



Tuomas Saarenheimo

Ageing, interest rates, and financial flows



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Ageing, interest rates, and financial flows

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Abstract

The median age of the global population is presently increasing by nearly three months every year. Over the next couple of decades, almost every country in the world is set to experience an unprecedented increase in the share of elderly population. This development has the potential to fundamentally affect the functioning of economic and financial systems globally.

This study concentrates on the effects of ageing on the evolution of global interest rates and financial flows. The study uses a 73-cohort general equilibrium overlapping generations model of five major economic areas (USA, EU-15, Japan, China, and India). Utilising actual population data and UN population projections, the model yields predictions for major economic and financial variables up to 2050.

The model predicts a decline in global equilibrium real interest rates over the next two decades, but the size of the decline depends crucially on the future evolution of public pension benefits. If the present generosity of pension systems is maintained – leading to a steep increase in the cost of the pension systems – the maximum decline of interest rates is projected to be about 70 basis points from present levels. If pension benefits are reduced to offset the increasing cost pressures, the decline in global equilibrium interest rates can be much larger, while increases in the retirement age work in the opposite direction.

The results do not anticipate a ‘financial market meltdown’ – a collapse in asset prices associated with the retirement of the baby-boomers – predicted by some. On the contrary, bond prices should fare fairly well over the next three decades. The main reason for this is that increasing life expectancy at retirement creates a need for higher retirement saving – in the future, people will want to retire wealthier than they do today. This trend more than offsets the negative effect of the retirement of baby-boomers on asset demand.

Key words: Ageing, real interest rates, financial flows, public pension systems

JEL classification numbers: J11, E44

Ikääntyminen, markkinakorot ja rahoitusvirrat

Suomen Pankin tutkimus Keskustelualoitteita 2/2005

Tuomas Saarenheimo
Rahapolitiikka- ja tutkimusosasto

Tiivistelmä

Maailman väestön mediaani-ikä kasvaa noin kolmella kuukaudella joka vuosi. Seuraavien vuosikymmenten aikana vanhusten osuus lisääntyy ennen kokemattomalla tavalla melkein kaikissa maailman maissa. Tämä kehitys vaikuttaa merkittävästi maailman talouden ja rahoitusjärjestelmän kehitykseen ja toimintaan.

Tässä tutkimuksessa analysoidaan ikääntymisen vaikutuksia kansainväliseen reaalikorkoon ja rahoitusvirtoihin. Välineenä on 73-kohortin yleisen tasapainon limittäisten sukupolvien malli, joka kattaa viisi talousaluetta (USA, EU15, Japani, Kiina ja Intia). Malli rakentuu YK:n väestöosaston väestöennusteelle ja tuottaa ennusteet keskeisille taloudellisille ja rahoitusmuuttujille vuoteen 2050 asti.

Mallin mukaan kansainvälinen tasapainoreaalikorko alentuu seuraavien kahden vuosikymmenen aikana. Muutoksen suuruus riippuu ratkaisevasti julkisten eläkejärjestelmien kehityksestä. Jos julkisten eläkejärjestelmien etuusperusteet säilytetään nykytasollaan (mikä johtaisi niiden kustannusrasituksen jyrkkään kasvuun), reaalikorko alenee suurimmillaan noin 70 peruspistettä nykyisestä. Jos kustannusrasituksen kasvu ehkäistään etuuksia leikkaamalla, kansainvälisten reaali-korkojen lasku voi olla jopa 150 peruspistettä, kun taas eläkeiän nostaminen loiventaisi korkojen laskua.

Tulokset eivät ennakoisi suurten ikäluokkien eläkkeelle jäämisen johtavan rahoitusvaateiden hintojen romahdukseen ("financial market meltdown"), jota eräät ovat ennakoineet. Päinvastoin, joukkovelkakirjojen hinnat näyttäisivät olevan lähivuosikymmeninä noususuunnassa. Keskeinen syy tähän on odotetun eläkkeellö-oloajan nopea piteneminen, joka lisää tarvetta eläkesäästämiseen – tulevaisuudessa eläkkeelle halutaan jäädä varakkaampana kuin nykyään. Tämä kehitys kumoo suurten ikäluokkien eläkkeelle jäämisen säästämistä vähentävän vaikutuksen.

Avainsanat: ikääntyminen, reaalikorot, rahoitusvirrat, julkiset eläkejärjestelmät

JEL-luokittelu: J11, E44

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1 Introduction

World's population is undergoing a change that is, in many respects, unprecedented. As a result of a sharp decline in fertility since roughly around the 1970's (the exact timing varies among countries), and a steady increase in longevity, the global population is ageing at a rate never seen before.

Although the details of demographic trends vary from one country to another, ageing is certainly a global phenomenon. The United Nations Population Division, in the medium variant of the 2002 revision to their population projections¹, predicts that the median age of the global population will increase from 26.4 in 2000 to 36.8 in 2050. As Table 1 shows, that similar increases in the median age will take place in all regions of the world. Equally dramatic will be the increase in the elderly dependency ratio. The UN projects the global dependency ratio to more than double from 11% in 2000 to 25% in 2050. From individual countries, the steepest absolute increases are seen in Japan (from 25% to 72%) and Italy (from 27% to 65%).

While the number of the elderly increases dramatically, the increase of the working age population is coming to a halt (Table 1) Almost all of the growth in the global working age population over the next half a century comes from Africa. In Asia and South America, working age population is essentially stable, while in Europe and, to a somewhat lesser extent, in North America, working age population is projected to decline substantially. As a result, population growth will, on average, provide almost no support for global economic growth over the next decades.

	Median age		Elderly dep. ratio		Working age pop. change 2000–2050
	2000	2050	2000	2050	
Europe	38	48	22%	49%	-15.5%
North America	35	40	19%	33%	-6.5%
South America	24	40	9%	29%	1.8%
Asia	26	39	9%	26%	1.2%
Africa	18	28	6%	10%	20.9%
World total	26	37	11%	25%	1.6%

It is worth underlining that while the change in demographic structures in the developed world is sometimes depicted as a temporary phenomenon related to the retirement of the post-war baby-boom generation, in fact only a very small part of the whole phenomenon is temporary. The factors underlying the demographic change – the decline in fertility and increase in longevity – are, to the extent such issues can be predicted, likely to be permanent. Hence, to the best of our present knowledge, the increase in median age and dependency ratio do not represent a temporary bump, but a permanent rise to a new plateau.

The change in demographic structures and the consequent slowdown in economic growth has the potential to affect many aspects of the global

¹<http://www.un.org/esa/population/publications/worldageing19502050/index.htm>

economic development. This study examines the effects of global ageing on the global financial flows and the equilibrium interest rate. Ageing relates to financial market development through various channels. Slower prospective growth of labour force and global demand creates fewer opportunities for investment. Therefore, investment demand should unequivocally fall and that, in isolation, would tend to reduce the equilibrium interest rate. However, the increasing population share of retirees who, according to the life-cycle model, are dissavers, could reduce aggregate saving and hence pushes interest rates upwards. As both investment demand and the supply of savings decline, the total effect on saving is theoretically indeterminate and becomes an empirical question.

Over the last few years, a number of empirical studies have sought to quantify the effects. Some considerable variation exists, both in the approach adopted, and in the results obtained. Some studies use age-specific consumption rates obtained from panel studies of individual countries and, extrapolating these consumption rates into the future, predict the future behaviour of aggregate saving rate and interest rates. Studies in this tradition tend to predict a marked fall in the global savings rate and a consequent increase in real interest rates (see, for example, Turner et al, 1998). On the other hand, simulations of models using overlapping generation specifications with cohorts of optimising consumers usually find more moderate effects on savings and tend to point to a moderate downward effect of ageing on the interest rate. For example, Miles (1999) and Mc Morrow and Roeger (2003) predict a fall interest rates of 0,7–0,8% by 2050. Also the INGENUE team (2002) finds similar results.²

This study joins the latter – OLG – tradition. Under the baseline assumptions, it obtains results that are similar to the OLG studies mentioned above: real interest rates are projected to decline by about three quarters of a percentage point over the next three decades, if no changes are introduced to the generosity of public pension systems or to the retirement age. However, assuming no changes to the parameters of pension systems may not be the most realistic starting point for the simulations. It is far from obvious that the generosity of transfers to elderly currently in place in developed countries (mainly public pension and health care systems) can and will be maintained also for future generations when demographic structures deteriorate. It is well known that ageing will put the financial viability of many elderly support systems under considerable stress. As global ageing makes working-age population an increasingly scarce resource, international tax competition over high quality labour force is likely to intensify, further exacerbating the stress on such systems.

Sustainability considerations have already led to a number of pre-emptive reforms in pension and other elderly benefit systems in many countries. Reductions in pension benefits and tightening of eligibility rules are almost

²Not all OLG-type studies project declining interest rates. For example, Kotlikoff et al (2001), using only US data, and Fehr (2003) et al, in a three-country model, predict a strong (up to 300 bps) increase in real interest rates. The stark contrast to other similar studies in the interest rate projection is somewhat of a puzzle. It may be related to more pessimistic assumptions regarding public expenditure growth.

certain to continue in the future. Such changes to pension systems will affect the intertemporal and intergenerational allocation of resources and hence the path of interest rates. The prospect of reduced benefits in the future will encourage more saving today and therefore provide an additional downward impetus to interest rates. On the other hand, increases in the retirement age will increase future supply of labour and output growth, and will have the opposite effect on interest rates.

Another potentially consequential assumption regards the future role of developing countries in the global economy. In the baseline projection, fast growing developing world, represented in this study by China and India, will provide profitable investment opportunities and thereby support the global rate of return on capital. Yet, long-term predictions of economic convergence are notoriously unreliable. Hence, this paper also looks into the global economic and financial market consequences if, for some reason, economic development in those countries turns out to be less positive.

This paper seeks to shed light on how the interaction of population ageing, reforms to pension systems, and the economic performance of developing countries affects future evolution of equilibrium interest rates and global financial flows. The next section presents the simulation model and data. Section 3 will present the results and sensitivity analysis. Section 4 will sum up the results.

2 Simulation model

2.1 Scope of the model and population projections

In order to analyse the effects of population ageing on interest rates and financial balances, a numerical multi-country simulation model was constructed. The model consists of several country blocks which can be linked to form a quasi-global model. For tractability and manageability, the global version of the model only includes the EU-15, the United States, Japan, China and India. This choice obviously excludes some important parts of the world economy, perhaps most notably the South-East Asia. However, any attempt to include these countries would necessarily have been crude, and would have involved treating them as a single block with homogenous fertility developments (as was done in the case of EU-15). The resulting gain would have been mostly illusory. The chosen five-block constellation covers most of the ageing industrialised world together with the most potent emerging economies, and it offers the necessary building blocks for modelling of the salient features shaping the global financial balance over the next decades. It allows examination of the interaction between the rapid change in demographics in the industrialised world and the increasing economic weight of the fast-growing emerging economies. In what follows, the combination of these five areas will be referred to as ‘the world’.

The simulation model utilises the medium variant of the demographic projections for 2000–2050 by the United Nations population division. These

projections consist of population forecasts for five-year age groups in five-year intervals. For the purposes of this paper, the UN projections needed to be supplemented in several ways. First, the projections were interpolated to provide annual projections for 1-year age groups. Second, the projections needed to be extended well beyond 2050. Although the focus of this paper is on the first half of the present century, the simulation model incorporates forward-looking behaviour and important intergenerational dynamics which make it necessary to run the model well beyond the actual period of interest. Hence, the demographic projections were extended until 2250 by assuming fertility rates constant at the level projected for 2040s.

2.2 Consumer choice and life cycle

The life cycle of individuals is modelled using a 73-period OLG. In the model, there are no minors; instead, individuals are ‘born’ at the beginning of their working career, at the age of 18. They work until the legal retirement age, which is set in the model at 63 years. The final age bracket in the model is the open-ended ‘90 and over’.

Retirees receive a pension, financed as a pay-as-you-go system by a tax on wage income. Individuals also have full access to capital markets, and contribute to their retirement income by saving during their working career. Individuals choose their consumption path by maximising a CRRA-type utility function:

$$\max \sum_{s=0}^S \beta^s \frac{c_{t+s}^{1-1/\sigma}}{1-1/\sigma},$$

$$st. \sum_{s=0}^S R_{t,s}^{-1} c_{t+s} \leq W_t.$$

Here W_t is the individual’s total wealth at time t and S is the expected remaining lifetime of the individual. $R_{t,s} = (1 + r_t)(1 + r_{t+1}) \dots (1 + r_{t+s-1})$ is the compounded rate of interest time t to time $t + s$. The handling of life expectancy in the model is rather straightforward: Each individual assigned a precise age at which he expects to reach the end of life. Since there is no bequest motive, the individual consumption decision is made so as to exhaust savings by that age. The expected moment of death is set initially at 77 years and rises thereafter together with gains in life expectancy as projected by the UN, reaching 84 years by 2050. By 2100, life expectancy is assumed to reach 87 years, after which it it stays constant.³

While crude, this handling of life-expectancy was still judged to be a better description of reality than the computationally feasible alternatives. The ideal choice, age and cohort-specific survival rates taken from the actual

³Actually, the model allows life expectancy to increase in fractions of years. A life expectancy of 77,3 years is modeled in the consumer’s problem as a survival function in which the individual expects to reache the age of 77 years with certainty, and the age of 78 with probability of 0,3.

life tables, would have been computationally too heavy to be feasible. The most common, and computationally fairly simple, approach would have been to assume a constant probability of death, leading to a Poisson distributed survival function. However, this would be starkly at odds with the actual survival function of a modern society, namely one in which death rate remains relatively small until around the age of 65 or so and increases sharply thereafter. The present choice was judged to be a reasonably close approximation to the reality.

Although individuals' consumption/saving decision are based on a precise expected time of death, the model does not actually truncate the age pyramid at that age. The sizes of *all* cohorts, from 18 to '90 and over', are determined by the population projection. The life expectancy variable only plays a role in the individual's consumption/saving decision. An individual with a life expectancy of 77 can, in fact, survive well beyond that age, but, from the age of 77 onwards, he will make consumption decision expecting not to survive beyond the current period. Since there is no bequest motive in the model, this assumption effectively means that i) all savings are exhausted by the expected time of death, and ii) for an individual surviving longer, consumption will be equal to the contemporaneous (pension) income, ie no further saving will take place.

Total wealth W_t consists of the present asset wealth M_t , plus discounted future wage (w_t) and pension (p_t) income.

$$W_t = M_t \sum_{s=0}^S R_{t,s}^{-1} [(1 - t_{t+s})w_{t+s} + p_{t+s}].$$

Pensions are financed by a proportional tax on wages, so the budget constraint of the pension system is

$$t_t w_t N_t^e = p_t N_t^p,$$

where N_t^e and N_t^p are the sizes of working-age and retired population respectively.

The solution to consumer's optimization problem is given by

$$c_{t+h} = \frac{(\beta^h R_{t,h})^\sigma}{\sum_{s=0}^S R_{t,s}^{-1} (\beta^s R_{t,s})^\sigma} W_t, \quad h = 0, \dots, S.$$

Figure 1 presents two examples of life-cycle consumption paths for individuals that entered the work force at the age of 18 in year 2000. A European, facing the prospect of relatively slow real income growth, would start saving early in the working career and accumulate wealth at an increasing rate until retirement. After retirement, the wealth would be consumed by the age of 84 (life expectancy for that cohort), after which no saving or dissaving takes place. For a Chinese of the same cohort, the expected rate of income growth is considerably higher and therefore the individual would dissave the first two decades of the working career. Also, since the fast income growth in the economy raises the future public pensions relative to the present wage income, the total pre-saving for retirement would be substantially less than for the European individual.

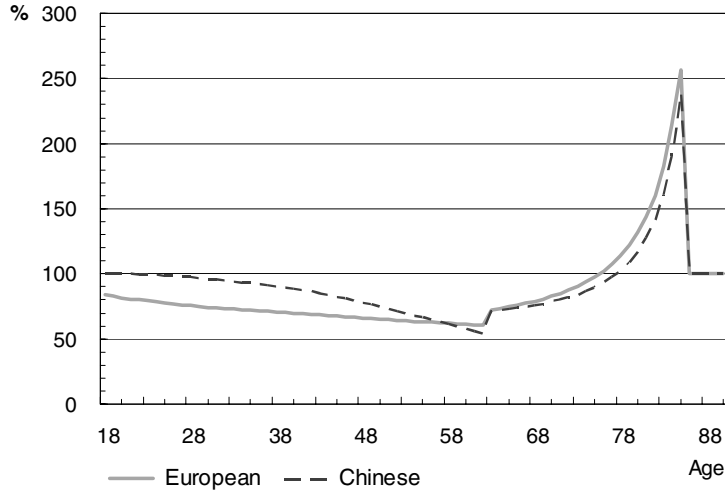


Figure 1: Consumption share of disposable income over the life cycle

2.3 Production technology and model calibration

Production takes place according to the Cobb-Douglas technology

$$Y_t = A_t K_t^\alpha L_t^{1-\alpha},$$

where A_t is the exogenous total factor productivity. There is no installation cost for new capital, so capital stock grows in direct relation to new investment

$$K_{t+1} = (1 - \rho)K_t + I_t,$$

where ρ is the annual rate of depreciation. Unemployment is not explicitly modeled. Instead, employment increases together with working-age population. This is equivalent to assuming that unemployment remains constant throughout the simulation period.

The model was calibrated to reflect the existing empirical literature and to yield an approximately correct starting point for the main economic aggregates. Most importantly, the initial global gross savings rate was kept close to its actual value of about 21% of GDP. One parameter with considerable relevance to the results is the intertemporal rate of substitution σ . Substantial disagreement exists in the literature on the value of this parameter, with micro-level and macro-level empirical work yielding widely different estimates (see eg Hall, 1988, Guvenen, 2003, Lucas 1990). The value 1/2 seems to be close to the mid-point of this disagreement and was used in the baseline simulations. When combined with the annual pure rate of time preference $1 - \beta$ of 1,8%, the model produced the desired value for savings rate. Annual rate of depreciation ρ was assumed to be 5%. The capital share of output α was chosen to be 0,36 for all countries except the USA, which traditionally has a low capital share, and was therefore assigned the value 0,32.

The initial productivity differentials between countries was chosen to provide roughly the correct initial relative output per capita. Thereafter total productivity was assumed to grow at the rate 1.3% per annum in the USA, 1.1%

in Europe and 0.9% in Japan. For China and India, projecting productivity growth was somewhat of a challenge. The initial productivity level is about 10% of the EU average for China and a little over 5% for India, so there is clearly substantial room for catching up. Hence, the baseline productivity growth in China and India was modeled as a catching-up process, depending on the productivity gap vis-à-vis USA (the productivity leader). The parameters were chosen so that the total factor productivity growth in China (India) starts at a little above 4% per annum initially, slowing down to about 3.5% by 2050, at which point the level of Chinese labour productivity is about 40% of the European level. Obviously, there is a great deal of uncertainty surrounding this assumption, so different scenarios will be provided below.

The fast expected catching-up process by the two emerging economies would, in the absence of any counterbalancing intervention, lead to massive capital inflows and current account deficits of more than 40% of GDP. Since nothing like that is observed in reality – in fact, both of these countries run presently a current account surplus – some kind of an adjustment was clearly needed. Specifically, it was assumed that investors require an additional premium for investments into China and India. It was found that in the baseline scenario, a premium of about 9 percentage points would suffice to bring the predicted current accounts of these two countries to more reasonable levels, that is to a deficit of 3–4% of GDP. This premium can be interpreted as reflecting the less-than-fully open nature of the two economies.

The generosity of a country's pay-as-you-go system has important consequences for private saving decisions. In the simulations, two alternative assumptions were used in this respect. In the first case, the net replacement ratio (net pension relative to net wage) was assumed to remain constant at its present level throughout the simulation period.⁴ In the second case, an upper limit was set for the pension tax rate. Once the tax rate hit this limit, pensions were adjusted so as to prevent exceeding the limit.

Finally, the initial capital stocks and wealth distributions need to be calibrated. Since there is no capital installation cost in the model, the initial level of capital stock is directly linked to the initial interest rate (via the marginal product of capital). An initial gross rate of return on capital of 12% (with a 5% depreciation rate implying a 7% net rate of return) turned out to be consistent with the actual savings rates and existing estimates of capital stocks.

Since in the model consumers of different age differ in their consumption behavior, the distribution of initial wealth (= initial domestic capital stock + net external assets) among cohorts matters to the simulation outcome. The decision was made to distribute wealth so as to approximate the model's steady-state distribution of wealth over the population. Thus, the bulk of the wealth was distributed to 50–60 year-old cohorts, while the cohorts recently entered into labour force or those approaching the end of their lifespan (and having thus run down most of their savings) received relatively little of the initial wealth.

⁴The current cost of pension systems was taken from McMorrow and Roeger (2004). The data for developed countries is likely to be accurate, while for China and India, the numbers are subject to considerable uncertainty.

The global version of the model is solved by first choosing an initial interest rate⁵ path for 2000–2250. The optimal consumption/saving decisions corresponding to this interest rate path is solved for all cohorts in all country blocks over the simulation period. These consumption/saving decisions imply a path for global investment demand and capital accumulation which, in turn, determines a path for marginal product of capital. This latter (net of depreciation) is then used to replace the initial interest rate path. This procedure is repeated until the paths for the interest rate and the net marginal product of capital converge over the whole simulation period.

An individual country block can also be simulated separately, once the model is closed by providing a path for a financial variable such as the global interest rate or current account balance. This can be used to analyse the role of international financial flows in the adjustment of the country block to ageing or, more generally, in breaking down the projected outcome to the contributions of different components.

3 Simulation results

3.1 Constant replacement rate scenario

The model was first simulated assuming that the pension replacement rates, net of taxes, are kept at their initial levels, allowing the cost of pension systems to rise as populations age. The results are presented in Table 2 and Figures 2a–c. According to the simulations, demographic changes push the global equilibrium interest rate (or, more precisely, the rate of return on equity) lower over the next quarter of a century. The total decline is projected to be about 0,7 percentage points, from 7% to about 6,3%. From the mid 2030’s onward the rate of interest will slowly begin to increase again and return to its present level by the mid-century. Underlying this decline in the rate of interest is an initial increase in the global supply of savings. The global savings and investment rates are projected to increase by about one percentage point by 2010, before the slowdown of labour force growth takes over and pushes savings and investment rates downwards again. By 2050 saving and investment have declined substantially below their present levels.

Table 2. Constant replacement rate scenario

	GDP growth rates		Per capita consumpt. growth	
	2000–2025	2025–2050	2000–2025	2025–2050
EU-15	1,7	1,0	1,5	1,4
USA	2,7	2,4	1,9	1,8
Japan	0,8	0,1	1,4	1,2
China	7,0	5,0	6,3	5,1
India	7,2	5,4	5,8	4,8
World	2,5	2,4	1,8	2,3

⁵Strictly speaking, the interest rate concept used here is the risk-free interest rate plus equity premium.

Considerable net financial flows are projected to take place. The fastest-ageing area, Japan, will initially be the only net provider of capital and will run a current account surplus of some 5% of GDP for the first decade of the century. Around 2020, the country will experience a temporary respite in the ageing process, which is reflected in a reduction of the current account surplus. The EU-15 will initially run a small current account deficit, which will turn into a surplus of more than 2% of GDP by 2025. The USA will remain a capital importer, and its current account deficit will mostly fluctuate at around 0–2% of GDP until 2030. After that, the demographic advantage of the USA vis-a-vis the rest of the developed world will narrow, and from 2040 onwards the USA will become a net capital exporter.

As explained above, the model was calibrated so that India and China will initially run small current account deficits. Over the coming decades, the deficit is projected to widen to up to 6% of GDP for India, and up to 4% of GDP for China, which suffers from markedly worse demographics. Consequently, foreign net indebtedness will increase and by 2050, it will stand at around 80% of GDP for India and around 60% of GDP for China.

Global growth will be seriously affected by the slowdown in labour force growth. Particularly in Japan, output will grow at less than a percent p.a. in the first quarter of the present century and practically come to a halt after that. In the EU-15, growth will slow down to about 1% p.a. In per capita terms, the economic performance of these countries looks somewhat better: even Japan manages to keep the growth rate of consumption per capita at above 1%. The US economy is projected to grow at a rate of around 2.5%. In China and India, GDP growth will, by assumption, be brisk at about 7% p.a. in 2000–2025 before gradually slowing down to around 5% p.a. in 2025–2050, as the room for catching up shrinks.

When the generosity of the public pay-as-you-go pension systems is kept unchanged, population ageing results in a considerable increase in the cost of these systems. In Europe the pension contribution rate, which initially starts at about 17% of gross wages, increases to about 28% by 2050. The increase is even more pronounced in Japan, where the initial pension contributions rate is more modest at 13%, but which nearly catches up with Europe by 2050. In the USA and China pension contribution rates approach 20% and in India 15% by 2050. It is worth noticing that this increase covers solely the increase public pension costs, and exclude any increases in the public outlays on other items such as elderly care and health care. Including such expenses in the calculations would accentuate the increase in taxes.

3.2 Pension tax cap scenario

As the above simulation shows, maintaining the current generosity of public pension systems would necessitate a dramatic increase in pension contributions. Given the increasing overall pressures on public expenditure, on one hand, and international tax competition on the other hand, it is far from certain that the required increases in contribution rates could actually be administered. More likely, pension systems will be balanced by a combination

Figure 2a. Saving and interest rate

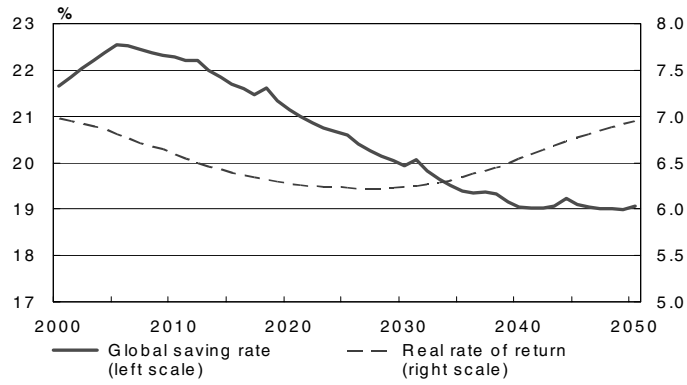


Figure 2b. Current accounts

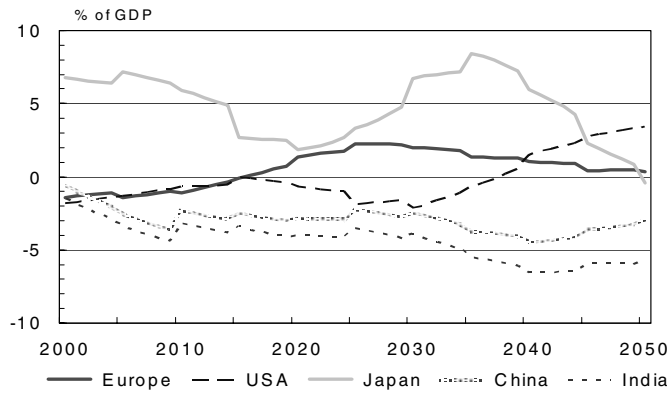


Figure 2c. Pension tax rates

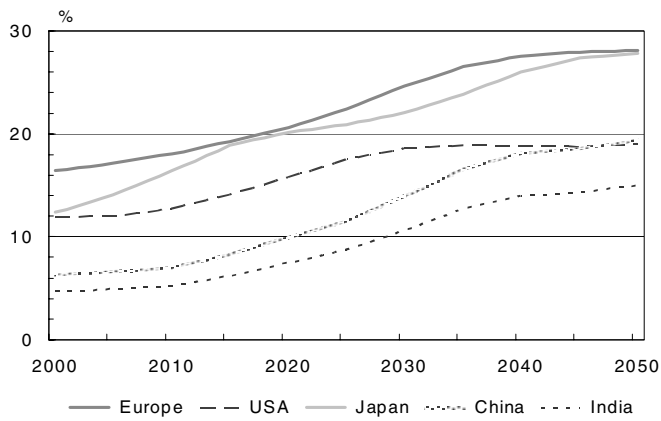


Figure 2: Constant replacement rate

of increases in contribution rates, reductions in benefits, and increases in the retirement age. The way this is done affects the magnitude of transfers from future generations to the present generations and thereby incentives to save and, eventually, the equilibrium interest rate.

In the pension tax cap scenario pension contribution rates are frozen from 2010 onwards and any resulting shortfall in the pension systems is financed by reducing pension benefits. Effectively, this means that contribution rate remains at a 18% in the EU-15, a little above 16% in Japan, 13% in the USA, and virtually at their present levels of about 7% and 6% in China and India respectively. This is arguably a more realistic scenario than the previous one which would result in exorbitant tax rates. Again, as the model does not include public expenditures on health care and elderly care, both of which are projected to increase steeply, it underestimates the growth of tax burden. The outcome of this simulation is reported in Figures 3a–c and Table 3.

Table 3. Pension tax cap scenario

	GDP growth rates		Per capita consumpt. growth	
	2000–2025	2025–2050	2000–2025	2025–2050
EU-15	1,8	1,1	1,5	1,4
USA	2,8	2,5	1,9	1,8
Japan	0,9	0,2	1,4	1,2
China	7,1	5,1	6,4	5,3
India	7,3	5,5	5,9	4,9
World	2,6	2,5	1,8	2,4

When future pension contributions are capped, the present working age population can rely less on transfers from future generations in financing their old-age livelihood and will try to make up the shortfall by increasing immediately their private saving. Hence, although the tax cap becomes effective only from 2010 onwards, the global gross savings rate jumps immediately by some 0,6 percentage points above its original level. By 2010, it will increase further to about 23%. As in the previous scenario, savings rate will start to decline from about 2010 onwards, but the decline will be much more modest than under constant replacement rate.

Increased savings translate into higher capital stocks and to higher output growth. Average output growth rates are about 0,1% higher across the board. The time profile of interest rate is similar to the one in the baseline scenario, but the total decline is more pronounced at 1,3 percentage points by 2030. Further, the increase in interest rate after 2030 is very subdued in comparison to the first scenario. Current account balances are only modestly affected by the change in pension replacement ratios. Most notably, capital flows to developing countries diminish somewhat.

These results show that, at the minimum, pension reforms have the potential to change substantially the future evolution of financial variables. It is worth noticing that the model used in the analysis has exogenous labour supply – ie tax rates have no effect on participation rates or economic growth. Arguably, a reduction in pension benefits would increase labour supply and thereby, at least during the transition to higher employment rate, generate

Figure 3a. Saving and interest rate

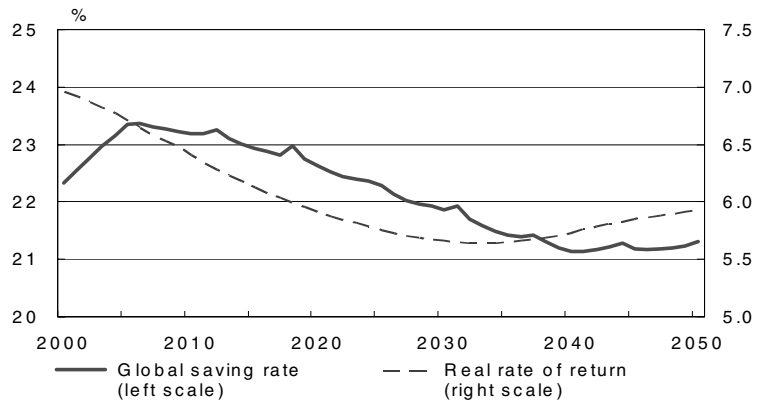


Figure 3b. Current accounts

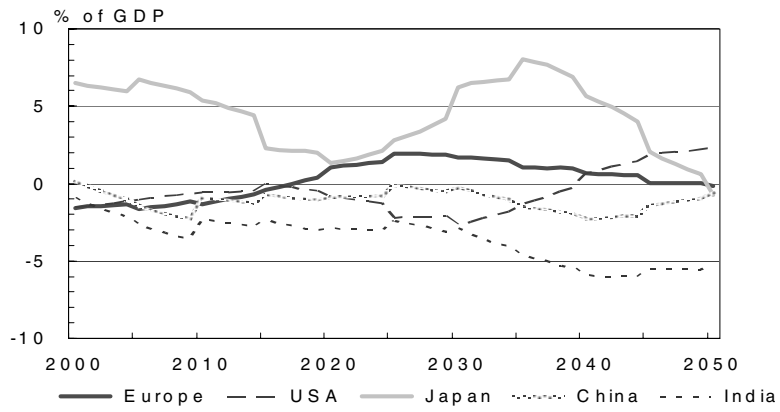


Figure 3c. Pension tax rates

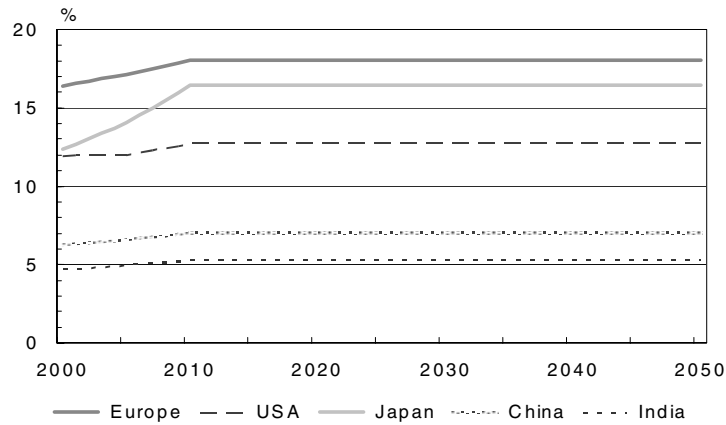


Figure 3: Pension tax cap

higher rate of economic growth. Higher growth would, at least to some extent, counteract the downward pressures on real interest rates. On the other hand, if in addition to pension costs, also the growth of other ageing-related public costs were capped, then the decline in interest rates would be even larger.

3.3 Slow growth scenario

The slow growth scenario follows the previous scenario by freezing the replacement ratios from 2010 onwards, but takes a more pessimistic view on the growth of total factor productivity. Specifically, the US total factor productivity growth is reduced from 1.3% to 1.1% per annum, while in China and India, the speed of the catching-up process is reduced so that the annual growth rates decline by about two percentage points on average. It is worth noticing that even in this slow growth scenario, China and India will still grow at above 5 per cent a year on average over the next quarter of century and will soak up considerable amounts of foreign capital. The results are presented in Figures 4a–c and Table 4.

Table 4. Slow growth scenario

	GDP growth rates		Per capita consumpt. growth	
	2000–2025	2025–2050	2000–2025	2025–2050
EU-15	1,8	1,1	1,5	1,4
USA	2,5	2,2	1,8	1,6
Japan	1,0	0,3	1,4	1,2
China	5,9	3,5	4,2	3,6
India	5,1	3,6	3,7	3,2
World	2,2	1,8	1,5	1,7

The prospect of slower income growth increases global saving somewhat further and creates an additional 0,3 percentage point downward impetus on interest rates, bringing the total decline to slightly over 1,5 percentage points over the next quarter of century. Global savings rate increases further by a fraction of a percent. Slower productivity growth in the USA diminishes investments in that country, bringing the country’s current account to small surplus for most of the simulation period. The current accounts of the two developing countries are, by construction,⁶ affected only slightly. Average growth rates in the USA, China and India obviously decrease. In the USA, the decline in growth rate is actually larger than the reduction in the rate of productivity growth, because deteriorating productivity growth redirects investments from the country and thereby exacerbates the negative effect on growth. The mirror side of this finding is that growth rates in the EU-15 and Japan increase slightly; fewer productive investment opportunities abroad

⁶Changing the catching up rate would, by itself, have a large effect on current account surplus of the two developing countries. This effect is not allowed to come through. Instead, the current accounts of the two countries are kept roughly unchanged at a modest deficit by adjusting the excess equity premium assigned to these countries. The interpretation here is that current account is, to some extent, a policy variable in these countries, and that the emergence of very large current account deficits would be prevented.

Figure 4a. Saving and interest rate

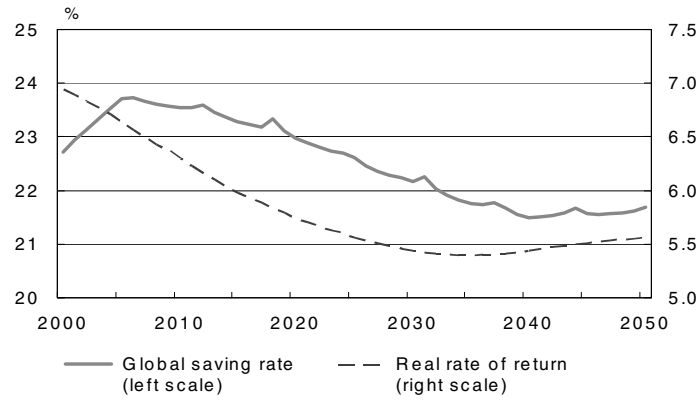


Figure 4b. Current accounts

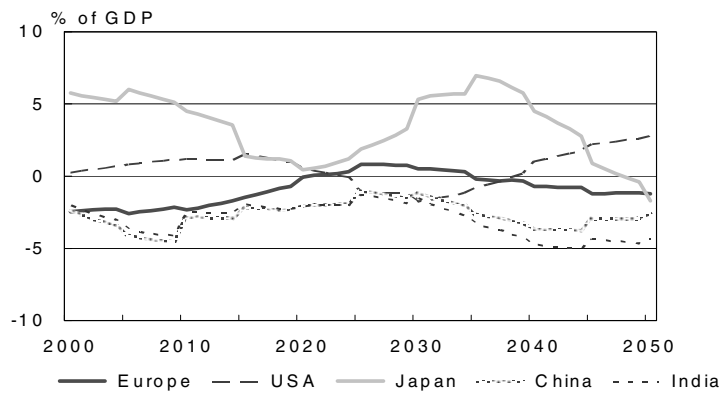


Figure 4c. Pension tax rates

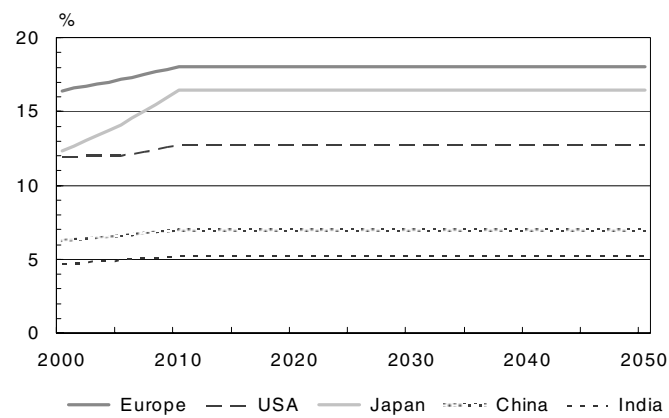


Figure 4: Slow growth

Figure 5a. Real interest rates with constant replacement rate

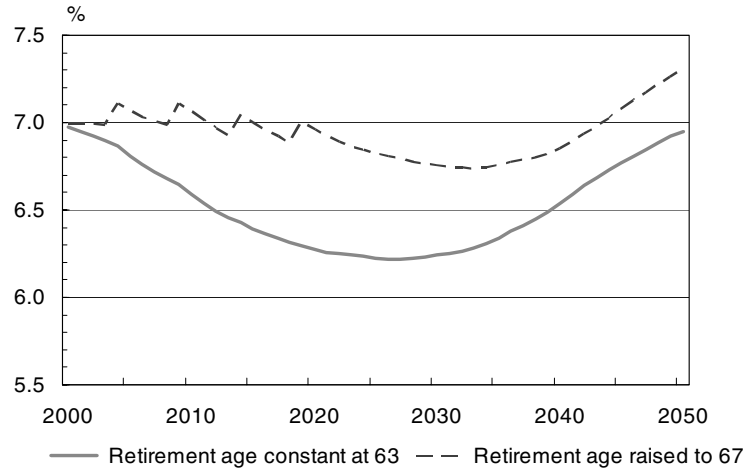


Figure 5b. Real interest rates with tax cap

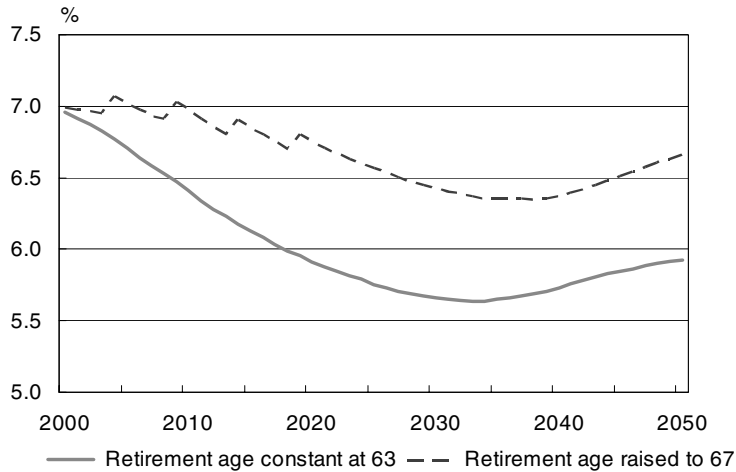


Figure 5: Retirement age and rate of return

redirects part of the capital outflows from these countries back to the home country, resulting in somewhat faster capital accumulation.

3.4 Increasing the retirement age

In the above simulations, retirement age has been kept at 63 years. However, most of the recent reforms to public pension systems have contained as one element some measures to increase the effective retirement age, and such efforts are certain to continue in the future. Hence, the sensitivity of the results was tested by assuming that the retirement age is increased in one-year increments to 67 by 2020. Figure 5a shows the effect of such a reform on the path of the interest rate.

When the replacement rate is kept constant at its initial level, the four year increase in the retirement age almost entirely neutralises the effect of ageing on the interest rate. Increased labour supply boosts capital demand so that the global interest rate remains virtually constant until 2020. After that, a mild and temporary decrease in interest rate is projected.

Higher supply of labour accelerates world output growth, but this effect is partly offset by the moderating effect of higher expected income growth on the global savings rate and capital accumulation. The net result is an acceleration of global output growth by about 0,2 percentage points per annum for the first quarter of the century. Pension tax rates on payrolls still increase, particularly from 2020 onwards, but the increases are much more subdued, and the pension tax rate remains in 2050 some 5 percentage points lower than with constant retirement age. Hence, while a four-year rise in the retirement age would reduce the stress on public pension systems, it would not alone neutralise the need for increases in pension contribution rates.⁷ Figure 5b shows the outcome if the increase in retirement age is combined with a freeze, from 2010 onwards, in contribution rates. In such a situation, global interest rates will decline, but only by some 0,6 percentage points – ie less than half of what was observed with constant retirement age.

3.5 Sensitivity to variations in preference parameters

The above simulations were based on the calibrated value of $1/2$ for the intertemporal elasticity of substitution σ . Although this is a reasonable mainstream estimate, the sensitivity of the results to this specific choice was examined. The model was simulated for two other values of σ , 1 and $1/3$.

Creating sensible sensitivity analysis with respect to the choice of σ is not altogether straightforward. Changing σ alone would shift the macroeconomic starting point of the simulation away from the actual values. For example, changing σ from $1/2$ to 1 (logarithmic preferences) would increase the responsiveness of of intertemporal consumption choice to intertemporal prices (interest rate) to the extent that global savings rate would increase by 10 percentage points to levels that are clearly at odds with reality. At the same time, the distribution of global saving would change considerably, resulting in current account deficits of 20% of GDP for China and India. Clearly, this would not be a sensible starting point for sensitivity analysis. Instead, any change to the intertemporal elasticity of substitution σ necessitates a more or less complete recalibration of the whole model.

In the case of the increase in σ to 1, the effects on global savings rate were counterbalanced by increasing $1 - \beta$, the annual rate of pure time preference, from 1,8% to 4,1%. The effects on current accounts were neutralised by roughly halving the equity premium for India and China. Similarly, the reduction in the value of σ to $1/3$ was accompanied by a reduction of the rate of time preference and an increase in the equity premium for the developing countries. It turned

⁷To prevent any increase in pension contribution rates, retirement age would have to increase to more than 70 years.

out that $\sigma = 1/3$ required a negative value (-0,3%) for pure time preference in order to be broadly consistent with the current observed global savings rate. Although difficult to justify in economic terms, this set of parameters was nevertheless included to illustrate the sensitivity of the outcomes over a wide range of parameter choices. Other assumptions followed that of second ('pension cap') scenario above.

Figures 6a and 6b illustrate the results. Changing the preference parameters has a clear effect on the savings motive and interest rate path. With logarithmic preferences ($\sigma = 1$), changes in investment and savings rates are overall be much more subdued than with the baseline assumptions. Particularly, the initial increase in savings is less marked, resulting in slower capital accumulation and higher interest rates. The real rate of interest reaches its trough in around 2030 at a level about 0,7 percentage points below its initial level and increases thereafter.

Correspondingly, a lower value of intertemporal elasticity of substitution (1/3) makes saving and investment rates more responsive to demographic changes and accentuates any changes in interest rates. Global saving rate initially increases by some 2 percentage points before settling on a downward trend. Interest rates decline by a total of 1,6 percentage points by the 2030's.

Overall, the sensitivity of the results to preference parameters appears to be limited, as long as the starting point of the model is kept reasonably close to the actual. In each case interest rates will decrease the next three decades and turn upwards thereafter.

3.6 Ageing and the 'financial market meltdown'

There has been considerable discussion about the effects of ageing on asset prices. Some financial analysts have argued that when baby boomers retire and start to run down their pension savings, the balance of supply and demand in asset markets tilts dramatically and drives down asset prices – the so-called 'asset market meltdown hypothesis' (eg Goldman Sachs, 2004). The decline in asset prices may be exacerbated by a decline in the marginal return on capital, caused by diminishing labour supply. Recently, a number of economic studies have been devoted to this issue, most of them finding some demographic effects on asset prices but concluding, by and large, against the meltdown hypothesis (eg Geanakoplos et al 2004, Poterba, 2004).

Many of the issues in the meltdown debate – such as the effect of ageing on the relative demand for stocks and bonds – are beyond the scope of this paper. On the whole, however, the prediction of falling real interest rates does not support the meltdown hypothesis, which would be associated with increasing real interest rates. Why is it then that the retirement of the baby boom cohorts do not seem to have a discernible effect on the asset markets?

The retirement of the baby boomers does, in isolation, have an upward effect on interest rates in the framework of this paper as well. However, this effect is masked by another, even stronger, trend that is often neglected in the discussions. This is the increase in prime savers' propensity to save. To illustrate this point, figure 7 presents the projected evolution of the gross

Figure 6a. Interest rates

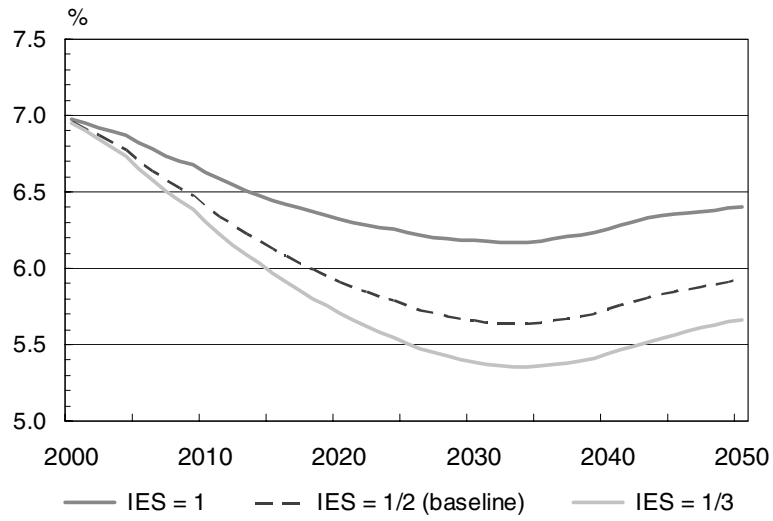


Figure 6b. Saving rates

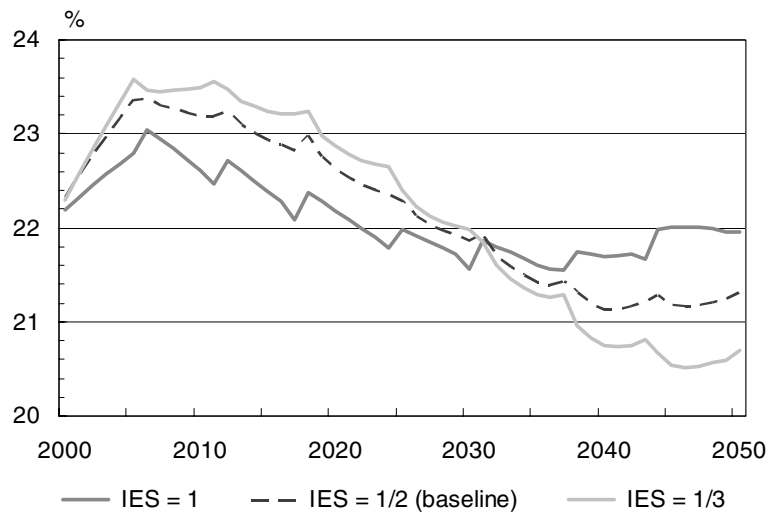


Figure 6: Pension tax cap

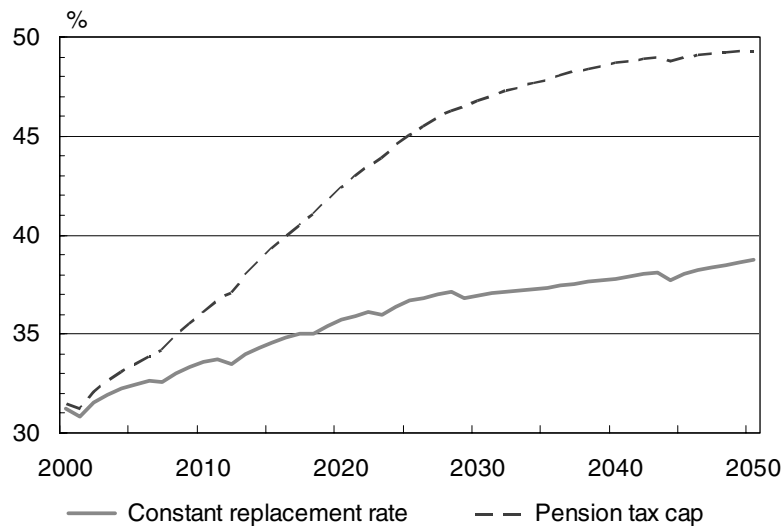


Figure 7: Saving rates at the age of 62

saving rate of European 62-year-olds, that is, the age group in the final year before retirement. The saving rate of this age group is projected to increase dramatically over the next 25 years: by about 7 percentage points even if the current pension replacement rate is maintained, and by more than 17 percentage points if pension contribution rates are capped at their 2010 level. Similar outcome applies to all prime-saver age groups and to all countries. This effect is strong enough to more than compensate for the decreased share of prime savers.

The reason for this projected increase in saving is straightforward, namely, the continuing increase in life expectancy. Over the next 50 years, life-expectancy at birth in developed countries is projected to increase by roughly seven years. If retirement age remains constant, this translates into something close to seven additional years in retirement. In other words, the expected time in retirement will increase by nearly 50% by 2050. In order to finance this additional time in retirement, individuals need to accrue much higher retirement wealth, either in the form of public pension rights, or in the form of private saving. The expected generosity of future pension system obviously has a major effect on the need for private retirement saving. Still, as figure 7 shows, retirement saving is projected to increase even if the present generosity of pension system were maintained.⁸

There is another, related but more speculative, consideration that may affect people's retirement saving but is beyond the scope of the current model. Casual observation suggests that people's perception about the nature of retirement is changing. Retirement used to be perceived as simply the possibility to withdraw from working life once old age has reduced a person's

⁸One reason for the relatively scant attention paid by researchers on the effects of lengthening life spans on saving may be that many studies analysing the effects of population ageing on financial markets have used variations of overlapping-generations framework in which the length and structure of life span is fixed and ageing is modeled as consisting solely of variations in cohort sizes (see eg Brooks, 2000).

ability to engage in productive work. Today, people who retire can usually look forward to several years or even decades of healthy life, and retirement is increasingly seen as an opportunity for fulfilling, active life. As life-expectancy and health in retirement continues to improve, such motives will surely continue to gain importance in the future. Increased expectations for the quality of life in retirement are likely to be associated with increased incentives for pre-retirement saving.

In sum, the risk of a financial market meltdown, caused by population ageing, appears to be limited. While the retirement of baby boomers will reduce the numbers of prime savers relative to dissavers (retirees), the effect of continuing increase in life expectancy on retirement saving is likely to more than counterbalance this and keep the aggregate demand for financial assets growing.

4 Discussion and conclusions

The analysis of this paper seeks to illustrate the possible scale of the effects of population ageing on global interest rates and financial flows. The results suggest that those effects will most likely be noticeable and can be substantial. During the demographic transition period that covers most of the first half this century, saving for retirement is projected to increase and push down the equilibrium rate of interest, which will reach its trough in the 2030's. The magnitude of the decline depends on many factors and can be anything in the range of 30–150 basis points. Among the main determinants of the magnitude of the decline are the future of pay-as-you-go pension systems and, to a lesser extent, the role of developing countries in the world economy.

As only approximately a fifth of the world population lives in countries currently considered developed countries, the future economic performance and the progress of integration in the world economy of the less developed world is obviously crucial to any long-term global economic issues. By 2050, China, India, Pakistan and Indonesia are projected to have a combined population three times as large as the present developed countries together. If these three countries settle on a trend of sustainable economic convergence and continue to deepen their integration in the world economy over the next couple of decades, that alone would mean a massive shift in the global economic geography. There is a great deal of uncertainty of the growth performance of these countries even in a few years' horizon, and very little definitive can be said for the much longer horizon of this paper. What is clear, however, is that the effect of these countries' economic performance on global financial flows depends not only on their growth performance but also on their policy towards foreign capital inflows. Even if the major developing countries managed to maintain fast economic growth over the next decades, an upward impetus on global interest rates would only materialise to the extent that they became substantial net importers of capital. So far, despite fast growth, this has not

happened. Both China and India have, as a matter of policy, maintained a strong current account. The projections above are based on the assumption that these countries will, in the near future, turn into net importers of capital.

From the viewpoint of global financial balance, the role played by public pay-as-you-go pension systems is even more important than the growth performance of developing countries. Just as global financial markets allocate resources geographically, PAYG pension systems allocate them intergenerationally, from future generations to the present. The extent to which the present generations are able to rely on future generations for their old-age support has a substantial effect on their savings behaviour. Any reforms that reduce the redistributive role of public pension systems tend to increase saving and push down the equilibrium interest rate.

The scale of this issue is huge. If the present generosity of PAYG systems is maintained, some countries end up paying almost a fifth of their national output in pension transfers, requiring pension payroll tax rates of nearly 30%. Could such high transfers actually be maintained? Several differing viewpoints can be presented. First, though public pension contributions have tax-like features (compulsory nature, redistributive role), they have, at the same time, also many elements of an insurance premium. A worker paying contributions to pay-as-you-go pension system not only finances other current retirees' pensions but, at the same time, also accrues pension rights for himself. Therefore, it can be argued that pension contributions do not have the same negative incentive effects as pure taxes. This argument has much truth to it, but it needs to be qualified in several respects. First, whenever the demographic structure fluctuates, a PAYG system creates winners and losers. In today's aging societies the winners are the baby boomers, the losers are the younger, smaller generations. The young generations, as well as the ever-shrinking generations of the future, end up paying considerably more in pension contributions than they receive in future pension rights. This excess of contributions over future receipts *is* a pure tax, which negative incentive effects. Second, accrued pension rights are promises of future payments which only have value if future generations decide to stay in that country's labour market and work in order to honor those promises. If doubts arise about the willingness or the ability of the future generations to do that, the nature of pension contributions change – the value of the accruing pension rights erodes and pension contributions become essentially taxes, with all the negative incentive effects characteristic to pure taxes. Hence, a PAYG system that loses its credibility can become a serious burden to the economy, even if the underlying arithmetics of its sustainability do not change. Although the situation of PAYG systems might presently seem manageable, increasing doubts about future sustainability can force reforms already well before the actual problems materialise.

One argument that tends to support the future political sustainability of PAYG systems is the so-called 'gerontocracy' argument. As life spans lengthen and generations shrink, the age of the median voter increases. The older the median voter, the less likely he is to support a pension reform that reduces pensions and pension contributions (an older person stands to lose more in pension benefits and gain less in terms of smaller payroll taxes). At some point, the median voter flips from the net-gainer camp to the net-loser camp,

after which the country is a ‘gerontocracy’, and political opportunity for a pension reform is, if not quite closed, at least greatly diminished (see Sinn and Uebelmesser, 2002).

Finally, there are arguments that emphasise the pressure from global tax competition and social shopping towards lower taxes and transfers (see eg von Hagen and Waltz, 1995, and Leers et al, 2003). As both firms and high-quality workers become more mobile, the elasticity of tax bases with respect to tax rates increase. In other words, net payers converge to countries with lower taxation while net recipients tend to search for places with high benefits. Such mobility makes strongly redistributive tax-benefit systems increasingly difficult to maintain. Although the quantitative importance of this argument is difficult to assess, there is little doubt that the mobility of capital and labour will keep increasing, making international tax competition an increasingly relevant element in shaping future pension systems.

The results show that, from the financial market’s viewpoint, it matters a great deal whether sustainability of pension systems is reached by reducing pension benefits or by increasing the effective retirement age: While cuts in future pension benefits accentuate the decline in the rates of return, increases in retirement age would have the opposite effect. If just half of the projected increases in life expectancy over the next five decades is reflected in higher retirement age, there would be little if any decline in interest rates.

References

- Brooks, R (2000) **What Will Happen to Financial Markets When the Baby Boomers Retire?** IMF Working Paper 2000/18.
- Börsch-Supan, A – Heiss, F – Ludwig, A – Winter, J (2003) **Pension Reform, Capital Markets and the Rate of Return.** German Economic Review 4(2), 151–181.
- Fehr, H – Jokisch, S – Kotlikoff, L (2003) **The Developed World’s Demographic Transition – the Roles of Capital Flows, Immigration, and Policy.** NBER Working Paper 10096.
- Geanakoplos, J – Magill, M – Quinzii, M (2004) **Demography and the Long-Run Predictability of the Stock Market.** Brookings Papers of Economic Activity.
- Goldman, S (2004) **Global Ageing and Bond Yields.** Goldman Sachs Global Interest Rate Strategy, 04/10.
- Guvenen, F (2003) **Reconciling Conflicting Evidence on the Elasticity of Intertemporal Substitution: A Macroeconomic Perspective.** University of Rochester, RCER Working Paper, No. 491.
- Hall, R E (1988) **Intertemporal Substitution in Consumption.** Journal of Political Economy, Vol. 96, No. 2, 339–357.
- INGENUE (2001) **Macroeconomic Consequences of Pension Reforms in Europe: An Investigation with the INGENUE World Model.** CEPII Working Paper 01-07.
- Kotlikoff, L J – Smetters, K – Walliser, J (2001) **Finding a Way Out of America’s Demographic Dilemma.** NBER Working Paper 8258.
- Leers, T – Maijdam, L – Verbon, H A A (2003) **Ageing, Migration and Endogenous Public Pensions.** Journal of Public Economics 88 (2003), 131–159.
- Lucas, R E Jr. (1990) **Supply Side Economics: An Analytical Review.** Oxford Economic Papers, 42, 293–316.
- von Hagen, J – Walz, U (1995) **Social Security and Migration in and Ageing Europe.** In Eichengreen, Frieden, and von Hagen, (eds.) *Politics and Institutions in an Integrated Europe.* Springer, Berlin, Heidelberg.
- Mc Morrow, K – Roeger, W (2004) **The Economic and Financial Market Consequences of Global Aging.** Springer, Berlin, Heidelberg.
- Miles, D (1999) **Modelling the Impact of Demographic Change upon the Economy.** The Economic Journal, 109 (January), 1–36.
- Poterba, J (2004) **The Impact of Population Aging on Financial Markets.** NBER working paper 10851.

Sinn, H-W – Uebelmesser, S (2002) **Pensions and the Path to Gerontocracy in Germany.** European Journal of Political Economy, Vol 19, 153–158.

Turner, D – Giorno, C – De Serres, A – Vourc'h, A – Richardson, P (1998) **The Macroeconomic Implications of Ageing in a Global Context.** OECD Economics Department Working Paper 193.

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