rho}(1 + \beta + \gamma \beta) \right] \\
+ \rho a_{t}^{i} b_{t} (1 - \tau_{t} - \rho + \beta (1 - \tau_{t} - \rho(1 + \gamma)) - \gamma R \beta (1 - \tau_{t-1}) 1/b_{t}) \\
+ \rho a_{t-1}^{i} b_{t} (1 - \tau_{t} - \rho + \beta (1 - \tau_{t} - \rho(1 + \gamma)) - \gamma R \beta (1 - \tau_{t-1}) 1/b_{t}) \\
(23)
\]

\[
d_{t}^{S} = R \left[ \frac{1}{R(1 + \beta + \gamma \beta)} [\beta R(1 - \tau_{t-1})(1 + \gamma) a_{t-1}^{i} - a_{t-1}^{i} (1 - \tau_{t})] \right] \\
+ (1 - \tau_{t}) a_{t-1}^{i} \left[ \frac{1 - \tau_{t} - \rho + \beta (1 - \tau_{t} - \rho(1 + \gamma)) - \gamma R \beta (1 - \tau_{t-1})}{1 - \tau_{t} - \rho}(1 + \beta + \gamma \beta) \right] \\
+ \rho a_{t}^{i} (1 - \tau_{t} - \rho + \beta (1 - \tau_{t} - \rho(1 + \gamma)) - \gamma R \beta (1 - \tau_{t-1})) \\
(24)
\]

Because in complex positions individuals work for a longer time and earn a higher wage, future consumption is higher for these individuals.

The budget constraint

As observed in equations (17) and (18), the fraction of time worked during the second period of life, does not directly depend on the ability distribution. Similarly, the critical ability level giving access to complex positions, \(a_{t-1}^{i*} = \frac{\phi}{b_{t-1}}\), only depends on the state of technology. In the aim of simplicity, we assume that abilities follow an uniform distribution defined between \([0, 1]\),
the budget constraint at a given date \( t \) can then be written as:

\[
\rho [1 - z^S(\tau_t, \tau_{t-1})] W^o S + \rho [1 - z^C(\tau_t, \tau_{t-1})] W^o C = \tau_t [W^Y + W^O]
\]  

(25)

\[
W^o S = \int_0^{a_{t-1}^*} w_t^o S \, da = \int_0^{a_{t-1}^*} a_{t-1} \, da = \frac{(a_{t-1}^*)^2}{2}
\]

(26)

\[
W^o C = \int_0^{a_{t-1}^*} w_t^o C \, da = \int_0^{a_{t-1}^*} b_t \, da = -\frac{b_t}{2}(1 - (a_{t-1}^*)^2)
\]

(27)

\[
W^Y = \int_0^{a_{t-1}^*} w^Y \, da = \int_0^{a_{t-1}^*} b_t \, da = \frac{[a_t^*] q^1_0 b_t}{2}
\]

(28)

\[
W^O = z^S(\tau_t, \tau_{t-1}) \int_0^{a_{t-1}^*} w_t^o S \, da + z^C(\tau_t, \tau_{t-1}) \int_0^{a_{t-1}^*} w_t^o C \, da
\]

(29)

putting everything together yields the following budget constraint

\[
\rho [(1 - z^S) \frac{(a_{t-1}^*)^2}{2} + (1 - z^C) \frac{b_t}{2}(1 - (a_{t-1}^*)^2)] = \tau_t [\frac{b_t}{2} + z^S(\tau_{t-1}) \frac{b_t}{2} + z^C(1 - (a_{t-1}^*)^2) \frac{b_t}{2}]
\]

(30)

The retirement decision

What is the threshold value of preference for leisure from which individuals decide to work during their second period of life? Setting to zero equation (15) yields:

\[
\gamma R = \frac{(1 + \beta)(1 - \tau_t - \rho)}{\beta R(1 - \tau_{t-1}) \frac{b_t}{y_t} - \beta \rho}
\]

(32)

which, depending on the type of job leads to:

\[
\gamma C = \frac{(1 + \beta)(1 - \tau_t - \rho)}{\beta R(1 - \tau_{t-1}) \frac{b_t}{y_t} - \beta \rho}
\]

(33)

\[
\gamma S = \frac{(1 + \beta)(1 - \tau_t - \rho)}{\beta R(1 - \tau_{t-1}) - \beta \rho}
\]

(34)

The threshold value \( \gamma \) decreases with the tax rate of the second period while it increases with the tax rate paid during the young period. That is, if you want individuals to delay retirement, you better tax them when they are young and reduce taxes during their old age. Preference for leisure depends thus on the taxation system. The trade-off between the wealth effect and the wage effect appears also in the denominator of equation (32). A dominant wage effect reduces the value of the denominator increasing the critical value of \( \gamma \) above which individuals decide
not to work during their senior period of life. Again, we observe that while the wealth effect neutralizes the substitution effect in simple jobs, the opposite holds true for complex position where there is a dominant wage effect. The threshold value $\gamma$ above which individuals decide not to work during their senior period of life is higher for individuals in complex jobs. Because access to these positions is linked to the acquired ability level of individuals, we can claim that higher ability individuals are more likely to work when becoming seniors.

3 Numerical simulations

The quantitative implications of the model concerning the effects of a biased technological progress on the retirement decision are clearly presented as a result of computational exercises. The objective of the numerical simulations is to analyze the impact of a change in the state of technology on the retirement decision. We then simply consider a sequence of stationary states associated with different values of $b_t$, but no transition dynamics is assumed between them. The lowest value of $b_t$ is imposed equal to $b_t = 1.2$ and the highest value to 1.5, other intermediate values of $b_t$ are also considered, i.e. $b_t = \{1.2, 1.3, 1.4, 1.5\}$. The choice of these values is discretionary and it will simply allow us to compare the retirement decisions associated with two consecutive values of $b_t$ for complex and simple jobs.

The attention is focused on a cohort of workers whose ability distribution is normalized to $[0, 1]$. We exclusively study the retirement decision of this cohort in the presence of different states of technology and no intergenerational dynamics is considered. More precisely, numerical results presented along these lines must be read as follows: given an initial state of technology, for example $b_{t-1} = 1.2$, the cohort of young workers entering the labor market at this stage has an ability distribution defined in $a_{t-1}[0, 1]$, pays taxes equal to $\tau_{t-1}$ and earns a wage equal to $w_{t-1} = a_{t-1}^t$. This cohort becomes old at date $t$. At this date, the state of technology equals 1.3. What is the retirement decision for our reference cohort of workers? If the initial steady state had been 1.3 and the progression 1.4, what would have been the retirement choice?\footnote{If at date $t$, the technological state has remained constant, the cohort of workers will pay the same taxes, will earn the same wage and will go on retirement at the same age as before, since nothing in this economy will have change with respect to the period where they were young (note that we are assuming that $N_{t-1} = N_t$ and there are no intergenerational variations in preferences).}

The baseline parameters used in computations are shown in Table 1. We adopt the standard parameter values employed by the literature. More precisely, we consider an annual interest
rate equal to 4% implying that $R = 3.24$, since each period lasts 30 years. The rate of time preference between the young and the old period ($\beta$) equals 0.33 (as in Belan, Messe, and Wolff (2011)), preference for leisure ($\gamma$) is set to 0.4, search costs of a complex job equal 10% of the maximum productivity level attainable by the initial cohort of young workers ($\phi = 0.1$) and the replacement ratio ($\rho$) associated with the pay-as-you go system equals 0.5.

Table 1: Baseline parameter values.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discount factor</td>
<td>$R = 3.24$</td>
</tr>
<tr>
<td>Rate of time preference</td>
<td>$\beta = 0.33$</td>
</tr>
<tr>
<td>Preference for leisure</td>
<td>$\gamma = 0.4$</td>
</tr>
<tr>
<td>Replacement ratio</td>
<td>$\rho = 0.5$</td>
</tr>
<tr>
<td>Search cost</td>
<td>$\phi = 0.1$</td>
</tr>
</tbody>
</table>

We consider a sequence of stationary states associated with different states of technology and we compare the retirement decisions between two consecutive states of a given cohort (whose ability distribution is normalized to $[0, 1]$) depending on their occupation. At date $t$ the government must pay the retirement pension of people being on retirement at $t$ from taxes levied on senior people still working during their second period of life and on the new cohort of young workers entering the labor market at date $t$ (the new cohort has the same size as the previous cohort). The tax rate levied by the government to ensure the budget constraint equilibrium depends on two interrelated factors:

- The share of senior workers that decides to keep working during the second period of life, and on the amount of time they decide to work. Both are tightly linked to the size of $b_t$ and the tax itself.

- Wages of young workers, which equal the ability distribution of seniors times the size of the technological shock, i.e. $a_t^i = b_t \cdot a_{t-1}^i$.

In sum, the tax rate $\tau$ depends on $b_t$ and $z_t$, which is itself affected by the tax rate (directly and via the preference for leisure).

Let’s first focus on the progression of the retirement decision (Figure 1). We realize that technological diffusion has opposite effects depending on whether we are considering simple or complex jobs. More precisely, whereas higher levels of technological development favor a delay in the retirement date in positions whose productivity is improved with technology (complex jobs),
Figure 1: Retirement decision in complex and simple jobs associated with different states of technology.
the progression is the opposite in positions where workers bear a skill obsolescence process (simple jobs). For seniors in complex positions, the gain in gross wages (productivity) induced by technological improvements overcomes the wealth effect as well as the effect associated with the tax increase and the preference for leisure. As a result, these seniors delay retirement from 64.77 years old to 65.27 years old. Productivity improvements at the end of the life cycle push thus individuals to keep working for a longer period of time. Conversely, seniors in simple jobs keep a constant wage (since their productivity is not improved) and bear an increase in taxes. They advance the retirement. For the lowest state of technology, these seniors leave on retirement at the age of 60.1, whereas for the highest state of technology the retirement age falls to almost 56.5 years old. The productivity loss fostered by the skill obsolescence process induces workers to retire earlier.

![Figure 2: Tax rate associated with different states of technology.](image)

The increasing path of taxes (Figure 2) along the technological diffusion process can be justified by two facts. On the one hand, the increase in complex wages pushes up taxes so as to keep a constant replacement ratio. Furthermore, as shown below, the proportion of workers occupying complex positions increases with $b_t$, which implies that there will be more high pensions to finance. On the other hand, the delay in the retirement age of workers employed in complex
positions does not seem to compensate the advance in the retirement age of workers employed in simple positions. The pension bill to be financed rises. Both events tend to increase taxes so as to keep a balanced budget constraint.

The behavior of saving and future consumption follow the retirement age. Whereas in complex jobs, for a given ability level, savings during the youth period decrease as the retirement age is delayed, we find the opposite behavior for the ability levels employed in simple jobs, where the retirement age is advanced as the state of technology increases. The path of future consumption complements this behavior. In complex positions, technological diffusion is associated with a delay of the retirement date. This increases income during the second period of life (wages being higher than retirement pensions) which allows individuals to benefit from a higher consumption level as $b_t$ raises. The situation is somewhat different in simple positions, where individuals barely work during their second period of life. Savings and the retirement pensions allow to smooth consumption among all technological states for people employed in simple positions.

Because individuals in complex and simple jobs are endowed with different ability levels, any analysis of consumption inequalities between both segments results complicated. Instead, we compare, for every technological state, consumption inequalities (present and future consumption) between the highest ability level employed in simple jobs and the lowest ability level employed in complex jobs. This implies that we are focusing in the lower bound of consumption inequalities, since we are considering the closest ability levels employed in different segments. Inequalities between ability levels widen as the distance between them increases. Two conclusions are drawn from Figure 3. First of all, whether we consider present or future consumption, inequalities between the complex and the simple segment rise together with the technological state. Second, inequalities between segments are deepen during the elderly stage. More precisely, during the youth period consumption for the lowest ability level employed in the complex segment is 6% higher than consumption for the highest ability level employed in the simple segment for $b = 1.2$. For the highest technological state ($b = 1.5$), this present consumption inequality attains 17%. When we consider future consumption, the corresponding percentages equal 10% and 20%. Initial inequalities between segments are magnified at the end of the life cycle.

To finish with this section, notice that the highest ability level employed in a simple job (or the lowest ability level employed in a complex job) progresses together with the state of technology, implying that the proportion of workers that may benefit from the technological diffusion process
Figure 3: Present and future consumption inequalities associated with different states of technology.
Figure 4: Threshold ability level in complex positions associated with different states of technology.
progresses with $b_t$. More precisely, given that the search cost of a complex position during the first period of life, does not depend on the progression of technology ($b_t$) during the second period of life, the trade-off between the expected gains of occupying a complex job and the cost, becomes more favorable with the importance of $b_t$. This yields lower ability workers to search for complex positions during the first period of life when the anticipated technological change during the second period increases. Figure 4 represents the threshold ability level from which it is in the interest of a young worker to search for a complex position depending on the size of $b_t$ during the second period of life. The ability distribution is defined within the interval $[0, 1]$, and we consider a hundred ability levels (every 0.1 points there is a new ability). For the lowest value of technological change, only 50% of young workers search for a complex positions. As we consider higher values of $b_t$, the share of young workers looking for a complex positions increases. For the highest value of $b_t$, it is in the interest of 80% of workers to search for a position whose productivity will be improved by technological change during the second period of life.

4 Data and descriptive statistics

The goal of the empirical part of the paper is to underline the major role of productivity as a determinant of the worker’s retirement age. Our intuition is close to Bartel and Sichermann (1993) and Friedberg (2003). In case of technological change the worker is likely to advance her retirement date if she suffers a drop in her productivity. Because we do not have a direct measure on the worker’s productivity, we claim that workers benefitting from training on-the-job after a technological change see their productivity indexed to the state of technology, whereas workers not benefitting from a training program will suffer skill obsolescence. This corresponds well to our theoretical framework, where worker’s in complex positions see their productivity improved together with the state of technology, whereas workers in simple jobs suffer from a skill obsolescence process. This last type of worker retires early whereas workers with an improved productivity delay retirement.

While Behaghel et al. (2011) do not find any significant effect of the interacted term between training and technical or organizational change, we conduct a different approach. Indeed, we focus on retirement expectations of older workers. For such a study, we need two types of information. First, we require data on the expected exit age of workers. Standard individual surveys contain information on transitions from activity to retirement or other pathways to
inactivity, but a few data set provide information on retirement expectations. As mentioned in the introduction, this variable may allow us to disentangle the demand-side from the supply-side causes of retirement decision. In this empirical study, we exploit a unique French cross-sectional survey entitled “Passage la retraite” conducted by INSEE in 2006 on a sample of 12451 individuals aged 50 or more. It includes information on the expected exit age of respondents still working and also on their health status, their marital and family background and their pension entitlements. We merge this data set with the French Labour Force Survey, that contains detailed information about socio-demographic individual characteristics, as well as job and firm characteristics.

Second, we need some information on the way workers are affected by technical or organizational changes in their work environment and also on the probability that their skills are updated after such a shock. As far as we know, there is no individual survey that gathers information on retirement intentions, technical changes in the work environment and training participation. So we choose to merge some aggregated data on adoption of ICT and participation to firm-sponsored training session with our individual data on retirement intentions. To build this aggregated dataset, we use the COI (Changements Organisationnels et Informatisation) individual survey 2006, carried out on a sample of 14369 workers.

The use of aggregated data in micro regressions is close to the spirit of the papers of Bartel and Sichermann (1993) or Ahituv and Zeira (2011). The difference here is that we build aggregated variables from micro data on technical change and firms’ investment in training, rather than using the macro data established by Jorgenson (2000). However, the issue here consists on the choice of the aggregation level. This implies a trade-off between having the finest decomposition and having a sufficient number of individuals in each cell. We account simultaneously for the sectoral and occupational specificity of the work environment. We define industries using the NAF-36 classification and we consider 4 occupations, i.e. executives, intermediary, employees and workers.

4.1 Aggregated data

From the individual survey COI, we consider 4 occupations (executives, intermediary, employees and workers) and 36 industries. We have therefore 144 cells. For each cell, we compute the average use of new technologies, the average probability of a technological change over the past

---

5Considering the NAF-16 classification and 4 occupations yields similar results.
3 years and the average probability of receiving training on-the-job on computing skills over the past 12 months.

Our data was collected in 2006, years after the ICT boom. So, our indicators of ICT use do not correspond to a recent technological change. Indeed, we observe in figure 5 that the probability of using computer in the work environment exceeds 0.8 (except for manual workers) regardless of the age group of the respondents. We therefore consider the probability for workers of having experienced a technical change in their work environment over the last 3 years for each sector-occupation cell. On the other hand, respondents are asked whether they participated over the last 12 months to a firm-sponsored training session on the use of new softwares or new computer devices. We use this information to define the probability of having been skill updated in computer skills over the last 12 months.

Figure 5: Probability of using a computer device in the work environment by age group and by occupation in 2006

![Figure 5: Probability of using a computer device in the work environment by age group and by occupation in 2006](image)

Source: COI (2006)

When working with these aggregated variables, restricting our sample only to older workers may raise a severe selection bias. Indeed, older workers who participate on a training session on
new computer tools may already intend to retire later, because updating induces improved work opportunities. However the reverse causality is also true. Employers invest in the worker’s skills because workers do not intend to retire early. In that second case, a high share of older workers reporting their participation to a firm-sponsored training session over the last 12 months may just stem from the fact that they have a high expected exit age. In this case, including such aggregated variables computed only on a sample of older workers in regressions to estimate the retirement intentions makes no sense.

To address this issue, we follow the approach of Friedberg (2003), and consider workers aged 24-49 rather than workers aged 50 or more to define our aggregated variables. The underlying idea is that a high probability of technological updating among workers aged 24-49 implies that the gains for the employer are higher than the training cost in this specific sector or occupation. We could then expect that the training effort will be also relatively higher for older workers, than in jobs displaying a lower training rate of workers aged 24-49. This assumption is supported by the data, which reveals a positive correlation coefficient, equal to 0.2495 and significant at a 1% level, between the training rates of both age groups of workers.

4.2 Personal data

The survey ”Passage a la retraite” contains three modules: the module A includes all individuals aged 50-69 years who are still working at the time of the survey. The module B is made up of individuals who already exited the labour force but who have already worked and the module C represents individuals who have never worked. In the regression analysis, the dependent variable is the age at which the respondent expects to leave his job. More precisely, respondents are asked whether they expect to exit the labour force before reaching 60, or between 60 and 64 or after 64. Since we focus on retirement expectations, we restrict our sample to individuals still working (module A). This could imply a sample selection bias given that at a given age, individuals willing to retire early are already out of the labour force. In the figure 6, we represent the share of employed workers in the whole population of respondents by age. We observe that among people aged 57 or more, the individuals still working count for less than 50% of the total number of respondents. After 62, i.e. the new legal retirement age that will be gradually implemented in France since the 2009 reform, this share is less than 10%. To attenuate the selection bias, we include in our sample only workers aged 55 or less.

The data contains a rich set of variables that may explain retirement intentions. In particular,
Figure 6: Share of employed workers in 2006 in France by age

Source: "Passage à la retraite" French Survey 2006
individuals are asked about the number of years of contribution to the pension scheme. This allows us to define a proxy of the distance to full retirement age, following the approach of Hairault et al. (2010), in order to control for a potential horizon effect\(^6\). We also know for each respondent the age, the gender, the marital status, the educational level, whether he works in the public or private sector, the tenure in the job, whether it is a full-time job, the monthly wage and the health status. Dropping the few missing or non plausible values, we end up with a sample of 1624 individuals.

4.3 Descriptive statistics

Let us first describe retirement expectations of French workers in 2006 and the individual and aggregated characteristics that we include in our analysis. Table 2 shows that while 52.34% of occupied respondents aged 50-55 intend to exit the labour force between 60 and 64, 34.73% plan to leave before 60 and only 12.93% report an expected exit age of 65 or more. In addition, when comparing the distributions of covariates in each column, we see that more than age, the distance to retirement seems to be strongly positively correlated with the expected exit age. This is consistent with previous empirical findings of Hairault et al. (2010). As the years to the full pension age increase with the exit age from the schooling system, it is not surprising that the higher the educational level, the higher the expected exit age. Thus, 18.1% of individuals who intend to exit their job after 65 are graduate or post-graduate, while this proportion is equal to 10.1% on average.

Our goal is to study the link between retirement expectations and some characteristics of their work environment affecting their productivity, such as the frequency of technical change or the chance to receive firm-sponsored training. We remark first that there is a positive correlation between average training rates observed for a job (for both workers aged 24-49 and for those aged 50-55), and the expected exit age of workers occupying that job. Considering for instance the cohort of 24-49 years old, while on average training rates equal 19.5%, jobs occupied by workers reporting the highest expected exit age display average training rates of 21.2% and those occupied by workers reporting the lowest expected exit age display average training rates of 16.1%.

\(^6\)Note that in their paper Hairault et al. (2010) use the number of contributive years from graduation, not taking into account discontinuous career. Moreover, they only consider older men. Here, using data about the number of years of contribution of the individual, we can build the distance to retirement for our whole sample.
### Table 2: Descriptive statistics

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>Expected retirement age</th>
<th>Less than 60</th>
<th>60-64</th>
<th>65 or more</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Individual characteristics</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td>52.40</td>
<td>52.47</td>
<td>52.25</td>
<td>52.42</td>
</tr>
<tr>
<td>Male</td>
<td></td>
<td>0.638</td>
<td>0.564</td>
<td>0.557</td>
<td>0.589</td>
</tr>
<tr>
<td>In couple</td>
<td></td>
<td>0.839</td>
<td>0.805</td>
<td>0.748</td>
<td>0.809</td>
</tr>
<tr>
<td><strong>Education</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary</td>
<td></td>
<td>0.360</td>
<td>0.256</td>
<td>0.290</td>
<td>0.297</td>
</tr>
<tr>
<td>Secondary</td>
<td></td>
<td>0.0674</td>
<td>0.106</td>
<td>0.0905</td>
<td>0.0905</td>
</tr>
<tr>
<td>Vocational</td>
<td></td>
<td>0.355</td>
<td>0.285</td>
<td>0.167</td>
<td>0.294</td>
</tr>
<tr>
<td>High School</td>
<td></td>
<td>0.0993</td>
<td>0.148</td>
<td>0.171</td>
<td>0.134</td>
</tr>
<tr>
<td>Undergraduate</td>
<td></td>
<td>0.0674</td>
<td>0.0906</td>
<td>0.100</td>
<td>0.0837</td>
</tr>
<tr>
<td>Graduate, postgraduate</td>
<td></td>
<td>0.0514</td>
<td>0.114</td>
<td>0.181</td>
<td>0.101</td>
</tr>
<tr>
<td><strong>Tenure</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less than one year</td>
<td></td>
<td>0.00887</td>
<td>0.0212</td>
<td>0.0524</td>
<td>0.0209</td>
</tr>
<tr>
<td>1-5 years</td>
<td></td>
<td>0.0532</td>
<td>0.0941</td>
<td>0.219</td>
<td>0.0961</td>
</tr>
<tr>
<td>5-10 years</td>
<td></td>
<td>0.0674</td>
<td>0.118</td>
<td>0.133</td>
<td>0.102</td>
</tr>
<tr>
<td>More than 10 years</td>
<td></td>
<td>0.871</td>
<td>0.767</td>
<td>0.595</td>
<td>0.781</td>
</tr>
<tr>
<td>Private sector</td>
<td></td>
<td>0.814</td>
<td>0.798</td>
<td>0.833</td>
<td>0.808</td>
</tr>
<tr>
<td>Full time job</td>
<td></td>
<td>0.917</td>
<td>0.894</td>
<td>0.833</td>
<td>0.894</td>
</tr>
<tr>
<td>Years to full pension age</td>
<td></td>
<td>5.374</td>
<td>7.526</td>
<td>9.438</td>
<td>7.026</td>
</tr>
<tr>
<td><strong>Aggregated variables</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average probability of a technical change</td>
<td>0.336</td>
<td>0.340</td>
<td>0.335</td>
<td>0.338</td>
<td></td>
</tr>
<tr>
<td>Average probability for workers aged 50-55 of receiving a firm-sponsored training</td>
<td>0.169</td>
<td>0.201</td>
<td>0.207</td>
<td>0.190</td>
<td></td>
</tr>
<tr>
<td>Average probability for workers aged 24-49 of receiving a firm-sponsored training</td>
<td>0.161</td>
<td>0.213</td>
<td>0.212</td>
<td>0.195</td>
<td></td>
</tr>
<tr>
<td>Number of observations</td>
<td></td>
<td>564</td>
<td>850</td>
<td>210</td>
<td>1624</td>
</tr>
<tr>
<td>Share of employed workers</td>
<td></td>
<td>34.73%</td>
<td>52.34%</td>
<td>12.93%</td>
<td>100%</td>
</tr>
</tbody>
</table>
The correlation between the retirement expectations of respondents and the probability that their job has been hit by a technical change over the last three years is not clear. We analyze whether this link is modified if we account for the probability that the respondent sees her skills updated after a shock. We decompose jobs by quartiles of average training rates and study the correlation between the expected exit age and the probability of technical change. Table 3 shows us that training may affect the relationship between technological change and retirement intentions. On the one hand, jobs with a low incidence of training display a negative relationship between the probability of a shock and the expected exit age. Indeed, among jobs with the lowest average training rates (quartiles 1 and quartiles 2), respondents who intend to exit early occupy jobs with a high probability of technical change relatively to jobs occupied by individuals who intend to exit after 65. On the other hand, regarding jobs with a high incidence of training, we see that it is the reverse story, that is the probability of having experienced a technical change is relatively higher for jobs occupied by individuals willing to exit later.

These first descriptive results indicate that the access to training may change the correlation between technical progress and retirement intentions. To go further, we have to regress the ordered dependent variable representing the expected exit age on our set of individual observables and aggregated variables.

Table 3: The correlation between retirement intentions and technical change by quartiles of average training rates

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>Expected retirement age</th>
<th>Less than 60</th>
<th>60-64</th>
<th>65 or more</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quartile 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average probability of a technical change</td>
<td>0.290</td>
<td>0.305</td>
<td>0.266</td>
<td>0.294</td>
<td></td>
</tr>
<tr>
<td>Quartile 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average probability of a technical change</td>
<td>0.349</td>
<td>0.328</td>
<td>0.320</td>
<td>0.335</td>
<td></td>
</tr>
<tr>
<td>Quartile 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average probability of a technical change</td>
<td>0.334</td>
<td>0.315</td>
<td>0.304</td>
<td>0.318</td>
<td></td>
</tr>
<tr>
<td>Quartile 4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average probability of a technical change</td>
<td>0.402</td>
<td>0.406</td>
<td>0.432</td>
<td>0.409</td>
<td></td>
</tr>
<tr>
<td>Number of observations</td>
<td></td>
<td>564</td>
<td>850</td>
<td>210</td>
<td>1624</td>
</tr>
</tbody>
</table>
5 Econometric analysis

5.1 Empirical strategy

We exploit the information on individual retirement intentions to build for each individual \( i \) employed in a sector-occupation cell \( j \) an ordered variable \( Y_{ij}^* = n \), with \( n \in \{0,1,2\} \), \( i \in 1, \ldots, N_j \) and \( j \in 1, \ldots, J \), where \( N_j \) is the number of units in the cluster \( j \) and \( J \) is the number of clusters. We define the underlying latent variable \( Y_{ij}^* \), that represents the propensity to delay the retirement decision in the following way:

\[
Y_{ij} = n \quad \text{if} \quad \mu_n < Y_{ij}^* \leq \mu_{n+1} \quad \text{with} \quad \mu_0 = -\infty \quad \text{and} \quad \mu_3 = +\infty
\]

We estimate the following unobserved effects ordered Probit regression:

\[
Y_{ij}^* = T_j \gamma + x_{ij} \beta + \epsilon_{ij}
\] (36)

where \( \beta \) and \( \gamma \) are vectors of parameters to be estimated. Explanatory variables are decomposed into two vectors: \( x_{ij} \) is a 1 x L vector of individual-specific characteristics and \( T_j \) is a 1 x K vector of aggregated variables defined for a specific cluster \( j \), especially regarding technical change or incidence of training. As observations within a cell \( j \) may be correlated in some unknown way, we assume clustered errors (Moulton, 1990). So, correlation may exist in \( \epsilon_{ij} \) within a job \( j \) but we assume that sampling scheme generates observations independent across cluster \( j \). Consequently, the error term \( \epsilon_{ij} \) can be decomposed in the following additive fashion:

\[
\epsilon_{ij} = c_j + v_{ij}, \quad i = 1, \ldots, N_j
\] (37)

The term \( v_{ij} \) is the idiosyncratic error, with \( v_{ij} | T_j, X_j, c_j \sim N(0,1) \). In addition, the random term \( c_j \), corresponding to unobserved heterogeneity in the job \( j \), is assumed normally distributed, so \( c_j | T_j, X_j \sim N(0, \sigma^2_c) \), where \( X_j \) is a \( N_j \times L \) matrix of unit-specific covariates. It allows us to estimate the Average Partial Effect (APE) of aggregated variables on the expected retirement age through a pooled ordered probit specification (Wooldridge, 2006), making the standard errors robust to arbitrary within-group correlation. Let \( a_{ij} = \mu_n - T_j \gamma - x_{ij} \beta \) and \( b_{ij} = \mu_{n+1} - T_j \gamma - x_{ij} \beta \), we can write:

\[
P(Y_{ij} = n | T_j, X_j, c_j) = \Phi[b_{ij}/(1 + \sigma^2_c)^{1/2}] - \Phi[a_{ij}/(1 + \sigma^2_c)^{1/2}]
\] (38)

where the \( \mu \) represent thresholds to be estimated along with the \( \beta \) and \( \gamma \) coefficients using maximum likelihood estimation.
5.2 Results

Our first results are reported in the table 4. For a sake of brevity, we do not display the estimates of the threshold $\mu$ but we check that for each regression they are significant at a 1% level. So it is relevant to consider an ordered variable rather than a binary variable to study expected exit age. The first column contains the coefficients obtained by regressing the ordered variable of expected exit age on our set of individual characteristics. We include fixed effects to control for unobserved heterogeneity specific either to the industry or the occupation. The estimates show the salient role of the chronological age to predict retirement intentions, in line with previous results of Taylor and Shore (1995) from US data. Furthermore, the distance to full pension age exerts a strongly positive and significant effect on the expected exit age, so it is an other empirical evidence of the horizon effect highlighted by Hairault et al. (2010). Consequently, it is not surprising that long-tenure workers, i.e. workers who entered the labour market at a early age and who are therefore close to the full pension age, intend to leave their job earlier that short-tenure workers. Finally, being in couple has a negative and significant effect on the expected exit age. However, decomposing by gender\footnote{Estimates are available upon request}, this effect is significant only for women. This is consistent with some role theory, in which women can be treated as care providers of the household (Talaga and Beehr, 1995).

The second column shows the effect of the probability of a technical change within a specific industry-occupation cell on the retirement intentions of older workers. It appears that this effect is not significant. In comparison, Ahituv and Zeira (2011) obtained a strong positive and significant effect of the sector-specific rate of technical change on the probability of non working, which supported empirical evidence of the erosion effect that they put forward in their paper. Our results could suggest that, when we study the expected exit age rather than effective transitions from work to inactivity, controlling only for the degree of technical change may provide an incomplete picture. This is consistent with our theoretical predictions. Indeed, we argue that what matters regarding retirement intentions is the way the productivity shifts along with the technical change. For our empirical illustration, we do not observe directly the productivity of workers. However, we treat the access to training as a way for workers to update their skills after a technological shock, so that their productivity is indexed to the state of technology. This raises two questions: does a better access to training have a significant effect on the age at which workers expect to retire? and does technical progress affect retirement
Table 4: The determinants of retirement intentions

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>0.131***</td>
<td>0.131***</td>
<td>0.131***</td>
<td>0.131***</td>
</tr>
<tr>
<td></td>
<td>(0.0208)</td>
<td>(0.0207)</td>
<td>(0.0211)</td>
<td>(0.0211)</td>
</tr>
<tr>
<td>Male</td>
<td>0.285***</td>
<td>0.286***</td>
<td>0.295***</td>
<td>0.285***</td>
</tr>
<tr>
<td></td>
<td>(0.0735)</td>
<td>(0.0889)</td>
<td>(0.0856)</td>
<td>(0.0854)</td>
</tr>
<tr>
<td>Single</td>
<td>0.222***</td>
<td>0.222***</td>
<td>0.223***</td>
<td>0.223***</td>
</tr>
<tr>
<td></td>
<td>(0.0756)</td>
<td>(0.0681)</td>
<td>(0.0675)</td>
<td>(0.0675)</td>
</tr>
</tbody>
</table>

**Education**

<table>
<thead>
<tr>
<th>(ref:Primary)</th>
<th>Secondary</th>
<th>Vocational</th>
<th>High School</th>
<th>Undergraduate</th>
<th>Graduate, postgraduate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.225*</td>
<td>-0.102</td>
<td>0.108</td>
<td>-0.0107</td>
<td>-0.0032</td>
</tr>
<tr>
<td></td>
<td>(0.119)</td>
<td>(0.0835)</td>
<td>(0.112)</td>
<td>(0.133)</td>
<td>(0.148)</td>
</tr>
</tbody>
</table>

**Tenure**

<table>
<thead>
<tr>
<th>(ref:More than 10 years)</th>
<th>Less than one year</th>
<th>1-5 years</th>
<th>5-10 years</th>
<th>Public sector</th>
<th>Part-time job</th>
<th>Years to full pension age</th>
<th>Average probability of a technical change</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.514**</td>
<td>0.534***</td>
<td>0.236**</td>
<td>-0.250*</td>
<td>-0.0556</td>
<td>0.142***</td>
<td>0.0512</td>
</tr>
<tr>
<td></td>
<td>(0.223)</td>
<td>(0.113)</td>
<td>(0.101)</td>
<td>(0.135)</td>
<td>(0.110)</td>
<td>(0.0115)</td>
<td>(0.285)</td>
</tr>
</tbody>
</table>

**Quartiles of average training rates**

<table>
<thead>
<tr>
<th>(ref:Quartile 1)</th>
<th>Quartile 2</th>
<th>Quartile 3</th>
<th>Quartile 4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.452***</td>
<td>0.294**</td>
<td>0.345**</td>
</tr>
<tr>
<td></td>
<td>(0.134)</td>
<td>(0.135)</td>
<td>(0.148)</td>
</tr>
</tbody>
</table>

**Interaction terms between probability of change and quartiles of average training rates**

<table>
<thead>
<tr>
<th>(ref:Probability * Quartile 1)</th>
<th>Probability * Quartile 2</th>
<th>Probability * Quartile 3</th>
<th>Probability * Quartile 4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.161***</td>
<td>0.896**</td>
<td>0.995**</td>
</tr>
<tr>
<td></td>
<td>(0.387)</td>
<td>(0.363)</td>
<td>(0.405)</td>
</tr>
</tbody>
</table>

Observations: 1,624
Log pseudolikelihood: -1,333.88
Pseudo $R^2$: 0.1538

Robust standard errors in parentheses. In columns (2) and (4) they account for within-cluster correlation.

*** p<0.01, ** p<0.05, * p<0.1

Source: COI (2006) and "Passage la retraite" French Survey 2006
intentions differently according to the propensity of employers to provide training?
As mentioned previously, to examine the causal effect of the training rate on the expected exit age, we address the simultaneity bias controlling for the access to training of workers aged 24-49. Decomposing these average training rates into quartiles, and treating jobs displaying the lowest training rates as the reference, we see in column 3 that coefficients associated with each quartile are significant and positive. So a better access to training may lead older workers to delay their expected exit age.

These results are similar to those obtained by Behaghel et al. (2011), who show that a high training rate implies a lower turnover rate among older workers, reducing therefore their exit rate.

Furthermore, our theoretical results imply that retraining may change the impact of a technological shock on the retirement intentions. Indeed, a technical change should lead older workers to delay their retirement age, provided that they occupy complex jobs with a probability of training equal to one, while it should have no effect on retirement intentions of workers employed in simple jobs with no possibility of retraining. Simple jobs in our empirical study could be characterized by the first quartile of training rates. In column 4, we introduce in the regression the interaction terms between the probability of technical change and the other quartiles of training rates. We see that our theoretical predictions are supported by data. Indeed, in the case of simple jobs, the technical change has a negative effect but not significant on the expected exit age. All the interaction terms we include in the model have a significant and positive effect. This suggests that the higher the probability of a technological shock on a job, the higher the expected exit age of older workers occupying this job, provided that they could benefit from a firm-sponsored training session to update their skills.

Contrarily to Behaghel et al. (2011), we put forward the idea that on-the-job training may mitigate the negative effect of technical progress on older workers’ employment via a supply side effect coming from the increase in the worker’s retirement expectations due to a productivity improvement. Indeed, when we focus only on the supply side determinants of retirement decisions, technical progress will not necessarily encourage older workers to early retirement, if employers allow their productivity to be indexed to the state of technology through a better access to training. This provides some evidence of the major role of productivity as a determinant of retirement decisions.
6 Conclusion

This paper underlines the major role of productivity as a determinant of the workers’ retirement expectations. There is a non negligible amount of literature analyzing the impact of the senior workers productivity on the firm’s hiring and firing decision (demand side) or in the senior workers’ labor and job flows (mixed demand and supply effects) in case of technological change. One of the contribution of this paper is to focus exclusively on the supply side. We propose a simple OLG model which predicts a divergent effect of technological change on the worker’s retirement decision depending on whether the worker’s productivity is indexed or not to the new state of technology. Workers whose productivity is improved delay retirement, whereas workers who support a relative skill obsolescence process advance retirement. These results are confirmed by our empirical analysis. Using the French databases COI and “Passage a la Retraite” 2006, we estimate that workers benefitting from a skill upgrading training program after a technological change, expect to retire later than workers not benefiting from this program.

References


