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and Lex Meijdam

# Population Ageing and the International Capital Market

Netspar Panel Papers



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Lex Meijdam

# Population Ageing and the International Capital Market

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# PREFACE

Netspar stimulates debate and fundamental research in the field of pensions, aging and retirement. The aging of the population is front-page news, as many baby boomers are now moving into retirement. More generally, people live longer and in better health while at the same time families choose to have fewer children. Although the aging of the population often gets negative attention, with bleak pictures painted of the doubling of the ratio of the number of people aged 65 and older to the number of the working population during the next decades, it must, at the same time, be a boon to society that so many people are living longer and healthier lives. Can the falling number of working young afford to pay the pensions for a growing number of pensioners? Do people have to work a longer working week and postpone retirement? Or should the pensions be cut or the premiums paid by the working population be raised to afford social security for a growing group of pensioners? Should people be encouraged to take more responsibility for their own pension? What is the changing role of employers associations and trade unions in the organization of pensions? Can and are people prepared to undertake investment for their own pension, or are they happy to leave this to the pension funds? Who takes responsibility for the pension funds? How can a transparent and level playing field for pension funds and insurance companies be ensured? How should an acceptable trade-off be struck between social goals such as solidarity between young and old, or rich and poor, and individual freedom? But most important of all: how can the benefits of living longer and healthier be harnessed for a happier and more prosperous society?

The Netspar Panel Papers aim to meet the demand for understanding the ever-expanding academic literature on the consequences of aging populations. They also aim to help give a better scientific underpinning of policy advice. They attempt to provide a survey of the latest and most relevant research, try to explain this in a non-technical manner and outline the implications for policy questions faced by Netspar's partners. Let there be no mistake. In many ways, formulating such a position paper is a tougher task than writing an academic paper or an op-ed piece. The

authors have benefitted from the comments of the Editorial Board on various drafts and also from the discussions during the presentation of their paper at a Netspar Panel Meeting.

I hope the result helps reaching Netspar's aim to stimulate social innovation in addressing the challenges and opportunities raised by aging in an efficient and equitable manner and in an international setting.

*Henk Don*

Chairman of the Netspar Editorial Board





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# POPULATION AGEING AND THE INTERNATIONAL CAPITAL MARKET

## **Abstract**

This paper analyses the effects of ageing on the international capital market. The first part applies a simple model and distinguishes between the cases of a small open economy and a closed economy to explore the separate effects of ageing, the design of pension schemes and government policy on savings, labour supply and the interest rate. The second part of the paper analyses cross-border capital flows and spillover effects caused by international differences in ageing patterns, pension schemes and policy reactions. The final part is devoted to the quantitative effects found by various recent simulation studies.

## **Summary**

The prospective ageing of the population in many countries will affect the economy in many different ways. This paper focuses on the long-run effects on the international capital market by providing an overview of insights from both theoretical and empirical literature related to this topic. The first part of the paper explores the qualitative effects of both ageing and policy reactions, including spillover effects between countries, while the second part describes the quantitative effects that result from extensive computational models in which all different elements are brought together. In order to understand the diversity of mechanisms that are at work, the paper starts with a basic model in which at each moment, two generations (the working young and the retired) are alive, and analyses the separate effects of ageing for a single country. The key variable that determines the interest rate is the capital-labour ratio, which indicates the relative scarcity of capital compared to the size of the active labour force. The higher the ratio, the lower the interest rate. Two extreme cases are distinguished: the country is either a small open economy, with perfect international capital mobility and an exogenously determined interest rate, or a closed economy, where the interest rate adjusts to equate supply of and demand for capital. Subsequently, the model is extended by allowing for two countries that are

large enough for developments in one country to affect the other. This reveals the international spillover effects of ageing and government policy. In case of a small open economy, the interest rate and the capital-labour ratio are fixed. Ageing, in the form of a higher life expectancy, increases aggregate savings, which are partly invested abroad. Likewise, a lower fertility rate decreases the size of the labour force and also leads to an outflow of capital. The returns on these additional foreign investments are subsequently used to finance part of the consumption in the ageing economy, so that it becomes a *rentier* economy.

The case of a closed economy applies if the country is large, if capital is not mobile across borders, or if all small economies experience the same developments. Ageing will increase the capital-labour ratio – having a positive effect on the wage but a negative effect on the interest rate. The size of these effects is influenced by the design of the pension scheme. The larger the funded component, the stronger the effects will be. While a pay-as-you-go (PAYG) scheme dampens these effects (especially if it is a defined-benefit plan), such a scheme simultaneously implies that ageing will lead to a lower consumption per capita.

The intermediate case is that of two countries with different characteristics but connected to each other through a common capital market. Developments in one country that affect savings and the size of the active labour force result in a changing capital-labour ratio and interest rate, thereby inducing an international capital flow and partly spilling over to the other country. A country that is ageing more strongly than another will –*ceteris paribus*– experience an outflow of capital. This also applies if it increases the funded part of its pension scheme relatively more, and if its public debt increases relatively less. Part of the beneficial effects of these policies that arise from a higher capital-labour ratio will then spill over to the other country, where wages will be higher and the interest rate lower. Likewise, countries with a funded scheme will eventually share in the costs of ageing in countries with an extensive PAYG scheme if the latter do not reform. These international spillover effects can be considered as externalities that individual countries typically do not take (fully) into account when formulating national policy. International policy coordination (e.g. through adherence to the Stability and Growth Pact and fine-tuning of pension policies) could therefore be welfare enhancing. Furthermore, countries with a relatively large public debt are more likely to favour a monetary policy that leads to a higher rate of inflation, which is harmful for

countries that rely on a funded scheme and form a monetary union with the previous ones. Because ageing puts more pressure on governments (especially those with extensive PAYG schemes) to reform, decrease benefits or increase contributions, an escape to higher public debt is quite plausible. The final part of the paper is devoted to the quantitative effects of ageing on the world interest rate. This basically boils down to the question whether ageing countries have sufficient opportunities to invest their relatively abundant capital in other parts of the world, including developing countries and rising countries like China and India. If international differences in the timing and extent of ageing are large enough, and if capital is quite mobile across borders, then the drop in the interest rate will be rather small. On the other hand, if the closed economy is a more likely scenario, and if pension systems are reformed towards more funded schemes on a large scale (without an accompanying increase in the active labour force), then the worldwide interest rate will sharply decrease, possibly resulting in what is called an asset *meltdown*. Simulation results from several studies that apply multi-country computational models show that the expected drop in the interest rate will be about 1 percentage point over the coming decades. If countries such as China are included, and if these are expected to grow and converge to the level of developed countries in the next period, then the drop in the interest rate will initially be lower, but in the medium- and long run they will be much larger, due to the increasing savings that leads to worldwide capital abundance.

## 1. Introduction

In the coming decades, many countries will experience an ageing population as a result of lower fertility rates and increasing longevity, which will lead to higher old-age dependency ratios. As can be seen from Figures 1–3, this is a worldwide phenomenon, but the timing and extent will differ between countries. Because also the design of pension schemes varies a great deal, the economies will be affected differently.

Due to increasing integration and globalisation, developments in one country can have serious consequences for other countries, which also holds for demographic developments. This is the central topic of this paper, which focuses on the imminent effects of population ageing on the international capital market, using the insights from recent theoretical and empirical studies in this area. Although this implies a macroeconomic perspective, we also pay attention to the microeconomic foundations in order to understand the various mechanisms behind the results. The starting point for the microeconomic analysis is the life-cycle model, according to which

*Old age dependency ratios* (Source: United Nations Common Database (UNCDB), 2008)  
Figure 1: Europe

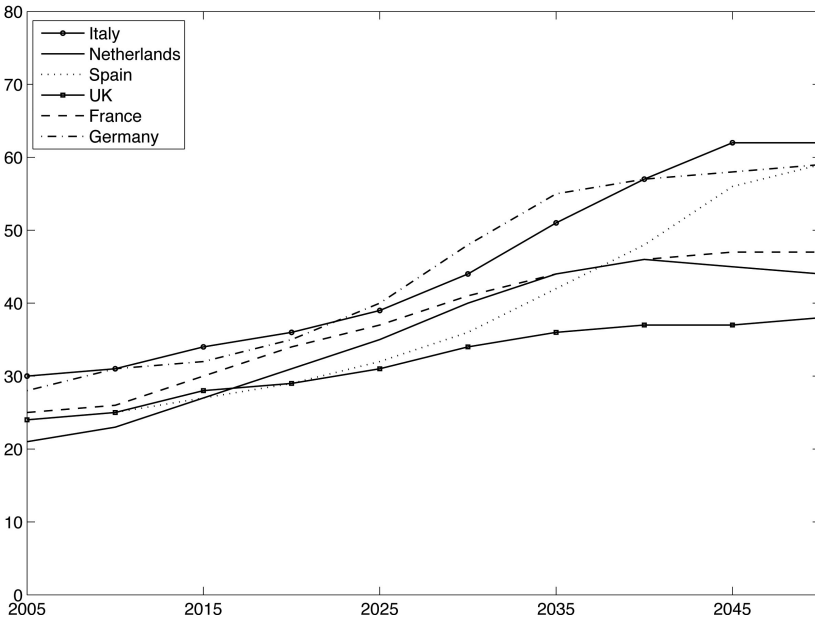
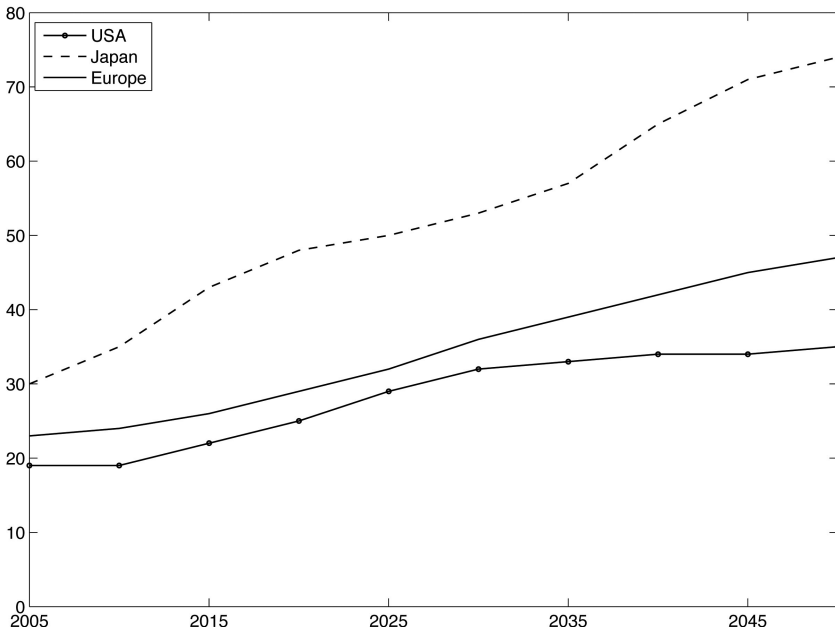


Figure 2: OECD

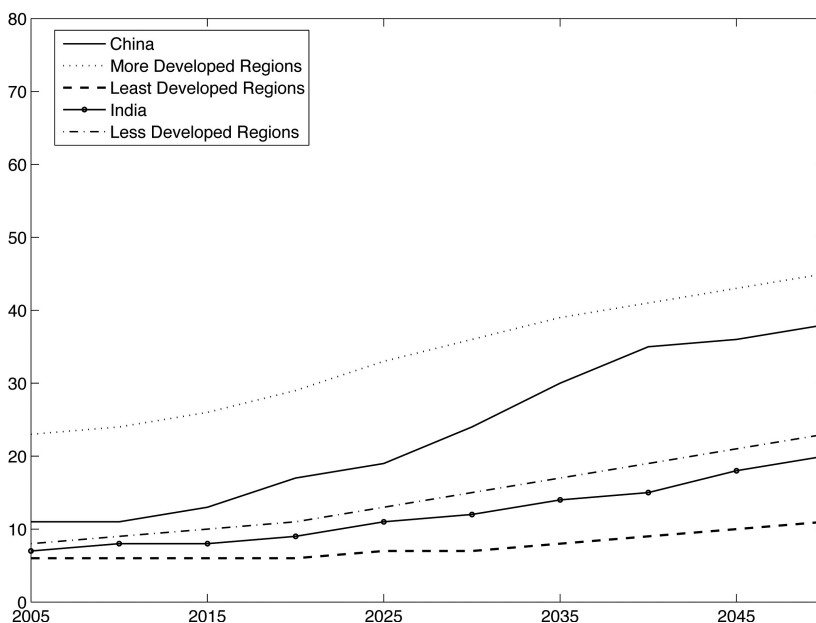


individuals save during their working life for their retirement, with saving through a pension fund providing a striking example of such life-cycle behaviour. We focus on the long-run effects of ageing and different policy measures, and refrain from discussing the short-run effects (see e.g., Adema, 2008), as well as from risk (see e.g., Fehr, 2009) and portfolio choice (see e.g., De Jong et al., 2008).

One of the key questions of this paper is how the interest rate on the world capital market will develop in the medium- and long run. This is the result of the interplay between several mechanisms. Broadly speaking, the interest rate is determined by the marginal product of capital, which depends on the relative scarcity of capital as reflected by the ratio of capital to labour. Ageing will affect this ratio through different channels. The first part of the paper disentangles these channels and analyses them separately for a single country.

Two extreme cases will be considered: a small open economy with perfect international capital mobility, and a closed economy. In the first case,

Figure 3: World



developments in one country (such as ageing) lead to changes in the amount lent or borrowed on the international capital market, and to accompanying adjustments of the current account, leaving the interest rate unaffected.

In the second case, domestic investments are completely financed with domestic savings, so that the interest rate endogenously adjusts to equate supply and demand for capital and therefore depends heavily on national developments. As the size of the capital stock is determined by the availability of financial means, we discuss how national savings change in an ageing society and how this is influenced by different elements of the pension scheme and government policy with respect to the retirement age, pension reform, the creation of government debt and so forth. The other important element of the capital-labour ratio consists of the size of the active labour force, which is directly influenced by ageing (which decreases the number of workers), but also depends on government policy with respect to, for instance, early retirement programs.



Both cases are relevant for analysing the international capital-market effects of ageing. On the one hand, ageing is a global phenomenon, which justifies the closed-economy approach, all the more so if capital is not perfectly mobile between countries. On the other hand, the timing and extent of ageing differs between countries. To analyse the consequences of such asymmetric demographic shocks, the use of a small-open-economy model is more appropriate.

The second part of the paper focuses on international capital flows and spillover effects, assuming perfect capital mobility. Through these flows, developments in one country can influence factor prices, consumption, investment and ultimately the welfare of people in other countries. For instance, because ageing will have different consequences for the interest rate (depending on the size of the funded and unfunded components of pension schemes), it triggers international capital flows, thereby causing positive or negative spillover effects of ageing in one country on other countries. Another example of international spillover effects is the creation of government debt to finance higher public expenditures due to ageing, and the consequences this has for inflation in different countries of the EMU. Of course, the size of these effects depends on the actual degree of international capital mobility, which will also be discussed.

After the separate mechanisms have been reviewed, the focus will be on the expected quantitative effects of ageing on the return to capital in the coming decades. The size of these effects not only depends on the degree of capital mobility, but also hinges on the question whether the differences in timing and the extent of ageing between countries are sufficiently large for the model of a small open economy to be the most suitable approach. If not, then the scenario of a closed economy is more likely, in which case the retirement of the baby boom generation may lead to such a capital abundance and labour shortage that the interest rate drops dramatically. Will this lead to an asset meltdown? Or will rising economies such as China and India provide investment opportunities that are sufficiently favourable to attenuate the decrease in the return to capital? In order to answer these questions, we discuss the findings of recent studies that apply extensive computational models aiming to bring all previously discussed elements together to generate numerical simulation results for different scenarios. The paper ends with some policy implications.

## 2. The basic model

This paper analyses how ageing affects international capital markets. Ageing is modeled as the result of two types of demographic shocks. The first is a decrease in population growth due to a fall in the fertility rate (i.e., the average number of children per woman). As illustrated in Figure 4, fertility rates in many countries dropped sharply in the 1970s due to the introduction of contraceptives and the increased labour force participation of women. In up-coming decades, fertility rates are expected to remain below the reproduction rate of 2.1 children per woman. The second type of demographic shock that causes the ageing of the population is the ongoing increase in longevity due to better nutrition and better provision of health-care. Figure 5 shows the development of life expectancy at birth between 1955 and 2050. In the first half of the twentieth century, life expectancy increased mainly as a result of reduced rates in infant mortality. The current (and prospective) decline in mortality occurs mainly at old ages, however, which causes the ageing of populations.

This section presents the model that forms the basis for the paper's analysis of the effects of demographic shocks. The first subsection describes

*Figure 4: Fertility rate* (Source: United Nations Common Database (UNCDB), 2007 and own calculations. The figures for 2010 and later are based on the medium variant projection of the UN population division.

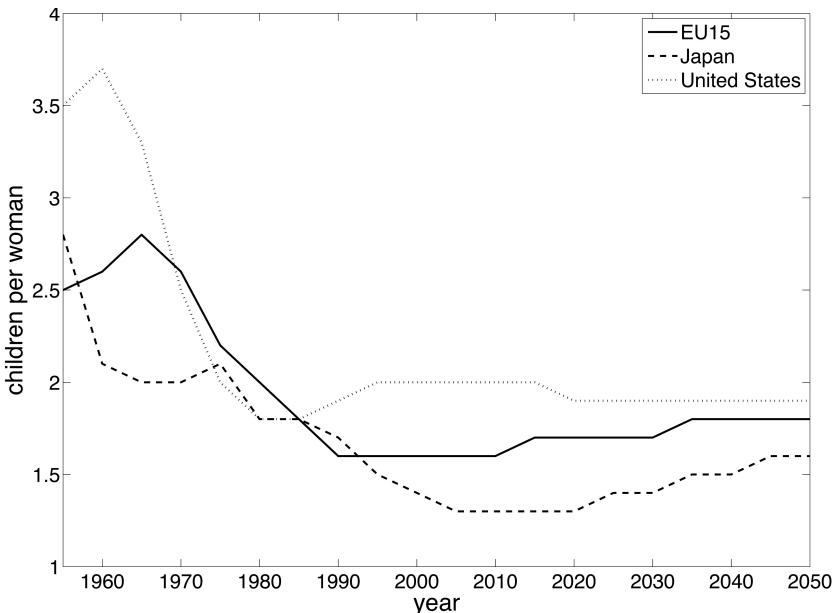
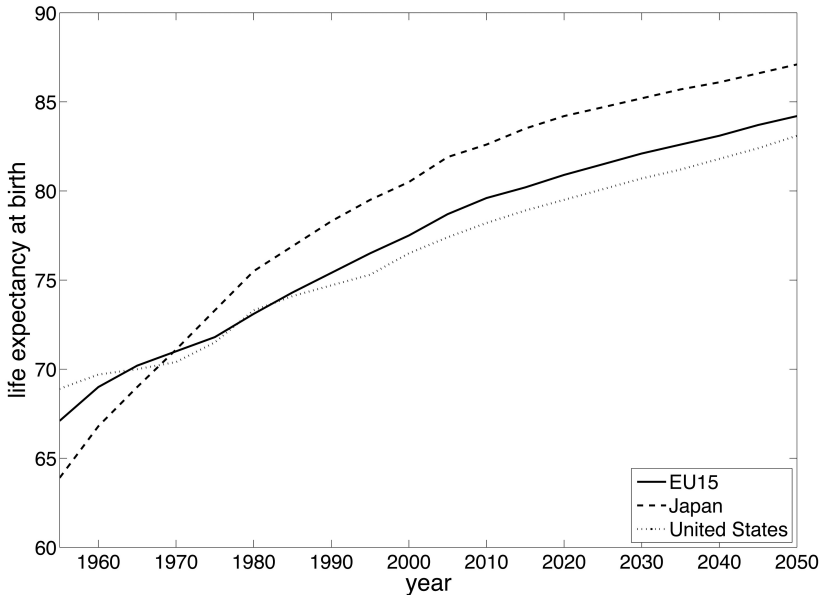


Figure 5: Longevity



the production side of the economy and how changes in the relative scarcity of capital affect factor prices. Section 2.2 adds a life-cycle model for individual savings to this set-up by introducing the Diamond–Samuelson overlapping-generations model. The final subsection extends the model with a pension scheme.

### 2.1 Ageing and the capital-labour ratio

The central variable in our analysis of the effects of ageing is a country's *capital-labour ratio*: the amount of capital relative to the amount of labour. This is the key variable because, given the neoclassical production function that is assumed (see Box 1), it determines factor prices (in a closed-economy setting) and/or international capital flows (in an open-economy setting),<sup>1</sup> and thus largely determines the welfare of current and future generations.

<sup>1</sup> Throughout the paper we abstract from international labour mobility. Note that a combination of labour and capital mobility in one model does not lead to internal

Only one good is produced (using capital and labour) that can be used as consumption or investment good, and is internationally tradeable. This implies that we ignore specialisation effects that may arise from international trade. Furthermore, this assumption implies that an individual demands the same commodity when young and old. Obviously, this is a strong assumption, considering the fact that the need for (non-tradeable) services such as health-care increases with age. Population ageing will therefore affect not only the capital-labour ratio, but also the sectoral structure of the economy and the relative price of tradeables and non-tradeables. These modifications will briefly be addressed in the conclusion of Sections 3 and 4, respectively.

Labour is measured as the effective supply of labour in the economy, and thus depends on demographics, labour-market behaviour and labour efficiency. Although ageing may also affect the latter two elements of effective labour supply (for example through changes in retirement behaviour or investment in human capital over the lifetime), in view of the available space, we focus on the direct effects of demographic change on labour supply and pay little attention to the effects of ageing on labour market behaviour and labour efficiency (although some modifications are discussed at the end of Section 4).

The word capital in the capital-labour ratio refers to the amount of physical productive capital (such as machines and so forth) in the economy. This should be distinguished from financial capital (consisting of stocks, bonds and so forth), which is meant in case of international capital flows. However, the value of stocks is closely linked to the value of the physical capital stock: assuming free entry, no adjustment costs of (physical) capital and no asset bubbles, these are equal.<sup>2</sup> The stock of physical capital is determined by past investment and depreciation. Investment is, in turn, strongly correlated with savings, which will be discussed in the next subsection.

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solutions unless a third, immobile production factor is introduced. The latter paper shows that allowing for labour mobility reinforces the consequences of international differences in demographics and policy, as labour tends to follow international capital flows. In general, the results are not qualitatively different. One important difference is, however, that labour mobility introduces the possibility of a globally welfare improving pension reform, which cannot be realised when only capital is mobile, see Section 5.2.

<sup>2</sup> That is, Tobin's 'q' (i.e., the ratio of the market valuation of real capital and the replacement cost of these assets) equals one (Abel, 1979).

**Box 1: The neoclassical production function**

Throughout this paper we assume a constant-returns-to-scale neoclassical production function (see for example Barro and Sala-i Martin, 2004, Section 1.2.2) with two factors of production: capital and labour. Production capacity is always fully utilized (so we abstract from Keynesian multiplier effects due to a lack of demand.) Production per labour efficiency unit  $y$  can then be described as a function of the capital-labour ratio  $k$ :

$$y_t = f(k_t), f'(k) \equiv \frac{df}{dk} > 0, f''(k) \equiv \frac{d^2f}{dk^2} < 0 \quad (1)$$

The development of the capital-labour ratio is determined by investment and depreciation, but also by the growth of the effective labour supply  $g$ : a growing labour supply –ceteris paribus– decreases  $k$ :

$$k_{t+1} = \frac{k_t - \delta k_t + i_t}{1 + g} \quad (2)$$

where  $i$  is investment per labour unit and  $\delta$  stands for the depreciation rate of capital. So in a steady-state (where  $k$  is constant) investment equals<sup>3</sup>

$$i = (\delta + g)k \quad (3)$$

That is, the faster the effective labour force grows, the more a country has to invest per worker in order to equip each future worker with the same level of capital (machines). The return on capital (or interest rate) equals:

$$r = f'(k_t) - \delta \quad (4)$$

The wage rate per labour efficiency unit is given by

$$w_t = f(k_t) - k_t f'(k_t) \quad (5)$$

In a closed economy, the capital-labour ratio is endogenously determined and determines the factor prices according to these equations. In a small open economy with perfect capital mobility, the interest rate cannot differ from the interest rate  $\bar{r}$  on the world capital market. That is, capital flows into (out of) the country so as to realize  $rt = \bar{r}$ . Inserting this in the previous equations determines the capital-labour ratio and the wage rate.

---

3 Variables without a time subscript refer to the steady state.

### *2.2 Savings: the overlapping-generations model*

The dominant framework in the research on the economic effects of ageing combines the neoclassical production function with a *life-cycle model* for individual savings. According to the life-cycle model (Modigliani and Brumberg, 1954) consumption is determined by expected lifetime income. Thus, consumers borrow against future earnings during their early student- and working life (when income is low), they save during their most productive working years and they consume saved assets (including the return on these assets) during retirement.<sup>4</sup> Here we use the simplest possible version of such a model, the *Diamond-Samuelson two-overlapping-generations model*.

The novelty of the model introduced by Paul Samuelson in 1958 was the demographic structure. In this stylised framework, a new generation of individuals who live for exactly two periods (of equal length), is born during each period. The first period contains their industrious life, and in the second period they are retired. So in each period, two overlapping generations are alive: a young generation of workers and an old generation of retirees. Diamond (1965) generalised Samuelson's framework. Contrary to Samuelson, Diamond assumed a store of value to be present, so that individuals have the opportunity to save for old age. This paper uses a version of the Diamond model that allows for changes in longevity and the fertility rate (see Box 2).

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<sup>4</sup> Attempts to test the life-cycle model against real-world data have met with mixed success. The main discrepancies between predicted and actual behaviour is that people drastically 'underconsume' early and late in their lifetime by failing to borrow against future earnings and not saving enough to adequately finance retirement incomes, respectively. People also seem to 'overconsume' during their highest earning years, and the elderly do not consume as much from their assets as would be expected. Specific alterations to the theory have been proposed to help it accommodate the data: a bequest motive, for example, and capital market imperfections (such as liquidity constraints). For an overview, see for example, Baranzini (2005).

**Box 2: Longevity in the two-overlapping-generations model**

Let  $N_t$  be the number of young people in period  $t$ , which is assumed to grow at a constant growth rate of  $n$  so  $N_t = N_{t-1}(1+n)$ . A constant fraction  $1-\varepsilon$  of each generation dies at the end of the first period of life, so the number of elderly in period  $t$  is  $M_t = \varepsilon N_{t-1}$ . As it is assumed that all young work and all elderly are retired, the old age dependency ratio, i.e., the number of retirees per worker in period  $t$  is given by

$$\frac{M_t}{N_t} = \frac{\varepsilon N_{t-1}}{(1+n)N_{t-1}} = \frac{\varepsilon}{1+n}$$

It immediately follows that both a decrease in fertility (lower value of  $n$ ) and an increase in longevity (higher value of  $n$ ) raises the dependency ratio. The fact that individuals may die at the end of the first period of life implies that they may unintentionally leave amounts of wealth. We have to make assumptions on who receives this wealth. One could assume either that it goes to the next generation as an (unintended) bequest, or that it is allocated to the surviving members of the same generation. Here we assume for simplicity that perfect annuity markets exist and that the wealth of those who decease is transferred to the survivors of this generation in the form of a higher return on their savings. The budget constraint for the first period of life is:

$$c_t^y = w_t - s_t \quad (6)$$

and the budget constraint for the second period is:

$$c_t^o = \frac{1+r_{t+1}}{\varepsilon} s_t \quad (7)$$

where  $c_t^y$  and  $c_t^o$  indicate consumption of a young individual in period  $t$  and consumption of the same individual when old (i.e., in period  $t+1$ ), respectively, and  $s_t$  stands for savings in period  $t$ . Consumers maximize expected utility over the lifetime, where future utility is discounted at a rate  $\rho$ <sup>5</sup>:

$$EU_t = u(c_t^y) + \frac{\varepsilon}{1+\rho} v(c_{t+1}^o) \quad (8)$$

<sup>5</sup> For convenience, we assume an additively separable lifetime utility function.

The first-order condition for this problem is: <sup>6</sup>

$$\frac{u'(c_t^y)}{v'(c_t^o)} = \frac{1+r_{t+1}}{1+\rho} \quad (9)$$

Savings by the young can be derived from this so-called Euler equation. The effect of a change in the interest rate on savings is the result of two opposing effects: a positive substitution effect and a negative income effect. Lifecycle models often assume that the income effect dominates and savings fall if the interest rate rises. In case logarithmic felicity functions<sup>7</sup> are assumed, both effects balance and savings per worker are independent of the interest rate:<sup>8</sup>

$$s_t = \frac{\varepsilon w_t}{1+\varepsilon+\rho} \quad (10)$$

Note that the young save more if longevity increases  $\left(\frac{\partial s}{\partial \varepsilon} > 0\right)$ , but that

changes in fertility do not affect  $s$ . Savings by the young differ from aggregate national savings, which includes dissaving by the old and the net saving by firms and by the government. Abstracting from government budget deficits, aggregate national savings per worker equal:

$$s_t^{agg} = s_t - \frac{s_{t-1}}{1+g} + \delta k \quad (11)$$

It follows that (for a given capital-labour ratio) an increase in longevity raises aggregate savings in the steady state if the economy is growing.<sup>9</sup> A decrease in fertility lowers aggregate savings in the long run, however. So the total effect of ageing on aggregate savings is unclear.

6  $u'(c_t^y) \equiv \frac{du}{dc_t^y}$  and  $v'(c_{t+1}^o) \equiv \frac{dv}{dc_{t+1}^o}$ .

7 I.e.,  $u(c^y) = \ln(c^y)$  and  $v(c^o) = \ln(c^o)$

8 To be precise, we should use the term savings per labour efficiency unit instead of savings per worker. For expositional reasons, we prefer to loosely speak of savings, consumption etcetera per worker throughout this paper. As we assume exogenous labour supply, at a given point in time, i.e., with a given number of labour efficiency units, this does not make a difference.

9 The same result is found by Sheshinski (2006) in a Blanchard-Yaari model, i.e., a model with an infinite number of overlapping generations where individuals at each point in time face a constant probability of death.



### 2.3 Savings and capital formation in a closed economy

In a closed economy, the capital–labour in a given period is determined by the savings accumulated by the young in the previous period and by economic growth (see Box 3). An important result of Diamond’s analysis is that in a laissez-faire economy individuals can save ‘too much’, leading to an inefficiently high capital–labour ratio. That is, the economy may become *dynamically inefficient*, implying that consumption per worker can be increased for all generations if savings are reduced (see Box 4). In case of a dynamically inefficient economy, government intervention is necessary to reduce savings and attain a socially optimal allocation. The government might accomplish this by introducing a pay-as-you-go (PAYG) pension scheme (see Section 2.5).

#### Box 3: Capital accumulation in a closed-economy model

In a closed economy, the savings of the young equal the next period’s capital stock. Note that (assuming that each worker supplies a constant number of hours of labour) effective labour supply rises due to a growing number of young individuals ( $n$ ) but also due to increasing labour productivity ( $x$ ), so  $1+g=(1+n)(1+x)$ . This growth of effective labour supply leads to capital dilution. That is, for a given level of next period’s capital stock, a growing labour supply lowers next period’s capital–labour ratio. Therefore, the relation between savings by the young and next period’s capital labour ratio is:

$$s_t = (1+g)k_{t+1} \quad (12)$$

From this we can derive the steady-state capital–labour ratio. In case of logarithmic felicity and a Cobb–Douglas production function  $y = Ak^\alpha$  ( $0 < \alpha < 1$ ) an explicit expression results:

$$\left[ \frac{A(1-\alpha)}{(1+g)\left(1+\frac{1+\rho}{\varepsilon}\right)} \right]^{\frac{1}{1-\alpha}} \quad (13)$$

From this expression it immediately follows that  $\frac{\partial k}{\partial g} < 0$  and  $\frac{\partial k}{\partial \varepsilon} > 0$

implying that ageing leads to a higher capital–labour ratio. This holds for both an increase in longevity (higher value  $\varepsilon$ ) and a decrease in fertility (lower value of  $n$  and thus of  $g$ ).

**Box 4: Golden rule and dynamic efficiency**

In a closed economy there is no import or export. In that case the difference between the production per worker and investment per worker equals consumption per worker. Figure 6 shows this consumption in the steady state as a function of the capital-labour ratio in the steady state. The consumption per worker reaches its maximum value if the marginal product of capital equals the marginal cost of capital in terms of additional investment required to maintain the capital stock, i.e., if  $f'(k) = \delta + g$  or equivalently, if  $r = g$ . This condition is called the golden rule of capital accumulation. An increase in the capital-labour ratio has two opposite effects on lifetime utility. First, more capital per worker implies a higher wage, which positively affects utility. Second, a higher capital-labour ratio implies a lower marginal product of capital and thus a lower interest rate, which lowers utility. For capital-labour ratios below the golden rule level, the positive wage effect dominates and increasing  $k$  raises lifetime utility. If  $k$  is above the golden-rule level, the interest-rate effect dominates and further increasing  $k$  lowers lifetime utility. At the golden-rule point, the two effects exactly cancel and steady-state lifetime utility is maximised:

$$\frac{dEU}{dk} = \frac{u'(c^y)f''(k)}{1+r} [s - k(1+r)] = 0 \quad (14)$$

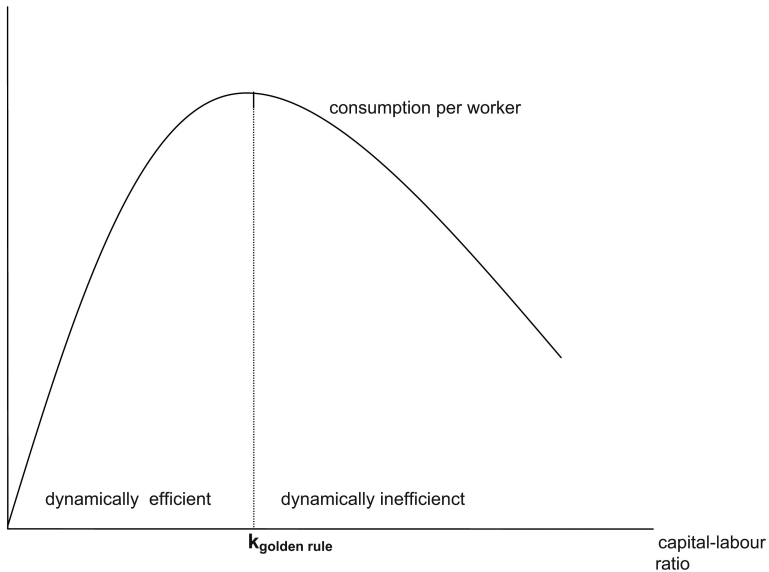
In a closed economy, using (12) this reduces to

$$\frac{dEU}{dk} = \frac{u'(c^y)kf''(k)}{1+r} [g - r] = 0 \quad (15)$$

Steady-state levels of the capital-labour ratio above the golden-rule level (i.e.,  $r < g$ ) are called dynamically inefficient as long-run utility can be increased without harming generations in the short run, namely by consuming more and saving less. Capital-labour ratios below the golden-rule level (where  $r > g$ ) are called dynamically efficient because long-run consumption can only be increased by raising investment, that is, by increasing savings and thus lowering consumption in the short run. It is generally assumed that economies are dynamically efficient. For an empirical assessment of dynamic efficiency in the US, see Abel et al. (1989) and Barbie et al. (2004). Leonard and Prinzing (2001) stress that the results for the US cannot be assumed to be true for all other countries; each economy needs to be examined separately.

*Figure 6: The Golden Rule*

consumption



#### 2.4 The small open economy: International capital flows

In a small open economy, international capital flows equate the return on capital to the return on the world capital market. As a consequence, the capital-labour ratio is determined on the world capital market (see Box 1) and investment is not necessarily equal to national savings. If savings exceed investment, then the small open economy has a surplus on the current account mirrored by a deficit on the capital account. This implies a flow of money out of the country to be invested abroad, leading to an increase in net foreign asset holdings. For the sake of exposition, we refer to this situation from now on as an outflow of capital.<sup>10</sup> In the opposite case (i.e., when the small open economy has a current-account deficit and investment exceeds savings), we speak of an inflow of capital.

What are the welfare effects of this international capital mobility? It is often thought that open capital markets raise welfare, as capital flows are

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<sup>10</sup> Although financial assets actually flow into the country in this case.

beneficial to both capital exporters (who find better investment opportunities abroad) and capital importers (who experience less scarcity of capital). This is not necessarily true however. Let's compare the situation of a small economy with perfect capital mobility to the situation of the same small economy in autarky (i.e., when capital flows to or from the rest of the world are not possible). Suppose that in autarky the capital-labour ratio in the small economy is higher than in the rest of the world. That is, the return on capital in the small economy is lower than it is abroad, and allowing for capital mobility would lead to an outflow of capital to the rest of world. This would indeed be good for domestic capital owners, as they would earn a higher return. However, the outflow of capital would also imply a lower capital-labour ratio in the small open economy and thus a lower wage rate compared to the situation in autarky. This is clearly a disadvantage for domestic workers. Because a consumer is both worker when young and capital owner when old, the net effect of capital mobility on his welfare in the long run is ambiguous and depends on whether the wage effect dominates the interest-rate effect (or the other way around). As shown in Box 4, this is determined by the capital-labour ratio in the economy in autarky: The wage effect dominates the interest-rate effect and an outflow of capital reduces welfare if (and only if) this economy is dynamically efficient (i.e., if its capital-labour ratio is below the golden-rule level). That is, an outflow of capital raises long-run welfare only if the economy is dynamically inefficient in autarky. By the same reasoning, an inflow of capital raises welfare if the economy is dynamically efficient in autarky, but lowers welfare in case of dynamic inefficiency.

Capital mobility may thus be beneficial, but it may also be a burden, depending on the initial situation. The reason that the opening up of a country does not necessarily improve welfare is that only one good is produced, which implies that international trade and financial mobility do not expand the consumption set of consumers and that there are no potential gains from specialisation.<sup>11</sup>

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11 The same holds in a two-country model. Buiter (1981) was the first to extend the overlapping-generations model to an open economy with two countries. He shows that the welfare effects of integration crucially depend on whether or not the economies are dynamically efficient. Just like in the small-open-economy model, it is not necessarily true that both economies gain from integration. See also Section 6.3.

### *2.5 Pensions in the Diamond–Samuelson framework*

This section extends the standard Diamond–Samuelson framework by introducing pensions. The first part briefly discusses funded pensions. However, as funded pensions are implicitly already part of the standard model, the largest part of this section is devoted to unfunded pensions and their effect on savings.

#### *Funded pensions*

Funded pensions can easily be included in the Diamond–Samuelson framework: in principle, all savings by the young are savings for old age. It may be assumed that part of these savings is determined by a pension fund. Note, however, that we have assumed perfect annuity markets. Therefore, as long as the pension fund does not redistribute within or between generations, and as long as these forced savings do not exceed the amount that the young would voluntarily save anyway, this does not change anything. Consequently, funded defined–contribution schemes (i.e., funded schemes where the benefit is completely determined by the return on individual contributions) do not really introduce new features into the model. Funded pension schemes with a defined benefit include elements of redistribution and may thus add new elements to our model. Note, however, that intragenerational redistribution cannot be analysed in our simple model because it assumes that all individuals of one generation are identical. Therefore, only the intergenerational redistribution by funded defined–benefit schemes can be included in our model. This is formally equivalent to introducing a PAYG scheme, however. That is, a funded defined–benefit scheme can be viewed as a combination of a funded defined–contribution scheme and a PAYG system. Because the latter will be discussed below, and (as explained above) the former does not add much to the model, we keep things simple and do not explicitly model pension funds.

In some countries, the fiscal treatment of pension savings differs from that of ordinary household savings. The Netherlands, for example, has the so-called EET regime ("omkeerregel"), which makes contributions to e.g., pension funds income–tax deductible. Also the returns to pension fund investments are not taxed, but the pension benefits that are eventually

received are subject to income taxation.<sup>12</sup> Because people often face a lower tax rate when retired than when working, this implies a gain in lifetime income. The effect of having an EET regime on individual (retirement) savings is ambiguous. On the one hand, the income gain occurs later in life, which induces people to save less in order to smooth consumption (income effect). On the other hand, the effective tax rate is lower after retirement, which has a positive effect on savings (substitution effect). But even if there is no difference in tax rates when working and retired, the effective tax rate on capital income is lower with an EET regime: the interest received on savings is exempt from taxation until retirement, which allows the individual to reinvest the full amount of capital income received, yielding interest in the next period. The total amount of tax paid over the lifetime is therefore lower with an EET regime.<sup>13</sup> Again, the effect on individual savings depends on the size of the income effect relative to the substitution effects. Because these work in opposite directions, it is unclear beforehand what the total effect is. The consequences for aggregate savings will be discussed briefly in Section 6.2; apart from that, we refrain from discussing the fiscal treatment of retirement savings in the rest of the paper.

### *Unfunded pensions*

We extend the standard Diamond–Samuelson model with a PAYG pension scheme. That is, the government runs a balanced–budget redistribution scheme that transfers money in a lump–sum fashion from the young generation to the old generation living in the same period. Various types of PAYG schemes are possible.

#### *• Defined–contribution or defined–benefit schemes*

With regard to demographic changes, it is important to know if and how the contributions to the scheme are adjusted, as this determines which generation bears the risk of demographic changes. For a defined–contribution scheme, the contribution rates are not adjusted to demographic shocks, implying that benefits will fall if ageing raises the

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12 Other countries that have such a regime include Germany, the UK and the US. France, however, has a TTE regime: contributions and investment income are taxed, but benefits are exempted.

13 Put differently, the net interest rate is higher. It can be shown that an EET regime is more efficient than ordinary income taxation, which includes capital income.

dependency ratio (i.e., the number of retirees per worker). For a defined-benefit system, however, the young generation bears the burden of the demographic risk, and ageing will lead to rising contribution rates.

• *Bismarckian or Beveridgean PAYG schemes*

In general, PAYG contributions distort labour supply decisions and thus lead to a welfare loss, what is known as the excess burden. The reason is that contributing to a scheme generally does not imply entitlement to an actuarially fair benefit when old. This welfare loss is larger in a Beveridgean PAYG scheme (with no link between the amount of contributions paid and the benefit received when old) than in a Bismarckian PAYG scheme (where benefits are directly linked to the contributions paid). However, because in a dynamically efficient economy the present value of the benefits falls short of the contributions, a distortion of the labour-supply decision remains.<sup>14</sup> The simple model presented below abstracts from labour-market distortions: labour supply is exogenous, and PAYG contributions thus do not cause an excess burden.<sup>15</sup>

*The Aaron condition*

As shown by Feldstein (1974, 1996), PAYG schemes reduce savings and thus the capital-labour ratio, which in a dynamically efficient closed economy decreases lifetime utility in the long run. In a small open economy, where the capital-labour ratio is determined on the world capital market, this effect is absent, of course. Instead, the decrease in savings implies an increase in foreign debt.<sup>16</sup> The effect of a PAYG scheme on lifetime income and utility in a small open economy with given factor prices was analysed in a seminal paper by Aaron (1966). For a given tax rate, this effect depends on the interest rate ( $r$ ) and the growth of effective labour supply ( $g$ ). The PAYG scheme raises (lowers) lifetime income and utility if the internal rate of return of the PAYG scheme,  $(\frac{1+g}{\epsilon})$  exceeds (falls short of) the rate of return on private savings  $(\frac{1+r}{\epsilon})$ . The resulting condition  $r < g$  is known as the Aaron condition (see Box 5), which is similar to the condition for dynamic inefficiency (see Box 4). Note that this does not imply that a

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14 For the definition and an empirical assessment of the tax rates implied in PAYG schemes in various countries, see Fenge and Werding (2004).

15 Endogenous labour supply is discussed briefly in the conclusion of Section 4.

16 Nielsen (1994) shows that a PAYG scheme leads to higher foreign indebtedness in a Blanchard-Yaari type of overlapping generations model.

pension reform that involves a transition of (a part of) the PAYG scheme into a funded scheme produces net gains (see Section 5.2 for further discussion).

**Box 5: PAYG pensions in the Samuelson–Diamond model**

Workers pay a tax  $\tau$  on wage income  $w$  that is used for transfers to the currently living old. The remaining wage income is used for savings for old age ( $s_t$ ) and for consumption while young:

$$c_t^y = (1 - \tau)w - s_t \quad (16)$$

When old, the individual consumes her savings, including the returns, and the transfer payment  $\eta$  from the government. Consequently, the old-age consumption of an individual born at the beginning of period  $t$  is given by

$$c_{t=1}^o = \frac{1+r}{\varepsilon} s_t + \eta \quad (17)$$

The government runs the transfer system as a PAYG scheme with the following (balanced) budget constraint,

$$\eta = \frac{(1+g)\tau w}{\varepsilon} \quad (18)$$

The Euler equation (eq. 9) is not affected by the introduction of pensions and assuming logarithmic utility, individual savings are now equal to:

$$s_t = \frac{\varepsilon}{1+\rho+\varepsilon w} \left[ 1 - \frac{(\varepsilon(1+r) + (1+\rho)(1+g))\tau}{\varepsilon(1+r)} \right] \quad (19)$$

Note that the PAYG scheme unambiguously reduces savings by the young  $\left( \frac{ds}{d\tau} < 0 \right)$  as stressed by Feldstein (1974). We can derive the following

equations for consumption:

$$c_t^y = \frac{1+\rho}{1+\rho+\varepsilon} \left[ w - \frac{\tau(r-g)}{1+r} \right] \quad (20)$$

$$c_{t+1}^o = \frac{1+r}{1+\rho+\varepsilon} \left[ w - \frac{\tau(r-g)}{1+r} \right] \quad (21)$$

where the term between brackets can be interpreted as lifetime income (i.e., the present value of all net income when young and old). It directly follows that the introduction of the PAYG scheme raises (lowers) lifetime income (and thereby consumption when young and old and lifetime utility) if  $r < g (r > g)$ . This is known as the Aaron condition.



*International policy coordination*

As mentioned above, in a small open economy, a PAYG scheme reduces savings but does not affect factor prices. Instead, it reduces the net flow of capital to other countries. Of course, in a world consisting of a large number of identical small open economies, this reduces the supply of capital at a global level resulting in a lower capital-labour ratio. This effect is typically neglected, however, by the individual small open economy. As stressed by Pemberton (1999) this implies that PAYG pensions in a small open economy produce a negative externality because of their effect on the world factor prices. Pemberton shows that, because of this external effect (which is neglected when countries decide individually), the gains from coordination of the PAYG policy between small open economies are potentially significant as coordination would lead to a higher capital-labour ratio. A comparable result can be found in Pestieau et al. (2006) who analyse the optimal design of the pension scheme in a model with heterogeneous agents, perfect capital mobility and a variable number of symmetric economies ranging from one (closed economy or perfect coordination) to infinity (small open economy without coordination). They show that the size of the PAYG scheme rises and the capital-labour ratio falls as the number of countries increases, i.e., as coordination becomes weaker.<sup>17</sup>

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17 Beltrametti and Bonatti (2004) reach the opposite conclusion: In their model, coordination depresses the capital-labour ratio. The reason for this different result is that (in contrast to for example Pemberton (1999), Beltrametti and Bonatti (2004)) they assume that the government also takes the future well-being of the current active generation into account.

### 3. Ageing in a small open economy

To set the stage, we discuss the long-run effect of ageing in a small open economy without PAYG pensions. First, ageing is modeled as an increase in longevity. Subsequently, we discuss the effect of a permanent decrease in fertility.<sup>18</sup> We focus on the effect on consumption possibilities. Of course, changes in consumption possibilities are an important determinant of changes in lifetime utility, but these are not necessarily the same. An increase in life expectancy, for example, may have a positive effect on utility, independent of the effect on consumption, just because of the joy of living longer. Such direct effects of demographic changes on utility are excluded from the analysis in this paper.

#### 3.1 *Rising longevity*

An increase in longevity implies that wage income earned has to be spread over a longer expected lifetime. As a consequence, workers will save more and reduce consumption when young and consume less during retirement. The increase in savings by the young initially strongly boosts aggregate savings. In the long run, however, dissaving by the old also rises, which tempers the increase in aggregate savings. But as long as young cohorts are larger than old cohorts, the net effect on aggregate savings is positive (see Box 2).

In the small open economy, the capital-labour ratio and the factor rewards are determined on the world capital market. The increase in savings by the young therefore does not affect these variables, but only leads to an increase in net exports and a surplus on the current account. The current-account surplus implies a flow of capital to the rest of the world (i.e., net foreign asset holdings increase). When retired, the agents will sell their net foreign asset holdings and use the returns for extra imports (and thus extra consumption). In the long run, the increase in imports for old-age consumption outweighs the increase in exports due to the higher savings (and thus lower consumption) by the young, so that the net export of the small open economy falls (and may even become negative). The negative effect of the lower net export on the current

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18 To keep things simple, we assume that there is no effect on labour market behaviour and labour efficiency. Moreover, we abstract from uncertainty and credit constraints, and assume perfect foresight.

account is counteracted by the positive effect of the net interest received from abroad on the additional net foreign asset holdings, so that the net foreign asset holdings per capita stabilise at the new, higher level.

In the long run, therefore, ageing transforms the small open economy into a rentier economy that invests its capital in the world capital market to import consumption goods when old. While this rentier effect raises consumption possibilities, it is not sufficient to prevent a decrease in average per capita consumption.

Figure 7 presents the long-run effect of an increase in longevity in the small open economy. The solid line represents the per capita average domestically produced amount of consumption as a function of the capital-labour ratio. For a given dependency ratio (i.e., a given number of elderly per worker), this is proportional to the consumption curve for the closed economy presented in Figure 6.<sup>19</sup> The actual per capita consumption is determined by the point on this curve that corresponds to the capital-labour ratio that is determined on the international capital market ( $k = k^*$ ). In the long run, the increase in longevity has two effects. First, due to the rentier effect net imports rise, which raises consumption above the domestically produced level of consumption. Second, the dependency ratio increases, implying that the consumption per worker has to be shared with more retirees. Hence, this dependency-ratio effect decreases average per capita consumption. It can easily be shown that the latter effect dominates the former, implying that increasing longevity lowers per capita average consumption in a small open economy.

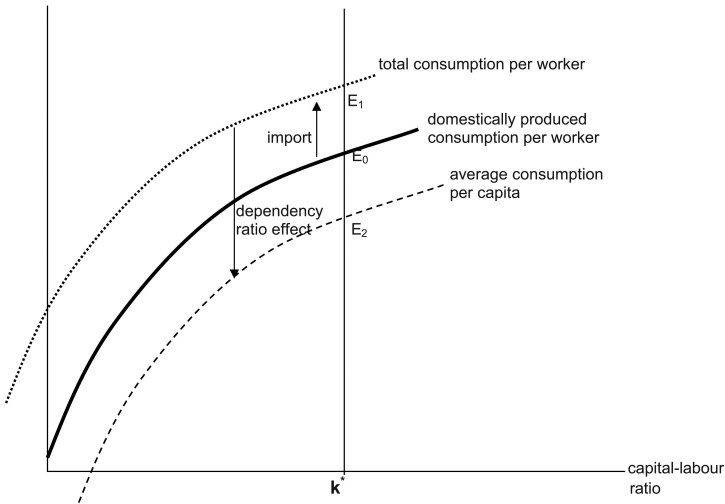
### 3.2 Decreasing fertility

Now we assume that longevity is constant but that fertility decreases (i.e.,  $n$  falls). In the absence of intergenerational redistribution, a change in fertility in a small open economy with given factor prices affects neither individual consumption nor savings levels. Still, several macroeconomic effects can be discerned. In particular, the increase in the relative size of the dissaving old cohort implies that aggregate savings fall. This is indeed what is found in most cross-country aggregate studies of savings behaviour (for an overview, see Bosworth et al. (2004)). Empirical studies of micro

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19 For expositional reasons we assume that in the initial situation the net export equals zero, so that actual per capita consumption per worker coincides with domestically produced per capita consumption.

Figure 7: An increase in longevity in a small open economy  
consumption

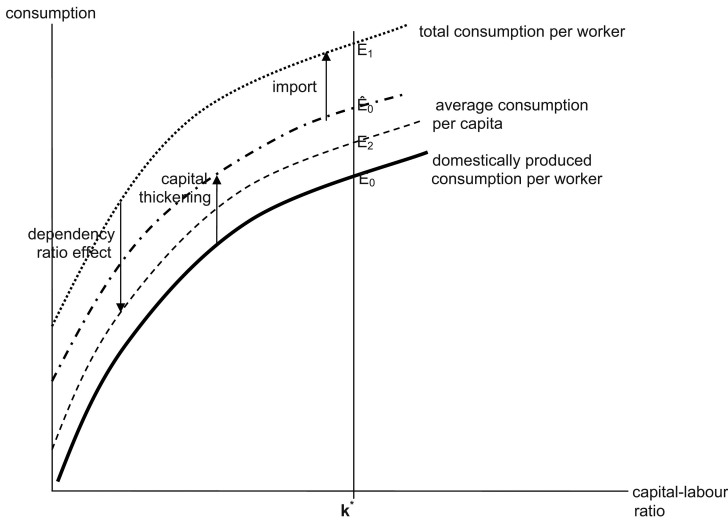


data do not always confirm that aggregate savings fall when fertility decreases. As noted by Miles (1999), this may well be due to the fact that in these studies savings rates are generally constructed from the difference between measured income and measured consumption at the micro level. This overestimates savings by the elderly, as income from a funded pension is income for the individual, but represents dissaving on a macroeconomic level. A recent cohort analysis of US household-level data by Dynan et al. (2009) suggests that savings rates from micro data are roughly consistent with aggregate time-series data.

Apart from the effect on savings, decreasing fertility has another important macroeconomic effect: a smaller labour force implies that less investment is needed to stabilise the capital-labour ratio at the given level and –*ceteris paribus*– more resources become available for consumption. The importance of the demographic influence on investment was emphasized in a seminal paper by Cutler et al. (1990).<sup>20</sup> This adds a third effect, the positive capital-thickening effect, to the dependency-ratio

<sup>20</sup> For an empirical study of the effect of demographics on investment, see, for example Higgins (1998).

Figure 8: An decrease in fertility in a small open economy



effect and the rentier effect described above. The net result of these three effects on average per capita consumption is ambiguous: per capita average consumption increases if consumption when young is smaller than consumption when old. Figure 8 illustrates this case.

### 3.3 Conclusion and modifications

In the long run, both a decrease in fertility and an increase in longevity transform the small open economy into a rentier economy that invests its capital in the world capital market to finance the import of consumption goods. This helps to moderate the negative effects of ageing on consumption.

Higgins (1998) combines empirical analyses of national savings and investment rates to project the effect of changes in the demographic structure on the current-account balances of a number of countries. Although there are significant differences between countries, he finds that ageing pushes countries towards current-account surpluses. In reality, however, this rentier effect may not be as strong as the small-open-economy model suggests. For example, capital may not be as mobile internationally as the model assumes (see Section 7). Also, the switch to a

rentier economy may have effects on the structure of the economy that are not included in our simple model. If, for example, the economy is comprised of two sectors of production (one producing labour-intensive services that are not internationally tradeable and another producing tradeable capital-intensive commodities), then the switch to a rentier economy will be accompanied with a switch to a more service-oriented economy. This may lead to a form of "Dutch disease" and hamper innovation and economic growth (see e.g., Van Groezen et al. (2005)). As shown by Bettendorf and Dewachter (2007), demographic changes may also affect the price of tradeable relative to non-tradeable goods, leading to effects that cannot be analysed in our simple model.<sup>21</sup> In the same vein, Sadka and Tanzi (1998) point to the real exchange-rate risk confronting pension funds. This risk is absent if governments adopt an exchange-rate policy aimed at maintaining purchasing power parity, as we implicitly assume in our model. However, a government may not strictly adhere to such a policy if ageing leads to a large outflow of capital, transforming the economy into a rentier economy. The most important problem with the small-open-economy model is, however, that ageing is actually a global phenomenon (see Figures 4 and 5). If many countries start to lend capital to the international capital market, then the interest rate will fall and the assumption of given factor prices will no longer hold. Therefore, we now analyse ageing in a closed economy, which takes account of all general-equilibrium effects.

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21 If, for example, in a two-sector Blanchard–Yaari overlapping-generations model, non-traded goods are used for investment purposes, then the increasing marginal cost of production in the non-traded sector implies economy-wide adjustment costs of investment that affect the adjustment path after a demographic shock, see Bettendorf and Heijdra (2006).

#### 4. Ageing in a closed economy

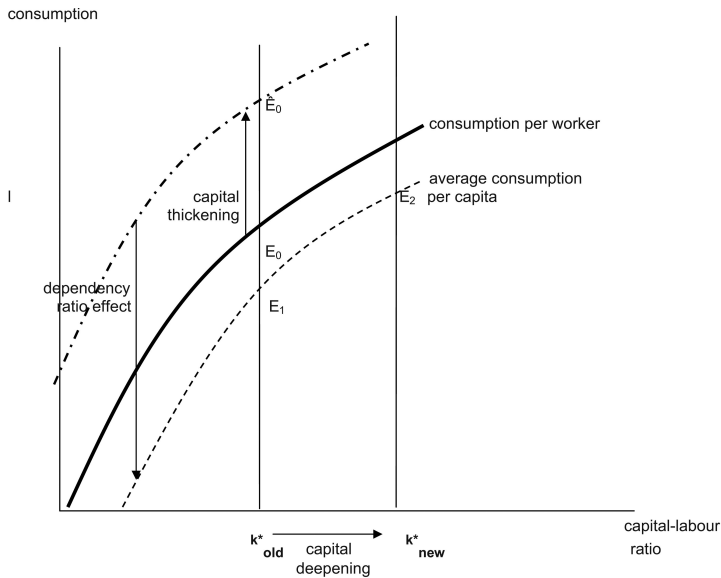
This section discusses the long-run effects of ageing in a closed economy. As in this model the effects of a decrease in fertility and an increase in longevity are qualitatively the same, we present only the former case. We first analyse the effects when there are no PAYG pensions. Subsequently, we discuss how the conclusions change if a PAYG scheme is assumed.

##### 4.1 No PAYG pensions

The effects of ageing in a closed economy are illustrated in Figure 6. In contrast to a small open economy, the closed economy cannot invest its additional savings abroad to moderate the negative effects of ageing. So there is no rentier effect on the consumption possibility curve but only a capital-thickening effect and a dependency-ratio effect. In general, the net result of both effects is ambiguous. However, it can easily be established that in case of a Diamond-Samuelson model without intergenerational transfers, for a given capital-labour ratio, the net effect on average per capita consumption is negative if the economy is dynamically efficient (Meijdam and Verbon, 1997, proposition 2).

In contrast to the small open economy, in a closed economy, the capital-labour ratio is not determined exogenously but depends on the savings decisions, so we can now have shifts along the consumption possibility curve. In particular, if ageing leads to higher savings, this will increase the capital-labour ratio, which (assuming dynamic efficiency) raises consumption per worker in the long run. The decrease in average per capita consumption possibilities for a given capital-labour ratio indeed implies that consumption when young falls and that savings and the capital-labour ratio rise (cf. eq. 13). This capital-deepening effect implies a shift along the consumption possibility curve to the right in Figure 8, and thus raises the consumption possibilities per worker. It can easily be shown that this increase in consumption possibilities dominates the other effects. That is, the net result of the dependency-ratio effect, the capital-thickening effect and the capital-deepening effect on consumption possibilities (and thus on lifetime utility) is positive (Heijdra and van der Ploeg, 2002, section 17.2.3). This result for the two-overlapping-generations models is confirmed by simulation studies using more detailed models with large numbers of overlapping generations (see for example Auerbach and Kotlikoff, 1987, Ch. 11). Moreover, Heijdra and Ligthart (2006) find the same

Figure 9: An decrease in fertility in a closed economy



result for a Blanchard–Yaari type of overlapping–generations model. So we can conclude that in a dynamically efficient closed economy without unfunded pensions, ageing raises the capital–labour ratio and thus welfare in the long run.

#### 4.2 PAYG pensions

The conclusion that ageing raises welfare in a closed economy because it raises the capital–labour ratio may change, however, if there is a PAYG pension scheme. Then, the negative dependency–ratio effect is larger than without pensions as, due to the PAYG transfers, the consumption of retirees is relatively large (i.e., the downward shift of the consumption curve is larger than in Figure 6). Another way of interpreting this is that ageing now has an additional negative effect, as it reduces the implicit rate of return to the PAYG contributions.

On the other hand, in case of fixed contributions to the PAYG scheme, the lower implicit rate of return of this scheme implies that PAYG benefits will fall and the incentive to save for old age will rise. So the capital–labour



ratio rises more, and the positive capital-deepening effect is reinforced (the shift to the right is larger than indicated in Figure 6). Adding all of the effects shows that the total net effect of ageing on welfare is ambiguous when PAYG contributions are fixed: if the size of the PAYG transfer is sufficiently large, then the negative effects will dominate the positive effects of a lower fertility, and lifetime utility will fall (Heijdra and van der Ploeg, 2002, section 17.2.3).

In case of a pension scheme with defined benefits, the total effect of a decrease in fertility on long-run welfare is more likely to be negative than with fixed contributions. The reason is that ageing now raises the PAYG contributions. That is, the inefficient PAYG scheme is extended and for a given level of savings, consumption when young falls and consumption when retired remains unchanged. Individuals will compensate this by saving less. As a consequence, the capital-labour ratio rises less (or may even fall). So there will be a weak capital deepening or none at all. Adema (2008, Appendix 2B) shows that for reasonable parameter values there is a positive capital-deepening effect if fertility falls.<sup>22</sup> In general, however, this is not strong enough to prevent a decrease in utility.

In case of an increase in longevity instead of a decrease in fertility, the positive capital-thickening effect is absent and the total effect on utility is more likely to be negative.

#### 4.3 Conclusion and modifications

We can conclude that in a closed economy without PAYG pensions, ageing in the long run raises the capital-labour ratio, which increases consumption and utility. The existence of a PAYG scheme weakens this positive effect of ageing on the capital-labour ratio in a closed economy and, if the system is extensive, it may even cause consumption and utility to fall.

#### Modifications

Of course, also in a closed-economy ageing may have effects on the sector structure of the economy that are not included in our simple model. Van Groezen et al. (2007), for example, show that in a two-sector economy

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<sup>22</sup> If, e.g.,  $f(k) = k^{0.3}$ , a period is 30 years, capital depreciates at 5% per year, time preference is 1% per year, and  $\varepsilon = 0.94$ , then the capital-deepening effect is positive as long as the PAYG tax is below 55% of the wage rate.

where the elderly consume a relatively large share of labour intensive services, ageing leads to wage increases, which raises the relative price of services. This inflation implies a decrease in the real return on savings. Consumers react to this with an extra increase in savings, which makes dynamic inefficiency more likely to prevail, especially if people strongly prefer a smooth pattern of consumption over their lifetime.

Another element that by construction is absent in our two-overlapping-generations model is *age-related demand for assets*: workers, as they grow older, may systematically vary their investment portfolio. If these age-related preferences remain constant over time, then shifts in the age composition of the population can have important effects on demand for different kinds of assets. These shifts in relative demand may affect asset prices and relative returns of different asset classes. An important example of this effect is the effect of ageing on housing demand and house prices, as studied in Mankiw and Weil (1989) for the US. They concluded that the two-decade rise in home prices starting in the late 1960s was mainly driven by the entry of the large baby-boom generation into age groups in which housing demand was rising rapidly. They forecasted a substantial long-term decline in home prices after 1980. Bosworth et al. (2004) show that for many years this prediction proved incorrect, as since the beginning of the 1990s the real price of homes sharply increased, while the demographic housing demand as calculated by Mankiw and Weil decreased. By now, we know that this may not have been more than a temporary bubble, and that the demographic fundamentals of the housing market may be more important than seemed to be the case in 2004. A second important channel of influence of the population age structure on asset prices is the relation between age and the share of the portfolio held in risky assets: it is generally believed that the older a person gets, the more risk averse (s)he becomes. Evidence for this was found by, e.g. Riley and Chow (1992), Bashki and Chen (1994), and Pålsson (1996). As a consequence, this would imply that the optimal share of wealth invested in risky assets decreases with age (see for example De Jong et al., 2008). Bosworth et al. (2004) report mixed evidence for this. However, other studies such as Poterba (2001) and Davis and Li (2003) point out the effect that the age structure of the population has on asset prices and returns; they find that the fraction of young people has a significantly positive effect on real equity prices. This relation between age structure and asset prices or asset returns is not included in our model. For a simple

stochastic overlapping-generations model that can be used to analyse this relation, see Geanakoplos et al. (2004). This model predicts that the price-earnings ratio should be proportional to the ratio of middle-aged to young adults, while the real rates of return on equity and bonds should be an increasing function of the change in this ratio. The authors compare the results of their model to the stylised facts on the US bond and equity markets in the past century. They find that the price-earnings ratio and the rate of return on equity fit the predictions quite well. The behaviour of the real interest rate departs much more from the model prediction and only after 1965 is significantly correlated with demographic developments.

If older individuals prefer to hold less risky assets, one would expect that a rise in the average age of the population would increase the risk premium between stocks and bonds. The findings of the very few papers that investigate this relationship often contradict each other. Bashki and Chen (1994), for example, confirm the above hypothesis and find that a rise in the average age increases the risk premium in the United States. Using a stochastic four-period OLG model, Brooks (2002) finds that the equity premium declines in the early stage of a 'baby boom' and then increases when the large cohort is old. The stochastic model of Geanakoplos et al. (2004) predicts, however, that the equity premium is smaller when the population of savers is older. This result is confirmed by Ang and Maddaloni (2005), who point out that the relationship between population age structure and the risk premium differs between countries. They show that the pattern that is found for the United States by Bashki and Chen (1994) does not extend to other countries. Pooling international data, they find that faster growth in the fraction of retired people decreases the risk premium. The model used in this paper is a deterministic model that features no difference in asset returns; we will therefore not analyse the effects of ageing on the risk premium.

Also, we have assumed labour supply to be exogenous. With endogenous labour supply, ageing affects the size of the labour force not only directly, but also indirectly via the labour-supply decision of the young. Ageing will –*ceteris paribus*– have an upward effect on the capital-labour ratio and gross wage. On the one hand, this stimulates individuals to supply more labour because it is more rewarding (substitution effect); on the other hand, with a certain number of hours worked, a person already earns more, allowing that individual to enjoy more leisure time without a drop in income (income effect). Depending on which of these two effects

dominates, labour supply increases or decreases after a rise in the wage rate. Overall, most empirical research<sup>23</sup> has found labour–supply elasticities close to zero for breadwinners, implying that both effects cancel out, which justifies our assumption of exogenous labour supply. For other categories, such as partners of breadwinners, the substitution has been found to dominate. In that case, labour supply will increase after a rise of the wage rate. This will dampen the effect of ageing on the capital–labour ratio. Of course, the design of the pension scheme (and pension reform) plays an important role too. If a country has a large PAYG scheme with defined benefits, then ageing leads to higher contribution rates and lower net wages. If this effect dominates, labour supply can actually decrease. But in case of defined contributions, ageing leads to lower (future) benefits, which stimulates labour supply when young, depending on the degree of actuarial fairness. The extent to which it matters whether or not one allows for endogenous labour supply can be shown with numerical calculations; this will be discussed in Section 8.2.

Finally, note that in our model labour supply is measured in labour–efficiency units, implying that labour supply is affected not only by changes in supply in hours, but also by changes in labour productivity. Labour productivity is assumed to grow at an exogenous constant rate. However, ageing may affect productivity through various channels. For example, the increase in wages caused by ageing may incite firms to invest more in labour–augmenting technological progress, which would partly offset the increase in labour scarcity. On the other hand, labour productivity of older workers may be lower than that of young workers, so that an increase in the average age of workers due to ageing may lower average labour productivity.<sup>24</sup> Also, older workers may be less willing to accept new technologies (see Canton et al., 2002). Finally, as mentioned above, ageing may cause a shift in the structure of the economy towards more service production. If technological development in the labour–intensive service sector is lower than that in the capital–intensive commodity sector, this will lead to lower productivity growth (Van Groezen et al. (2005)).

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23 See e.g. Blundell and MaCurdy (1999) for an overview.

24 For an overview of the literature on the relation between age and productivity, see for example Euwals et al. (2009).

## 5. Policy reactions to ageing

Our analysis thus far has explored the effect of demographic shocks, taking the pension scheme as given. That is, we have not taken into account policy reactions to the ageing of the population. This section discusses the effects of various policy reactions. First, we present the effects of exogenous policy changes in reaction to ageing (including a (partial) replacement of the PAYG scheme by funded pensions, an increase in government debt, and stimulating labour-market participation). Second, we discuss the effects of demographic shocks in models where intergenerational redistribution is endogenous. That is, we analyse ageing in models with altruism, where decisions on intergenerational transfers (including not only PAYG pensions and government debt, but also bequests) follow from intertemporal optimisation by a dynasty or a government.

### 5.1 Government debt

The increase in the old-age dependency ratio caused by ageing puts pressure on the government budget. If strong reductions in benefits for the elderly are to be prevented, the intergenerational transfers that exist not only within the pension scheme but also in health-care and so forth imply that tax rates will have to rise. Governments have some freedom in choosing the timing of taxation, however. That is, governments may use government debt to roll over part of the burden to future generations. Although this may be done for purely political reasons, it may also be motivated by efficiency reasons, especially in case of a temporary demographic shock (like a baby boom). It is well known that it is efficient to smooth tax rates over time (Barro, 1979). This implies that a government should raise its debt when a temporary increase occurs in the dependency ratio. It also implies, however, that it should immediately raise taxes and lower its debt when a future increase in the dependency ratio is anticipated.<sup>25</sup>

The effect of a higher public debt on the capital-labour ratio (in a closed economy) or on international capital flows (in a small open economy)

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<sup>25</sup> The creation of a saving fund for PAYG pensions like the so-called 'AOW-fonds' in the Netherlands may also be interpreted as a temporary decrease in net government debt. This also holds for the US Social Security Trust Fund (if revenues exceed payments), which is used to buy government bonds.

depends crucially on the extent to which private savings react. If citizens are fully aware that a higher public debt implies higher future taxes, and in response they increase their savings by the same amount as the rise in public debt, then Ricardian equivalence (Barro, 1974) asserts that there will be no effect on national savings. Consequently, the capital–labour ratio or net foreign asset holdings will not be affected. However, Ricardian equivalence requires a very restrictive set of assumptions to hold.<sup>26</sup> Empirical research generally rejects Ricardian equivalence, although some studies have found Ricardian effects in saving behaviour.<sup>27</sup>

If public debt increases without an equally large increase in private savings, this will lead to crowding out of the private capital (i.e., a lower capital–labour ratio, or a negative effect on net foreign asset holdings). Assuming dynamic efficiency, future utility will be lower in both cases. So, without an equally large increase in private savings, the creation of government debt implies intergenerational redistribution of welfare: current generations gain due to lower taxes, but the welfare of future generations will be lower. It is interesting to note that in a closed economy the lower capital–labour ratio that results if government debt is increased, implies lower wages and a higher return on capital. This is advantageous for the position of pension funds offering a defined–benefit pension (like many Dutch occupational pension schemes do). In the same vein, lowering public debt (or introducing saving funds for PAYG pensions) in view of anticipated ageing worsens the position of defined–benefit pension funds (Sadka and Tanzi, 1998). This effect on factor prices is of course absent in a small open economy. However, as noted by (Sadka and Tanzi, 1998), the effect of changes in government debt on the real exchange rate may have comparable results for the position of defined–benefit pension funds.

### *5.2 Pension reform*

In view of the rising dependency ratio and the resulting decrease in the rate of return of the PAYG scheme, many countries are considering pension reform (i.e., a (partial) replacement of the PAYG scheme by funded pensions). This could take several forms. Within the existing pension scheme, public pensions (the so-called ‘first pillar’) could be reduced,

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26 For example, it requires generations to be sufficiently altruistic towards future generations (see Section 5.4); this is not a usual assumption in 2-OLG models.

27 For a review of the literature on Ricardian equivalence, see for example Briotti (2005).

while at the same time private, collectively arranged pensions (the 'second pillar', often managed by pension funds) could be increased. Alternatively, the reduction of public pensions could be accompanied by an increase in private savings by individuals (such as the 401(k) plans and IRA accounts in the US). Such a reform raises not only savings by the young, but also (assuming a growing number of young individuals) aggregate savings. In a small open economy, this results in a flow of capital to the rest of the world. In a closed-economy setting, it raises the capital-labour ratio. As is evident from the Aaron condition, assuming dynamic efficiency, this raises the welfare of the currently young and future generations. However, without supplementary policies, it harms the elderly during the transition.

The government may want to compensate the elderly in case of a pension reform. This is possible via the creation of government debt. As explained above, if Ricardian equivalence does not hold, then government debt implies intergenerational redistribution of welfare. Consequently, if the elderly during the transition are compensated, then the gains from the pension reform for current and future generations of young people will be lower. A pension reform would be very attractive if, after compensating the elderly, the net welfare effect for future generations were still positive. Unfortunately, this is not the case: it is well-known that a PAYG pension scheme is Pareto efficient. That is, abstracting from distortions by the PAYG scheme (other than the crowding out of private savings) it is not possible to have one generation gain from decreasing the size of the PAYG scheme without harming at least one other generation. This applies to both a small open economy (Verbon, 1989) and a closed economy (Breyer, 1989).

### *5.3 Increasing labour-market participation*

Another policy reaction considered in many countries is focused on increasing labour supply: for example, through increasing the effective retirement age or the labour supply of women. Evidently, if such a policy is effective, it lowers the capital-labour ratio in a closed economy, leading to lower wages and a higher interest rate. These effects may be reinforced if the degree of utilisation of human capital stimulates investment in schooling. The effect of this type of policy on utility is ambiguous. In an economy without any distortion of the labour-supply decision, a policy of stimulating labour supply would introduce a distortion and thus lower welfare. In reality, labour-supply decisions are distorted by many factors such as taxes, early retirement schemes, or a fixed retirement age. If the

policy is to stimulate labour supply by eliminating or reducing such an existing distortion, this may increase welfare. Given that there are typically a large number of distortions, this is by no means guaranteed, however: second-best theory teaches that distortions may interact and reducing one distortion does not necessarily raise welfare.

In a small open economy, increasing the labour supply results in an inflow of capital instead of a drop in the capital-labour ratio, implying that it is more likely to increase welfare than in a closed economy. It should be noted that such a policy has a negative international externality comparable to that of introducing a PAYG scheme (discussed earlier in Section 2.5). Consequently, the welfare effects will be smaller (or even negative) if many countries apply the same policy and there may be scope for policy coordination.

#### *5.4 Altruism and bequests*

The Diamond-Samuelson model discussed earlier abstracts from intergenerational altruism (i.e., individuals have finite horizons and do not care about their descendants). Instead, one may assume that people value their children's happiness (see Barro, 1974). That is, one may assume that a person derives utility not only from his own lifetime consumption, but also from the prospective utility of his children, and that that person uses bequests as an instrument to affect the latter.<sup>28</sup> It can easily be shown that this, in principle, transforms the overlapping-generations model into a dynastic model, comparable to the well-known Ramsey model (see Weil (1987) and Kimball (1987)). In such a model, decisions are derived from maximising a dynastic welfare function including utility of all current and future generations. Two types of dynastic welfare functions can be distinguished: a Benthamite welfare function and Millian one. The former type of welfare function results from the altruistic model if the prospective utility of a child is weighted by the number of children. A Millian welfare function results if altruism is modeled as parents taking account of the utility of a representative child, disregarding the number of children. The

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28 Alternatively, one could assume a joy-of-giving model, where parents derive direct utility from the size of the bequest they leave (Yaari, 1965). It should be noted that we analyse only intended bequests. We excluded unintended bequests by assuming perfect annuity markets. For the effect of PAYG pensions on accidental bequests, see Abel (1985). Also note that we exclude strategic altruism, i.e., intergenerational transfers as payment for services provided by children (Bernheim et al., 1985).



effect of changes in fertility crucially depends on which type of welfare function is assumed. Canton and Meijdam (1997) show that in a closed economy with a Millian welfare function, a decrease in fertility raises the capital-labour ratio. That is, with a Millian welfare function there is a capital-deepening effect similar to the effect described above in the non-altruistic case. With a Benthamite welfare function, however, the capital-labour ratio is not affected by fertility. The intuition for this is that (with a Benthamite welfare function) fewer births imply a reduced weight on future generations in dynastic preferences. There is no need to endow them with more capital than the current cohort. Therefore, bequests sharply fall, implying a strong decrease in savings (see Bohn, 2006).

There is one caveat in the analysis of altruism and bequests so far: bequests cannot be negative, as parents cannot force children to make transfers to them. Therefore, the correspondence between altruistic overlapping generations and the Ramsey model only holds when altruism is strong enough to exclude negative transfers to future generations. However, different from private households, governments are able to enforce transfers from children to parents. In fact, a PAYG scheme is nothing more than a mechanism to enforce such transfers. Government debt is yet another mechanism to do so. Government debt or a PAYG scheme can therefore be rationalised as the outcome of optimising a dynastic social welfare function with a relatively low degree of altruism towards future generations. So the results for the altruistic model also apply if we assume the existence of a welfare-maximising government using intergenerational transfers as an instrument (Meijdam and Verbon, 1997). In fact, it is not necessary to assume that the government takes the utility of all future generations into account and sets intergenerational transfers over an infinite horizon. The same outcome is reached if the government during each period determines the intergenerational transfer so as to maximise a weighted sum of utilities of the generations living in that period, taking future transfers as given (Meijdam and Verbon, 1996).

## 6. International spillover effects via capital markets

As discussed in Section 2.1, the return to capital (the interest rate) is determined by the size of the capital–labour ratio. If a country is a closed economy, then population ageing or changing savings behaviour results in changes in this ratio, leading to a different value of the interest rate. However, most economies nowadays have open borders, allowing investors to include foreign assets in their portfolio, thereby transferring part of their (financial) capital to other countries. In the extreme case a country can be seen as a small open economy where the capital–labour ratio and the interest rate are determined on the world capital market. This section considers the intermediate case by assuming that the world consists of two countries of the same size that are large enough to affect the capital–labour ratio. In so doing we take into account not only the effects via changing factor prices (as in the closed–economy case), but also the effects via capital flows (as in the small–open–economy case). If one country is larger than the other, the effects for the larger country will move towards the effects in a closed economy, while the effects for the smaller country resemble more the effects in a small open economy. This framework allows us to analyse how countries affect each other when they differ in their ageing pattern, pension systems, policy reactions, and so forth.

Capital flows will occur –*ceteris paribus*– from countries with an initially high capital–labour ratio to those with a low capital–labour ratio, until interest rates are equal.<sup>29</sup> This then automatically implies equal values of the capital–labour ratio and wages. Any disturbance that causes asymmetric effects on the capital–labour ratio between countries, and thereby on the interest rates, triggers international capital flows. These capital flows will also affect the well being of people. The utility effects of these capital flows are referred to as international spillover effects via capital markets. This section analyses these international spillover effects of capital flows. We distinguish between international spillovers resulting from demographic factors, institutional factors, factors relating to individual preferences, and policy reactions.

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<sup>29</sup> The following discussion assumes a situation of perfect international capital mobility. See Section 7 for a discussion of imperfect capital mobility.

### 6.1 Capital flows and demographic factors

Capital flows caused by demographic factors occur if countries experience a different timing or extent of population ageing. This can be illustrated with an example of two countries, A and B. A country's capital stock,  $K^i$  ( $i = A, B$ ), is financed with domestic savings,  $S^i$ , and net foreign investments,  $F^i$ , so  $K^i = S^i + F^i$ .<sup>30</sup> If  $L^i$  denotes the total number of labour-efficiency units, the capital-labour ratio is given by  $K^i / L^i$ . International capital mobility implies that these ratios are equal:  $K^A / L^A = K^B / L^B = k$ , and that one country's capital outflow equals the other country's capital inflow ( $F^A + F^B = 0$ ).

Country  $i$ 's old-age dependency ratio is denoted by  $\mu^i$ , and net foreign assets per labour-efficiency unit by  $f^i \equiv F^i / L^i$ . For the moment we assume that aggregate savings are constant. If the total population size does not change (so that ageing is merely an increase in inactive people and a decrease in active people), and labour-participation rates do not change either, then the change in the capital flow into country  $A$  can be written as

$$\mathbf{d}f^A = \frac{L^B}{L^A + L^B} k \left( \frac{\mathbf{d}\mu^B}{1 + \mu^B} - \frac{\mathbf{d}\mu^A}{1 + \mu^A} \right). \quad (22)$$

From this we can clearly see that if country  $A$  experiences relatively more ageing compared to country  $B$ , then  $\mathbf{d}\mu^A / (1 + \mu^A) > \mathbf{d}\mu^B / (1 + \mu^B)$  holds, which implies a capital flow from country  $A$  to country  $B$  (i.e.,  $\mathbf{d}f^A < 0$ ). This will be more pronounced if the initial capital-labour ratio is high and if country  $A$ 's labour force is smaller than that of country  $B$ . The reason is that if one country has a more severe ageing of its population than the other, its labour force will shrink more. This makes capital relatively more abundant ( $k^A > k^B$ ), which has a stronger downward effect on the interest rate ( $r^A < r^B$ ). Consequently, capital will flow from that country to the country where ageing is not as strong ( $\mathbf{d}f^A < 0$ ,  $\mathbf{d}f^B > 0$ ) until the interest rates, and thereby the capital-labour ratios, are again equal.

If the two countries were identical in the initial steady state, these capital flows imply that country  $A$  becomes a net lender on the international capital market and country  $B$  a net borrower. Compared to the closed-economy case, these international capital flows result in a lower capital-labour ratio for country  $A$ , while the capital-labour ratio is higher in

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30 Note that if  $F^i$  is negative, the country is investing part of its savings abroad.

country  $B$ . Now we present a framework to analyse the welfare effects of these capital flows.

### *Long-run utility effects*

As explained in Box 4 in Section 2.2 a rise in the capital-labour ratio will have positive utility effects in the long run in a dynamically-efficient closed economy. This effect is also present in the open-economy case, where we allow for capital flows between countries. There is, however, an extra current-account effect, which becomes more evident if we rewrite equation (14) to

$$\frac{dEU}{dk} = \frac{u'(c^y) f''(k)}{1+r} [k(g-r) + s - k(1+g)] \quad (23)$$

The first term between the brackets shows the golden-rule (GR) effect that was also present in the closed-economy case. A higher capital-labour ratio implies a lower interest rate  $r$  and less capital underaccumulation; the economy will therefore be closer to the golden-rule point where consumption per capita is maximised ( $r=g$ ). The second and third terms represent the so-called current-account (CA) effect. The direction of this effect crucially depends on whether a country is a net borrower or a net lender on the international capital market. If a country is a net borrower,  $s < k(1+g)$  holds, and this CA effects reinforces the positive GR effect. The intuition is that the lower interest rate that results from a higher capital-labour ratio is advantageous for a country that borrows money. This implies that a rise in the capital-labour ratio will unambiguously have positive utility effects for a country that is a net borrower. The country that has less severe population ageing (country  $B$ ) will therefore experience unambiguously positive utility effects in the long run from the capital inflow. If a country is a net lender, however,  $s > k(1+g)$ , and the CA effect will dampen the positive GR effect (as the lower interest rate hurts a country that is an exporter of financial capital). A higher capital-labour ratio will therefore have ambiguous effects on the utility of individuals living in a country that is a net lender on the international capital market. If an economy finds itself far enough from the golden-rule level of capital accumulation, the GR effect will dominate the CA effect. Adema (2008, Appendices 2.C.2. and 3.A.2) show that this is the case for realistic parameter values. This allows us to conclude that lifetime utility increases if the capital-labour ratio increases in a dynamically-efficient open

economy. As the outflow of financial capital results in a lower capital–labour ratio in the country that ages relatively more (country *A*) compared to the closed–economy case, this country experiences negative spillover effects from the fact that it has one capital market with a country that ages less. The country with less severe population ageing (country *B*), on the other hand, benefits from the fact that it shares a common capital market with country *A*.

### *Data and empirics*

Figure 1 in the Introduction shows the projected development of old–age dependency ratios for several European countries. Ageing will be more pronounced in southern European countries (like Spain and Italy), and less so in France and the Netherlands. This would –*ceteris paribus*– imply a capital flow from the former to the latter countries.

Within the OECD (see Figure 2), capital flows based on different demographic developments are expected to occur from European countries and especially Japan to the United States. At the global level, China will experience relatively little ageing until 2025, implying that the current large capital outflow from China might be reduced in the coming decades if the more–developed regions have higher old–age dependency ratios. In the years thereafter, however, the Chinese old–age dependency ratio will sharply increase, which will increase the capital outflow again. The less– and least–developed countries, on the other hand, face a much smaller ageing population and are therefore expected to experience capital inflows.<sup>31</sup> The above analysis of the international spillovers then shows that, based on differential ageing patterns, a country like the Netherlands gains from the fact that southern European countries have a more severe ageing of their population as this might lead to an inflow of financial capital. On the other hand, other regions in the world (like the US and developing countries) have populations that age less, and there might be a net capital outflow from the Netherlands to these countries, so that ultimately, the long–run welfare of the Dutch is affected negatively.

Several empirical studies confirm that demographic factors matter for international capital flows. Drawing on time–series and cross–section data

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31 Note that this is solely based on comparative demographic developments. Naturally, other factors (such as technological progress, education, and political developments) play an important role too.

for 100 countries, Higgins (1998) shows that for the period 1950–1990, differences in the timing of demographic change across countries and regions affect international capital flows. Countries with a higher old-age dependency ratio have higher savings compared to domestic investments, and are therefore capital exporters. Lane and Milesi-Ferretti (2001) find that long-term capital movements are explained by a small set of fundamentals, among them demographic factors: a country's net foreign asset position, caused by a capital outflow to other countries, is positively influenced by a higher share of workers close to retirement. However, this does not hold for the people older than 65. Lührmann (2003) even demonstrates that demographics is the most important determinant of cross-border capital movements. Domeij and Flodén (2006) use a standard neoclassical growth model with demographics that is consistent with the life-cycle hypothesis, and find that the data generated by the model can explain a small but significant fraction of real-world capital flows between 18 OECD countries from 1960 to 2002, particularly after 1985 (which is consistent with increasing international capital mobility in the last decades).

### *6.2 Capital flows and institutional factors*

Apart from demographic factors, institutional factors also determine the size and direction of capital flows. The institutional factors consist of different types of pension schemes, fiscal treatment of retirement savings, and early retirement arrangements.

#### *Funded versus PAYG pensions*

The first institutional factor involves the degree of funding in pension schemes, which affects savings and thereby the supply of capital. As was shown in Equation (19), an unfunded or PAYG scheme has a negative effect on savings. So if one country (say country  $A$ ) mainly finances its pensions with a PAYG scheme, savings will be relatively low, implying a low capital-labour ratio and high interest rate if it were a closed economy. But if the country has an integrated capital market with another country ( $B$ ), which has a larger degree of pension funding (through e.g., pension funds or private savings accounts), then an international capital flow will occur from the country with a funded scheme to the country with an unfunded scheme. The size of this capital flow into country  $A$  is given by

$$f^A = \frac{L^B}{L^A + L^B} (s^B - s^A), \quad (24)$$

which obviously is positive if per capita savings in country  $B$  are higher than in country  $A$ , due to the presence of a more generous PAYG scheme in the latter country. The capital flow from country  $B$  to country  $A$  will affect people in the latter country positively, while long-run welfare will fall in the country with relatively more funding, under realistic parameter values.

Table 1: Pension pillars in 2003 (%)

	First pillar	Second pillar	Third pillar
France	97	1.5	1.5
Spain	97	1.5	1.5
Italy	96	2	2
Germany	94	4	2
Sweden	75	20	5
Netherlands	56	37	7

Source: Boeri et al. (2006).

Table 1 shows the relative size of the three pension-scheme components in several European countries, and Table 2 shows the amount of pension funds' assets. In Spain, France, Italy and Germany, the first pillar (which consists of PAYG-financed retirement income) is the most important part. In other countries, such as the Netherlands, Sweden, and Anglo-Saxon countries like the United States and the UK, the funded part is more substantial.

Table 2: Autonomous pension funds' assets % of GDP in 2007

France	1	Canada	55
Italy	3	United States	77
Germany	4	United Kingdom	79
Japan	7	Australia	105
Spain	8	Netherlands	138

Source: OECD Global pension statistics

The degree of funding is also important for the effects of population ageing on the capital-labour ratio. Countries with a (largely) funded pension scheme would experience a larger increase in their capital-labour ratio if they were closed economies, due to the fact that their savings and capital stock are high, compared to countries with extensive PAYG schemes. With open borders, ageing in both countries will therefore imply an additional

capital flow from the country with a mostly funded scheme (like the Netherlands, Australia and the United States) to the country with a basically unfunded scheme (like France, Italy and Germany). Put differently, the capital-deepening effect is smoothed over both countries.

These capital flows result in long-run positive spillover effects for the PAYG country, which benefits both from the higher capital stock and the resulting lower interest rate on its borrowings from abroad. The funded country, on the other hand, is negatively affected by the lower capital stock, but gains from the resulting higher interest rate (as it is a lender on the international capital market). For realistic parameter values, the first effect dominates and therefore a country with funded pensions is in the long run adversely affected by the existence of a PAYG scheme in the other country if the population is ageing. As most EMU countries mainly use PAYG pension schemes, a country like the Netherlands (relying to a relatively large extent on funded pensions) can be considered as relatively small. If the funded country is smaller than the PAYG country, the negative spillover effects for the funded country become larger (as the capital outflow will be larger).

#### *Fiscal treatment of retirement savings*

As was discussed in Section 2.5, the special fiscal treatment of pension savings through an EET regime can affect the savings decision of households, and thereby aggregate private savings in a country. Apart from this, the fiscal treatment of pension savings also influences the effect of demographic developments on national savings. With an EET regime, retirement savings (such as contributions to a pension fund) are tax deductible, while the pension benefits are taxed when paid out to retirees. For the government, this implies lower tax revenues when a vast part of the population is of working age, leading –*ceteris paribus*– to a higher government deficit and lower national savings. If people anticipate future ageing by saving more, these higher private savings are partly offset by the higher government deficit. On the other hand, when the ageing process actually occurs, relatively many people receive pension benefits and pay income taxes. The reduction in private savings is then partly offset by a lower public deficit compared to the situation without an EET regime. Hence, such a fiscal treatment dampens the effect of population ageing on national savings. Consequently, it will also affect the timing, size and



possibly the direction of international capital flows, especially if the countries involved have different fiscal treatments.

*Defined benefits versus defined contributions*

Another factor that matters for the effects of ageing on the capital-labour ratio is the degree to which either contributions or pension benefits adjust to shocks; that is, whether the system is characterised by defined benefits or defined contributions.<sup>32</sup> In case of a PAYG scheme with defined benefits, ageing implies that contributions made by younger generations will have to increase to pay for the pension promises made to the retired.<sup>33</sup> Consequently, savings will decrease, and more capital will flow from the funded to the unfunded country, reinforcing the negative spillover effect of the unfunded system for the funded country. However, if the PAYG scheme is characterised by fixed contributions, then ageing means lower pension benefits and forward-looking individuals will respond to this by increasing their savings. The difference with the country with a funded scheme will become smaller, and less capital will flow into the country with an unfunded scheme. The international spillovers will therefore also be smaller for both countries.

Something similar holds for a funded scheme. Although such a scheme is not directly affected by population ageing, it can experience considerable indirect effects through downward pressure on the interest rate caused by ageing. Here, too, a distinction can be made between defined contributions and defined benefits. With defined benefits, a lower return to capital must be compensated by higher contributions of the young. In that case, a PAYG element enters the funded scheme, which acts like an insurance, and savings will consequently decrease. The increasing effect on the capital-labour ratio will then be dampened, as will changes in international capital flows, if all funded countries run such a scheme. On the other hand, a lower interest rate will decrease pension benefits in case of a defined-contribution scheme. Forward-looking individuals will respond to this by increasing their private savings (if the income effect dominates the substitution effect). In the latter case, the capital-

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32 Also referred to as intergenerational risk-sharing factors.

33 This also applies to full indexation of pension benefits.

deepening effect and international capital flows (and thus the international spillovers) are reinforced.<sup>34</sup>

### *Early retirement*

The last institutional factor concerns early retirement programs, which affect labour supply. If countries have different early retirement schemes, this will –*ceteris paribus*– lead to differences in labour supply.<sup>35</sup> With generous programs providing incentives to retire early, labour supply will be lower compared to other countries, which has an upward effect on the capital–labour ratio. This leads to a capital flow to other countries with less generous early–retirement programs. This can also be seen from equation (24). If both countries have the same aggregate savings, but people in country *A* retire earlier than in people in *B*,  $L^A$  will be lower than  $L^B$  and consequently  $s^A > s^B$ . This will lead to capital flows out of country *A* ( $f^A < 0$ ).<sup>36</sup> This capital outflow will affect people living in the country with the more generous early–retirement scheme negatively in the long run.

### *6.3 Capital flows and preferential factors*

Preferential factors can also play a role. If citizens of one country have a higher rate of time preference than citizens of another country, savings will be higher in the latter (see also equation (19)). As with a difference in the degree of pension funding, this leads to a capital flow to the country with a high rate of time preference (see e.g., Buiters (1981)). It has always been held that people in Japan have a relatively low rate of time preference, as saving rates were very high in the past, reaching a peak of 24 percent of disposable household income in the 1970s. During the last decade, however, saving rates in Japan declined dramatically from 11.8% in 1998 to 3.1% in 2008 (OECD, 2008), indicating that time–preference rates went up. In the US saving rates are even smaller: 0.6 percent in 2008, implying that

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34 As was shown in Box 2 in Section 2.2, with a Cobb–Douglas utility function both effects cancel out, and a change in the interest rate has no effect on savings.

35 This actually holds more generally for differences in labour efficiency and differences in all sorts of labour–market institutions.

36 Of course, also here the degree of funding is important: if people finance their early retirement by saving more,  $s^A$  will be higher than  $s^B$ , implying an even bigger capital outflow from country *A*. However, if early retirement is financed on a PAYG basis, this negatively affects savings in country *A*. If this latter effect dominates, the opposite happens: capital will flow into country *A*.

individuals in the US have a high rate of time preference. In Europe, on the other hand, saving rates are still relatively high (9.3% in the Euro area) and therefore people in Europe are relatively patient and have a low rate of time preference. The framework in Section 6.1 then shows that the US gains from the capital inflow, while EMU countries lose (as capital flows out of these countries towards the US, resulting in a lower capital-labour ratio).

#### 6.4 Capital flows and policy reactions

Countries that are confronted with an ageing population can take several policy measures. Subsequently, this can affect international capital flows. Here we discuss the most important policy reactions: a shift to a more-funded pension scheme, an increase in the retirement age, and a higher government debt, which might be accompanied with higher inflation (risk).

##### *Pension reform*

Population ageing puts pressure on pension schemes financed on a PAYG basis, as the rise in the old-age dependency ratio implies that either contributions to the scheme have to rise to high levels or pension benefits have to fall to a large extent. One of the most-discussed proposals to increase the sustainability of the pension system is to reform the PAYG scheme and switch to a more-funded scheme. An example of such a reform can be found in the so-called Riestert reforms in Germany that took place in 2001. Pension reforms that involve a transition from PAYG financing to a more-funded scheme will affect national savings, and thereby international capital flows. Let  $\tau$  be the PAYG contribution rate. As was shown in Equation (19) in Box 5, savings are negatively affected by a PAYG scheme, so  $s = s(\tau)$  with  $s' \equiv \partial s / \partial \tau < 0$ . Ignoring the direct effects of ageing on capital flows, changes in the size of the PAYG scheme ( $d\tau$ ) in countries  $A$  and  $B$  will affect the capital flow to country  $A$  as follows:<sup>37</sup>

$$df^A = \frac{L^B}{L^A + L^B} s' (d\tau^B - d\tau^A). \quad (25)$$

If, for example, country  $A$  reforms its pension scheme to a more-funded scheme ( $d\tau^A < 0$ ), and the other country does not, there will be a capital flow from country  $A$  to country  $B$  ( $df^A < 0$ ). If country  $A$  is small relative

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<sup>37</sup> In deriving this expression, we assumed that savings responses to changes in the PAYG contribution rate are the same in the two countries; that is,  $s^{A'} = s^{B'} = s'$ .

to country  $B$ , then a larger share of its additional savings will flow to country  $B$ . This switch to funding increases the capital-labour ratio in both countries and will increase welfare in the long run in a dynamically-efficient economy. However, as part of the extra savings is invested in the non-reforming country  $B$ , the long-run welfare gains for the reforming country  $A$  are smaller compared to the welfare gains in a closed economy. If the other country implements a similar reform, however,  $\Delta f^A = 0$ , and the effect on the aggregate capital flow ( $F^A$ ) depends on the relative size of the country.

#### *Increase labour-force participation*

Another policy option is to increase the retirement age or to stimulate labour-force participation of the young generation. If effective, this will lead to an increase in the labour force and will thus partially offset the effects of ageing. In terms of the previous analysis (see equation (22)), later retirement implies that the old-age dependency ratio increases to a smaller extent, so  $\Delta \mu$  takes a smaller value. If this occurs more in country  $A$  than it does in country  $B$ , then equation (22) shows that capital will flow into country  $A$  ( $\Delta f^A > 0$ ) to ensure equality of capital-labour ratios between the countries. Many European countries decided to gradually increase the official retirement age. However, this is a sensitive issue. Our analysis shows that if one country decides not to increase the official retirement age, while other countries succeed in increasing labour-force participation, part of the (pension) savings will be invested in these other countries. This capital outflow, in turn, will –ceteris paribus– affect welfare negatively in the long run.

#### *Government debt*

In the coming decades, population ageing will put great pressure on public finances in the EMU. This is especially true for countries that have large public pension schemes financed on the basis of PAYG, where the working population pays taxes to finance the pension benefits of the elderly. In these countries the projected increases in government expenditures are enormous (see European Commission, 2006) and the temptation for governments to use debt instead of raising taxes or lowering pension benefits will be large.

Denoting public debt per capita by  $d^i$  for country  $i$ , equation (24) changes to

$$f^A = \frac{L^B}{L^A + L^B} \left[ (s^B - d^B) - (s^A - d^A) \right]. \quad (26)$$

As can be seen from this equation, the effect of a higher public debt on capital flows depends crucially on the extent to which private savings ( $s$ ) react. If, for instance, public debt increases in country  $A$ , without an equally large increase in private savings in that country, this will lead to a crowding-out of the capital stock (see also Section 5.1) and to a capital inflow from the country that does not use debt (or does to a lesser degree).<sup>38</sup> Consequently, as was analysed by Persson (1985), this leads to redistribution of intergenerational welfare in different countries. For both countries it holds that the initial welfare effects are favourable, but future generations will be adversely affected due to the lower capital-labour ratio. Future generations in country  $A$  are to some extent protected by the fact that they have a common capital market with country  $B$  (as part of their public debt will be financed with savings of the latter country). Part of the debt burden is thus transmitted to the country that does not increase its public debt via the capital market. Put differently, debt in country  $A$  causes negative long-run spillovers for country  $B$ .

### *Inflation*

Another way that government debt might affect other members of a monetary union is that high levels of debt may lead to higher levels of inflation or a higher risk of inflation. High levels of nominal government debt may give governments an incentive to put pressure on the central bank to create surprise inflation, as this will reduce the fiscal burden of debt service. In a closed-economy setting, unexpected inflation is a zero-sum game. On the one hand, the government gains from unexpected inflation (as it decreases the real value of government debt and the real return on government bonds). On the other hand, the people (or pension

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38 If, on the other hand, Ricardian equivalence holds, and savings increase by the same amount as the rise in public debt, there will be no effect on international capital flows. Furthermore, if a switch to a more-funded scheme is accompanied by an equally large increase in public debt (e.g., in order to avoid a double burden for any generation alive during the transition), then the rise in  $S^i$  is offset by the rise in  $D^i$ , and there will be no effect on international capital flows. See Sections 5.1 and 5.2 for more details.

funds<sup>39</sup>) that invested in government bonds lose from the unexpected fall of the real return on government bonds. In a closed economy, the gain for the government is exactly high enough to compensate the agents that lose from the unexpected inflation shock.

In a two-country world in which one country relies on PAYG pensions and the other has a fully-funded pension scheme, however, the PAYG country gains from unexpected inflation at the cost of the funded country. This means that there may be a conflict of interest on monetary policy when countries with different pension schemes form a monetary union. The reason for this result is that residents of the funded country hold a relatively large share of the total amount of government bonds because they save more than people in the PAYG country. This implies that the PAYG country can export part of the inflationary tax on debt holders to the funded country, while it still receives the full gain of a lower debt burden, and a net gain results. So when a PAYG country forms a monetary union with a funded country, it has an incentive to put pressure on the central bank to increase inflation unexpectedly. This gain of unexpected inflation for a PAYG country rises with the amount of nominal government debt. This implies that when PAYG countries finance their increased pension obligations that result from the ageing of the population by issuing more debt, the incentive (of PAYG governments) to lobby for surprise inflation will rise. On the other hand, unexpected inflation will harm funded countries more if PAYG countries issue large amounts of nominal government debt. The conflicts of interest on monetary policy between PAYG and funded countries may therefore be reinforced if population ageing raises government debt in PAYG countries.

If the decision-making process of the central bank is not completely transparent to market participants, it is not clear how the central bank will react to these conflicting interests. As a consequence, there will be more uncertainty about what the final outcome for inflation will be, and inflation risk may rise with the level of government debt in PAYG countries. Higher inflation risk makes government bonds less attractive to hold, and

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39 Pension funds lose from unexpected inflation only if they guarantee the pension benefits of their participants in real terms (i.e., if they index the benefits). If pension benefits are guaranteed only in nominal terms, pension funds do not have to worry about surprise inflation. The retirees will then bear the full burden of the unexpected inflation shock.

the return the government has to pay on bonds will rise.<sup>40</sup> In a monetary union, inflation risk is a common risk factor for all members. This implies that not only the countries that increase their debt have to pay a higher risk premium on their government bonds, but also governments that do not increase their debt will face higher interest obligations. Therefore, both countries experience negative welfare effects from the rise in inflation risk.<sup>41</sup>

In the coming decades it will therefore be important for funded countries that the rules of the Stability and Growth Pact are met, so that debt levels of PAYG countries do not rise to overly high levels. The use of government debt by PAYG countries to cope with the costs of ageing benefits the initial generations in these countries, as they suffer most from ageing. Future generations, however, are harmed by the larger debt burden. In a monetary union, part of this burden can be shifted to the funded country, and the debt burden can be reduced by an unexpected rise in inflation when the PAYG country successfully lobbies at the central bank. If this lobbying only raises perceived inflation risk, however, then the negative effects of a rise in the riskiness of government bonds in response to a higher level of public debt cannot be shared with the funded country. It may therefore also be in the interest of PAYG countries to obey the fiscal constraints stated in the Stability and Growth Pact in order to prevent large increases in government debt, which may raise inflation risk. Moreover, it is important for all countries that a central bank like the ECB is independent, credible and transparent, so that it is clear how monetary policy is determined and so that the risk of inflation does not rise when debt levels are high.

Another implication of the analysis above is that market participants (perceiving that the risk of inflation is too high) might (in the coming decades) put more pressure on governments to issue indexed bonds. This implies that if future governments want to use debt in order to collect the necessary funds to finance their expenditures, then the market will be

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40 This is only the case when investors are interested in the real return on their investments.

41 If a larger amount of government debt only increases default risk, then countries with different debt levels would face different risk premiums. In that case, agents that invest in government bonds will be compensated for the higher risk in the form of a higher return, and the country that does not increase its debt does not have to pay a higher interest rate on its debt.

willing to finance this debt only if the return on government bonds is guaranteed in real terms. As inflation risk is a common risk factor for all member states of the EMU, this also means that countries that do not increase their debt levels are still forced to issue indexed bonds.

### *6.5 Key results and policy implications*

This section analysed how countries affect each other if they have different ageing patterns and different retirement institutions. These differences will lead to capital flows between countries thereby inducing international spillover effects. Policy reactions in response to ageing will also affect capital flows and consequently the well being of people in other countries. In general, we therefore conclude that governments should not only consider the domestic situation and developments when deciding on the policy measures in response to ageing, but also take into account the fact that other countries also have ageing populations and that this will affect their people as well. Summarising, we can say that a country is more likely to experience a capital outflow to other countries and negative spillover effects if:

- its population is ageing more (compared to other countries),
- it runs a relatively extensive funded-pension scheme,
- it switches to a more-funded scheme (or pursues this course to a greater extent than other countries do),
- its pension plans are mainly defined-contribution,
- its citizens have a relatively low rate of time preference,
- it has a more generous early-retirement scheme,
- it increases the retirement age less than other countries do,
- it increases government debt in response to ageing relatively less than other countries do.

Our analysis shows, for example, that in a country like the Netherlands (where policy makers are currently discussing whether the official retirement age should be increased or not), one should also consider what the neighbouring countries do (i.e., in countries where part of the Dutch financial capital is invested). If other countries increase their retirement age, this will negatively affect countries that do not increase their retirement age, as part of their savings will be invested in countries where capital is relatively scarcer. So if other European countries increase their retirement age, it might be better for the Netherlands to increase the retirement age as well.



This section also showed that countries in the European Union with funded pension schemes, such as the Netherlands, would in the long term bear part of the burden of an ageing population in countries operating a PAYG system. The funded countries will eventually share in the costs of ageing in the PAYG countries, particularly if these countries are using government debt to finance the long-term costs of ageing.<sup>42</sup> If government debt is very high, then governments of PAYG countries have an incentive to put pressure on the central bank to create surprise inflation (as part of the inflation tax will be borne by investors in the funded countries). And when it is not clear to market participants how the central bank will react to these conflicting interests, the market might perceive that the risk of inflation is higher and ask a higher risk premium on government bonds in general. This has direct negative implications for all countries in the monetary union. It is therefore vital that all countries in the EMU comply with the Stability and Growth Pact. It is also important that the European Central Bank is independent, credible and transparent.

Another implication of a higher risk of inflation is that it might be advisable that pension funds reallocate their investment portfolio more towards real assets, and invest less in nominal bonds, when they index the pension benefits of their participants. Furthermore, market participants might force governments to issue indexed bonds so that the return on government bonds is guaranteed in real terms instead of in nominal terms. In that way, governments of PAYG countries with high debt levels no longer have any incentive to lobby for surprise inflation, which dampens the risk of a higher inflation.

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<sup>42</sup> High debt levels could also result from the current deficits that accumulate during the economic crisis.

## 7. How mobile is capital internationally?

In the previous sections, it was assumed that capital moves freely between countries as long as there is an interest rate difference. This is an important assumption because if it holds, ageing countries can invest their excess savings abroad, in countries with younger populations, so that the marginal product of capital (the interest rate) would not decrease much. It is, however, questionable whether capital is indeed perfectly mobile internationally. At the other extreme, with completely immobile capital, the setting of a closed economy applies and a sharp increase in the capital–labour ratio is to be expected, especially if labour participation does not increase. This section discusses results from studies on international capital mobility.

### *7.1 Empirical observations*

There are several ways to investigate the degree of international capital mobility. One way is to look at the correlation between domestic savings and investments. If capital were perfectly mobile, there would hardly be any correlation. In a seminal paper, Feldstein and Horioka (1980) found that for the period 1960–1974, these two are strongly correlated, indicating that capital is quite immobile.<sup>43</sup> Naturally, financial markets have become more integrated over the last decades, and international capital flows have become more important. A more recent study by Obstfeld and Rogoff (2000), which conducted the same research as Feldstein and Horioka, found that for the period 1990–1997, the correlation decreased (but remains significant), so capital has indeed become more mobile.<sup>44</sup> Blanchard and Giavazzi (2002) note that the saving–investment correlations have decreased in Europe, especially in the Euro area. Therefore, according to this measure, one may conclude that capital is becoming more mobile, although this seems to be restricted to industrialised countries. Taylor (2002) reaches a similar conclusion by analysing time–series of current accounts for 15 countries since 1850.

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43 Corbin (2001) doubts whether such correlations stem from capital immobility. She finds that specific individual country effects account for these correlations.

44 In Feldstein and Horioka (1980), a regression coefficient of 0.91 between the domestic savings and investments ratios is found; Obstfeld and Rogoff (2000) find a value of 0.64.

Table 3: Bonds and stocks owned by ABP in 2007

	bonds	stocks
Netherlands	12.4%	7.7%
EMU	45.2%	17.5%
rest Europe	6.5%	17.1%
North America	33.6%	39.6%
Rest of the world	2.3%	18.1%
Total	100%	100%

source: ABP Annual report 2007

Another approach involves investigating consumption–risk sharing. If the correlation of GDP between different countries is smaller than the correlation of per capita consumption, this points to international risk sharing, which is only possible if capital is mobile between countries. Artis and Hoffmann (2007) find that international risk sharing increased in the 1990s. In Europe, one–third of the macroeconomic risk sharing achieved through international financial markets was realised through capital–income flows. This might have been caused by the elimination of exchange–rate risk among EMU countries. Outside Europe, however, this is not the case. This is in line with the results found by Blanchard and Giavazzi (2002).

Finally, one can look directly at the extent to which portfolios of domestic investors consist of external assets. Lane and Milesi–Ferretti (2005) find that especially among industrial countries, the distribution of net external positions has widened, and portfolios are less specialised in domestic securities. Looking more specifically at pension funds (as an example), we see that most bonds and stocks owned by the largest Dutch pension fund (ABP) were foreign (see Table 3). Most bonds are European or from North America, while stocks are more evenly spread from all over the world.

### 7.2 Causes of international capital immobility

The previous section showed that according to several measures, capital is not completely mobile internationally, especially to countries outside the OECD area. Several causes of capital immobility have been described in the literature and will be briefly touched upon here.

Gordon and Bovenberg (1996) give the following potential explanations of capital immobility. First of all, governments can impose capital controls. This will directly restrict the opportunities of investors to move capital to places with the highest rate of return. Secondly, purchasing foreign

securities involves high transactions costs. In that case, some difference between interest rates can persist.<sup>45</sup> However, especially in developed countries these costs are not very large. Thirdly, investing abroad often implies exchange-rate or currency risk. This risk has disappeared for countries within the EMU. Furthermore, financial markets allow investors to hedge against this risk for an increasing number of foreign currencies. The fourth explanation for capital immobility (and according to Gordon and Bovenberg (1996) the most plausible nowadays) is asymmetric information: investors lack the knowledge to make a good prediction about future returns to investments in a foreign country. The more distant the country is (not only geographically but also culturally), the less information and the more uncertainty. In this respect, political risks play an important role too. Portes and Rey (2005) develop a gravity model and conclude that distance is indeed an important factor explaining observed international transaction flows. Consequently, all this leads to a 'home bias'. It is uncertain how this will develop in an ageing society. On the one hand, as pension funds mature and start paying out pension benefits, their time horizon becomes shorter, leaving them less time to make up for lower-than-expected returns to investments. In a sense, this makes them more risk averse, which would strengthen the home bias. This would correspond to the view that the older a person gets, the more risk averse (s)he becomes (see Section 4.3). This relates to the recent discussion (in e.g. the Netherlands) that pension funds, after the harmful consequences of the financial crisis, should invest more in domestic assets and less in foreign assets. Following such a strategy would make the scenario of a closed economy more realistic. On the other hand, as Attanasio et al. (2007) state, "important steps have been taken in the past few years with respect to 'financial engineering' of emerging markets, so one may expect capital to flow freely and more safely in the years to come." Furthermore, they predict that there will be a reversal of capital flows from developing to developed countries (see also Section 8.3). Since the latter tend to be more politically stable and have more developed financial institutions, this will reduce political and other risks, and thereby increase the degree of international capital mobility.

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45 In economic models this is often modeled as a capital-adjustment cost.

*Conclusion*

Capital has become more mobile over the last decades, especially between developed countries, but the assumption of perfect capital mobility seems too strong for the world as a whole. The most likely scenario will therefore be between that of a closed economy and open economies with perfect capital mobility. This mitigates the size of the international spillover effects discussed in the previous section. Within the EMU, however, perfect capital mobility is a reasonable assumption. Among the countries in this region, the differences in ageing patterns are not very large, but institutions do vary a lot. International spillover effects will therefore mainly stem from institutional differences.

## 8. Ageing and the return to capital: quantitative results

The paper thus far has discussed the qualitative effects of ageing on the international capital market. This section focuses on the expected magnitude of these effects.

### *8.1 Asset market meltdown?*

In a small open economy, savings can be invested abroad and the interest rate is hardly affected, unless other countries experience the same demographic developments, at which point the scenario of a closed economy is more applicable, and ageing will put downward pressure on the interest rate (especially if it is accompanied by an increasing supply of capital due to a move to more-funded pensions). This might even lead to a situation of dynamic inefficiency and a so-called 'asset market meltdown'. The likelihood of such a scenario is a controversial issue among economists. In recent years, many papers have presented a quantification of these effects. Abel (2001, 2003), for instance, apply a general-equilibrium model and conclude that ageing indeed will cause a sharp decline in asset prices, even if a bequest motive is included that causes individuals not to sell all of their assets by the end of their life. A similar result is found by Brooks (2002), who uses a 4-OLG model of a closed economy in which young people invest in risky capital (stocks) and old workers invest most of their savings in safe bonds. Because ageing causes the capital-labour ratio to increase, the returns on stocks and bonds in 2020 will be 92 and 82 basis points below their levels in 2000. After 2020, there will be a gradual return to the steady state. As discussed in Section 4.3, Geanakoplos et al. (2004) find mixed results, but on the whole they tend to conclude that there is a significant relationship between demographic developments and the capital market.

Others, such as Poterba (2001, 2004), doubt whether demographic developments will have sizeable effects on the capital market. Based on historical observations that are used to generate a projected asset demand and return for the coming decades, their study concludes that the actual effect of ageing on the returns to capital (if any) will be very modest (although it should be noted that historical data have thus far shown little variation in demographic structure, which makes the predictive power of

such regression results quite limited).<sup>46</sup> Subsequent studies therefore have developed computational general-equilibrium models in order to quantify the above-mentioned effects. These simulation studies typically use detailed projections of demographic developments and different institutional features in a multi-country model with multiple overlapping-generations of the type introduced by Auerbach and Kotlikoff (1987). These projections, which compare scenarios of a closed economy with those of open economies and perfect capital mobility, can be used to show the impact on the interest rate and the size of the international spillover effects caused by (differences in) ageing, pension schemes, reforms and so forth. The rest of this section will summarise the main results of the most recent studies in this field.

### *8.2 Ageing, pension reform and international capital flows*

The INGENUE (2001) paper was one of the first to build an applied general-equilibrium model to analyse the international effects of ageing. The model has 15 overlapping generations and distinguishes between six regions whose demographic developments differ.<sup>47</sup> Labour supply is exogenous, and PAYG pensions are of the defined-benefit type, so that contribution rates adjust to e.g., demographic developments. The productivity of developing countries is assumed to converge very slowly and incompletely to the level of the developed countries. The interest rate is projected to decrease from 4.2% in 2000 to 3.6% in 2035 and afterwards. Different pension reforms in European countries have additional effects on the interest rate. If PAYG contribution rates are kept constant, the pension replacement rate will be 50% lower by 2050, and savings will be higher. This partial shift to a more-funded pension scheme causes an additional drop of the interest rate of 15 basis points. If, however, the retirement age is gradually postponed by five years, the interest rate will fall by 15 basis points less due to the higher labour supply until 2020, but afterwards it will gradually return to the baseline level. Finally, this model can be used to quantify the international spillover effects by comparing the outcomes with

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46 Geanakoplos et al. (2004) also note that if globalisation implies a gradual decrease in the home bias on financial markets, this will weaken the relation between national demographic developments and national financial markets.

47 These six regions are US/Canada/Australia/New Zealand, the EU, Japan, emerging or transition countries with an already ageing population (e.g. Russia and China), emerging and developing countries like India, and developing (mostly African) countries.

the case of Europe as a closed region. In the latter case, interest-rate fluctuations are much more pronounced. For instance, with constant contribution rates, the drop in the interest rate will be up to nearly 100 basis points more in case of a closed economy, implying a total decrease of about 150 basis points by 2050. But in case of a constant (gross) replacement rate, the change in the interest rate will be close to zero. Furthermore, economic growth rates in the closed-economy model are lower for all scenarios and fluctuate more (although the time profile is roughly the same).

A similar model is developed by Börsch-Supan et al. (2006), but with 85 overlapping generations and four regions consisting of France/Italy/Germany, the rest of the European Union, the rest of the OECD, and the rest of the world. Furthermore, labour supply is endogenous. Two scenarios are considered: one in which the pension replacement rates are maintained in the continental European countries (which boils down to a defined-benefit system), and another in which contribution rates are fixed at their level of 2006 (implying lower PAYG benefits due to ageing and a partial transition to a more-funded pension scheme).

Rapidly ageing countries such as Germany and Italy will initially experience a current-account surplus (and thus a capital outflow and an accumulation of foreign assets), but at some point they will become net importers. The more countries there are to invest capital in, the later the moment at which such a rapidly ageing country starts running current-account deficits and becomes a rentier economy. As such countries also run down their foreign assets, the period of being a rentier economy is limited (about 40 years), after which the current account will be balanced. The rate of return to capital will decrease by about 100 basis points (from 7% to 6%), which cannot be qualified as an 'asset meltdown'. Furthermore, the difference between a closed economy and a global economy with perfect capital mobility is small, so the variety of demographic developments across countries is not substantial enough to have a big impact on the interest rate. Finally, a pension reform towards more-funded pensions in only Germany, Italy and France decreases the interest rate further by 25 basis points. On the one hand, savings will increase (and thereby the capital-labour ratio); on the other hand, their model includes endogenous labour supply: more funding stimulates labour supply because in the reform scenario, PAYG contributions are kept constant, so benefits will decrease, to which individuals respond by increasing both savings and



labour supply. This effect decreases the capital–labour ratio and thus has a positive effect on the interest rate. The assumption of endogenous labour supply is quite important: if it were exogenous, the only way that people can react to lower future PAYG benefits is by saving more, so the move to a more–funded scheme goes along with a larger increase of savings, without a higher labour supply. This results in a much more pronounced rise of the capital–labour ratio and a larger decrease of the rate of return to capital, especially in case of a closed economy (i.e., no international capital mobility).

As for the welfare effects of pension reform, the greater the number of foreign countries to invest in, the smaller the number of cohorts that experience a welfare loss. However, these differences between the various capital mobility scenarios are small. Roughly speaking, individuals born after 1982 benefit from having fixed contributions instead of fixed replacement rates.

Krueger and Ludwig (2007) develop a 75–OLG model with only OECD countries, divided in three regions: the US, EU, and the rest of the OECD countries. Specific for this model is that it includes idiosyncratic uncertainty about labour productivity and mortality. This implies that the income of some persons ends up being mainly capital income, while that of others is mainly labour income. Furthermore, it also implies that people have a precautionary motive to save. According to the simulation results for the case of fixed PAYG contribution rates, the world interest rate is predicted to gradually fall by approximately 100 basis points (from 7.5% to 6.5%) until the year 2050. Capital will flow from the EU and the rest of the OECD to the United States in the next 30 years. This is due to the fact that the US is ageing relatively less and because the savings rate sharply decreases as a result of the retirement of the baby boom generation, which, in the US, is relatively largely financed by funded pensions. If the United States and the rest of the OECD were closed economies, the US interest rate would decrease by 10 basis points less, and the interest rate of the other countries would decrease by another 20 basis points.

The effects depend a lot on the design of the PAYG pension scheme. If the pension replacement rate is kept constant, contribution rates will increase by more than 7 percentage points in the next decades. Consequently, the decline of the world interest rate is much less pronounced: only 20 basis points. Finally, if instead of higher PAYG taxes or lower benefits, the retirement age is increased by five years, the drop in

the interest rate is the same as before (almost 100 basis points). The latter alternative leads to lower welfare losses and for some groups even welfare gains from ageing.

### *Conclusion*

Recent simulation studies show that the interest rate is expected to drop by about 0.5–1 percentage points in the long run due to ageing. If many countries reform their schemes to a more-funded pension system, instead of increasing contribution rates, then the drop in the interest rate will be somewhat more pronounced. A larger drop is also expected if labour supply does not increase (e.g., if the retirement age is not increased).

### *8.3 Developing countries: reversal of capital flows?*

Attanasio et al. (2007) explicitly focus on developing countries in their analysis by considering two regions: northern (developed) countries and southern (developing) countries. These regions differ in several respects: developing countries are not ageing as strongly and quickly, they do not have extensive PAYG pension schemes, and their productivity levels are lower. The assumption is that the demographic structure and productivity levels converge to those of the developed countries and will be equal by 2200. Within the regions, they assume completely homogeneous countries. There are 24 overlapping generations.

The simulation results show that if the developed countries as a whole are a closed economy, then the interest rate gradually decreases by 180 basis points (from 6.6% to 4.8%) until 2040, after which it stabilises.<sup>48</sup> The effect of a smaller work-force dominates the effect of lower savings, so the capital-labour ratio rises. However, somewhat surprisingly, if capital is mobile to the southern developing countries, the interest rate is expected to fall by much more, to a level that is eventually 150 basis points below the level that would occur in a closed economy. This is due to the fact that the developing countries' population is growing fast and they are catching up in terms of GDP growth (and so will save more), while at the same time the Northern countries face higher PAYG taxes (and therefore save less). As a matter of fact, capital will flow from North to South until 2020, but after

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<sup>48</sup> This drop is larger than calculated by e.g. Börsch-Supan et al. (2006), which can be explained by (among other things) the fact that this paper applies fewer overlapping generations, a lower value of the capital share in output, a higher discount factor and the absence of leisure in the individual utility function.

that the direction changes, and capital will flow from South to North. This result is also found by Brooks (2003) with a simulation model, and by Helliwell (2004) based on empirical results. The drop in the interest rate will be even more dramatic (from 7.4% to 2.8%, and thus about 450 basis points) if Northern countries reform their pension systems towards a fully funded scheme without creating additional government debt.

#### *8.4 Capital flows to China and India*

Instead of treating all developing countries as one group, as in Attanasio et al. (2007), the paper by Fehr et al. (2008) specifically considers China and India as separate countries to which capital can flow. The other regions are the US, the EMU countries, and Northeast Asia. Furthermore, a distinction is made between low-, middle- and high-skilled labour. The labour productivity of China is assumed to converge to the US level in 15 years, and that of India in 75 years. Furthermore, the rate of time preference in these two countries is initially relatively low (implying high savings rates), but is assumed to converge to the level of other countries by the year 2030. Two scenarios are considered: with and without China and India. Without these countries, the interest rate will slightly decrease until 2020, but then increase to a level that is 80 basis points higher in 2100 than it is today (starting from a rate of 11.9%). This is due to two reasons. First, the assumption that technological progress causes the time endowment to grow at an exogenously given constant rate of 1% per year, which increases effective labour supply and decreases the capital-labour ratio. Second, this model comprises a detailed tax and social security system for the countries (including e.g., health-care, the costs of which are to a large extent borne by working individuals). Hence, ageing implies higher tax rates (as is the case with DB-pensions), which have a negative effect on savings (also because capital taxes rise). Altogether, this implies that ageing reduces savings more than the (effective) labour supply does, so the capital-labour ratio decreases, the interest rate rises and wages decrease.

However, the inclusion of China and India leads to a sharp decrease of the interest rate (of 360 basis points by 2050), and a small increase thereafter. This is due to the rapid increase in the supply of capital by these countries, and their ageing populations. In the medium- and long run, these capital flows to the US and EMU will lead to a higher GDP. This is accompanied by a sharp increase of the wage received by high-skilled

labour (23%), while low-skilled labour earns a wage that is 25% lower, which means that income inequality will increase substantially.

### *8.5 Summary*

The simulation studies that have appeared in the literature all predict a decrease of the interest rate, roughly by about 1 percentage point. While this can hardly be classified as an asset meltdown, it will nevertheless have substantial consequences for different generations. The decrease will be more pronounced if many countries move towards a more-funded scheme (e.g. by keeping the PAYG contribution rate constant and lowering pension benefits), and if the retirement age is not increased. Capital flows to countries like China and India can in the short run attenuate the drop in the interest rate, but in the medium- and long run they will reinforce the drop. This crucially depends on the development in these countries: the faster they converge to the developed countries (in terms of technological progress, savings rates, demographics etc.), the lower the interest rate will be, and a situation of dynamic inefficiency is more likely to occur.

## 9. Policy implications

Although ageing is a worldwide phenomenon, the timing and the extent of ageing differ between countries. Moreover, there are large differences in institutions, policies and preferences. These differences may lead to international capital flows. For example, countries where the population is ageing relatively fast or where workers retire early will see part of their savings flow abroad. Also countries with a relatively small unfunded pension scheme or with a low rate of time preference will experience an outflow of capital. These capital flows have several consequences: they may lead to spillover effects (implying that uncoordinated policy making may be suboptimal), but they may also offer possibilities to smooth the consequences of local demographic changes over the globe (implying that the consequences for factor prices will be relatively small).

Since capital can move freely within the European Monetary Union, perfect capital mobility seems a reasonable assumption. The differences in ageing patterns among the countries in this region are not very large, however, which implies that there will only be minor possibilities to smooth the consequences of population ageing via capital flows within the EMU. On the other hand, institutions vary considerably within the EMU, and international spillover effects from this source may be important. If, for example, some countries increase the retirement age and others do not, capital will flow from the latter countries to the former. Moreover, countries with relatively large funded schemes, such as the Netherlands, will in the long run bear part of the burden of population ageing in countries with extensive PAYG schemes, particularly if these countries use government debt to finance part of the long-term costs of ageing. Mounting government debt in countries with large PAYG schemes implies a stronger incentive for these countries to lobby for surprise inflation, which would imply that part of the burden of debt is rolled over to countries with extensive funded schemes. On the other hand, these conflicting interests may increase the perceived inflation risk, which will increase the risk premium on nominal government bonds. This affects all countries in the monetary union negatively. In order to prevent this, it is important that all countries in the EMU comply with the Stability and Growth Pact and that the European Central Bank is independent, credible and transparent. Another implication of a higher risk of inflation is that it might be advisable that pension funds reallocate their investment portfolio more

towards real assets and invest less in nominal bonds if they guarantee the pension benefits of their market participants in real terms. Furthermore, governments might be forced by the market to issue indexed bonds so that the return on government bonds is guaranteed in real terms instead of in nominal terms.

From a global perspective, differences in demographics are much larger, but capital may not be as mobile as it is within the EMU. One of the key questions for policy is therefore whether the international capital flows are indeed large enough to prevent sizeable effects on wages and the interest rate. Or, will we experience a worldwide increase in savings, leading to a fall in the return to capital and possibly even an asset meltdown? In terms of theory, the question is whether the small-open-economy model or the closed-economy model is most appropriate for the analysis of the consequences of ageing. If the small-open-economy model applies (i.e., if demographic risks can be perfectly shared via the capital market), then the effects of ageing are relatively small: the economy is transformed into a rentier economy and the negative effects of an increase in longevity on consumption will be partly offset by the positive effects caused by a decrease in fertility (which frees up resources from investment). When the closed-economy model applies, the increase in savings cannot be channeled abroad, but has to be invested in the home economy, leading to a decrease in the return to capital and rising wages. This raises lifetime utility, but the consequences for workers and retirees will be contradictory: whereas workers can consume more, retirees can consume less. Such a development may be regarded as undesirable from the viewpoint of solidarity between workers and retirees. However, ageing makes it increasingly difficult to prevent growing inequality between these two groups. PAYG pensions may moderate the differences in the consequences for both, but this comes at the cost of worsening economic development in general: with a sizeable PAYG scheme, average consumption possibilities will fall with ageing. The same holds for intergenerational transfers in funded defined-benefit schemes, particularly if they promise a wage-indexed benefit. Consequently, the more the closed-economy scenario applies, the more pronounced the effects of ageing will be, and the greater the dilemma between efficiency and intergenerational equity.

Whether the open-economy model or the closed-economy model is most appropriate is largely an empirical question. Countries can invest their excess savings abroad, in countries with younger populations, only if

capital is sufficiently mobile internationally. Empirical research shows that, although mobility is not perfect, capital has become more mobile over the last decades. The most likely scenario will therefore be between that of a small open economy and a closed economy. Recent simulation studies using multi-country models show that the interest rate is expected to drop by about 1 percentage point in the long run due to ageing. While this cannot be classified as an asset meltdown, it will nevertheless have substantial consequences for different generations, particularly the elderly. The actual decrease may be higher if many countries reform their pension scheme to a more-funded system, and if the retirement age is not increased. The greatest risk with respect to the return on capital in the long run is due to capital flows from countries like China and India. Although capital flows to these countries may attenuate the decrease in the interest rate in the short run, they will reinforce the drop in the long run. Precisely how strong this effect will be depends crucially on the development in these countries: the faster they converge to developed countries, the lower the interest rate will be. The effect may be substantial: studies predict decreases of the interest rate up to 4.5 percentage points, especially when many countries switch to funded pensions. While this still cannot be seen as a complete asset meltdown, changes of this magnitude would of course have huge effects on retirees and pension funds and may even push the economy towards a situation of dynamic inefficiency.

These results provoke the question to what extent a country should rely on investing on the capital market to secure a decent old-age income, and which part of the pension savings should be invested internationally. Some claim that it would be welfare-improving if pension funds invested a larger part of their capital in their own country (arguing that this would not only increase national investments, and thus boost the economy, but would also make the pension funds less sensitive to developments on the international capital market). Indeed, as discussed in Section 2.4, an outflow of capital may decrease domestic welfare. However, with open capital markets, changing the investment policy of pension funds will have virtually no effects. If a larger part of pension savings is invested domestically, the resulting downward pressure on the interest rate will stimulate other domestic investors as well as foreign investors to reallocate their portfolios and invest a larger part in other countries. Eventually, the interest rate will still be equal to the rate determined on the international capital market. Pension funds will therefore be unable to escape the

consequences of international developments for the capital market unless the entire country is effectively isolated from the international capital market. This is not a serious policy option, however.

In conclusion, the capacity of the capital market to guarantee a prosperous old-age, especially in times of population ageing, appears to be much smaller than it may seem from a microeconomic perspective. Taking this into account, it would be wise to not put all of our eggs into one basket and to leave a role for intergenerational transfers. PAYG schemes or defined-benefit elements in funded schemes provide a valuable complement to the possibilities for providing old-age income offered by the capital market (i.e., via private savings or defined-contribution schemes). However, we cannot escape the trade-off between efficiency and intergenerational equity; ageing raises the dependency ratio and thus the 'price' of intergenerational solidarity. Therefore, the policy to maintain a decent standard of living in old age is not complete without a third element: the labour market. The flip side of the abundance of capital due to the growing savings for old age is that labour will become relatively scarce and wages will rise. Relying to a larger extent on the labour market to provide income during old age therefore becomes increasingly attractive (i.e., intensifying labour-force participation by the elderly). With rising longevity and a rising reward for labour, this seems to be a natural choice.



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# SUMMARY OF DISCUSSION

## **Population Ageing and the International Capital Market**

By Yvonne Adema, Bas van Groezen and Lex Meijdam

Discussants: Leon Bettendorf and Hans Fehr

Adema, van Groezen and Meijdam analyse the effects of ageing (policies) on the interest rate and on wages in the long run and in an international context. The effects are analysed by investigating how ageing affects the capital-labour ratio ( $k \equiv (K/L)$ ). The authors conclude that ageing will, in the long run, increase the capital-labour ratio, leading to a decrease in the world interest rate and an increase in wages.

### **Discussion by Leon Bettendorf**

Adema et al.'s paper deserves praise for its extensiveness in combining both theory and empirics, and in clearly distinguishing the effects of ageing on closed, small open and intermediate economies. The main limitations of the paper relate to its focus on the long run alone and its deterministic setting, setting aside all effects of uncertainty and diversification in assets and goods.

#### *Spillover effects put into perspective*

The authors focus on the (international spillover) effects of ageing running through the international capital market (capital flows and the interest rate  $r$ ). In order to put their findings into perspective, Bettendorf thought that it would be worthwhile to consider the spillover effects of ageing through other channels too.

First, consideration should be taken of the spillover effects of ageing through the channel of monetary policy in the European Monetary Union. The authors of the paper argued that PAYG countries with high government debt could pressure the European Central Bank (ECB) to increase inflation in

order to decrease the value of their debt. However, Bettendorf found this to be unlikely, given that the ECB has shown a high degree of independence until now. He therefore posited that an opposite effect might be even more likely: spillover effects from fast- to slow ageing countries can be expected, as the former are more likely to face higher inflation, compelling the ECB to increase interest rates.

A second channel through which spillover effects from ageing might be expected, is labour mobility. With population ageing, countries with more rewarding pension schemes (think of the Netherlands, for example) could become more attractive to immigrants (say, from Eastern European countries) than the countries with less rewarding pension schemes (which are currently attracting immigrants).

Thirdly, as ageing intensifies and the labour costs rise, we can expect innovative labour-saving technological progress spillovers to become more prevalent.

Bettendorf suggested that relaxing the paper's assumption that domestic and foreign tradable goods are perfect substitutes would reveal a fourth channel: as ageing changes the relative demands and prices of tradables, spillover effects arise through flows of tradables and real exchange rates. Finally, account should be taken of the effect of ageing on non-tradables (e.g. health-care services). The demand for these is likely to be higher in an ageing economy. Hence, one could argue that economies will tend to become more closed, reducing the amount of spillover effects from one country to another.

*Focus on the spillover effects of ageing through the international capital market*

Bettendorf then commented on the spillover effects of ageing through the international capital market, as analysed in the paper.

• *A note on welfare spillover effects of pension funding*

Bettendorf found that of the most interesting conclusions of the paper is that countries with large funded pensions will, in the long run, bear part of the ageing burden of PAYG-countries. To fully appreciate this conclusion, he noted that a few subtleties should be kept in mind.

Consider, for example, a world that consists of a country with large funded pensions (say, the Netherlands) and a PAYG country that increases its government debt (say, Italy). Italy's increasing debt leads to a crowding out



of capital (i.e., a decline in the capital-labour ratio). A first important note with respect to the welfare implications of the increased debt is that the initial, short-run effect will lead to a welfare increase in both countries. All effects described in the paper hence only apply in the long run, and are opposite to those of the short run. A relevant question is then whether short-run or long-run effects should be given greater emphasis. Secondly, in the long run, a welfare loss for the Netherlands can be expected that dampens the welfare loss of Italy, as argued in the paper. However, it should be mentioned that Italy is also experiencing a welfare loss in the long run that is even larger than the welfare loss of the Netherlands.

Bettendorf then made some reflections on this result. A fundamental cause of the current credit crisis can be found in the global imbalances in savings. The huge savings of both China and the OPEC countries led to a low world interest rate that contributed to bubbles in, for instance, the asset markets and housing markets. In the future, the supply of savings money from these (ageing) countries is likely to remain high or even increase. To counterbalance the downward pressure on the interest rate, therefore, a growing demand for capital (coming from some countries issuing debt at the other side of the market) doesn't seem too unappealing.

• *The "one asset" assumption*

Whereas Bettendorf agreed with the authors' assertion that, within the EMU, perfect capital mobility is a reasonable assumption, he maintained that this does not imply that domestic and foreign assets are perfect substitutes, yielding the same interest rate. As an illustration he mentioned the interest-rate spread on ten-year (10y) government bonds. Consider the interest rate on 10y government bonds of Italy, Greece and the Netherlands, respectively, relative to the interest rate on 10y government bonds of Germany. Between 2008 and this date, these countries were consistently paying a higher interest rate than Germany, with peaks up to 3 percent (for Greece) and more than 2 percent (for Italy) in February. The Netherlands was paying about half a percent more than Germany in February.

Bettendorf returned now to the previous example concerning Italy issuing debt: this would cause Italy's interest rate to increase more (higher risk premium). A beneficial situation for the Netherlands then arises, as Dutch pension funds would be able to invest in foreign government bonds yielding a high interest rate, while the government itself would issue bonds at a lower interest rate.

• *Simulation results from CGE-models for the interest rate*

The final point made by Bettendorf concerned the paper's summary of the simulation results as follows: "The simulation studies all predict a decrease of the interest rate by about 1% point".

Bettendorf found this to be a bit misleading, in view of different starting levels. While some studies (INGENUE, 2002) start at 4.2% and predict a decrease of almost one percentage point at the top of ageing, other studies (Börsch-Supan et al., 2006) predict a similar fall in the interest rate, but starting at about 7 percent. Hence the resulting interest rate prediction is thus far from unanimous.

### **Discussion by Hans Fehr**

Hans Fehr's comments on the paper were structured as follows. First and foremost, he expounded on the relationship between population ageing and the world interest rate. Second, he highlighted the missing aspects of uncertainty. Finally, he emphasized the importance of analysing the effects of ageing in a global context.

*Population ageing and the world's interest rate*

Fehr noted that Adema et al.'s results in terms of the interest rate and wages are based upon the effects of ageing on the capital-labour ratio, which are found to be positive (ageing leads to capital deepening; i.e., an increase of  $k=K/L$ ). The paper then nicely describes how capital deepening leads to a decrease of the world interest rate and an increase of wages.

This result is clear in an economy without government, and in the long run. The paper also explains how having a PAYG scheme obscures the effects of ageing on the interest rate. Fehr noted, however, that in most simulation studies the existence of counterbalancing effects in the PAYG scheme case are never dominating over the primary effects of capital deepening. Hence, the paper predicts a decrease in the interest rate between 0.8% and 2.6% and a rise of real wages by up to 13%. Such an increase of real wages would be a very positive aspect in helping finance the cost of ageing. However, Hans Fehr expressed his doubts whether such an optimistic view (high wage rise expectations) is realistic since these results are highly dependent on the specific public sector context in which they were derived. Indeed, while a government sector is assumed in Adema et al., it is merely

present in the form of an institution providing a PAYG pension scheme. A health care system, a long-term care system and a tax system are all missing in the model.

Kotlikoff, Smetters and Walliser (2007) introduce a very detailed model of the American economy with ageing. In addition to the PAYG pension scheme, their model included a health care system, long-term care system and a tax system. A crucial difference in this model is that the tax base is allowed to change as the population structure alters. The proportion of the working population to pensioners decreases, so that taxes need to increase to keep financing public goods.

Fehr, Jokisch and Kotlikoff (2004, 2008) extended the original model of Kotlikoff, Smetters and Walliser (2007) to include Europe and Japan in addition to the United States. In their model, which also includes a detailed tax- and social security system, ageing is found to reduce savings more than the effective labour supply. Thus, the capital-labour ratio is predicted to decrease. The world interest rate therefore increases, while wages decrease (by 3 percentage points and 15 percentage points, respectively). Whether or not this scenario is valid, this result still provides insights contrary to those discussed in Adema et al.

#### *Population ageing and the international risk premium*

Since the authors excluded most of the discussion about uncertainty, an important point is missing. In any discussion of the effects of ageing on the capital market, both the interest rate and the risk premium should be considered.

As optimal portfolio shares for risky assets fall with rising age, population ageing will change the demand structures for shares and bonds, so that the risk premium increases. Note that this is merely a consequence of optimal portfolio behaviour, and not of an increase in risk aversion.

#### *Population ageing and globalisation*

Finally, Fehr noted that the effect of globalisation cannot be over-emphasized. Fehr, Jokisch and Kotlikoff (2008) estimate a model with and without India and China. The results in their paper changed dramatically. In the case with only 3 three countries (US, Europe and Japan), the interest rate is found to slightly increase, while wages are decreasing. However, with the inclusion of India and China, with their very high savings and growth rates, the interest rate drops considerably, while wages do not rise. As in Adema

et al., capital moves from the south to the north, with the effects of globalisation on the capital market dominating demographic effects. Hence, Fehr argued that we should consider ageing in a more global context, taking into account developments in countries such as China and India.

### **The authors' reply**

Bas van Groezen agreed with Leon Bettendorf that a country's increasing government debt leads to a long-term welfare loss not only for other (funded) countries, but also for the country itself. However, this does not alter the paper's point that the dampening of the welfare loss for the issuing country by other countries leads to an increased incentive for issuing debt by the former country.

Yvonne Adema responded to both Leon Bettendorf and several people in the public who had questions regarding the importance of the short-run effects of ageing. She agreed that the welfare effects of ageing in the short run could very well be opposite to those in the long run. The aim of the paper, however, was not to focus on the short run or on the current credit crisis, as the truly major effects of ageing will be experienced in the long run (say, 20 years) only.



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# POPULATION AGEING AND THE INTERNATIONAL CAPITAL MARKET

The prospective ageing of the population in many countries will affect the economy in many different ways. Yvonne Adema (Erasmus University Rotterdam and Netspar), Bas van Groezen (Utrecht University and Netspar) and Lex Meijdam (Tilburg University and Netspar) focus in this paper on the long-run effects on the international capital market by providing an overview of insights from both theoretical and empirical literature related to this topic. The final part of this paper is devoted to the quantitative effects found by various recent simulation studies.

