

This version: 05 January 2009, last update 17 August 2009

Aging, Asset Markets, and Asset Returns: A View from Europe to Asia

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ACKNOWLEDGEMENTS: We are grateful for the helpful comments by Mitsuhiro Fukao, Takatoshi Ito, Colin McKenzie, and the participants of the Seventh Asian Economic Policy Review Conference in Tokyo. Helen Grupp provided valuable assistance. Financial support from the US Social Security Administration (grant #10-M-98363-1-01 to the National Bureau of Economic Research as part of the SSA Retirement Research Consortium), the German Science Foundation (DFG), the VW-Foundation, the German Insurance Association (GDV), and the Land Baden Württemberg, is gratefully acknowledged. All opinions are ours and do not imply the consent by any of the above individuals and organizations.

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by Axel Börsch-Supan and Alexander Ludwig

1. Introduction

Population aging will be a major determinant of long run economic development in industrial and developing countries. The extent of the demographic changes is dramatic especially in some Asian and European countries. The steep increase in their old-age dependency ratios will deeply affect future labor, asset, and goods markets.¹ The expected strain on public budgets and especially social security has already received prominent attention, but aging poses many other economic challenges that threaten productivity, growth, and financial stability if they remain unaddressed.

The central aim of this paper is to investigate the effect of aging on asset markets and asset returns, focusing on markets for productive capital, i.e., capital used in the production of goods and services. Aging has complex effects on the markets for real capital. If elderly people save less than younger people, an aging society saves less. This should increase interest rates since supply of funds gets tight. At the same time, the younger generation becomes ever smaller, so there is also less demand for new investment. The equilibrium effect is thus uncertain.

Pessimists, such as Mankiw and Weil (1989) believe in the so-called “asset meltdown” hypothesis: households demand for financial and housing assets will plummet between 2030 and 2040, when the baby boomers retire and die, asset values will melt down dramatically and the return on financial investments will fall sharply.²

Optimists, such as Poterba (2001), stress economic mechanisms which soften or even reverse the negative impacts of aging on capital markets. One such important counter-mechanism is an aging society’s need for more capital since capital must increasingly substitute for labor. This rising demand for real capital increases the return to capital at exactly the same time as pessimists fear the prospect of an asset meltdown.

¹ The old-age dependency ratio is defined as the population aged 65 and over divided by the working age population of age 15-64.

² The Mankiw-Weil paper spawned a fierce methodological discussion, see Venti and Wise (1990), Engelhardt and Poterba (1991); Hamilton (1991), Hendershott (1991), Woodward (1991), the rebuttal by Mankiw and Weil (1992), and a new set of critical papers by McFadden (1994), Swan (1995) and Skinner (1996).

In order to be able to judge whether the pessimists or the optimists are right, we quantify the potential effects of aging on asset prices using a sophisticated overlapping generations (OLG) model with international diversification reflecting the global nature of the markets for productive capital. The results from this model indicate that there will be some decline in the value of productive capital, but it is relatively small. So aging is not as damaging as the pessimists make believe, but markets for productive capital are not immune to demography, as some optimists claim. The magnitude of the decline depends on many parameters, notably the extent of global diversification and the evolution of the capital to labor ratio which might be subject to future labor market and pension policy interventions.

Our quantitative model shares features with a literature that studies the effects of population aging, pension reform, the return to capital and welfare in multi-country models with overlapping generations. Examples are Brooks (2002, 2003), Henriksen (2002), Feroli (2003) and Domeij and Floden (2005) who mainly focus on international capital flows, and Börsch-Supan, Ludwig and Winter (2006), INGENUE (see Aglietta et al. 2007), Fehr, Jokisch and Kotlikoff (2005), Krüger and Ludwig (2007) and Attanasio, Kitao and Violante (2006, 2007) who more closely analyze the relationships between demographic change, pension reforms, international capital flows, relative factor prices and welfare. As far as the return to capital is concerned, a general theme in these papers is confirmed by our results: there will be some decline in the value of productive capital, but it is relatively small. The interactions between the demographic developments in Asia, especially India and China, on the one hand and the U.S. and Europe on the other hand, have so far received relatively little attention. An exception is Fehr, Jokisch and Kotlikoff (2007) who find that China's contribution to the developed world's own development is positive in the short as well as the long run.

Our paper combines various features from this literature and adds several new features of our own to the models used in previous work. First, as in the above cited papers, we investigate how strong "asset meltdown" effects are in an aging economy that is embedded in global financial markets. To this end, we link a neoclassical model of returns to capital with a model of global financial equilibrium with a particular emphasis on spillovers from Europe to Asia and vice versa.

Second, we realize that aging will precipitate labor market and pension reform. These reforms will, in turn, change labor supply and saving behavior. Hence, the paper investigates which effects pension and labor market reforms in Europe have on global capital accumulation, capital to labor ratios, and rates of return. To the best of our knowledge, this link between global financial markets on the one side and European labor force participation and saving

behavior on the other side has not been modeled before. As it turns out, predicted financial market performance is not only quite sensitive to saving behavior, but also to labor supply.

The third novelty in this paper is therefore to explicitly model labor supply behavior reacting to labor market and pension reforms. In particular, we acknowledge that policies do not necessarily translate one-to-one in labor market outcomes, and model potentially adverse behavioral reactions to these reforms. Our paper shows that such behavioral reactions have important implications for predicting macroeconomic aggregates, including capital accumulation, capital to labor ratios, and thus rates of return.

The point of view in our paper is from “Old Europe”, namely the three largest Continental European countries France, Germany, and Italy. These countries have large pay-as-you-go pension systems and vulnerable labor markets. They are quickly and deeply aging and have low labor force participation rates. These three countries serve as prototypical countries in which aging is strong and has already, or will, sooner or later, precipitate incisive labor market and pension reforms.

We then expand our view on global financial markets, including especially the emerging large economies of China and India. Our core model therefore covers three world areas: the three large Continental European countries France, Germany, and Italy; the United States; and the three biggest Asian economies China, India, and Japan. For analytical purposes, we contrast this model with a bipolar world of Old Europe and the U.S. on the one side, and a model that includes the rest of the developed world on the other side.

The paper proceeds as follows. Section 2 presents several variants of our overlapping generations’ model. Section 3 analyses accumulation and returns on the markets of productive assets in a small world of an ageing Europe and the relatively youthful United States. Section 4 then investigates the impact of reform policies in Europe to volume and returns on global asset markets. Section 5 summarizes our results with a view on economic and social policy implications.

2. The MEA-OLGA model variants

Savings, capital returns and international capital flows are the outcome of complex interactions between supply and demand on German and international capital markets, influenced by demography and the capital and goods markets. Initial theory-based models to estimate the effects of demographic changes on the development of returns on productive capital can be found in Cutler et al. (1990), Börsch-Supan (1996), and Reisen (2000). More recent work is based on models of overlapping generations (OLG). Such models have a long

tradition. They were developed as theoretical models by Samuelson (1958) and Diamond (1965) and extended by Auerbach and Kotlikoff (1987) to be used for the first time in a near-reality computer simulation model. Since then, such models have undergone considerable development processes, enabling them to mirror reality more closely. The models have increasingly developed from semi-theoretical analytical tools to genuine forecasting and simulation models.³

In the sequel of this section, we employ the next generation of OLG models characterized by the implementation of realistic demographic data (Börsch-Supan, Ludwig and Winter, 2002; INGENUE, 2001; Börsch-Supan, Heiss, Ludwig and Winter, 2003; Börsch-Supan, Ludwig and Winter, 2006, Börsch-Supan and Ludwig, 2008). The MEA-OLGA simulation model, as we call our incarnation of this model type, was the first that combines three crucial features:

- it has a detailed annual account of past and future demography;
- it is not restricted to one country but also covers international trade and capital movements, thus describing the possibility to “diversify the demographic risk”;
- it features a variety of labor supply assumptions from fixed to fully flexible labor supply, including a mixture of exogenous and endogenous labor supply components.

We are taking a long-term perspective, abstain from all short-term considerations which also justifies our assumption that exchange rates have no role to play in our real economic model.

(a) Households

In our model, which is based on Börsch-Supan and Ludwig (2008), labor supply has an endogenous and an exogenous component. While we treat labor market and pension reforms and the resulting variation in employment numbers as exogenous, households endogenously adjust hours worked and may thus counteract parts of the reforms.

Our main assumptions on this interplay between the exogenous variation of employment numbers and hours worked are as follows. We model the decision of a household with preferences over consumption and leisure. Total labor supply of a household of age j as derived from the household’s optimization is the product of exogenous employment numbers l_j and the endogenous decision on hours worked at age j , h_j (momentarily suppressing the time index t and the country index i to simplify notation). The crucial difference between the

³ Similar multi-country OLG models have been developed, among others, by Feroli (2002), Henriksen (2002), Brooks (2003), Domeij and Floden (2005), Attanasio, Kitao and Violante (2006, 2007) and Ludwig and Krüger (2007).

two labor supply components is that hours worked may not exceed the time endowment (which we normalize to one) while employment numbers l_j , can take any positive value.

As the age-specific employment l_j is exogenously increased, e.g., due to an increase in the retirement age, the household endogenously decreases hours worked, h_j . In the absence of any constraints, the two components of labor supply are perfect substitutes such that the exogenous variation of l_j leaves the labor supply of the household unaffected. However, the exogenous variation of l_j affects total effective labor supply for those households for whom the time endowment constraint is binding. As a consequence, the exogenous employment variation of l_j has some effect on aggregate effective labor supply but the overall effect is substantially smaller than in an alternative specification of our model with fully exogenous labor supply where

We now describe this mechanism in detail. An exogenous fraction $l_{t,j,i}$ of each household supplies work. This fraction of the household endogenously decides on the hours of work $h_{t,j,i}$. The other fraction of the household, $1-l_{t,j,i}$, does not work and fully enjoys leisure. Accordingly, total labor supply of a household is given by the product of the two components, $l_{t,j,i} \cdot h_{t,j,i}$ and total leisure is therefore $1-l_{t,j,i} \cdot h_{t,j,i}$ whereby we restrict time endowment to one.

The household derives utility from consumption $c_{t,j,i}$ and leisure $1-l_{t,j,i} \cdot h_{t,j,i}$ and the household's per period utility function is given by

$$u(c_{t,j,i}, 1 - h_{t,j,i} \cdot l_{t,j,i}) = \frac{1}{1-\theta} (c_{t,j,i}^\phi (1 - l_{t,j,i} h_{t,j,i})^{1-\phi})^{1-\theta}.$$

The maximization problem of a cohort born in period t at $j=0$ is given by

$$\max \sum_{j=0}^J \beta^j \pi_{t,j,i} u(c_{t+j,j,i}, 1 - l_{t+j,j,i} h_{t+j,j,i}),$$

where β is the pure time discount factor. In addition to pure discounting, households discount future utility with their unconditional survival probability in period, $\pi_{t,j,i} = \prod_{k=0}^j s_{t+k,k,i}$.

A feature of our model is uncertainty about the time of death expressed in the term $\pi_{t,j,i}$ in equation (5). We assume that accidental bequests resulting from premature death are taxed by the government at a confiscatory rate and used for otherwise neutral government consumption.⁴ We do not include intended bequests in our model.

Labor productivity changes over the life-cycle according to age-specific productivity parameters ε_j . Hence, the age-specific wage is $w_{t,j,i} = w_{t,i} \cdot \varepsilon_j$.

⁴ An alternative assumption would be to redistribute accidental bequests to the population according to some scheme. The redistribution would however not affect our results much and we therefore opted for this simplifying assumption.

Denoting total assets by $a_{t,j,i}$, maximization of the household's intertemporal utility is subject to a dynamic budget constraint given by

$$a_{t+1,j+1,i} = a_{t,j,i}(1+r_t) + \lambda l_{t,j,i} h_{t,j,i} w_{t,j,i} (1-\tau_{t,i}) + (1-\lambda)p_{t,j,i} - c_{t,j,i},$$

where $\lambda=1$ for $j=0, \dots, jr$ and $\lambda=0$ for $j>jr$ and jr is the exogenous retirement age. $\tau_{t,i}$ is the contribution rate to a PAYG financed public pension system and $p_{t,j,i}$ is pension income, see below.

Furthermore, maximization is subject to the constraint that hours worked are positive and may not exceed one, hence,

$$0 \leq h_{t,j,i} \leq 1.$$

(b) Pensions and government

The only purpose of the government in our model is to organize a prototypical public pension system that is pay-as-you-go financed and provides flat (i.e. not earnings-related) pension benefits. We assume that the budget of the pension system is balanced in all t,i such that

$$\tau_{t,i} w_{t,i} L_{t,i} = \sum_{j=jr+1}^J p_{t,j,i} N_{t,j,i} = \rho_{t,i} w_{t,i} (1-\tau_{t,i}) \sum_{j=jr+1}^J N_{t,j,i}$$

where $\rho_{t,i}$ denotes the net replacement rate and $\tau_{t,i}$ the contribution rate of the pension system in t,i . Households consider the contributions as pure taxes.

The main policy parameter is the net replacement rate ρ ; the contribution rate τ responds passively to balance the pension system's budget. If ρ is large, public pensions crowd out private saving through the households' consumption/saving decision. Moreover, since the benefits are not related to individual earnings, we consider the contributions to the pension system as pure taxes with the associated labor supply distortions which work through the households' labor supply decision.

(c) Production

The production sector in each country consists of a representative firm that uses a Cobb-Douglas production function given by

$$(2) \quad Y_{t,i} = F(\Omega_{t,i}, K_{t,i}, L_{t,i}) = \Omega_{t,i} K_{t,i}^\alpha L_{t,i}^{1-\alpha},$$

where $K_{t,i}$ denotes the capital stock and $L_{t,i}$ is aggregate effective labor supply of country i at time t . α is the capital share and $\Omega_{t,i}$ is the technology level of country i growing at the exogenous rate g .

The firm's problem is static such that wages and interest rates are given by

$$(3) \quad w_{t,i} = \Omega_{t,i}(1-\alpha)k_t^\alpha,$$

$$(4) \quad r_t = \alpha k_t^\alpha - \delta,$$

where k_t is the capital stock per efficient unit of labor and δ is the depreciation rate of capital. Note that k_t is the same across all countries by the definition of $\Omega_{t,i}$.

(d) International equilibrium

Given initial capital stocks $K_{0,i}$, a competitive equilibrium of the economy is defined as sequences of disaggregate variables for the households, $\{c_{t,j,i}, l_{t,j,i}, h_{t,j,i}, a_{t,j,i}\}$, sequences of aggregate variables, $\{C_{t,i}, L_{t,i}, K_{t,i}\}$, prices for labor as well as contribution rates to the pension system, $\{w_{t,i}, \tau_{t,i}\}$, in each country i , and a common world interest rate $\{r_t\}$ such that firms and households behave optimally, the budget constraints of governments are satisfied and national as well as international markets clear.⁵

(e) Numerical implementation

Our time line has four periods: a phase-in period, a calibration period, a projection period, and a phase-out period. First, we start calculations 110 years before the calibration period begins with the assumption of an “artificial” initial steady state in 1850. The time period between 1960 and 2004 is then used as calibration period in order to determine the structural parameters of the model. Our projections run from 2005 through 2100.⁶ The phase-out period after 2100 has two parts: a transition to a steady-state population in 2200 and an additional 100-year period until the macroeconomic model reaches a final steady state in 2300.

We determine the equilibrium path of the overlapping generations model by using the modified Gauss-Seidel iteration as described in Ludwig (2006). The algorithm searches for equilibrium paths of capital to output ratios, and, in case there are social security systems, pension contribution rates in each country.

(f) Calibration

Calibration of the model entails three separate elements. First, we use a detailed population and baseline labor force projection described below.

Second, we calibrate the pay-as-you-go public pension systems with data on replacement rates taken from Palacios and Pallarès-Miralles (2000) and employee’s social security contributions

⁵ See Börsch-Supan and Ludwig (2008) for a formal definition.

⁶ Results are displayed through the year 2050 to show the main period of population aging.

taken from OECD (2001). We solve for equilibrium contribution rates using the PAYG budget constraint.

Third, we choose the structural parameters by reference to other studies. This is most critical for the consumption weight in the utility function, φ , that determines the relative preference for labor versus leisure and thereby indirectly the number of households at the constraint with $h_j=1$. We set $\varphi=0.66$ which corresponds to the value determined by minimum distance methods in Börsch-Supan, Ludwig and Winter (2006). The remaining structural model parameters, referring to an annual periodicity of the model, are as follows: the capital share in production is $\alpha=0.4$, the growth of labor productivity is $g=0.016$ and the depreciation rate of capital is $\delta=0.05$. Technology levels are calibrated to match relative per capita income levels in the different world regions relative to the U.S. ($\Omega_i=1.0$) which requires a range for Ω_i from 0.017 (India) to 1.326 (Japan). The discount factor is set to $\beta=0.99$ (Hurd, 1989) and the coefficient of relative risk aversion is set to $\theta=2$ which is in the middle of the range [1,4] considered as reasonable in the literature.

(h) Demography

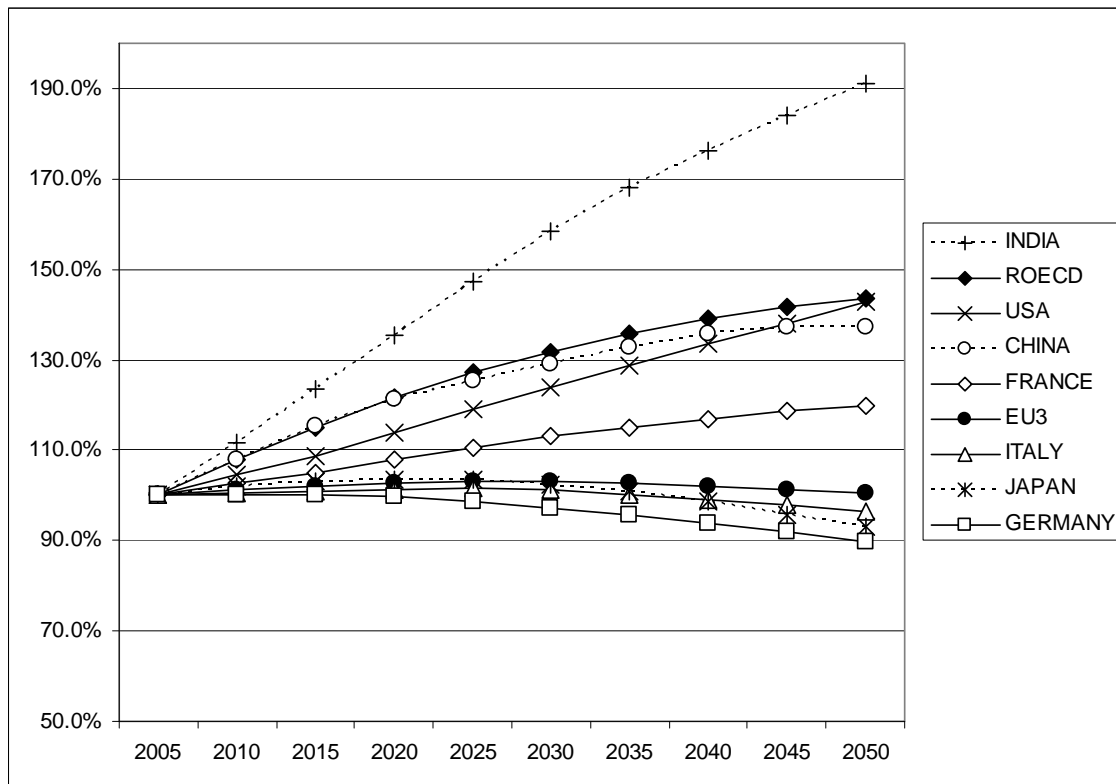
We project the demographic development based on three key assumptions. First, we provide projections of mortality based on a Lee-Carter decomposition, using past mortality rate changes derived from the Human Mortality Database (2008). The resulting life expectancies in 2050 coincide with the current UN projections for Germany and the U.S., but are slightly higher for France and Italy (UN has age 85 compared while our projections yield age 86 and 87, respectively). Demographic projections in the other world regions are based on the United Nations (2006) and we employ the methodology described in details in Börsch-Supan, Ludwig and Winter (2006).

Second, we assume that fertility rates are exogenous and remain constant on today's level. Third and similarly, we assume constant and exogenous migration flows, based on the current medium variant of the UN projections which is about the long-term average. It is important to note that these migration flows are small relative to the decline in the labor force projected in section 3.

Figure 1 shows the relative growth of the population aged 15 years and over which will be the base of our projections and simulations. There are stark differences across countries and regions. India and the U.S. keep growing almost linearly, while China, France, and the rest of the developed world (ROECD) grow at a declining rate. The adult populations of Germany

and Italy decline after 2020. It is notable that the decline is smaller in Italy mainly due to the higher expected migration to Italy.

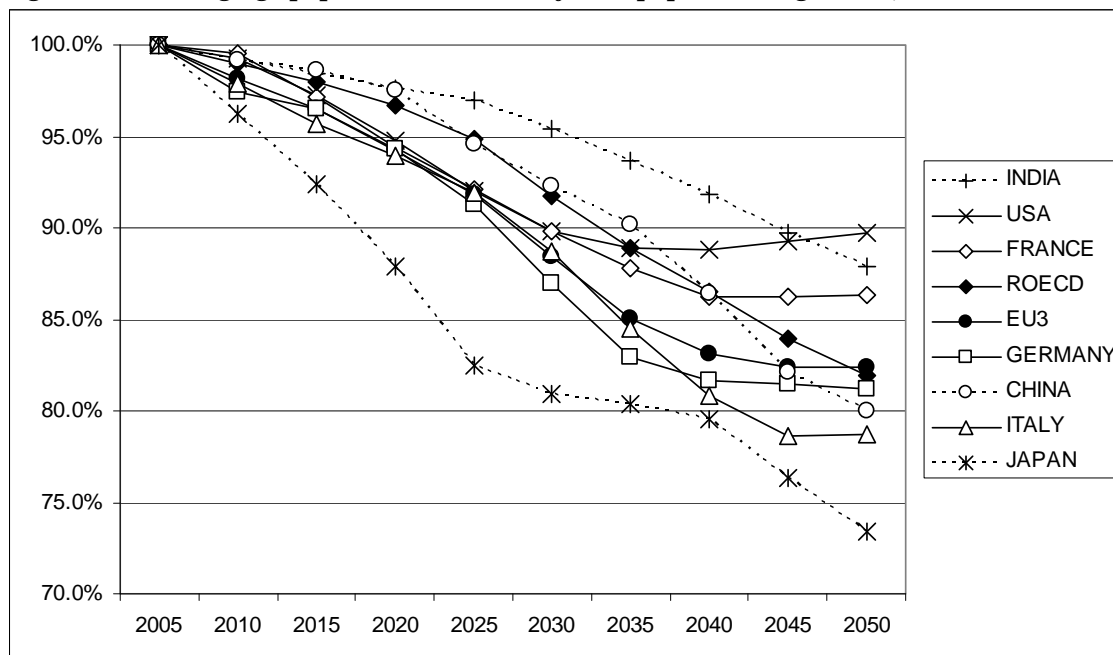
Figure 1: Population 15 years and older, indexed to 2005=100%



Source: Own projection based on assumptions detailed in text. EU3 denotes the union of France, Germany and Italy. ROECD denotes the OECD countries except those countries shown separately in the graph.

Truly remarkable is the decline of the working age population (age 20-64), see figure 2. Relative to total population aged 15 and older, India and the U.S. will loose about 10% of their working age individuals between 2005 and 2050. In China, Germany, the loss is about twice as high, and in Japan and Italy almost three times as high.

Figure 2: Working age population as share of total population aged 15+, 2005=100%



Source: Own projection based on assumptions detailed in text. Working age is age 15 to 64. EU3 denotes the union of France, Germany and Italy. ROECD denotes the OECD countries except those countries shown separately in the graph.

(g) Capital mobility

The model describes long-term trends in capital movements, precipitated by the glacial forces of population aging and the long-run effects of labor market reforms. We therefore assume perfect capital within the regions modeled and justifies the assumption that exchange rates have no role to play in the MEA-OLGA model. Whereas the short-term exchange rate induces flows of capital movements which, although considerable, are of short duration and of less interest to us in the context of demography, the long-term exchange rate and the long-term capital flows are determined jointly by the fundamental variables of demography and overall economic development. Section 3 describes a bipolar world of perfect capital mobility between Old Europe and the U.S. (and of course among the three European countries). Relative to the rest of the world, they represent a closed economy. Section 4 expands this world and assumes perfect capital mobility also to the three big Asian countries and the rest of the developed world. Capital is modeled as immobile with respect to the developing countries.

3. Interactions between Labor and Asset Markets

The central aim of this paper is to investigate the effect of aging on the global market for productive assets, in particular the evolution of its volume and the rate of return. In our earlier work, we have shown that asset returns are highly sensitive to labor supply. In particular, the decline in asset returns is considerably larger in a world of fixed labor supply than in a world in which labor supply and saving decisions are linked by endogenously determined household behavior.

In this section, we model this linkage and show its implications for asset returns in a simple two-region setting of “Old Europe” versus “Young USA” in order to focus on these linkages. In the following section, we will then add the effects of the emerging large Asian economies on asset returns.

The novelty of our approach is to treat labor supply as a decision which is endogenous but has strong exogenous components driven by labor market policy. Total labor supply is a result of labor market entry age, female labor force participation, unemployment rates, and labor market exit age, to name the four most important parameters. These parameters are strongly governed by institutional restrictions. Labor market entry age, e.g., is a function of the school system. Germany, e.g., has regulations that generate late entries into the school system, a long duration in high schools and universities, and thus a late labor market entry age. Similarly, female labor force participation is a function of institutions such as kindergarten and afternoon school which tend to be provided by public entities in Europe. Unemployment is a function of the duration and generosity of unemployment compensation. Labor market exit, finally, is strongly governed by pension regulations that effectively make the early eligibility age also the effective age of labor market withdrawal. Our main point is that from an individual’s point of view, labor supply has important exogenous components which restrict possible endogenous labor supply decisions.

It is unlikely that these exogenous components remain unchanged over the course of population aging and the general change of society over the next two decades. We therefore define two polar scenarios representing the potential changes in the institutional framework restricting households’ labor supply decisions:

- In the status quo scenario (STATQUO), age and gender specific labor force participation rates will remain as they are at baseline in 2005; this was the scenario underlying figure 2.
- The labor market reform scenario (LREFORM) includes four reform steps:
 - RETAGE: an increase in the retirement age by 2 years;

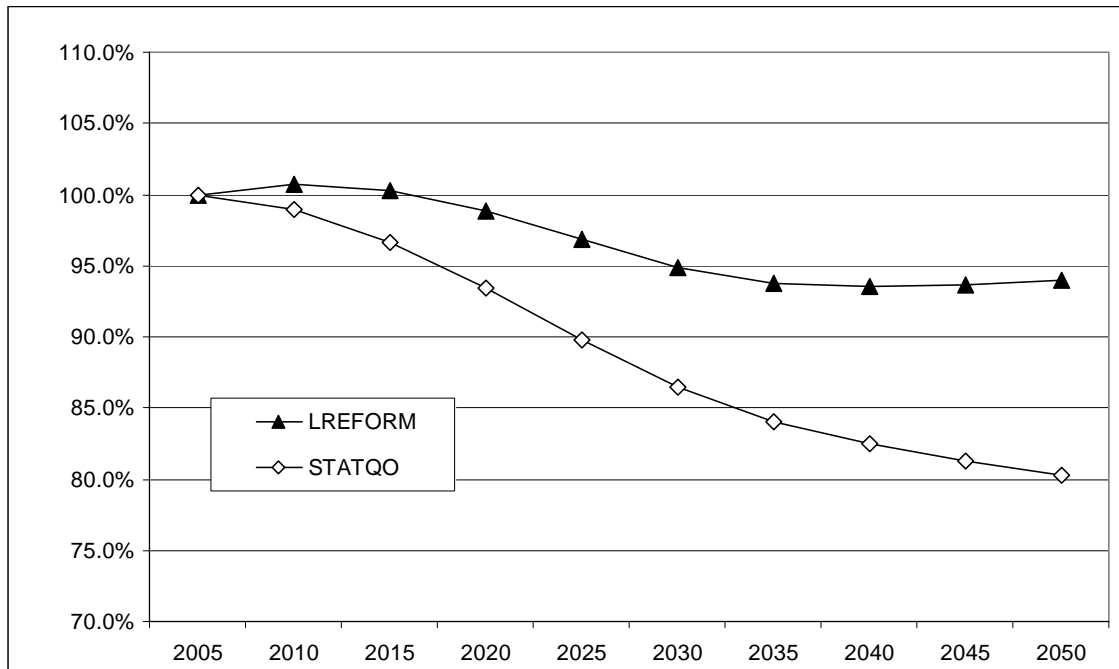
- JOBENTRY: a decrease in the job entry age by 2 years;
- FEMLFP: an adaptation of female labor force participation rates to those of men;
- UNEMP: a reduction of unemployment to 40% of its current level.

The increments are motivated by actual policy proposals: in Germany, the statutory retirement age has been raised from 65 to 67 years in a series of transitions until about 2020; in France and Italy, similar steps will follow with some delay. The change in the European high school and university system (the so called Bologna process) is expected to decrease duration in schooling by about 2 years. Finally, 40% of current unemployment represents the conventional estimate of the NAIRU (Ball and Mankiw, 2002).

These reform steps will be phased in linearly between 2010 and 2050. Overall, these reform steps do not appear to be overly radical; in fact, their combination would lead in 2040 to labor force participation rates fairly similar to those in Denmark today. They result in a substantial

increase in labor force participation $L_{t,i} = \sum_{j=0}^J l_{t,j,i} N_{t,j,i}$, as depicted in figure 3:

Figure 3: Employment, indexed to 2005=100%, EU3 (France, Germany, and Italy)



Attempts to actually execute reforms with those goals have faced stiff opposition in France and Italy, and more recently and to a somewhat lesser extent also in Germany. Hence, while we treat the reforms and the resulting variation in employment numbers as exogenous, households in our model endogenously adjust hours worked and may thus counteract parts of

the labor market reforms, see the more sophisticated household model specified in section 2(b). As we will show, these reactions lead to a lower number of total hours worked than would be implied by figure 3, and they have repercussions on asset markets and asset returns.

We structure our results by investigating three dimensions, each with two polar assumptions:

- Labor market reforms: no reform at all, resulting in future labor force participation rates that equal the current ones (STATQUO or SQ) versus the implementation of all four reform steps described above (LREFORM or RF)
- Pension system: a prototypical pension system of Continental Europe, purely pay-as-you-go, providing flat social security benefits financed by distorting contributions (FLATSS or FL) whereby we maintain the current country-specific replacement rates also in the future ($\rho_{t,i}=\rho_{2005,i}$ for $t>2005$) versus a fully-funded, voluntary private accounts system which generates no distortions (SAVING or SA) where pay-as-you-go pension replacement rates are zero ($\rho_{t,i}=0$).
- Labor supply reaction: Fixed hours supply (EXOGENOUS or EX) versus endogenous supply of working hours (ENDOGENOUS or EN) as described in the households optimization problem (subsections 2a and 2b).

This set-up yields a two-by-two-by-two table of underlying assumptions displayed in table 1. The eight resulting combinations are labeled, e.g., by “FL-SQ-EX” to denote a flat benefit pay-as-you-go social security system (FL) with status quo labor force participation (SQ) and an exogenously given hours supply (EX), by “SV-RF-EN” to denote a fully-funded private savings based old-age provision system (SV) with a comprehensive labor market reform (RF) and an hours supply which reacts endogenously to ageing and policy changes (EN), etc.

Table 1: Set up of scenarios

	Extensive margin: Labor market regime			
	Constant age and gender specific labor force participation (STATQUO, diamonds)		Increasing age and gender specific labor force participation (LREFORM, triangles)	
	Intensive margin: Hours' supply			
Pension system	EXOGENOUS hours supply (dashed line)	ENDOGENOUS hours supply (solid line)	EXOGENOUS hours supply (dashed line)	ENDOGENOUS hours supply (solid line)
Pay-as-you-go with flat benefits (FLATSS, thin line)	<i>FL-SQ-EX</i>	<i>FL-SQ-EN</i>	<i>FL-RF-EX</i>	<i>FL-RF-EN</i>
Fully funded voluntary accounts (SAVING, thick line)	<i>SV-SQ-EX</i>	<i>SV-SQ-EN</i>	<i>SV-RF-EX</i>	<i>SV-RF-EN</i>

On the following pages, we develop how the main outcome variables of our general equilibrium model emerge from the two exogenous changes that drive our model:

- the demographic aging process in the background, and
- lifting of labor supply restrictions.

We display results for total labor supply, domestic capital stock, and asset returns. We refer the reader to Börsch-Supan and Ludwig (2008) for results on living standards, especially GDP and consumption per capita. All figures refer to the aggregate of France, Germany, and Italy (“EU3”). The U.S. is modeled in the background with similar changes in retirement age and female labor force participation, but no other exogenous policy changes.

All figures have the same design (cf. table 1). We denote exogenous labor supply by a dashed line and endogenous hours' supply by a solid line. The high labor force participation scenario (LREFORM) is marked by triangles, the constant labor force participation scenario (STATQUO) by diamonds. Finally, the flat benefits pay-as-you-go social security system (FLATSS) features a thin line, while the fully funded pension regime (SAVING) is identified by a thick line.

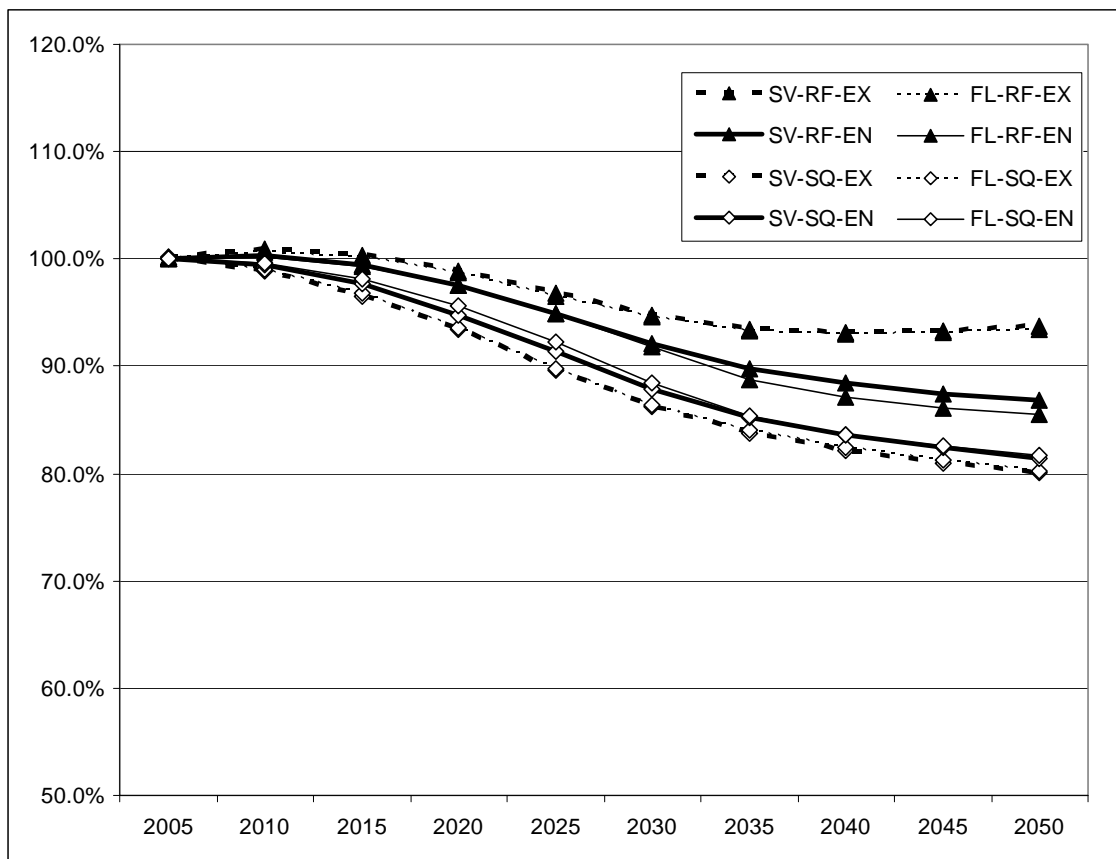
3.1 Total labor supply

Total labor effective supply is the product of labor force participation, working persons, and

hours per person:
$$L_{t,i} = \sum_{j=0}^J l_{t,j,i} h_{t,j,i} N_{t,j,i} .$$

Its evolution under the eight scenarios is displayed in figure 4. If hours are exogenous, there is no difference between the two pension system scenarios. Hence, the lines for FL-RF-EX and SV-RF-EX at the very top overlap as well as the lines representing FL-SQ-EX and SV-SQ-EX at the very bottom. If hours are endogenous, the increase in the number of working persons in the LREFORM scenario is only partially reduced by the decline in hour's supply.

Figure 4: Total labor supply, indexed to 2005=100%, EU3

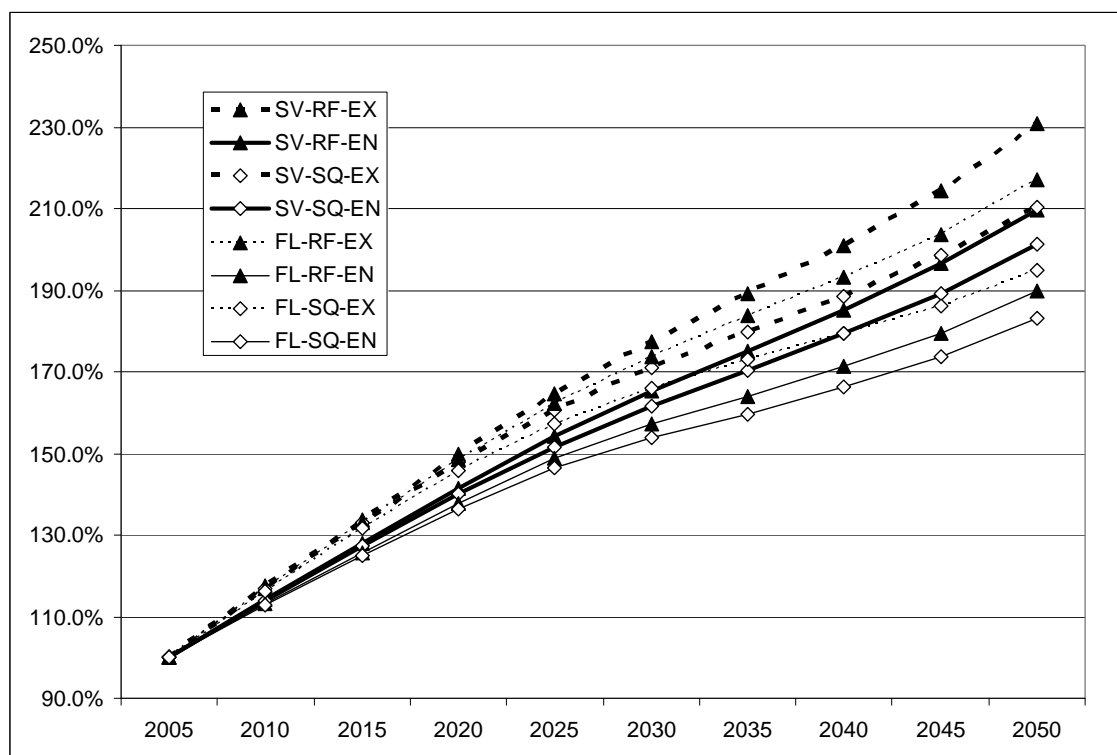


3.2 Capital accumulation

Figure 5 depicts the first main outcome variable of interest in this paper: the evolution of the combined domestic capital stock of France, Germany, and Italy. As expected, capital accumulation is much higher under a funded pension system than in a pay-as-you-go system. There is also substantially more capital accumulation in the high labor force participation

scenario (LREFORM) as compared to constant participation (STATQUO). Finally, capital accumulation is higher if endogenous hours' supply is not dampening the effect of a higher labor force participation. Combining these three effects yields the eight trajectories of figure 5. Capital accumulation is highest under a fully-funded system with high labor force participation and no dampening effect of endogenous hours (SV-RF-EX). It is lowest in a pay-as-you-go system with status-quo labor force participation and the full force of negative incentive effects (FL-SQ-EN).

Figure 5: Evolution of the capital stock in EU3, indexed to 2005=100% old



3.3 Asset returns

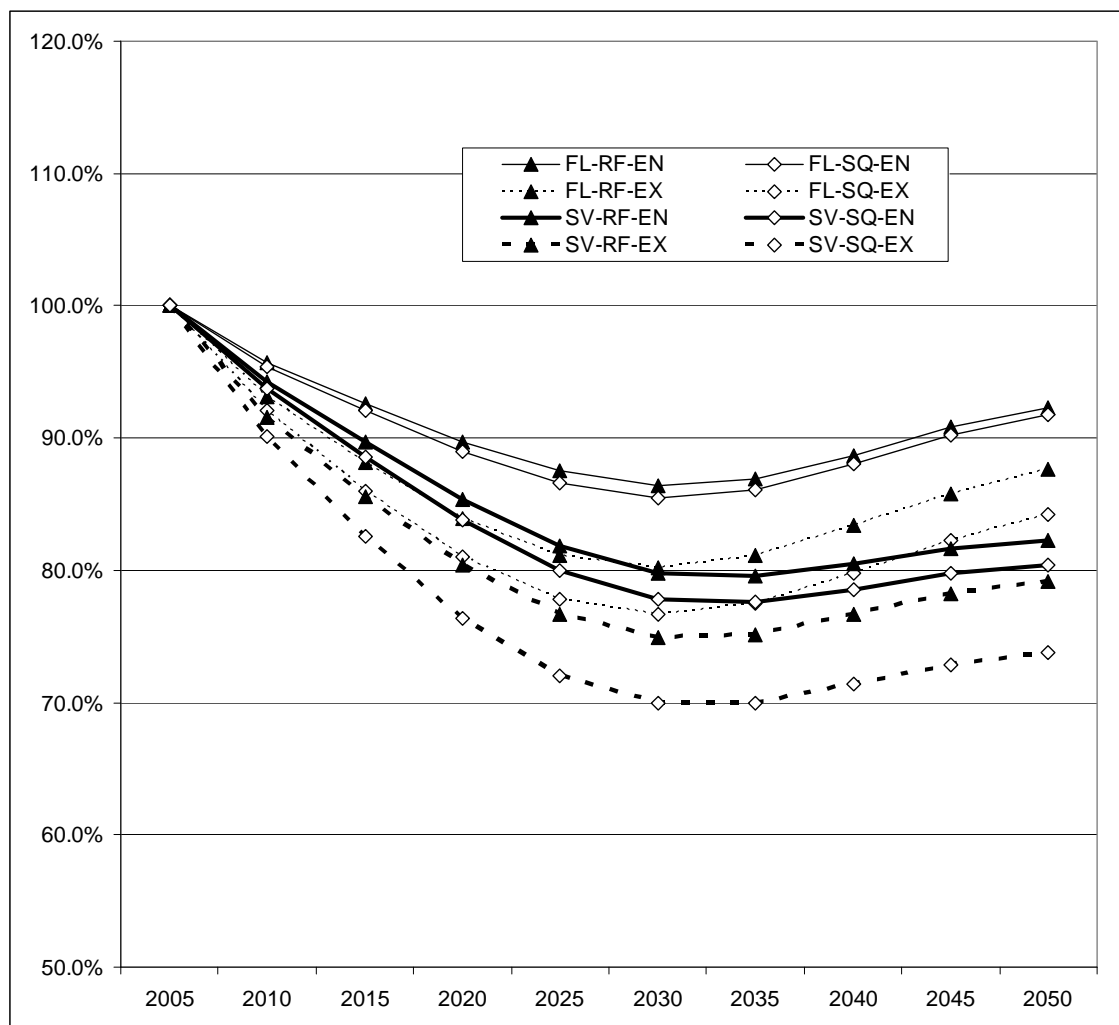
Figure 6 depicts the second main outcome variable of interest in this paper: the rates of return to productive assets. The figure shows the strong interactions between asset markets and labor supply. The rates of return are normalized to 100% in 2005 in order to purge them from level effects at the initial date.

The general message is clear: There will be a decline in asset returns due to population aging but there will be no devastating “asset meltdown”. The extent of the decline, however, strongly depends on labor supply. Three general lessons emerge from figure 6. First, as shown earlier, a fundamental pension reform increases the capital stock and thus reduces rates of

return (yellow lines vs. blue lines). This effect dominates all other effects after about 2035. Second, lifting labor supply restrictions increases rates of return (red triangles vs. blue diamonds) in almost all circumstances. The third effect is more complicated. Endogenous hours' reactions dampen total labor supply and thus have a tendency to reduce rates of return. On the other hand, capital accumulation is slower, see figure 5, which overcompensates this effect.

The demography-induced decline in asset returns is therefore lowest in a pay-as-you-go system with high labor force participation and the full force of the hours' reaction (FL-RF-EN), and highest under a fully-funded system with status-quo labor force participation and no dampening effect of endogenous hours (SV-SQ-EX).

Figure 6: Asset returns, indexed to 2005=100%



4. Spillover effects between Old Europe and Growing Asia

We now extend our analysis to include China, India and Japan (“ASIA3”), and investigate which effects labor market reforms in Europe have on a global capital market in which Asia plays an increasingly important role. This role of course heavily depends on the future growth rates of China and India which are impossible to predict with any reasonable accuracy. We therefore work with three scenarios:

- **LOW GROWTH:** Productivity in China and India grows at the same rate as in the rest of world (1.6% p.a.);
- **HIGH BUT DECLINING GROWTH:** Productivity in China and India features a linearly declining grow rate from 4% in 2005 to 1.6% in 2050;
- **HIGH GROWTH:** Productivity in China and India continues to grow at a rate (4% p.a.) which is much higher than in the rest of world (only 1.6%).

The resulting shares in total GDP covered by our model are depicted in Figure 7. In 2005, when we start our simulations, the U.S. GDP share is about 40%; the three big Asian countries obtain a share of about 30%; and the three Continental European countries have a GDP share of slightly more than 20%.

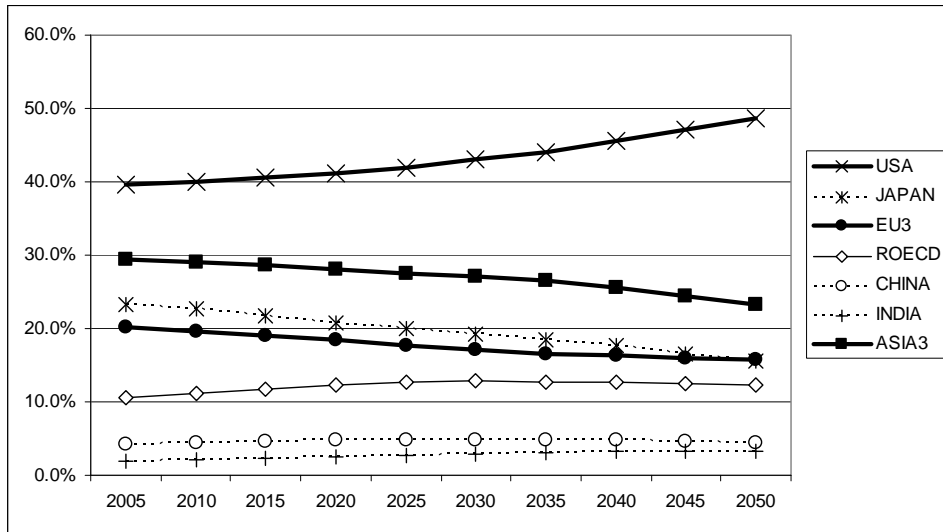
In the low growth scenario, the share of the three biggest Asian economies is declining, mainly due to the shrinkage of Japan, while the U.S. share is strongly increasing. The GDP figures of China and India remain relatively small and stay substantially below the GDP of EU3 and Japan in 2050. Adding the three Asian economies to EU3 and the U.S. essentially amounts to adding Japan, a rapidly aging country, because of its overwhelmingly large share in the GDP of ASIA3.

In contrast, the high growth scenario generates a converging trend between the U.S. and ASIA3, with China’s GDP almost reaching the GDP of Old Europe and Japan. The GDP growth of China and India more than compensates for the shrinkage of Japan. Adding the three Asian economies to EU3 and the U.S. now not only adds the GDP of Japan, but also the large GDPs of India and China. Due to the large growth rates, they absorb a lot of capital. While also China and India are aging, India ages very slowly and modestly, and China’s dependency ratio will stay below that of Old Europe for the foreseeable future.

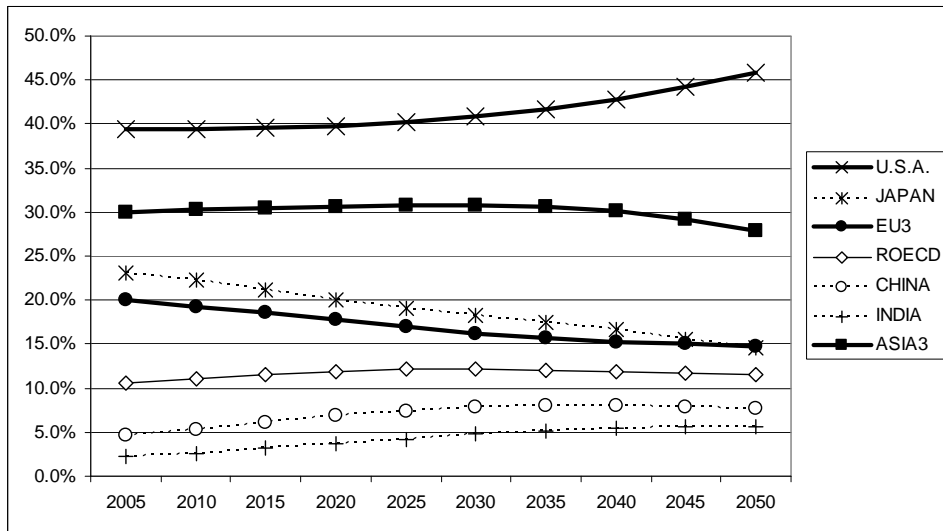
The in-between scenario may be the most realistic one. Here, productivity growth in China and India converges to the productivity growth in the rest of the world, producing a small increase in the GDP share of the three big Asian countries until about 2035, followed by a moderate decline.

Figure 7: Share of World GDP in three growth scenarios, 2005-2050.

Low growth:



High but declining growth:



High growth:

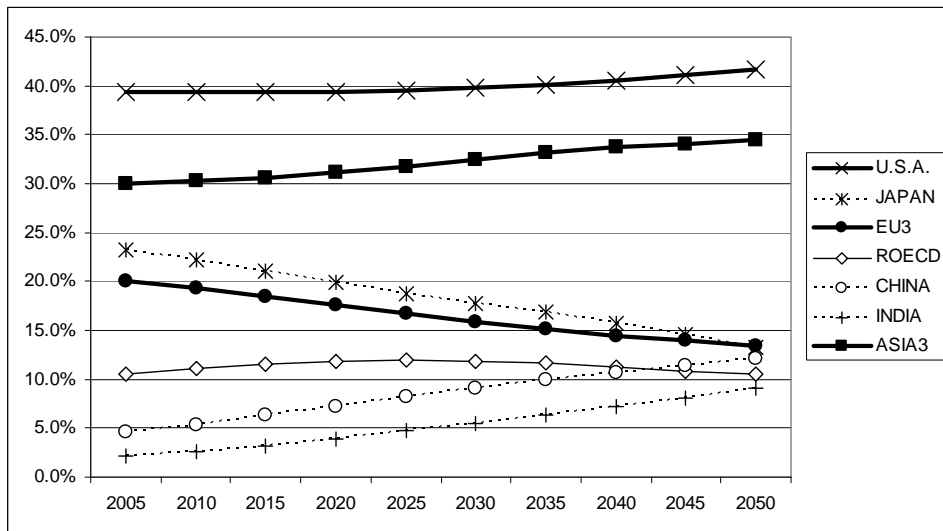
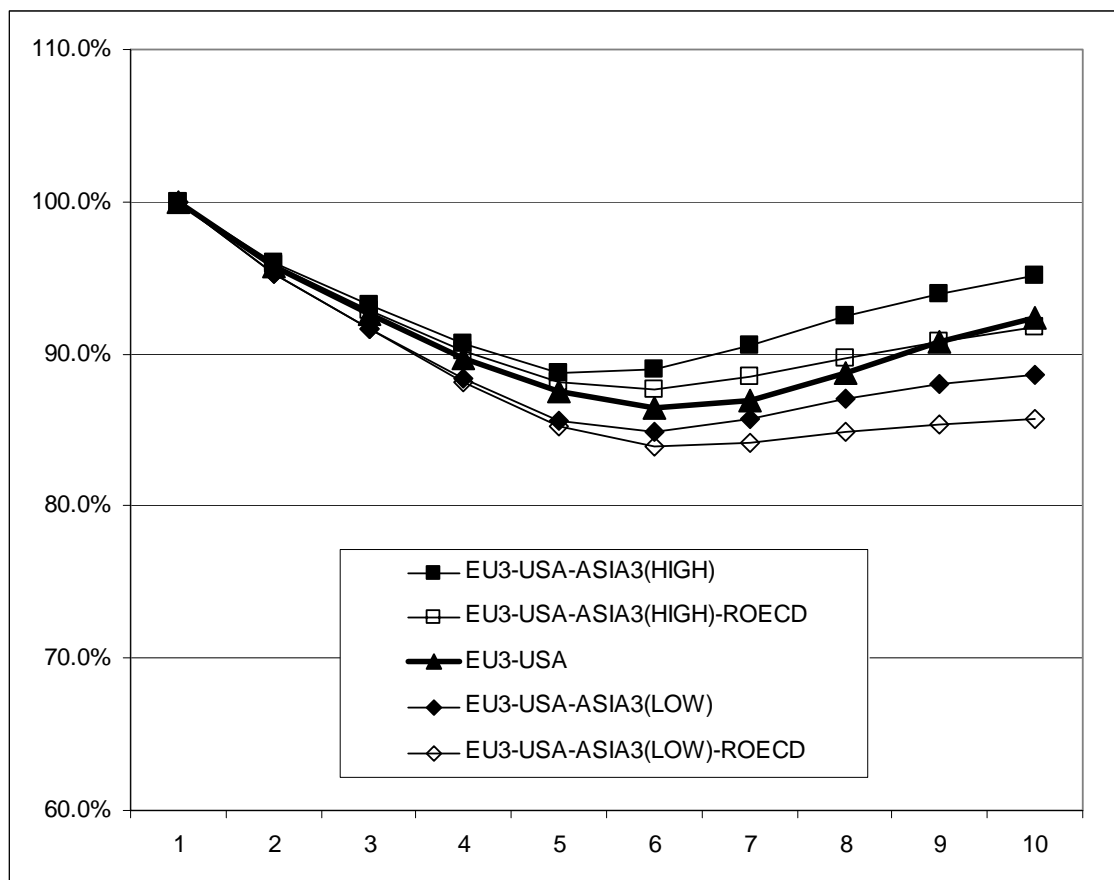


Figure 8 presents our first main result: the evolution of asset returns during the demographic transition depends on the extent of international diversification of assets, but especially to the type of countries to which European capital is exported. The future growth rates of the recipient countries play as much a role as the demography. Among the eight cases discussed in the previous section, figure 8 starts with the case of a pay-as-you-go public pension systems, the full range of labor market reforms described in section 3, and an endogenous hours' response to changes in the economy.

Figure 8: Rate of return from productive assets, pay-as-you-go pensions, 2005-2050.



Compared to the closed bipolar economy of the previous section, the rate of return decline becomes smaller when China and India keep growing as much as they do currently, see the lines marked “ASIA3(HIGH)”. In the case of a funded pension system with its large accumulated capital, this effect is of a noticeable magnitude.

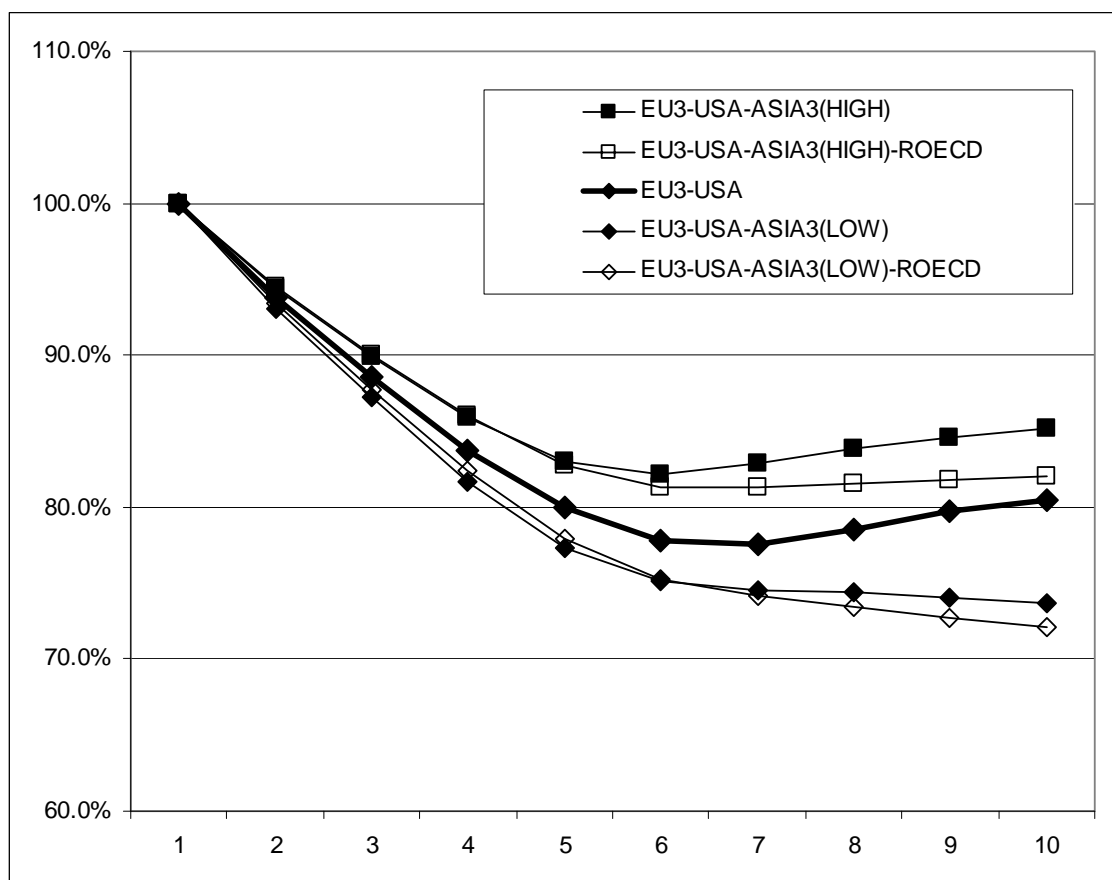
With equal growth across all countries, the world of Old Europe and the U.S. adds essentially Japan. Due to the low growth rate, Japan keeps dominating, in terms of GDP, China and

India. Since Japan is aging even more than Old Europe, the rate of return to productive assets declines relative to the closed economy case, see the lines marked “ASIA3(LOW)”.

Adding the rest of the developed world (“ROECD”) has a similar effect. Because the ROECD countries are aging faster than China and India and have a relatively large GDP weight, rates of return are depressed relative to adding only the Asian countries.

The qualitative results are similar, but the differential effects of international diversification are even more pronounced in a world of funded pension systems, see Figure 9. Moreover, as already discussed in section 3, the overall decline of asset returns is considerably larger due to the abundance of capital relative to the pay-as-you-go case.

Figure 9: Rate of return from productive assets, funded pension systems, 2005-2050.



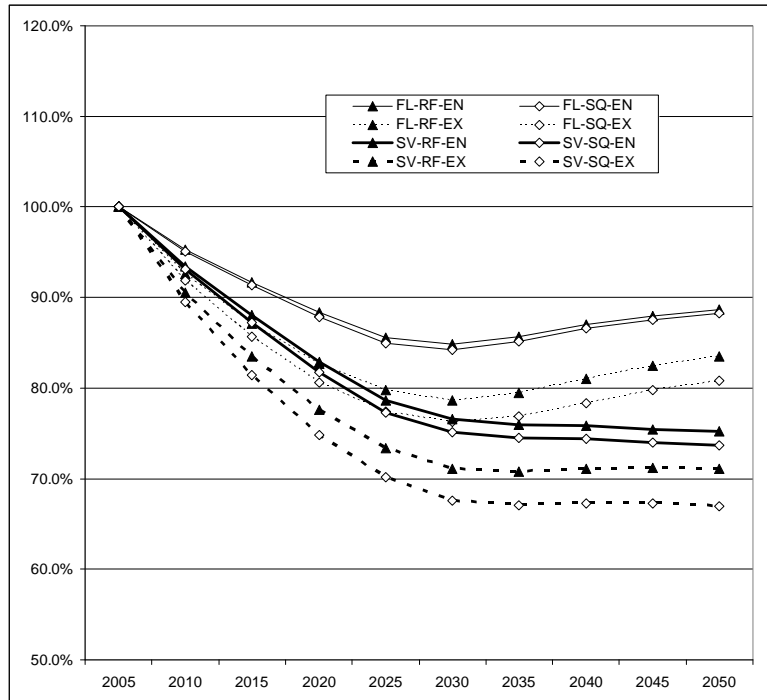
Among the eight cases discussed in the section 3, figures 8 and 9 depict the two most extreme cases in terms of pension system and labor market reform interactions. Figure 10 depicts the full range, separately by growth scenario. It shows our second important result: labor market

reforms and pension system design in Continental Europe have sizeable effects on the global rate of return to productive assets. The range of returns across all eight scenarios is only slightly smaller than in the limited capital mobility case described in the previous section. It is smallest when China and India maintain their high growth because their combined GDP weight will then become larger than that of the three countries representing Old Europe. Hence, there are spillover effects from labor market reforms in Europe to Asia via the global asset markets; in addition, there are spillover effects from growth in China and India to Europe and the rest of the world.

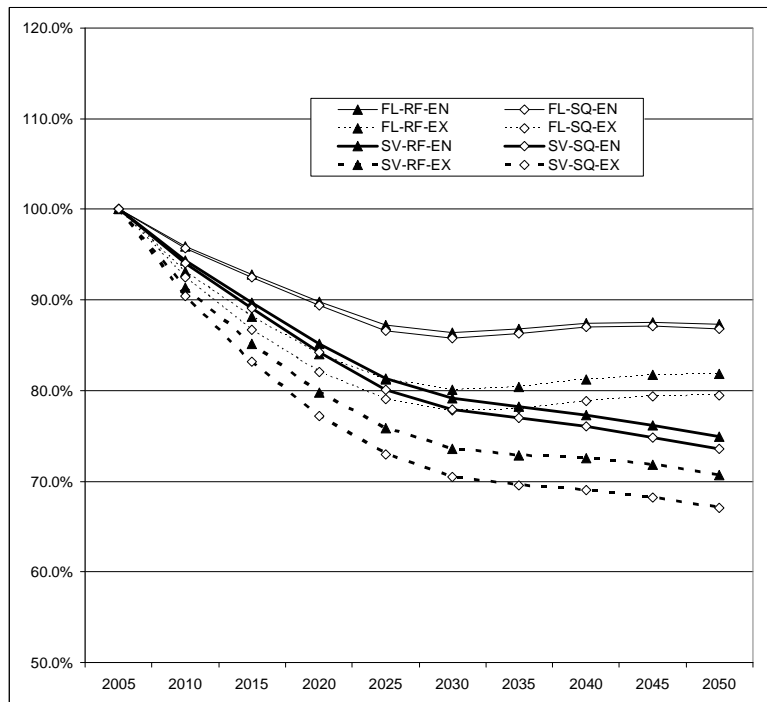
Adding the rest of the OECD countries depresses all figures slightly but the effect is relatively small, as has been seen in figures 8 and 9, and there are no qualitative changes.

Figure 10: Rate of return from productive assets in three growth scenarios, 2005-2050.

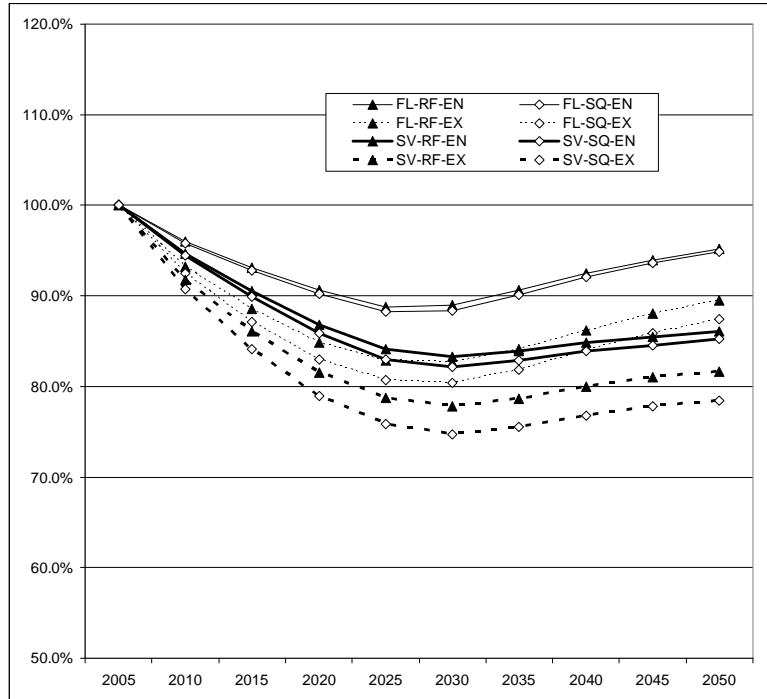
Low growth:



High but declining growth:

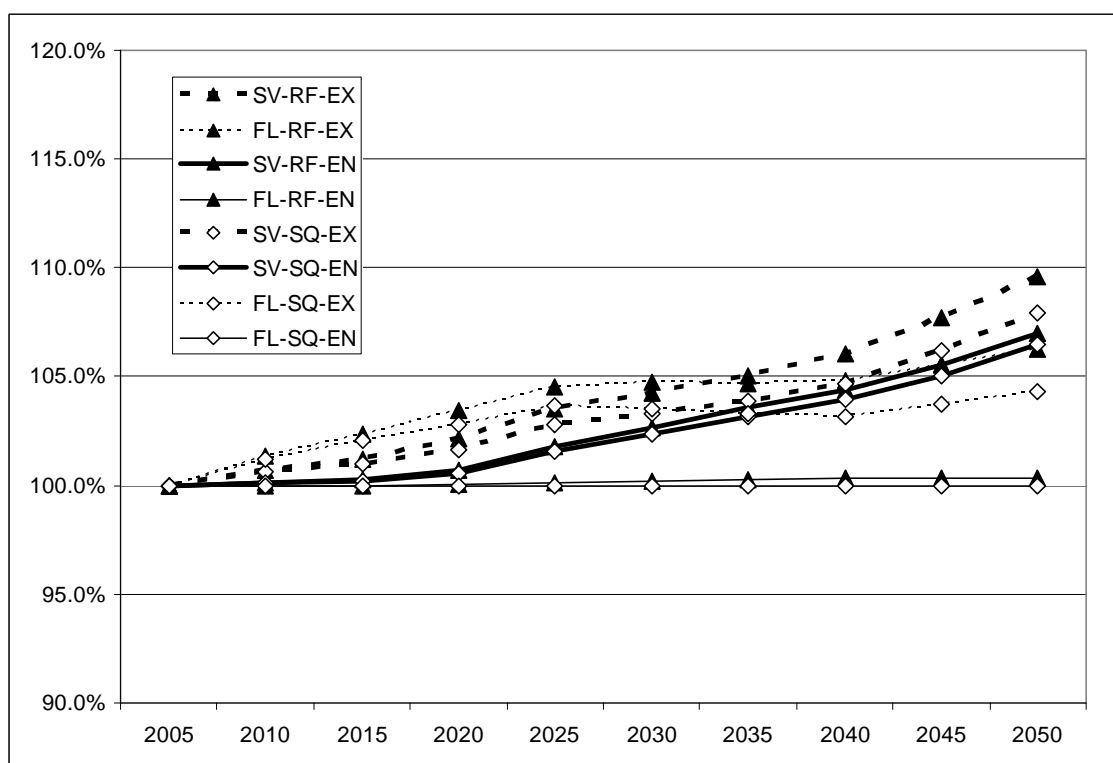


*High
growth:*



Labor market reforms in Europe increase labor supply (figure 4) and capital accumulation in Europe (figure 5), therefore also output and consumption per capita in Europe. The detailed transmission mechanisms are discussed in Börsch-Supan and Ludwig (2008). In addition, there are also spillover effects of European labor market reforms in Asia. Figure 11 depicts the case of Japan. It shows per capita consumption relative to the base case of no labor market reform and a flat-benefits public pay-as-you-go pension system. Labor market reform in Europe (red triangles) increases Japanese per capita consumption. In addition, per capita consumption in Japan will be higher if the three Continental European countries have a pre-funded pension system (yellow lines).

Figure 11: Spillover effects of reforms in Europe to per capita consumption in Japan



5. Summary and Outlook

Aging is affecting markets for productive assets in a complex way. Only a general equilibrium analysis can separate the various diverging trends. The results of our analysis are thus subtle: neither the pessimists with their catastrophic "asset meltdown" hypothesis are right, nor the optimists who claim that capital markets are immune against demographic change.

The key reason behind this is that aging societies need more productive capital to take the place of labor, which is scarce, so the demand for capital is increasing. Moreover, the internationalization of capital markets allows finance to be provided for those production facilities abroad in "younger" countries (notably India and the United States) from which, in future, consumer goods will be imported to the "older" countries (the most prominent being Germany, Italy and Japan). There is a beneficial spillover from growing and still relatively young Asia to Old Europe.

There are also strong interactions between asset markets and asset returns on one side, and labor supply behavior on the other side. Capital accumulation is much higher under a funded pension system than in a pay-as-you-go system. This effect is strengthened by a labor market reform that reduces labor supply restrictions. In turn, countries with funded pensions and therefore ample capital supply feature lower rates of return than countries in which a pay-as-

you-go system makes capital scarcer. Lifting labor supply restrictions increases rates of return because the given capital becomes more productive. The effects of endogenous hours' reactions are complicated. They dampen total labor supply and thus have a tendency to reduce rates of return. On the other hand, they slow down capital accumulation which drives asset returns up. Hence, there is a second beneficial spillover effect, caused by reforms in Old Europe and beneficial not only to Europe but also to the Asian countries.

Even if capital markets are not threatened by a devastating "asset meltdown", economic policy makers cannot afford to relax. The development of employment looks much less rosy. The main effect of demographic change is that the number of gainfully employed persons will fall sharply from 2010 onwards, whereas the number of consumers will largely remain constant until around 2040. This will put pressure on production capability and thus also on the overall growth of our economy: labor - at least in the highly skilled sector - will become increasingly scarce because it is not possible to compensate for this decline in employment per head of population by intensifying capital. For this, the change is too rapid and too extensive. Education and training will assume an increasingly important role to keep returns of productive capital high. Our future research will thus focus more on the role of human capital in the aging process

The paper shows that asset markets play an important role in an aging society. The logic of this is obvious because labor is becoming scarce. There are however two further reasons. Firstly, capital investments are the only way of distributing resources over time and between the generations. More specifically, in the case of the demographic shift, capital investments are the vehicle that allows part of the earning power of baby-boomers to be used to finance their own pension instead of allowing the entire pension to be financed by those of the next generation, who will be completely overwhelmed because of their greatly reduced numbers. We therefore need the capital market so that the earning power of the younger generation is not overwhelmed by the excessive demands of the older generation.

The second reason lies in the international mobility of capital. As we know, mobility of the factor labor is not particularly good and we old countries cannot expect that younger countries will help to finance their pay-as-you-go systems, nor is it likely that a surge of migrants will pay their pension contributions. Capital, in contrast, can move around the global economy and bring in earnings from countries abroad where labor is more plentiful than it is here. For "old countries" such as Germany, Italy and Japan in particular, an open and globalized world can be of assistance during the aging process. Rich in consumers, poor in labor, these countries must have an intrinsic interest in boosting their imports. Free trading relations are therefore a

substitute for inward migration. The capital invested abroad provides better production possibilities abroad and generates capital income for the retirees at home.

Returns on real estate will be more affected by the demographic trend because there is much less room for international diversification and because housing cannot substitute for scarce labor as productive capital can. The pessimism of Mankiw and Weil (1989), however, who made the asset meltdown hypothesis popular in the USA, appears to be misguided due to the many methodological flaws of this paper. Notwithstanding the price drop due to the recent burst of the real-estate bubble, Mankiw and Weil's prediction of a housing price drop between 1990 and 2010 to half of their original levels will certainly not come true.

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