Overcoming the old-age dependency challenge

Is pension reform the only answer?

Written in preparation of the Faculty of Law Seminar
Kobe University Japan

April 2018

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Abstract

The increase in life expectancy is arguably the most remarkable by-product of modern economic growth, but it causes population ageing, which *ceteris paribus* translates into a decline of the share of working-age individuals and rising old-age dependency. Since labour remains the most important factor of production, the negative impact of population ageing on economic growth is - in first approximation - proportional to the decline of the working age population. This is the main rationale for a bleak outlook on economic living standards, especially in rapidly aging countries like Japan, Italy and Germany. However, one should not equate demography with economics and assume a fixed labour supply and unchanged institutions, such as labour markets and pension systems, stable education/work/retirement sequences. These bleak statements underestimate what societies have always done largely when confronted to new challenges: adapt, evolve and reform. A rather obvious start is to consider that working age population is a choice variable. Its upper bound (currently generally considered to be 60-65 and referred to as the legal retirement age) can explicitly or implicitly be indexed on life expectancy. This is one of the principles underpinning many recent pension reforms. We will show in this paper that there are many more avenues that need to be explored to combat rising dependency...

KEYWORDS: population ageing, dependency, productivity, pension and related reforms

JEL CLASSIFICATION: J11; J24; D24; O30

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1. A few words about demography

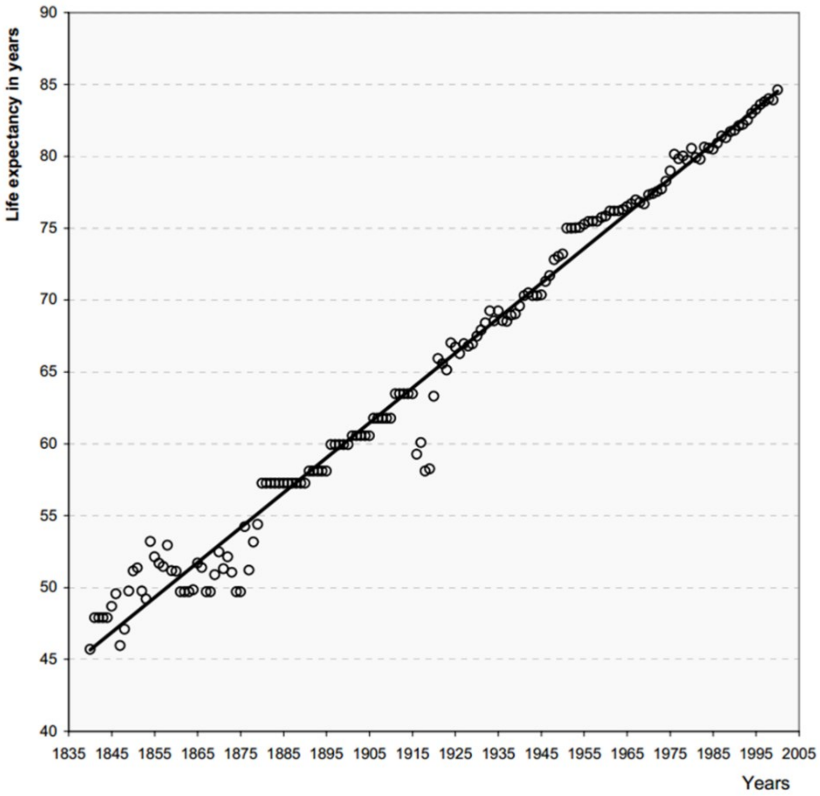
The increase in life expectancy is arguably the most remarkable by-product of modern economic growth. In the past 30 years, we have been gaining roughly 2.4 years of longevity every decade in advanced economies, and demographers consider that we should keep gaining at least 1.2 year/decade until 2050. Together with a sharp reduction of the number of childbirths per women, this implies population ageing.

Note that fertility variations create "transitory" shocks, while rising longevity does seem more permanent. Supporting this statement, the frontier of longevity has increased almost linearly since the beginning of the 19th century (***Figure 1***).

A more careful examination reveals that the rise has been driven by reduction of mortality among different age groups at different moments of our history: first, a dramatic drop of child mortality and then reduction of mortality concentrated in prime and old-age groups. The current sources of rising longevity are linked to progresses made in the treatment of cardiovascular and cancers affecting older groups [a process mobilising top-notch and very expensive technology]

Successfully managing ageing (now primarily driven by extended longevity) over the next 2/3 decades is one of the major structural challenges faced by decision-makers, particularly so in the area of health, social security administration (pensions), labour market institutions (retirement…), but also education or technological innovation.

Figure 1- Historical trend in female life expectancy[1] 1840-2005



Note: Country with the highest life expectancy. The linear trend: slope=2.43 and R2=0.98. Source: Oeppen and Vaupel (2002).

2. The demographic dependency ratio and living standards

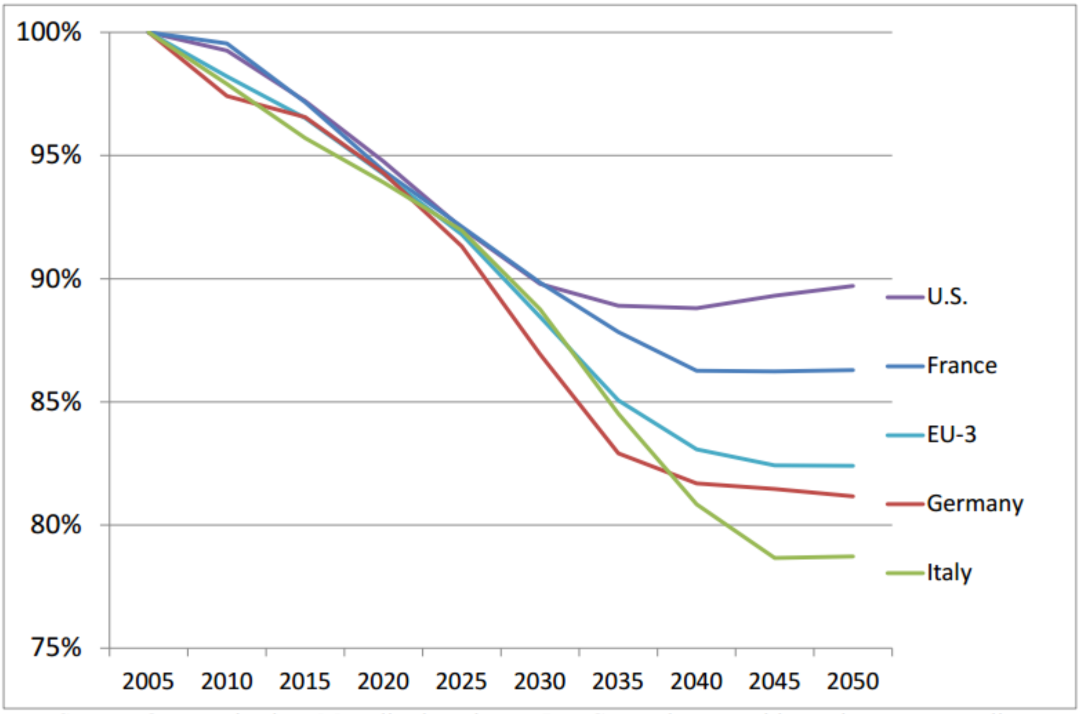
The key macroeconomic challenge of population aging is the decline of the share of working-age individuals in the population. Since labour is the most important factor of production, the negative impact of population ageing on economic growth is - in first approximation - proportional to the decline of the working age population (*WAP*). This is the main rationale for a bleak outlook on economic living standards, especially in rapidly aging countries like Italy and Germany.

About living standards, the most basic equation is

$$Y/P = Y/WAP \,.\, WAP/P \qquad [1.]$$

where standards of living as reflected by the income per head is fundamentally the product of labour productivity (*Y/WAP*) and the working age population ratio (*WAP/P*); i.e. the term that is mechanically (and negatively) impacted by ageing (***Figure 2***).

Figure 2- Projection of the evolution of working age-population (share of people aged 20-65 in total population, 100%=2005)



Source: Own projection. Mortality based on a Lee-Carter decomposition using past mortality rate changes derived from the Human Mortality Database (2012); constant fertility rates (France: 1.89, Germany: 1.34, Italy: 1.29); and constant migration flows, based on the UN (2010) projection (France 100,000, Germany 150,000, Italy 135,000 net migrants p.a.).

Source: Börsch-Supan, A. (2014), Aging Societies: Individual and Societal Plasticity, Munich Centre for the Economics of Aging (MEA) WP 22-2014.

The above expression can be restated to highlight the role of the people who are not part of the working age population (*NWAP*) and calculate the share of the dependent population ($\alpha = NWAP/P$)

$$Y/P = Y/WAP \,.(1 - \alpha) \qquad [2.]$$

An alternative presentation consists of highlighting the role the different segments of the population outside the working age population (i.e. young $NWAP^y/P$ and old people $NWAP^0/P$)

$$Y/P = Y/WAP \,.\, (1 - \alpha^y - \alpha^O) \qquad [3.]$$

And for those who are used to discussing these issues in terms of dependency ratio, it is immediate to show that

$$WAP/P = (1 - \alpha^y - \alpha^O) = 1/(1 + D^y + D^o) \qquad [4.]$$

with

- the youth dependency ratio $D^{y}= NWAP^{y} /WAP$;

- the old dependency ratio $D^{0}=NWAP^{0}/WAP$

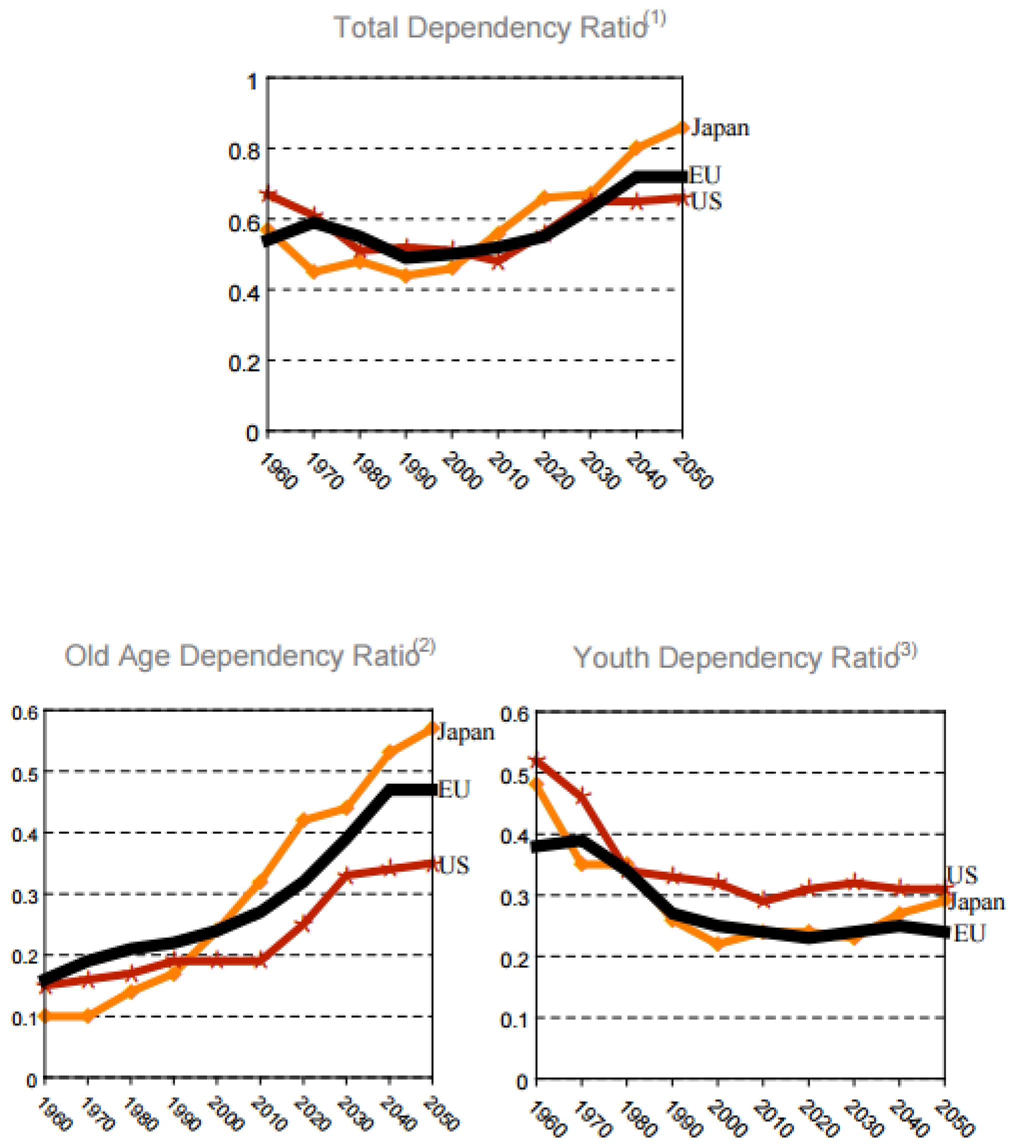
Or more generally

$$WAP/P=(1- \alpha)= 1/(1+D) \qquad [5.]$$

Linking the working age population ratio to the share of the dependant population and the overall dependency ratio (*D*)

The reason many analysts focus on the overall (demographic) dependency ratio and its evolution (*Figure* ***3***) is that it gives an idea of how many young/ old people each person in working age is supposed to support financially either directly or via tax-based transfer systems.

Figure 3- Demographic Dependency. Europe, USA & Japan 1960-2050



Note: (1): Total Dependency Ratio = (Population under 14 or above 65) / (Pop. aged 14-64) (2): Old Age Dependency Ratio = (Population above 65) / (Pop. aged 14-64)
Source: McMorrow, K. and Roeger, W. (1999)

3. The actual cost of dependency

What is implicit above is that one cares about *i)* the opportunity cost of dependency: ie. the foregone production of inactive people whose magnitude is reflected in the shrinking working-age population ratio (or the rise of the overall dependency ratio) *ii)* and its consequence in terms of the average output per capita (equation [1]). What is also implicit in the latter statement is that dependent people invariably consume part of the output generated by a limited number of active people and that they get access to that output thanks to State-sponsored transfer mechanisms. We could even argue that what is implicitly assumed is that dependent people consume exactly the same thing as working-age people.

One way of questioning the relevance of these assumptions is to assume that dependent people consume a very limited amount of resources (in comparison with those who work). The risk of declining output per head highlighted by equation [1] could then be considered as numerically true, but considerably overstate the economic/social challenge.

To the contrary, and probably more realistically, consider the scenario in which dependent people (youth and elderly) consume as much as, or even more than, people in their working age. Then the conclusion would be that equation [1] underestimates the economic challenge ageing societies are confronted with.

Young people are generally studying. And old people presumably require more health/elderly care (although we will see below that this assumption is debated among health economists). This raise the question of the actual direct cost of young + old dependency. Do we have reasons to believe that these people "consume" a lot?

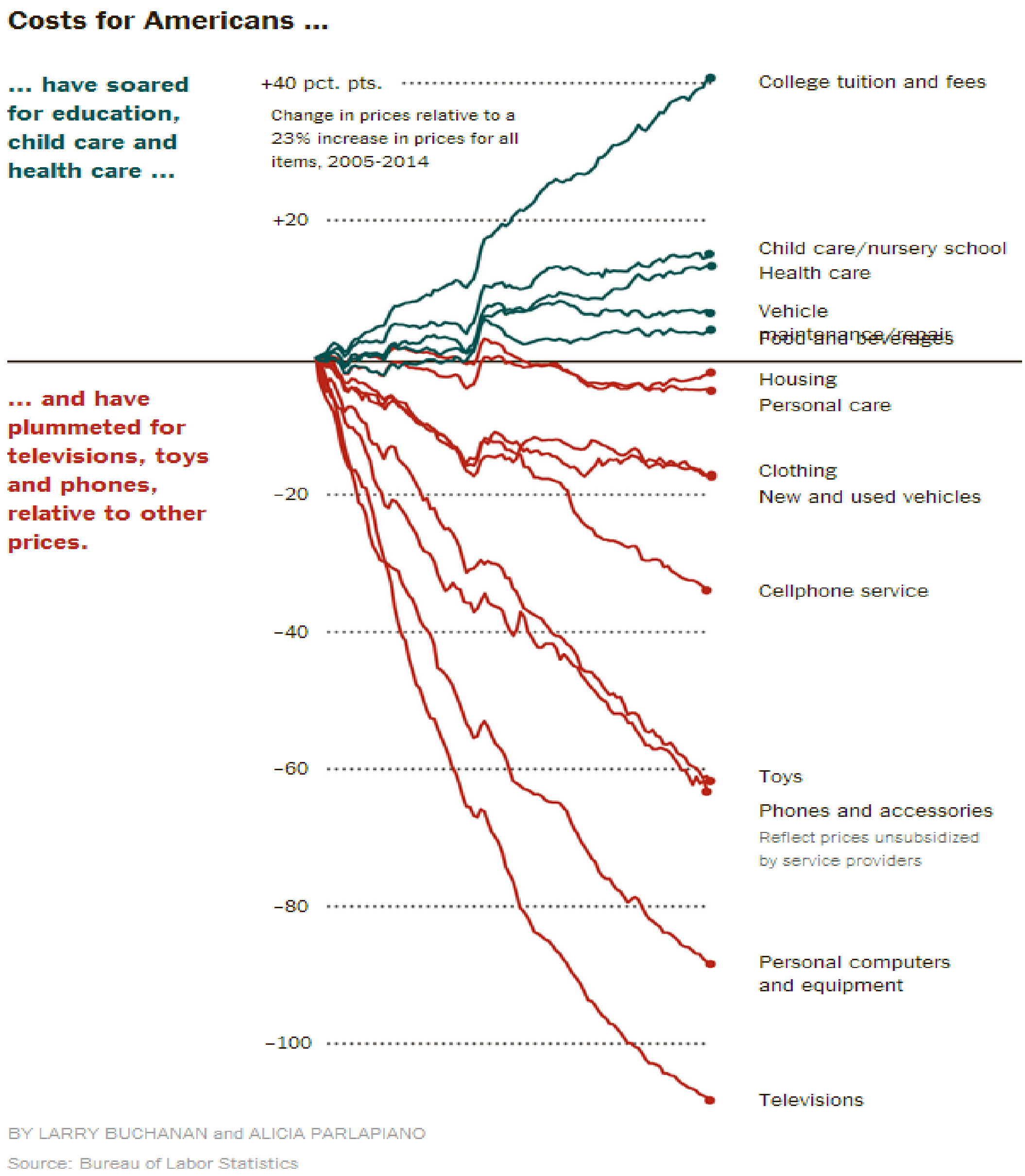
i The Baumol cost disease

Nobel-prize winner W. Baumol has elaborated the theory of "cost disease", applicable to the sort of goods and services that tend to be in high demand among the dependent segments of the population. Baumol explains that in a range of businesses, such as car or ICT manufacturing, workers are continually becoming more productive due to technological innovations to their tools and equipment. In contrast, in some labour-intensive sectors that rely heavily on human interaction or activities, such as elderly care, education, or the performing arts there is little or no growth in productivity over time. As with the string quartet example, it takes nurses the same amount of time to change a bandage, or college professors the same amount of time to mark an essay, in 2006 as it did in 1966. This is because those types of activities rely on the movements or functions of the human body, which cannot be engineered to perform more quickly, accurately or efficiently in the same way that a machine, such as a computer, can.

The term "cost disease" refers to the logical consequence of the asymmetry in productivity gains: the "disease" involves a constant rise of relative unit costs in sectors experiencing no increase of labour productivity in relative to other sectors which do.

Baumol's cost disease is often used to describe the consequences of the lack of growth in productivity in the quaternary sector of the economy and public services such as hospitals and universities. These activities that are heavily labour-intensive, in which there is little growth in productivity over time because productivity gains come essentially from a better capital technology, and whose relative unit cost tend to rise dramatically over time (***Figure 4***)

Figure 4- Change in prices relative to a 23% increase for all items, 2005-2014



Source: Bureau of labour statistics, 2014

ii) Recent work on the determinants of rising health costs

Given that the rise of demographic dependency is primarily driven by the rise of old-age dependency (youth dependency is probably slightly in decline even if we account for the fact the young people spend more and more time in education), it makes sense to further discuss the health care cost of ageing.

Health care is very costly. Most advanced economies already devote some 9-17% of the GDP to finance their health care systems. And the dynamic of health care costs is worrisome as – in line with Baumol's prediction – growth of expenses in that sector exceeds by far that of the GDP.

However, health economists do not jump to the conclusion that ageing is a key driver of the high inflation observed in most advanced economies in the health sector (Garibladi, Marting,& Van Ours, 2010). At least three candidates should be considered; age; preferences; and the very special sort of technical evolution taking place in the health sector (i.e. new treatments to treat existing conditions). Garibladi, Marting,& Van Ours (2010) argue that both macro and micro evidence shows that the impact of ageing *per se* on health care costs is limited. In contrast, the role of preferences and technology is crucial.

There is a strong positive correlation between age and average health care, but this mainly reflects the strong correlation between age and proximity to death (i.e.; a one-time event that causes a peak in health care cost).

Analysis in terms of proximity to death for different age groups (i.e. people who died at significantly different age) reveals a common pattern : similar levels of expenditure whatever the proximity, with some sharp rise 4 months before death. The point is that, conditional of not dying within a year [being a survivor], health costs rise only moderately with age.

The main problem with health care, is that these conditional age-cost profiles experience a systematic upward shift over the years, without any indication of a rise of morbidity/incidence of medical conditions. And this points at the role of preferences and technology

- About technology: in the heath sector, technological innovation is such that pure substitution effects (the replacement of one treatment by a new one, possibly at a lower unit cost) are dominated by extension effects (the use of the treatment in many more cases, for many more patients. For instance, coronary angioplasty appeared in the 1970s (and consists of inflated balloons or stents to re-establish the flow of blood in blocked arteries) is less costly than bypass surgery. However, the evidence is that angioplasty is now used way more often than the bypass surgery it is replacing. Similar examples exist in the treatment of depression (Prozac) or cataract… better techniques (sometimes less expensive on a per treatment basis) generally lead to a boost of their use, driven both by professionals (supply creating its own demand) or patients.

- About preferences: heath care seems to be a normal good[2]: unlike bread/food, income elasticity is high: very close to 1 if not higher than 1. Economists who have studies the relationship between per capita health expenditure (*H*) and GPD per capital at country level (i=...N)

$$lnH_{it}=\alpha_i + \beta lnGDP_{it} + u_{it} \qquad [6.]$$

generally find estimates of β that are close to 1. The tentative conclusion is that one cannot count on GDP growth to stem the rise of overall spending on healthcare. What has been observed with bread/cereals, and spending on food in general, is unlikely to happen with healthcare.

4. Overcoming the dependency challenge

4.1. The usefulness of a broad view

On second view, the statements made in Section 1 exemplify a common mistake: equating demography with economics and assume a fixed labour supply and unchanged institutions, such as labour markets and pension systems, stable education/work/retirement sequences. These statements underestimate what societies have always done to a large extent when confronted to new challenges: adapt, evolve and reform.

A bit of algebra for instance shows that many things could adjust to compensate for the contraction of the working age population ratio.

i. Indexing working age on life expectancy

a. The upper bound

Let us first consider that the working age population *WAP* is a choice variable, and consider the possibility that the upper bound of the age band (*AB*) defining the working age population (currently generally considered to be 65) is indexed on life expectancy (*LEXP*)[3]

$$Y/P= Y/WAP(AB[LEXP] \,.\, WAP(AB[LEXP])/P \qquad [7.]$$

[2] Normal goods are any goods for which demand increases when income increases, and falls when income decreases but price remains constant, i.e. with a positive income elasticity of demand.

[3] Historians tell us that employment rate among individuals age 65+ , particularly among men, used to be very high at the end of the 19th century, way above 70%, reflecting the quasi absence of any large scale pension systems. And the major trend since has been the rise of the idea of paid retirement and, in parallel, the rapid and steady decline of the old-age (65+) employment rate. Prima facie this is supportive of the view that indexing retirement age on life expectancy should be feasibly; particularly if one accounts for the dramatic reduction of the incidence of physically demanding tasks between the 19th century and today.

with

- *AB[LEXP]*= the size of the age band defining the working age population

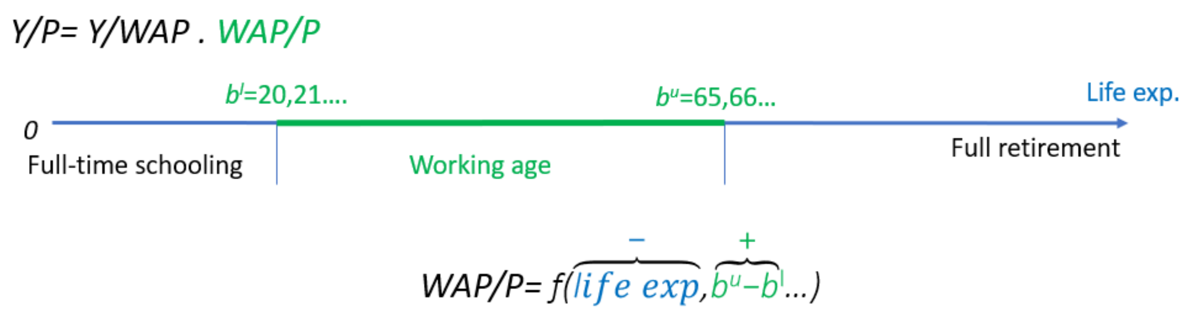
- and $\frac{\partial AB[LEXP]}{\partial LEXP}$>0

Economists at the OECD (Oliveira Martins et al. 2005), have simulated the impact of such an indexation on the old-age dependency ratio, and conclude that this move (except perhaps in Japan) could significantly slow down the increase in old-age dependency ratios due to ageing. In other words, conditional on minor variations of the youth dependency ratio, a stabilisation of the old dependency ratio could contribute a lot to stabilizing the working age-population ratio around its mid-2000 level, preventing i) dramatic tax increments to finance pay-as-you go pension schemes, or ii) a general reduction of the level of individual pensions.

b. But also the lower bound

As Figure 5 suggests, the share of life dedicated to work - and hence the level of the ratio (*WAP/P*) - is also a function of the age of entry into the labor market. The latter is logically higher as young people devote more time to study; the trend observed in many countries in recent decades. The consensus among economists is that such an extension, in a context of aging, is overall a good thing, as it contributes to raising skills / human capital; one of the determinants of labor productivity, which is none other than the term *Y/WAP* in equation [1], and whose growth is a priori very important means of counteracting the effects of aging.

Figure 5 – The working age population and its upper (and lower bound)



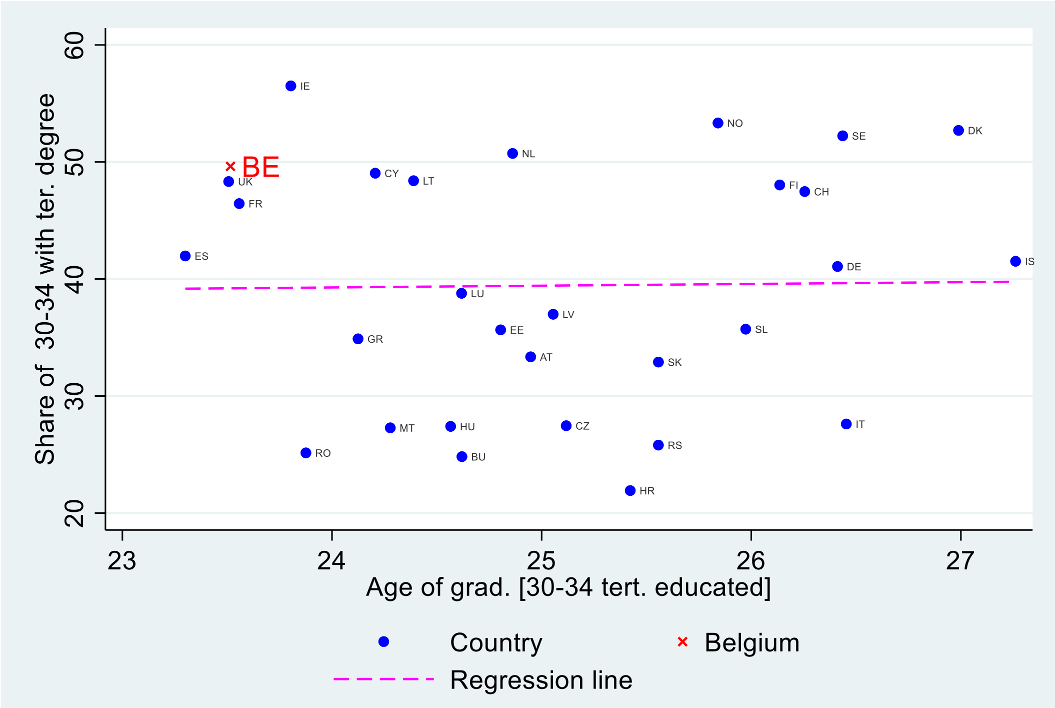
However, a careful examination of the data suggests that it is wrong to think that the duration of education is automatically synonymous with an increase in the level of human capital and, hence, labour productivity in an economy. EU-SILC data for the period 2010-15 show a very large heterogeneity in Europe (horizontal axis in Figure 6) in the age at which a higher/tertiary degree is obtained. In itself, this is a challenging fact. Why, on average, do Danish or Icelandic young people complete their higher education at the age of 27, whereas British or French young people complete it at just over 23? The difference is considerable, ranging from 4 to 5 years between extremes. And its implications on the proportion of people in employment are not insignificant, since higher education now concerns about 50% of the cohort or even more in most European countries. And above all, there is no positive correlation between the duration of studies and the proportion of 30-34 individuals with a higher degree (Figure 2). The argument that while there is a cost to extending studies - particularly in terms of dependency ratios - but increases the probability of access to a higher education diploma is not borne out by EU-SILC data.

Another way of understanding the relationship between length of study and economic performance is to focus on the wage premium for tertiary graduates. Because beyond the degree, economists will agree that what matters is the effect on wages; which wages in a competitive labour market are supposed to reflect productivity. More time spent on obtaining the higher diploma - with a better quality of learning? - result in a higher salary bonus? Not really. Figure 7 even suggests the opposite, with a negative correlation between the duration of studies and the gross wage premium.

Some argue that older students in Denmark have accumulated significant labour market experience as many of them hold student jobs, something that help them have a smoother and faster STW transition. The high incidence of student jobs among Danes is confirmed by OECD data. In Denmark about 70% of those aged 23-24 have such a job. Yet, even more Australian students (85%), for example, work but still manage to graduate at a much younger age.

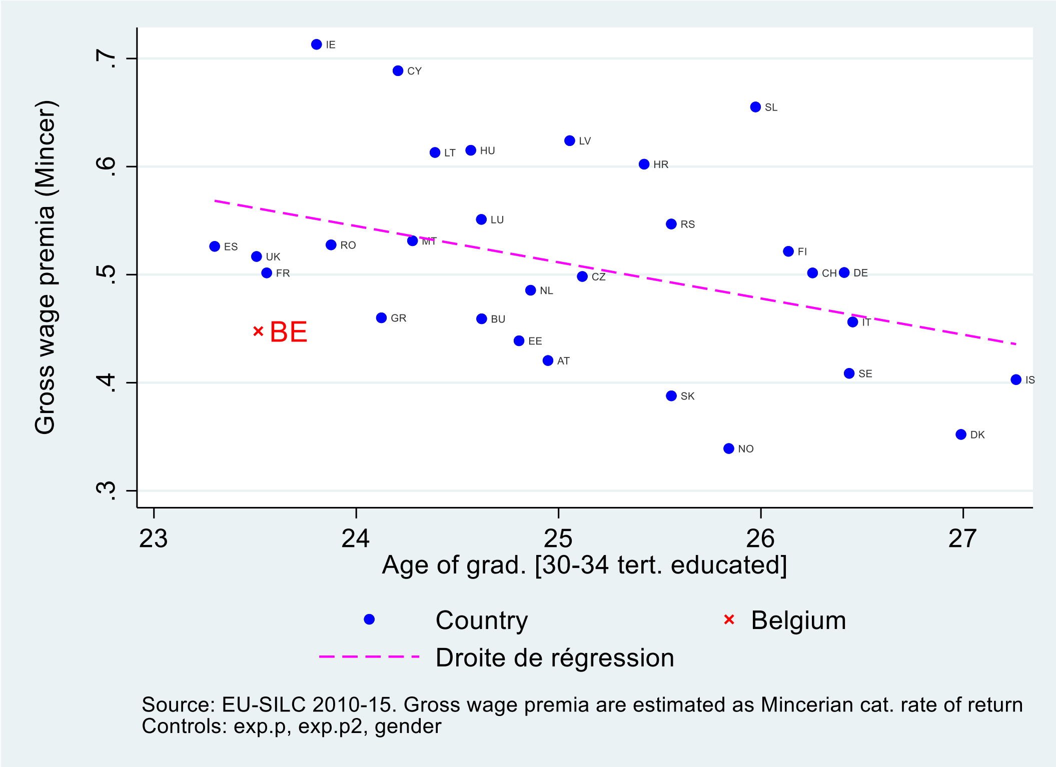
In summary, there is no evidence that countries where young people spend more time in higher education generate an economic benefit; on the contrary. The phenomenon of long studies has a certain cost - in terms of postponing labour market entry and increasing the dependency ratio (ie. a lower PAT/P ratio in equation[1]) - but it does not generate any gain in terms of human capital or productivity (ie. a higher Y/PAT ratio in[1]).

Figure 6 – Proportion of the population aged 30-34 with a tertiary degree and age at which the diploma was obtained



Source: EU-SILC 2010-15

Figure 7 – Wage premium (gross salary) for persons aged 30-34 with a teriary degree and age of graduation from that degree



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ii. The view of labour economists

What is more, most labour economists would favour a decomposition of output per head (*Y/WAP*) that highlights the role of actual amount of work accomplished (i.e. total number of hours worked *H*) by the people belonging to the working age population.

$$Y/P = Y/H \,.\, H/WAP(.) .\, WAP(.)/P \qquad [8.]$$

Labour economists would also further decompose the number of hours per working-age individual by introducing *L* the number of employed people, and *LS* the labour supply (employed people + unemployed ones) to account for i) the intensity of work (*H/L*), ii) the difference between people who are in employment and those who are willing to be in employment (*L/LS*) (i.e. the risk of unemployment) and iii) the willingness to work among individuals forming the working-age population (*LS/WAP(.)*) i.e. labour participation

$$H/WAP(.)= H/L.\ L/LS\ .\ LS/WAP(.) \qquad [9.]$$

Note the that latter equation can be rewritten to make the unemployment rate ($\mu \equiv (LS-L)/L$) appear explicitly

$$H/WAP(.)= H/L.\ (1-\mu).\ LS/WAP(.) \qquad [10.]$$

iii. And the view of those who focus on labour productivity and growth

Finally, economists studying productivity and growth are also familiar with a simple decomposition of aggregate labour productivity (*Y/H*) using a Cobb-Douglas specification of output[4]

$$Y= A.\ K^{\alpha}\ (QH)^{\beta} \qquad [11.]$$

with QH aggregating educated & non-educated labour

$$QH= \mu_0 H_0+ \mu_1 H_1 = \mu_0 H_0+ \mu_1 H_1 + \boldsymbol{\mu_0 H - \mu_0 H} =$$

$$\boldsymbol{\mu_0 H} + \mu_0 H_0+ \mu_1 H_1 \boldsymbol{- \mu_0 H_0 - \mu_0 H_1 = \mu_0 H + (}\mu_1 \boldsymbol{- \mu_0)} H_1 =$$

$$\mu_0 H[1+ (\lambda - 1)S] \qquad [12.]$$

where $\lambda= \mu_1/\mu_0$; $S= H_1/H$

$$Y= A.\ K^{\alpha}\ (\mu_0 H[1+ (\lambda - 1)S])^{\beta} \qquad [13.]$$

$$Y= A^{\$}\ K^{\alpha}\ H^{\beta}(1+ (\lambda - 1)S)^{\beta} \qquad [14.]$$

and with constant returns to scale *ie.* $\beta= 1-\alpha$

$$Y/H= A^{\$}\ (K/H)^{\alpha}\ (1+ (\lambda - 1)S)^{\ 1-\alpha} \qquad [15.]$$

Highlighting the contribution of total factor productivity ($A^{\$}$) – the overall state of science and technology), capital deepening (*K/H*) - the amount of capital per hour and the share of educated workers (*S*) as well as their relative productivity (λ). For more on this see Werding, 2007; Vandenberghe; 2017.

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[4] And assuming constant return to scale.

iv. And finally

If we combine these elements, we end up with an expression of the income per head

$Y/P= A^{\$} (K/H)^{\alpha} (1+ (\lambda - 1)S)^{1-\alpha}\ H/L.\ (1-\mu).\ LS/WAP(.).\ WAP(AB(LEXP)/P$ [16.]

that is function of

- the level TFP
- the stock of capital in relation to labour (capital deepening)
- the educational attainment of the workforce
- the annual duration work and the incidence part-time work
- the risk of unemployment
- the participation rate
- and the share of the working age population (in the total population) that is function of how one defines working age and could logically be indexed on life expectancy

Many of these terms amount to variables that, to some extent, can vary independently of each other, and as the result of specific policies.

- FTP growth can accelerate if decision-makers improve industrial policy, properly finance fundamental research and promote the dissemination of its outcomes.
- Capital deepening can be encouraged by fiscal policy (and to some extent by ageing itself if one assumes that savings is higher in an ageing population, and that savings translate into more investment and thus more capital);
- Social partners can agree on longer hours of work or additional working days per year. Prescott (2004) calculated that, in the mid-2000s, Americans worked 50 percent more than do the Germans, French, and Italians. Americans average 25.1 working hours per person in working age per week (*H/WAP*), but the Germans average 18.6 hours. The average American works 46.2 weeks per year, while the French average 40 weeks per year. Why do western Europeans work so much less than Americans?
- Many European countries (or regions of Europe) experience two-digit unemployment rates meaning a huge wage or potential labour, while experiencing a rise of their dependency ratio;

- In Denmark, students finish their university degree on average at the age of 29.5; in Australia at 23;

- Female participation to the labour force is still way below that of men in Germany and Japan, due to a mix of cultural barrier and a lack of adequate provision of day care.

- Since the early 1990's legal age or retirement has been increased in many countries, although few (except Denmark) seem to have committed to index that age on life expectancy.

On a purely numerical basis, Börsch-Supan (2014) suggests that a combination of the following four policies would fully offset the above-discussed macroeconomic implications of population aging for Europe

- students start working two years earlier;

- women participate in the labour force as much as men;

- workers exit the labour force two years later;

- public pensions are organized on a defined contribution basis rather than as defined benefits [with benefits indexed on life expectancy, actual GDP growth ...]; [5]

4.2. The role of technological progress- Could ageing be coinciding with a "new age machine"?

This is a topical question. It can be related to FTP *(A)* and the capital deepening terms (*K/H*) as direct determinants of output per individual in the working age population (*Y/WAP*) in equation [1]. Could

[5] Many OECD countries have introduced reforms in their pensions system that consists of protecting the working-age populations from the financials consequences of longer lives, and the overall population from a generalized slowdown of the private economy due to very high levies). Traditionally, pension entitlements were "defined" by some sort of formula. In theory, at least, this meant that the annual value of the pension was the same whatever happened to life expectancy. These "defined-benefit" schemes dominated both public and private pension provision in OECD countries in the second half of the 20th century. Over the last decade, however, this defined-benefit paradigm has been diluted and pension systems around the world have become much more diverse. Most significant has been the expansion of **defined-contribution** pension schemes, where the pension depends on contributions and interest earned on them. In some countries, these have replaced all or part of the public defined-benefit pension scheme. In others, a requirement to contribute to the defined contribution (DC) plan was added on top of existing state pensions. Finally, in countries with widespread, voluntary occupational pensions, employers have tended to shift these from defined-benefit to defined-contribution (or a mix of the two). The point is that in defined-contribution schemes, individual retirees bear the burden of changes in life expectancy as lower pensions. When people retire in a defined-contribution plan, the accumulated contributions and investment returns must be converted from a lump sum into a regular pension payment, known as an annuity. And the calculation of the annuity is based on projected life expectancy of retirees at the time of retirement. So, pensions will be lower as people live longer. As such, these reforms do not lift the working age population ratio. Another question is to determine if they entice people to postpone retirement. We will see further that this depends on the presence or absence of implicit tax on retirement postponements.

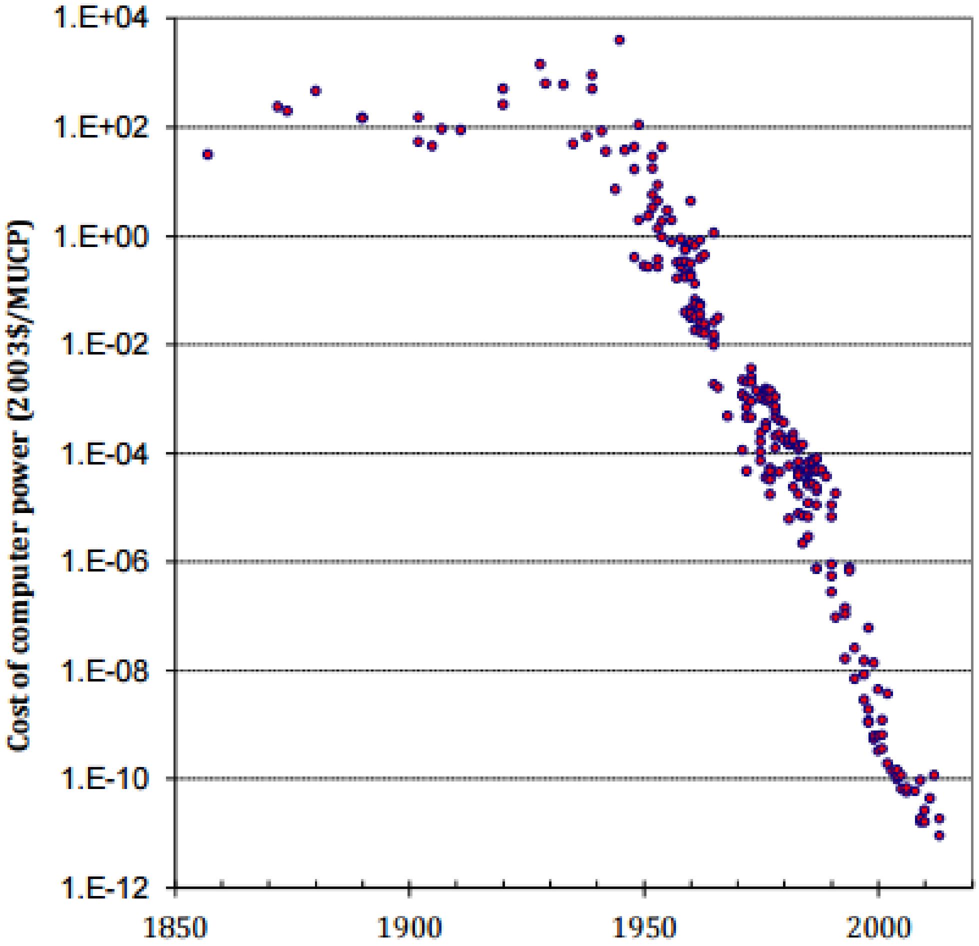
it be that robots, computers, e-platforms or artificial intelligence are about to generate a rise of the labour productivity of a magnitude recorded in the wake of the two previous industrial revolutions that is, IR #1 (steam, railroads) from 1750 to 1830 and IR #2 (electricity, internal combustion engine, running water, indoor toilets, communications, entertainment, chemicals, petroleum) from 1870 to 1900?

i) The accelerationists

Brynjolfsson & Mc Afee (2012), strongly believe that we are about to embark in IR#3. The key idea (dubbed “singularity” by Nordhaus (2015)) is that rapid growth in computation and artificial intelligence will cross some threshold - or “singularity” - after which economic growth will accelerate sharply; as an ever-accelerating pace of improvements cascade through the economy.

The foundation of the accelerationist view is the continuing rapid growth in the productivity of computing. One important milestone will be when inexpensive computers (***Figure 8***) attain the computing capacity of the human brain. Current estimates are that the computational capacity of the human brain is in the range of 10^{18} computations per second; a performance supercomputers may have reached in 2017. This said, computational speed does not easily translate into human intelligence. Existing robots & computers are known for being “good” (effective & cheap) at following predefine sequences of tasks, but so far, relatively lousy at pattern recognition & low-level task requiring basic sensorimotor skills … and they are very expensive to reprogram (you need to stop the assembly line to allow the engineers to change the place where robots drill/weld). But recent developments (artificial intelligence, machine learning is changing this. What Google (and many others) have been able to achieve with driverless cars epitomizes a vast range of innovations that will vastly increase the range of tasks that can be automated; something that should boost productivity… and thus potentially compensate for the rise of.

Figure 8- The progress of computing measured in cost per computation per second deflated by the price index for GDP in 2006 prices



Nordhaus (2008) updated by the author using PassMark from http://www.cpubenchmark.net/, results as of April 2014.

ii) The sceptics

But so far, these optimistic predictions lack clear statistical support, at least at the macro level. Nordhaus (2015) does not find evidence that we could be approaching "singularity". Other economists like Gordon (2012) are quite pessimistic about what the digital revolution can do for aggregate labour productivity.

There is the computer paradox, about Robert Solow's 1987 quip, "You can see the computer age everywhere but in the productivity statistics". The paradox has been defined as the discrepancy between measures of investment in information technology and measures of output at the national level. It was widely believed that office automation was boosting labour productivity (or total factor productivity). However, the growth accounts did not seem to confirm the idea. From the early 1970s to the early 1990’s there was a massive slow-down in growth as the machines were becoming ubiquitous. (Other variables in countries' economies were changing simultaneously; growth accounting separates out the improvement in production output using the same capital and labour resources as input by calculating growth in total factor productivity, AKA the "Solow residual"). The productivity paradox has attracted a lot of attention because technology seems no longer to be able to create the kind of productivity gains that occurred until the early 1970s. Gordon, commenting on the steady decline in TFP growth since the 1970s in the US and other advanced economies, is arguing that technology in general is subject to diminishing returns in its ability to increase efficiency. IR #3 (computers, the web, mobile phones…) created only a short-lived growth revival between 1996 and 2004 (mainly in the US).

At the core of Gordon’s argument is that recent ICT development has focused not on labour-saving innovation, but rather on a succession of entertainment and communication devices that do the same things as we could do before, but now in smaller and more convenient packages. The iPod replaced the CD Walkman; the smartphone replaced the “dumb” cell phone with functions that in part replaced desktop and laptop computers; and the iPad provided further competition with traditional personal computers. These innovations were enthusiastically adopted, but they primarily provided new opportunities for consumption on the job and in leisure hours, rather than a continuation of the historical tradition of augmenting human labour's potential with machines.

Even if innovation were to continue into the future at the rate of the two decades before 2007, Gordon argues that the U.S. faces severe headwinds that are in the process of dragging long-term growth to half or less of the 1.9 percent annual rate experienced between 1860 and 2007. These include demography & education.

- The “demographic dividend” is now in reverse motion. The original dividend was another one-time-only event, the movement of females into the labour force between 1965 and 1990, which raised hours per capita and allowed real per-capita real GDP to grow faster than output per hour. But now the baby-boomers are retiring, no longer included in the tally of total hours of work but still included in the population. Thus, hours per capita are now declining, and any tendency for life expectancy to grow relative to the average retirement age will further augment this headwind. Whenever hours per capita decline, then output per capita must grow more slowly than productivity

- The second headwind is the possibility of a plateau in educational attainment, as exemplified by the U.S. situation over the past 20 years (Golden & Katz, 2008). The U.S. is steadily slipping down the international league tables in the percentage of its population of a given age which has completed higher education. The very idea of a plateau in educational attainment is worrisome, in particular for the prospect of innovation-driven productivity gains, as education (particularly of the advanced sort i.e. college degrees, PhD's) is generally seen as *complement* of innovation. The "plateau" in educational attainment points at several problems. One is the cost disease in higher education, i.e. the rapid increase in the price of college tuition relative to other goods (see supra). Another one has to do with the very particular (in fact joint) nature of human capital production. Education specialists insist on the crucial role of the family and the immediate neighbourhood in transmitting and nurturing the willingness to learn and the ability to postpone gratification that it requires. In parallel, the evidence collected by econometricians over the past 30 years show how limited the impact of external interventions (smaller class sizes, higher spending per pupil, remediation programmes…) on attainment can be (Hanushek, 2006).

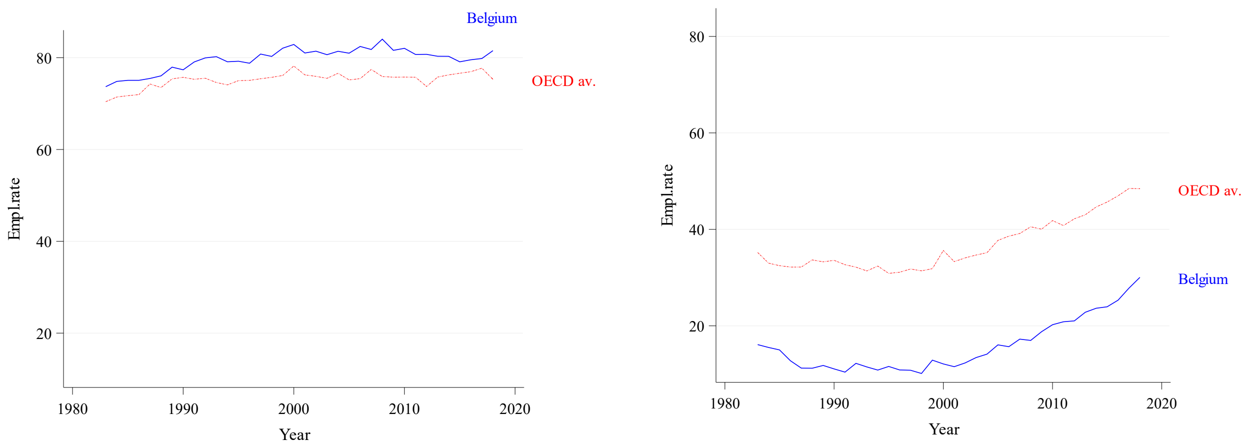
5. Concluding remarks

The "broad view" exposed above, in combination with the possibilities offered by technological progress, are conducive to a rather optimistic view of ageing. The merit of the above developments is to convey a more optimistic view about the economic challenges of ageing. But the approach remains mechanical. And reality is complex. What may work numerically and in theory - based for instance on Eq. [16] - may not work as a political programme in an aging society (Börsch-Supan, 2014). The plasticity of a society is limited for a multitude of reasons. Understanding these reasons is the main opportunity and the challenge for research on aging societies. Human behaviour is complex and innovative political actions may turn out with unexpected results.

A case in point is the difficulty of raising the "actual" retirement age [and not just the legal/reference age of retirement] in many European countries. Figure 6 shows that although most OECD countries in 2015 set the legal age of retirement at 65, less than half of people age 60-64 are employed (even less in Belgium).

Figure 6 – Prime-age (30-34) vs Old (60-94) employment rates: 1983-2018; Belgium -OECD, LFS

30-34 60-64



Ageing and policies aimed at maintaining older individuals in employment raise crucial issues that have received too little attention so far. Many existing studies look at the consequence of ageing population. However, the consequences of an ageing workforce from the point of view of firms, forming the demand side of the labour market, have received much less attention. EU-SILC data show a negative relationship between older individuals' employment rate and how much they cost to employ, suggesting the labour cost can be a barrier to old employment. There is also abundant evidence suggesting that firms ''shed'' older workers. Dorn and Sousa-Poza (2010) [5] show for instance that involuntary early retirement is the rule rather than the exception in several continental European countries. In Germany, Portugal, and Hungary, more than half of all early retirements are, reportedly, not by choice. These elements give to understand that one cannot take for granted that older individuals who are willing/forced to stay in the labour force do get employed. And this calls for a fully-fledged research agenda on the barriers to old-age employment (Vandenberghe, 2011a,b;2013; Vandenberghe et al. 2013)

- Another example are the ill-designed part-time/flexible retirement schemes -- aimed at helping older workers stay longer in employment. In some countries (e.g., Finland and Germany), these reforms have led to the perverse result that the overall supply of old labour actually decreased (the positive impact on longer years in employment was annihilated by a widespread reduction of hours; in other words the reforms have enticed many individuals who would have worked full-time [in the absence of the reform] to opt for part-time work.

- On a political level, misconceptions about the short-term costs and the long-term benefits of structural reforms may lead to reform unwillingness, or even backlash. Moreover, virtually all structural reforms have winners and losers and imply redistribution not only between the rich and the poor, but often also between the young and the old, creating veto groups which undermine or weaken societal plasticity.

- One should also never forget that coping with ageing (if we exclude the case where the bulk of the adjustment correspond to longer careers) may requires more public or private transfers. One thing is to identify ways to increase labour productivity and the amount of wealth produced globally (via whatever mechanism highlighted in Eq. [16] above). A rather distinct one is to get those who produce that extra wealth to accept that a larger part of is ultimately transferred to retired people. Taxation and social security contribution levels are already high in many countries and raising them further may crease labour disincentive effects.

- Properly understanding the determinants of societies' plasticity in front of the ageing challenge raises research questions that invariably point at economics, health care, sociology, individual and social psychology. There is a need for more interdisciplinary research and multi-disciplinary data sets.

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