What are the financial implications of an ageing population for European citizens?

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Abstract

This article proposes an overlapping generation model to explore the impact of ageing across Europe on individual wealth. Once calibrated to U.N demographic data, the model shows that for European countries (whether mature or emerging) demographic shifts will lead to sizeable fluctuations in individuals' wealth. The generations born between 1990 and 2010 will indeed experience a constant reduction (up to 10%) in the wealth they accumulate over their whole lifecycle, whilst the prosperity of later generations will revert back to the level of baby-boomers (i.e. individuals born in the 1950s). The model also shows that those fluctuations could potentially be mitigated by delaying the moment at which retired individuals transform the capital accumulated through their private pension schemes into an annuity complementing public retirement allowances.

JEL classification. H55, H75, J32.

Keywords. Wealth management, retirement plans, demographic trends.

I. Introduction

Over the past decades, the population of European countries has greatly benefited, health-wise, from the advances of science. The result has been a steady increase in life expectancy. But with the ageing of their population, European states have faced growing difficulties in funding their social security schemes, notably on the pension front.

As a result, governments have started a series of reforms to find the right mix of active workers and retirees (Poterba 2014). Several adjustments to public social schemes have so far been explored: raising the level of taxes paid by active workers to fund the growing pool of retirees (Blake 2006), increasing the mandatory length of one's active period, boosting the ranks of active workers through immigration (Serrano, Eguía et Ferreiro 2011), decreasing public pension allowances …

The main policy implemented across the European Union (E.U) has for now been to keep collecting the same level of taxes from active workers whilst postponing retirement (Fanti 2015). However, given that immigration alone is not sufficient to compensate the current deficits in the European working population

[1] The findings and opinions expressed in this paper are those of the author(s) and do not reflect any positions from any company or institution.

and that several empirical evidences[2] suggest that it will soon prove difficult to postpone retirement any further, reforms must continue.

Considering the continued ageing of their population, states will thus have to resort to reforms which will not prove popular over the next decades – namely raising taxes and reducing retirement allowances. But if citizens will certainly find those reforms detrimental over the short run as they will immediately loose purchasing power, a question remains about them experiencing a financial loss over the long run.

The mechanics behind this question are yet simple. As individuals live longer, if they experience a small reduction in their immediate purchasing power (whether active or retired) the additional years of life they will benefit from will still yield an increase in wealth. In that case, states may be able to articulate a relatively simple and positive message to their constituents. But if mandatory adjustments prove detrimental, not only will states face difficulties in implementing those changes but at micro economic level, individuals will also have to rethink about their consumption patterns.

This paper will therefore develop a simple lifecycle model to help evaluate the upcoming social tax changes and their wealth-wise impact (at individual level) across European countries[3]. This model, detailed in section II, will then be calibrated to United Nations data and be used to inform a discussion around the potential challenges faced by future generations.

II. A lifecycle model:

Individuals are productive members of the society. Their lifecycle is made of three parts (Browning et Crossley 2001) (Cocco, Gomes et Maenhout 2005), (Cocco et Gomes 2013) and (Heer, Polito et Wickens 2020). First, individuals are born and trained to contribute to the society. This learning period last τ_l years. Individuals then become active and start contributing by taking up a job. When active, they earn an income worth $\rho \geq 0$. Individuals remain active whilst their health allows it. Empirical evidences point that they have a constant productivity whilst healthy (Börsch Supan et Weiss 2016) (Börsch-Supan, Hunkler et Weiss 2021) . After $\tau_A \geq \tau_l$ years of activity, individuals retire as their ability/productivity starts to naturally decline (Lazear 1979) (Skirbekk 2004) (Mahlberg, et al. 2013). Note that throughout their life, individuals have a chance to die $d(t,x)$ which is dependent on their age x and evolves with time t thanks to technological progresses. To finance the third part of their lifecycle (i.e. retirement), individuals can rely on a mix of public and private pension allowances (which are made available through contribution whilst individuals are active). This section will therefore propose a simple model describing how public pensions are managed by states (in a context of demographic shifts) and the associated implications for individuals' retirement funding and overall wealth.

[2] Individual productivity is indeed known to drop significantly due to a decline in physical and cognitive abilities after 40 years to 50 years of activity (Lazear 1979) (Hellerstein, Neumark et Troske 1999) (Börsch-Supan et Weiss, Productivity and age: Evidence from work teams at the assembly line. 2016), such that workers beyond a certain age are simply no longer competitive on a globalized labor market. At some point, carrying on with postponing the mandatory retirement age will therefore only be fueling the share of unemployed workers with older individuals (Staubli et Zweimüller 2013).

[3] Note that the aim of this paper is not to provide an accurate forecast on pension allowance or personal savings level but to provide a direction of travel and some reasonable orders of magnitude to be better prepared for the change we all face.

A. Public pensions and population dynamics:

Public pensions are designed as a social mechanism to rebalance wealth (at any point in time t) from $A(t)$) active workers (who have the physical ability to generate an income) towards $R(t)$ retirees who do not possess the means to sustain an activity. Calling $p(t,x)$ the number of individuals in the country at time t of age x, the amount of active workers (resp. retirees) can be calculated[4] as: $A(t) = \sum_{x=\tau_l}^{\tau_l+\tau_A-1} p(t,x)$ (resp. $R(t) = \sum_{x=\tau_l+\tau_A}^{+\infty} p(t,x)$).

This redistribution is enabled by a tax scheme. Active workers see a portion $\theta(t)$ of their income redirected towards the state and transformed into an allowance worth $\phi(t).\rho$ for retirees (here $\phi(t)$ represents the replacement rate provided by the scheme).

As public pensions are designed as mechanism to transfer wealth from one part of the population to the next (Lee 1994) (Settergren et Mikula 2005) and thus differ from private retirement scheme where allowances are generated through capitalization, the amount perceived by the state must equal the expenses associated the pensions (i.e. $A(t).\rho.\theta(t) = \phi(t).\rho.R(t)$).

Property 1. The design of public pension schemes entails a linkage between the state demographic structure, the level of taxes and the replacement rate.

$$\phi(t) = \frac{A(t)}{R(t)}.\theta(t)$$

But beyond the budget consideration depicted in property 1, states must also ensure that they maximize the welfare of their population. Within countries, individuals have a utility $u(.)$ for a level of income I which is assumed to have a functional form of a Cobb Douglas type (i.e. $u(I) = I^\alpha; \alpha \in]0;1[$). So, for states to maximize the welfare of their constituents, they must adopt a level of tax ($\theta(.)$) which is a solution of the following problem:

$$\max_\theta \rho^\alpha.\left(\sum_{x=\tau_l}^{\tau_A+\tau_l-1}\big(1-\theta(t)\big)^\alpha.p(t,x) + \sum_{x=\tau_l+\tau_A}^{+\infty}\left(\frac{A(t)}{R(t)}.\theta(t)\right)^\alpha.p(t,x)\right) \quad (1)$$

Corollary 1. Under the assumption that individuals have a utility for income that follows a power law, states seeking to maximize the welfare of their population adopt a public pension scheme $[\theta(.),\phi(.)]$ which is only driven by demographic considerations and where individuals have the same level of disposable income during their active and retirement period.

$$\forall t\ [\theta(t);\phi(t)] = \left[\frac{R(t)}{\big(A(t)+R(t)\big)};\frac{A(t)}{R(t)+A(t)}\right]$$

This then shows that for an ageing population, the replacement rate of public pension is decreasing over time as long as the growth of the active population is below the growth of the pool of retirees (i.e. $\frac{\Delta_t A}{A(t)} < \frac{\Delta_t R}{R(t)}$).

[4] Public data providers such as the United Nations or the O.E.C.D provide demographic forecasts at country level by age bands that can be used to infer the evolution of the pool of active workers and retirees.

B. Personal wealth and retirement savings:

Section II – A has shown that, at state level, population dynamics fully drive public pension schemes. But if the state offers a macro-economic structure to support its population, individuals also have additional opportunities to maximize their own wealth within the system proposed by their country. One those opportunities revolve around leveraging individuals' capacity to save and invest a portion $s(.)$ of their income ρ (whilst active) to complement the public pension scheme available during retirement. This capitalization is realized through private pension schemes.

Now, at a micro-economic level, individuals' investment decisions are a function of a several parameters. A person born at time T lives on average $L(T) = \left\lfloor \sum_{k=0}^{+\infty} k.\mathrm{d}(\mathrm{T}+\mathrm{k},\mathrm{k}).\Pi_{z<k}\left(1-d(T+z,z)\right)\right\rfloor$ years and can save a portion $s(T+x,x)$ of its income ρ (whilst active [i.e. $\forall x \in \{\tau_l; \ldots\ldots; \tau_A - 1\}$]). Those savings are then invested on a financial product (via a private pension scheme) yielding a return[5] $r > 0$. When individuals retire, they then convert the capital accumulated through those investments into a fixed annuity $\Psi(T) = \rho.\frac{\left(\sum_{k=0}^{\tau_A-1}\left(s(T+\tau_l+k,k+\tau_l)\right).(1+r)^{\tau_A-1-k}\right)}{L(T)-(\tau_l+\tau_A)}$, which complements the public pension scheme. If individuals do not have any time preferences, their investments patterns are then structured as described in the following lemma.

Lemma 1. Given that individuals' utility towards income is increasing (i.e. $\alpha > 0$) and that investments yield a positive return (i.e. $r > 0$), the absence of time preference leads individuals to invest as much as they can. Their savings patterns are therefore independent of their age and react to states changes in public pension schemes:

$$\forall x \in \{\tau_l, \ldots.; \tau_A - 1\}; s(t,x) = 1 - \theta(t)$$

In this set up, individuals' wealth W is thus a function of the individual birth date T as well as local demographic changes (i.e. $A(.), R(.)$). Individual behavior is then about saving as much as possible whilst active and postponing all earnings towards retirement[6]:

$$\frac{W(T)}{\rho} = \underbrace{\sum_{x=\tau_l+\tau_A}^{L(T)} \phi(T+x)}_{Public\ pension\ allowance} + \left(\underbrace{\sum_{k=0}^{\tau_A-1} \phi(T+\tau_l+x).(1+r)^{\tau_A-1-k}}_{Personal\ savings}\right) \quad (2)$$

Lemma 2. Assume that progresses in healthcare technologies are not fast paced (i.e. individuals do not gain more than a year of life expectancy between two time steps $\Delta_t L < 1$). Two individuals who have the same retirement strategies but are born a year apart in an ageing society (i.e. $\Delta_t \phi \leq 0$) accumulate a different level of wealth and the younger ends up being poorer than his elder.

[5] Note that for the sake of simplicity, notions of risks associated to the volatility of financial products are omitted from the discussion. Readers are invited to refer to the work of (Cocco, Gomes et Maenhout 2005) to further explore those topics.

[6] Note that the model is of course a bit simplistic but could be adjusted (without changing its properties) to delve into considerations of livings standards (incl. health related expenses) that lower individuals' savings abilities. This will however not be discussed in this short article and be expanded upon into a future research project.

$$\frac{\Delta_{\mathrm{T}} W}{\rho} = \underbrace{\phi\big(T + L(T)\big) - \phi(T - 1 + \tau_l + \tau_A)}_{\leq 0} + \sum_{k=0}^{\tau_A - 1}\Bigg(\underbrace{\Delta_{T+\tau_l+k}\phi}_{\leq 0}\Bigg).(1+r)^{\tau_A - 1 - k} \leq 0$$

Lemma 3. To compensate the loss in wealth entailed by the reduction in public allowances and in the absence of any adjustments to the length of the mandatory active period (i.e. τ_A), individuals can choose to delay the conversion of their capital (accumulated through a private pension scheme) into a fixed annuity by ϵ periods every year, such that:

$$\epsilon(T) \geq \frac{\ln\left(1 + \frac{\big(\phi\big(T + L(T)\big) - \phi(T - 1 + \tau_l + \tau_A) + \sum_{k=0}^{\tau_A - 1}\big(\Delta_{T+\tau_l+k}\phi\big).(1+r)^{\tau_A - 1 - k}\big)}{\sum_{k=0}^{\tau_A - 1}\phi(T + \tau_l + k).(1+r)^{\tau_A - 1 - k}}\right)}{\ln(1+r)} \quad (3)$$

Interestingly, the model shows that in a location with an ageing population and where the government can no longer increase the length of activity required to qualify for a public pension scheme, individuals either end up losing wealth if they choose to leverage their investments as soon as their elders or end up experiencing a polarization of their income profile towards the latest part of their life (see figure 1). Given that individuals' needs evolve as they age, this may also entail a change in retirees consumption patterns.

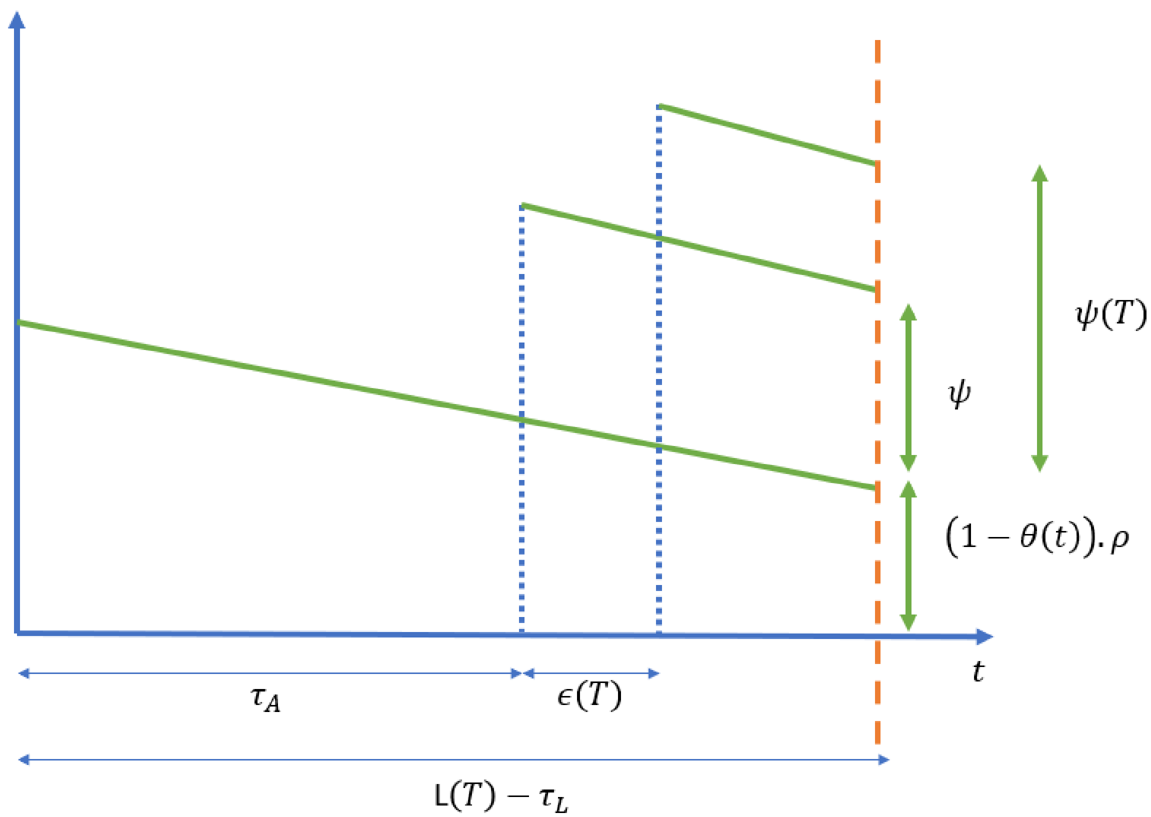

Figure 1 - Evolution of individuals' disposable income over their lifecycle

III. Ageing across E.U countries – what should we expect for individuals’ wealth?

European Union countries have experienced significant demographics shifts over the past decades (i.e. ageing population). This has notably been reported by the United Nations [referred to as U.N in the rest of this article]. As a result, states have started to reform their public pension programs. This section will leverage the model developed in section II to discuss what further reforms could look like as well as the associated impact on the wealth of European citizens. This will be done by calibrating the previously described model to information extracted from the U.N database.

A. Model calibration to U.N data:

The U.N provides a probabilistic forecast of the evolution of populations around the world at country level. Those yearly estimates span from 2021 to 2100 and are provided by age groups regrouping individuals within 5 years age bands. This answers questions such as “what is the number of individuals aged 20-25 in Germany that can be expected by 2050?”.

Population forecasts are based on probabilistic projections of total fertility and life expectancy at birth and account for migration patterns [7]. They present several scenarios: a “median” one, a series of scenarios accounting for some degree of statistical deviation (referred to as the 80% or 90% interval scenarios in the graphs below) and scenarios where massive changes in fertility (+/- 0.5 child per individuals) are considered.

When it comes to the E.U, the U.N forecasts a slight reduction in population (see figure 1) coupled with a drastic ageing. By 2100, it is indeed expected to have a total of about 650M individuals across the E.U (compared to 750M today – i.e. a 10-15% reduction). On one hand, the number of retirees $R(t)$ (i.e. individuals of age 65+) is likely to increase rapidly from 140M to 200M by 2050 and will then remain stable (i.e. about 50% increase). On the other hand, the number of active workers $A(t)$ (i.e. individuals of age 20 to 64) is forecasted to continuously plummet from 450M in 2020 to less than 300M by 2100.

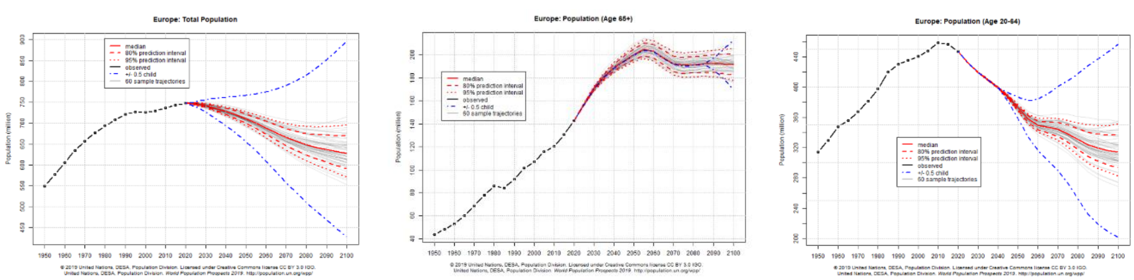

Figure 2 - Evolution of the E.U population over the next decades as per the U.N

The structural framework provided by the U.N therefore offers ideal inputs to the proposed model as it quickly enables the estimation (at country level) of the transition in replacement and tax rates associated to public pension schemes ($\phi(.), \theta(.)$) as well as the evolution of individuals’ wealth $W(.)$.

[7] https://population.un.org/wpp/Graphs/DemographicProfiles/900

B. Implications at individual level:

Leveraging the U.N data (i.e. the estimates for $A(.), R(.)$), it is possible to estimate the level at which replacement rates ($\phi(.)$) are likely to evolve over a few generations. Results, displayed in Figure 3, show that, according to the U.N "median" demographic scenario, replacement rates, which are currently worth about 75% of active workers' income, are going to decrease down to 65% over the next 20 years and then plateau. Interestingly, the situation is similar across all E.U countries whether they are mature or emerging. Besides, the pace at which replacement rates are forecasted to go down is slow ($\phi(t+1) - \phi(t) < 1\%$).

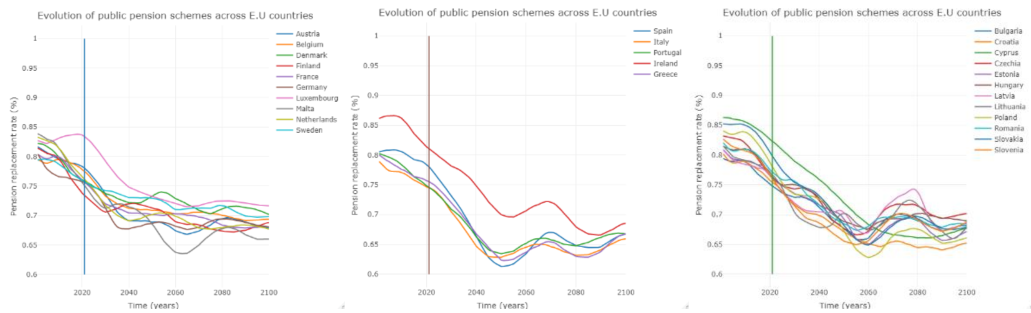

Figure 3 - Forecasted evolution of replacement rates provided through public pension schemes across E.U countries.

In the meantime, taxes used to fund public pension schemes (indexed according to the rate $\theta(.)$) are forecasted to increase to account for the growing share of retirees in the population (see corollary 1). Model calibration results displayed in figure 4 indicate that across all EU countries taxes rates should increase by 10% (i.e. from 15 -20% to 25%-30%) by 2050 independently of the country's level of maturity.

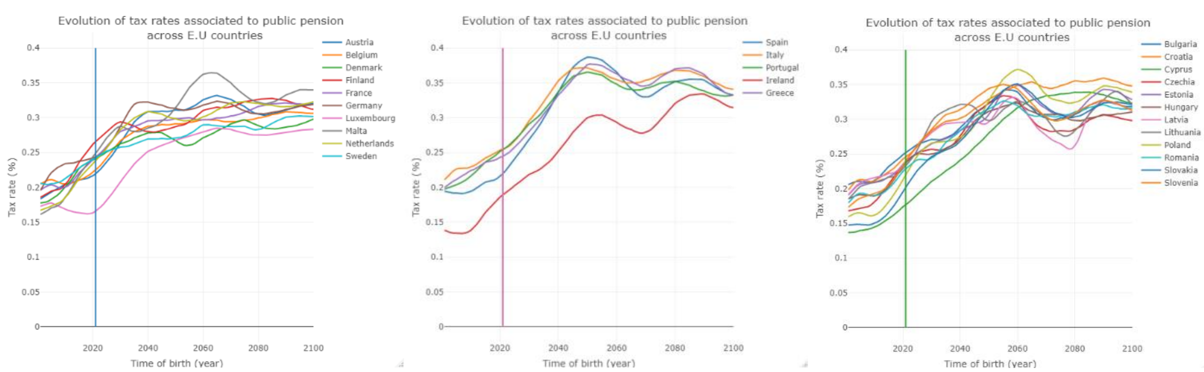

Figure 4- Forecasted evolution of tax rates enabling public pension schemes across E.U countries.

Those changes should have a direct impact on individual's wealth. If individual's retirement allowances as well as their accumulated savings[8] drop by 10 points, European citizen's wealth should decrease by 10 points too in the absence of any changes in either their life expectancy or the duration of their capitalization effort. This could of course have severe repercussions on individuals' and households' consumption and budgets and raises additional questions about the actual feasibility of such reforms.

The model has therefore been used to assess how the evolution in life expectancy forecasted by the U.N would impact individuals' overall wealth (assuming that financial products yield a stable return[9] of $r =$

[8] Savings will mechanically drop as taxes rise – see lemma 1.

[9] This could for instance be achieved by buying and holding shares for a long period and perceiving the associated dividends.

3%,). This estimation was done assuming that individuals convert the capital accumulated through their active period (via a private pension scheme) into an extra retirement allowance as soon as they stop working. Results displayed in figure 5 show that the sharp transition in taxes and retirement allowances imposed by the ageing of European populations leads, as anticipated, to a decrease of 10% in the total wealth for the generation born in the 2000s -2010s compared to baby-boomers (born in the 1950s). Interestingly, future generations are however forecasted to experience a gradual wealth increase as they will live longer whilst taxes and retirement allowances will remain stable.

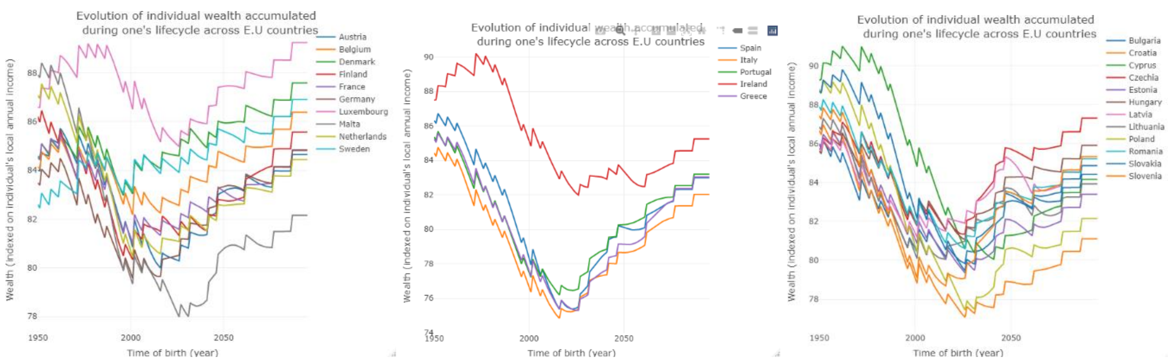

Figure 5 - Evolution of individual wealth across EU countries and generations

This forecast yet raises the questions of private adjustments available to individuals to keep a level of wealth at least similar to the one of their elder (if not superior) in a context where public schemes have to evolve. A first option could be to invest in more aggressive financial products (i.e. products yielding higher returns) to try to accumulate more capital. This however is subject to higher risks and may only be of interest to individuals with a certain risk profile. On the other hand, a more popular option could revolve around postponing the moment when individuals transform the capital (accumulated through their private pension schemes) into an extra allowance (as suggested by lemma 3). Looking back at the model and its results, should individuals born in 2000s capitalize for an extra 3 to 5 years before transforming their capital into an annuity, they could offset their decline in wealth. The downside of this option would be that the early part of their retirement may be less comfortable financially speaking that the one of their elders, but that they may overall benefit from a wealthier end of life.

To conclude the empirical study sustaining this paper, a sensitivity analysis was performed based on the various scenarios provided by the U.N department of social and economic affairs. Its aim was to stress test the robustness of the previous findings. Results at a E.U level are displayed in figure 6. The analysis shows that up until 2050-2060, little variations should be expected with respect to state choices pertaining to public pensions (i.e. $\phi(.), \theta(.)$) but long-term changes (notably around fertility) could have a major impact on the design of social schemes when the current generation retires (i.e. post 2060). In the most optimistic scenarios, social benefits associated to public pensions could go back to levels like the current ones and individuals' wealth would even increase. On the other hand, a continued reduction in fertility (i.e. pessimistic scenarios) would further erode the efficiency of social schemes and would lead to a continued decline in wealth. This would indicate that previous findings on wealth should be robust until 2050s but that from individuals reaching retirement in the 2060s, further adjustments to their private capitalization scheme may be required based on the evolution of the current demographic context.

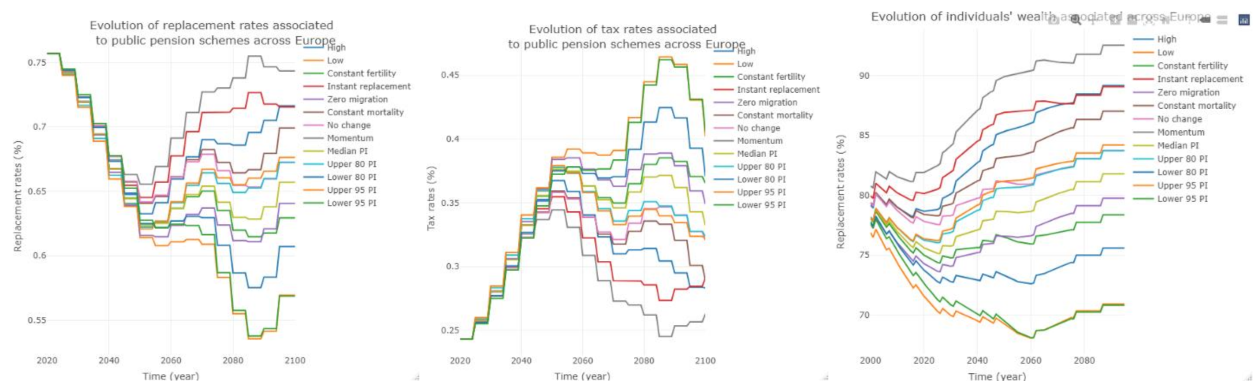

Figure 6 - Different scenarios pertaining to the evolution of public pensions schemes and individuals' wealth across the E.U

IV. Conclusion

Recent scientific developments in health sciences may have led individuals to live longer lives, but not necessarily wealthier ones. Once calibrated to U.N data, the simple model developed in this article forecasts that to account for the ageing of their population, all E.U countries will have to raise the taxes used to fund public pension schemes, whilst retirement allowances will have to be reduced. The result is that even if individuals live longer, the conjunction of increased taxes and reduced retirement allowance will lead the current generation to a 10% loss in wealth. An option to offset this decline consists in having individuals further leveraging 3 to 5 more years before transforming it into a complementary retirement allowance. The consequences at an individual level of those demographic shifts are yet important and sizeable. Active individuals could indeed loose up to 10% of their consumption power if states cannot find a way to rebalance their current tax schemes and they will have to make complex financials decisions and arbitrages around the investments structuring their private pension schemes which require a high level of financial literacy (something that is known to be currently in short stock).

Interestingly current trends suggest that this problem may be a short to mid-term one and that individuals born after 2050 -2060 (i.e. in 2 generations) may come to a world where personal wealth is (structurally) on the rise as taxes and allowances stabilize whilst life expectancy still raises. Those long-term considerations are however subjects to caveats and, as shown when using multiple U.N. demographic scenarios, are highly dependent on individuals' choices when it comes to fertility.

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