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Old Europe Ages. Can it Still Prosper?

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Abstract

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 in some countries and will deeply affect future labor, financial and goods markets. 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 and growth if they remain unaddressed.

There is no shortage of policy proposals to address population aging. However, little is known about behavioral reactions, e.g., to pension and labor market reform. This paper sheds light on such reactions in three large Continental European countries. France, Germany, and Italy have large pay-as-you-go pension systems and vulnerable labor markets. At the same time, these countries show remarkable resistance against pension and labor market reform. Key issues taken up in this paper are interactions between pension and labor market policies, and the behavioral reactions to reform. Which behavioral reactions will strengthen, which will weaken reform policies? Can Old Europe prosper even if behavioral reactions counter current reform efforts?

JEL Classification: J11, J21; D13; E27; H55; F16, F21

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1. INTRODUCTION

The aging process will deeply affect future labor, capital and goods markets. On a macroeconomic level, labor is becoming relatively scarce in the aging countries. This will precipitate changes in the relative price of labor, will lead to more capital intensive economies, and might generate large international flows of labor, capital and goods from the faster aging countries to the slower aging countries. To the extent that such flows are imperfect, or aging patterns are correlated across countries, domestic output might decline in those countries in which aging is so strong that it indicates a shrinking work force.

On a microeconomic level, the age composition of the labor force will change, which in turn might affect aggregate productivity. Consumption and savings patterns are likely to change when the elderly become a larger proportion of consumers and savers, with widespread implications for capital and goods markets. Labor force participation might also change in response to labor scarcity and a changing wage to interest ratio.

While aging is a global phenomenon, there are marked international differences in the speed and the extent of the aging processes. Even within the industrialized countries, differences are large. Europe and Japan already have a much older population than North America. Italy and Germany are aging faster than France and Great Britain. Italy and Germany are projected to shrink in size; dramatically so after 2040, when the baby boom generation will generally will be deceased. To the extent that labor force shrinkage precedes population shrinkage, these countries will face steeply falling support ratios (workers per consumers). One possible implication is slower economic growth and, in the worst case, stagnating or falling standards of living if the force of aging is stronger than the force of productivity growth.

This paper will focus on the aging process and its macroeconomic implications in Continental Europe, represented by its three largest countries, France, Germany, and Italy. These countries have large public budgets and pay-as-you-go financed social security systems. The conclusion that this is unsustainable has already received prominent attention. In addition, these countries have labor markets characterized by low participation rates, high unemployment, and high wages. The countries are particularly vulnerable to the challenges of globalization, due to the high tax and contribution burden in total labor compensation. In spite of these problems, France, Germany, and Italy have been remarkably resistant to labor market and pension reform. If governments managed to push such reforms through parliament, workers may thus react adversely and preclude at least some of the expected effects of the reforms. The main questions posed in this paper are therefore: What are possible behavioral reactions to reform policies? Which direction will these reactions take and how large are they? And ultimately: Can Europe prosper even if behavioral reactions counter current reform efforts?

Some behavioral reactions will reinforce the intended effects of reform. A good example is raising the statutory retirement age. This measure has direct effects on the labor supply by bringing older individuals to the labor market. Indirect effects emerge from endogenous labor supply reactions, e.g., through incentives generated by the tax and contribution burden that actuarially unfair, regressive social security systems impose on households. Raising the retirement age will lower social security contributions in such pension systems. In response to rising net wages, labor supply may then increase at all ages.

There are, however, also behavioral effects that reduce the impact of policy reforms. To take up the same example, older workers, now forced to work longer, may exploit part-time opportunities given favorable treatment by the pension system. In some countries (Finland, Germany) such opportunities led to a very early transition to part-time work with the perverse result that in some sectors hours supplied actually decreased in response to pension reform. Along the same line, encouraging female labor supply, e.g. through public provision of day

care facilities, may precipitate a decrease in male labor supply. This within-household substitution would be perfectly rational when the household desires joint leisure and joint household production.

Little is known about these behavioral reactions. Key issues addressed in this paper are, therefore, interactions between pension and labor market policies, and the behavioral reactions to reform. Which behavioral reactions will strengthen, which will weaken reform policies? What are the quantitative effects of the behavioral reactions?

Our macroeconomic framework emphasizes the crucial role of labor supply in understanding the effects of aging on economic growth and living standards. The importance of the role is easily seen from the fundamental components that determine a nation's output and income. Write domestic output Y (GDP) of a country with N inhabitants as $Y = A \cdot F(L, K)$. From a macroeconomic point of view, the main effect of aging is to reduce the relative size of the labor force L as a share of total population N and, in some countries, even in absolute terms. Unless this is compensated for either by an increase in total factor productivity A or an increase in the capital stock per worker, K/L , or a combination of those two, domestic output must decline due to the decline in L . Since L is changing quite differently across countries, the growth of Y will reflect these differences. Hence, the current pecking order of G8 countries or similar country groups will look quite different in one or two generations. Moreover, the macroeconomic effects of aging are crucially influenced by the evolution of L . In our paper, L will be determined by two mechanisms: a policy driven change in the number of workers participating in the labor market, and an endogenously determined number of hours supplied by each labor market participant. Since labor force participation is relatively low in France, Germany, and Italy, there is a somewhat ironic source of opportunity from the aging process: the aging process may trigger structural changes easing higher labor force participation that have been long overdue in these three countries. The main question is whether that opportunity will actually be grasped.

A first aim of this paper is to project these relationships over the next two generations until 2050. For this purpose, we extend the multi-country overlapping generations model (Börsch-Supan, Ludwig, and Winter 2007) to our case. An important feature of this model is its multi-country nature. No country in Continental Europe is even approximately modeled by a closed economy. France, Germany, and Italy have large export sectors and considerable foreign direct investments.¹ These provide a second source of opportunities during the global aging process: not all income needs to come from domestic production, and gross national product (GNP) may become substantially larger than gross domestic product (GDP) if foreign direct investments create large returns. We complement France, Germany, and Italy, as countries that save more than they invest, with the United States (US), representing the rest of the world currently absorbing the Continental European savings.² We will not analyze international issues in this paper, as this has been done by Börsch-Supan, Ludwig, and Winter (2007), but we emphasize that such equilibrating forces are modeled in the background of our labor market oriented analysis.

We simulate various pension and labor market policies and investigate their impact on production and consumption per capita in this four-country world. A second feature of our model is therefore a pension system that represents all possible mixtures between pure pay-as-you-go and pure individual accounts. A third and new feature is a combination of exogenous changes of labor supply at the extensive margin (working persons) and endogenous responses of labor supply at the intensive margin (working hours). We think of exogenous changes as lifting institutional restrictions. Examples of restrictions are a minimum labor market entry age generated by the school system; a maximum labor market

¹ Migration rates, however, are small relative to the changes in working age population. We therefore do not model migration flows in this paper.

² In a future version, we will model the remainder of our four-country world as a fifth region.

exit age generated by the pension system; a low female labor force participation generated by inflexible working hours and unavailable day care facilities. Endogenous hours react to policy and market changes, e.g., to social security taxes and contributions, but also to the exogenous changes of the number of working persons.

The key arguments in our paper rest on a set of three-way comparisons that is best imagined by a two-by-two-by-two table. In one dimension, we model the two extreme positions of pension policy. One extreme is a fully-funded, voluntary private accounts system with no distortions and perfect intertemporal consumption smoothing. The other extreme is a pay-as-you-go pension system with flat benefits financed by a contribution that is perceived as a pure tax with the associated labor supply distortions. The second dimension reflects labor market policies. One extreme is the complete failure to adapt those institutional arrangements that keep labor force participation so low in France, Germany, and Italy. The result are unchanged low labor force participation rates by age and gender continuing in the future. The polar case, for some an extreme, is the adjustment of all societal systems, from kindergarten to retirement policies, to increase age and gender specific labor force participation rates across the board. Finally, the third dimension in these comparisons will isolate behavioral effects. One extreme is a fixed hours supply by each working individual. As polar case, we derive an hours supply function which is responsive to wages net of taxes and contributions.

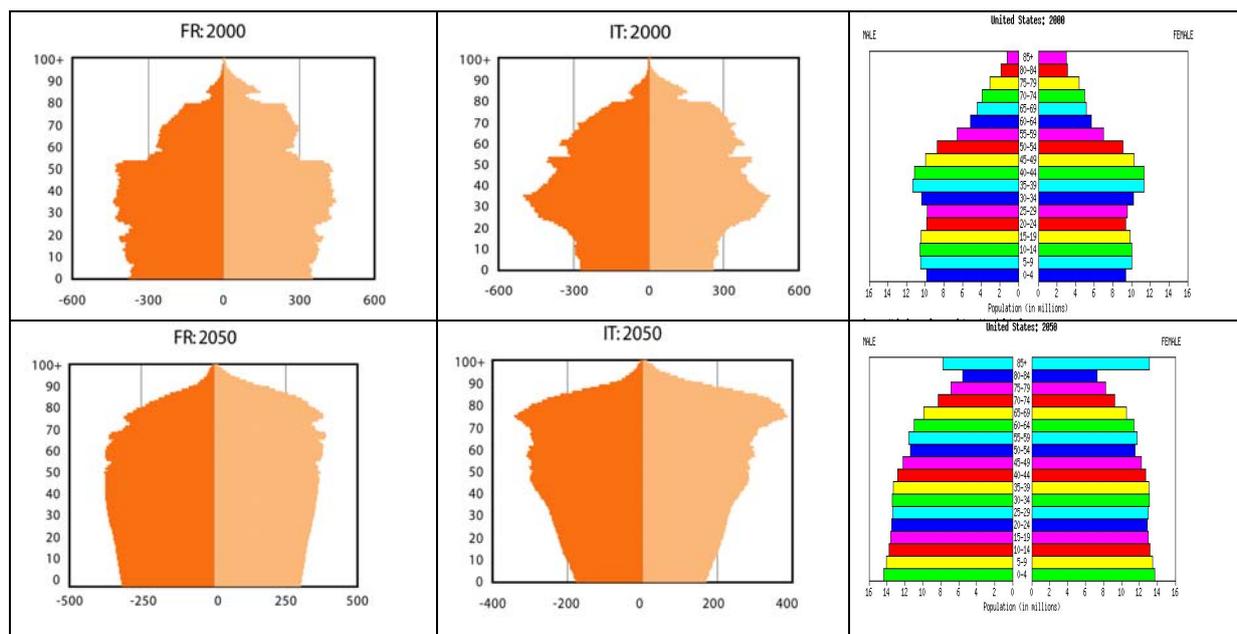
Our paper shows that direct quantity and indirect behavioral effects are large. They both significantly affect economic growth and living standards. Due to strong interaction effects between pension system and labor markets, a smart combination of pension policy and adaptation of institutions related to the labor market can do more than each policy in isolation. We show that changes in pension and labor policies and labor market practices can offset the effects of population aging on economic growth and living standards. On balance, however, behavioral effects limit the effects of such reform efforts. Taking positive and negative behavioral effects into account, a combination of many policy measures is necessary in order to keep per capita consumption from falling behind the secular growth path.

The rest of the paper is structured as follows. Section 2 briefly sets the demographic background. Section 3 describes the current labor market situation and our exogenous labor market scenarios. Section 4 presents the multi-country computational general equilibrium model with a combination of exogenous and endogenous labor supply. Sections 5 through 7 show our results. In section 5, we first focus on the effect of labor market policies, given the current pay-as-you-go pension systems. Higher old-age labor force participation raises issues of age-specific productivity, which are briefly addressed in Section 6. Section 7 is the core of the paper. We now also vary the institutional framework of pensions and investigate the interactions between pension and employment policies, and the behavioral reactions to pension and labor market reform. Section 8 concludes.

2. DEMOGRAPHY

While the patterns of population aging are similar in most countries, the timing and extent differ substantially. The US population is considerably younger and will age later and to a slower extent than the European Union, especially Germany and Italy. This is most graphically depicted in the changing population pyramids of our four countries between 2000 and 2050, see Figure 1.

Figure 1: Population Aging in France, Italy, and the US, 2000–2050



Source: Eurostat and US Census.

The differences are startling. The graph showing French population in 2050 is a pyramid that features almost equal cohort sizes up to age 70, while Italy has a strongly inverted pyramid structure and the US, in turn, has the population structure of a normal pyramid. The differences can largely be attributed to different fertility rates (France and the US have fertility rates close to the replacement level, see Table 1), while Germany and Italy lose about one-third of their population from generation to generation due to fertility rates that are below 1.4.

Table 1: Fertility Rates and Life Expectancy

	Total fertility rate	Life expectancy at birth	Healthy life expectancy	Life expectancy in year 2050
France	1.89	80.3	71.3	86
Germany	1.34	79.0	70.2	84
Italy	1.29	80.4	71.0	87
U.S.	2.10	77.8	67.6	83

Source: Eurostat (2008); US Census (2008); OECD Health Data 2007; WHO (2006); and authors' own computations.

Life expectancy also differs remarkably among the four countries. The differences are accentuated in the healthy life expectancy, a measure developed by the World Health Organization (WHO) based on functional ability: it measures the expected age without functional limitation as defined by a set of disability indicators. Healthy life expectancy in France is almost four years higher than in the US. Note that in the European countries healthy life expectancy is about 10 years higher than the average retirement age.

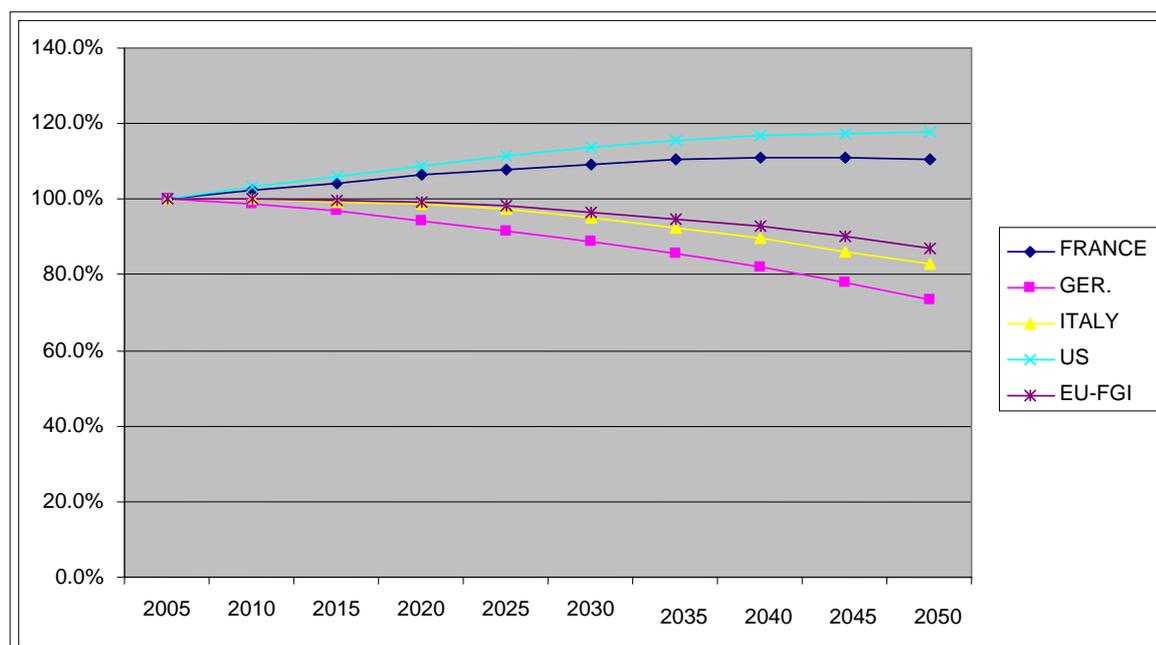
We compute the future demography of the four countries based on three key assumptions: constant fertility rates, no migration, and a Lee-Carter projection of mortality.³ Fertility rates are taken from Table 1, which also shows the resulting life expectancy in 2050. The life expectancy figures are slightly higher than the current United Nations projections (age 85 for France and Italy, same as Table 1 for Germany and the US).

³ The estimation procedure is based on the data provided by the Human Mortality Database (2008).

One may object that the assumption of zero migration is counterfactual, as it clearly is. There are two reasons for doing so. First, for the purpose of this paper, we want to isolate the effects of domestic labor supply changes, both due to exogenous policy actions and endogenous household reactions. It is clearer to do this against a zero migration background. Second, current migration rates are small relative to the expected future changes in working age population.

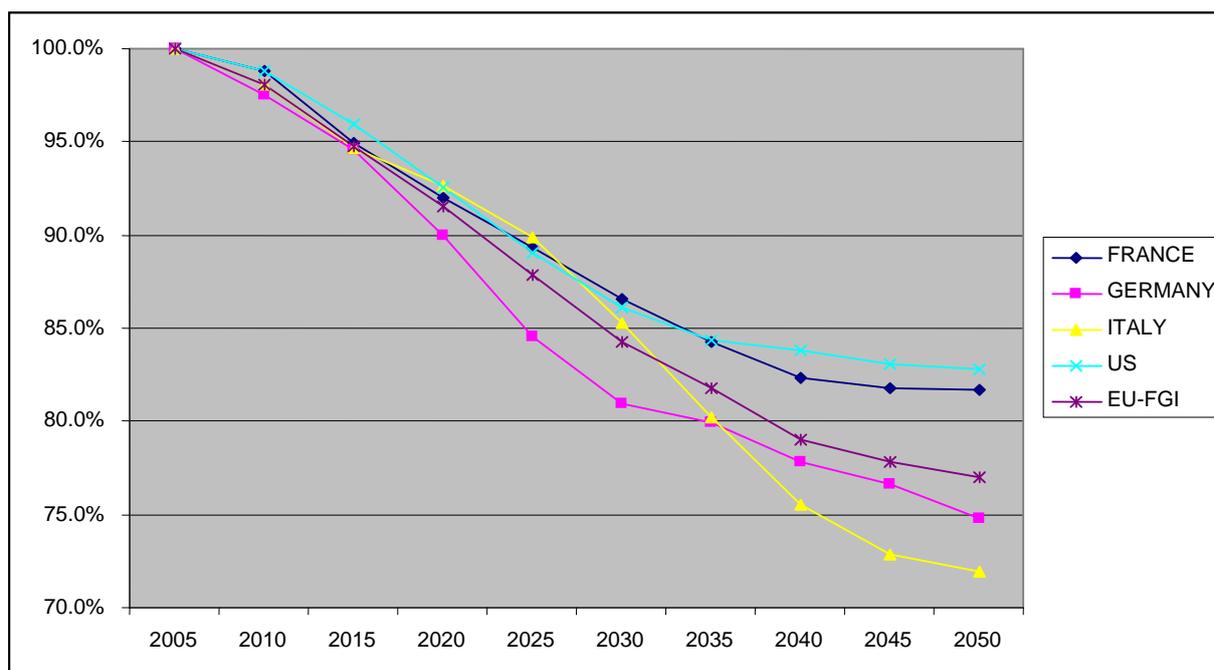
Figure 2 shows total population aged 15 years and over, which will be the base of our projections and simulations. Figure 2 reflects the stark differences of the population pyramids that we have seen in Figure 1. There will be population growth in France and the US, but a significant decline in Germany and Italy. The fifth line represents the aggregate of France, Germany, and Italy which we will call EU-3 to represent the three largest Continental European countries.

Figure 2: Population Aged 15 and Over, Indexed to 2005=100%



Source: Authors' calculations.

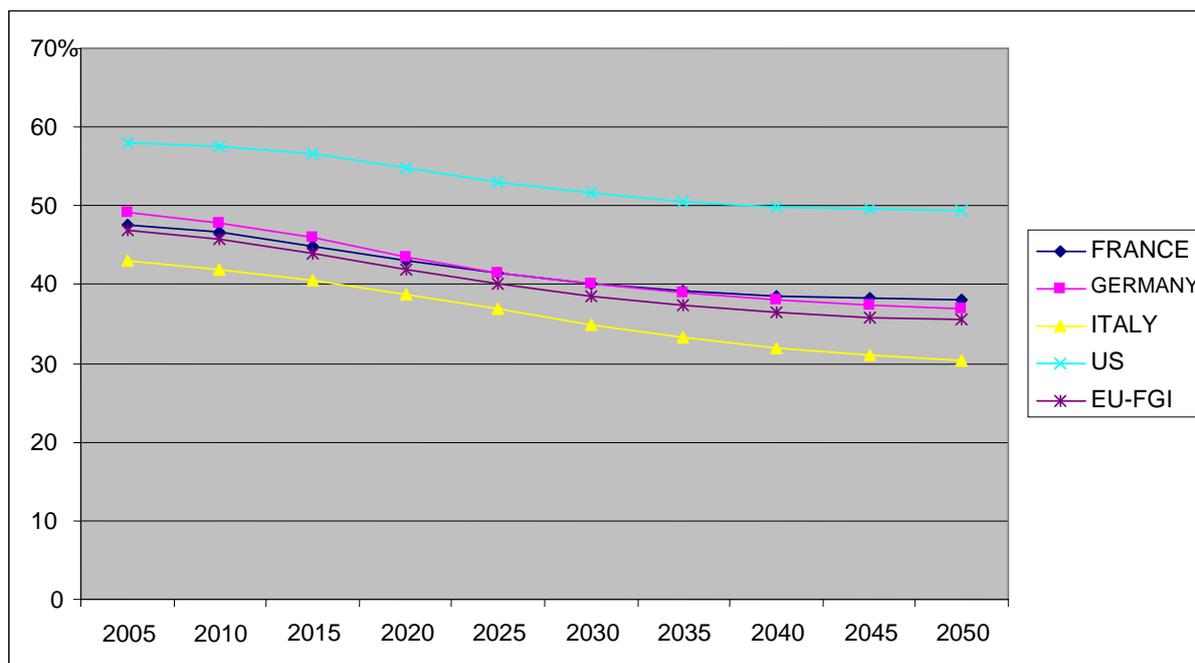
Even more remarkable is the change in the share of those who are of working age (Figure 3). With regard to total population aged 15 and older, the US will lose about 17% of its working age individuals between 2005 and 2050. In Italy, the loss is almost twice as high, 28%. France and Germany are in between. France is closer to US and Germany closer to Italy, reflecting the fertility rates in Table 1.

Figure 3: Ratio of Working Age Population to Total Population, Indexed to 2005=100%

Source: Authors' calculations.

3. EMPLOYMENT

The demographic differences, in particular those between Italy and the US, are amplified by the differences in labor force participation. Figure 4 shows the percentage of individuals employed in the population aged 15 and older. This is a variant of the “support ratio” reflecting the number of workers per adult consumer. US support rates are much higher than the European ones. In Europe, Italy stands out with the lowest support ratio. Unlike its demographic position, France is similar to Continental Europe in its low labor force participation; current French labor force participation rates are actually lower than the German ones.

Figure 4: Number of Workers to Population Over the Age of 15, Not Indexed

Source: Authors' calculations.

Figure 4 is based on the assumption of constant age and gender specific labor force participation rates. Given this assumption, Germany today (i.e., in 2005) has almost exactly the same low support ratio which the U.S. is projected to have after 2040. In this sense, Germany is one generation ahead of the US with regard to the macroeconomic balance between individuals in production and individuals who consume.

Figure 4 also shows that the decline of the support ratio, given the assumption of no behavioral changes, will be more pronounced in the three European countries than in the US (24.3% vs. 15.0% between 2005 and 2050), increasing the current differences of the support ratios among the four countries.

Aggregate employment is largely determined by 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 entry 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 factors which restrict possible endogenous labor supply decisions.

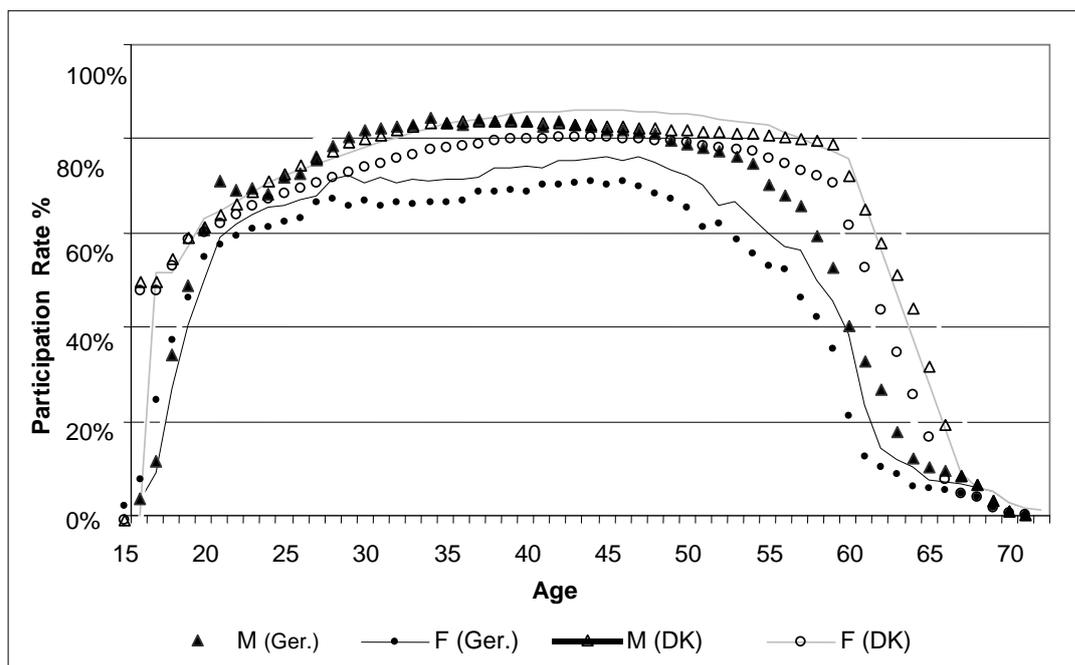
It is unlikely that these exogenous components remain unchanged over the next two decades as the population ages and society in general changes. We therefore define six scenarios representing the potential changes in the institutional framework affecting households' labor supply decisions. In our OLG model (see Section 4) we will model the changes in labor supply factors represented by these six scenarios as exogenous changes in the number of persons working, and model endogenous labor supply reactions as each working person's choice of hours worked.

The six exogenous labor supply scenarios are:

- STATQUO: constant age and gender specific labor force participation rates;
- RETAGE: an increase in the retirement age by two years;
- JOBENTRY: a decrease in the job entry age by two years;
- FEMLFP: a change in the female labor force participation rates so that they equal those of men;
- UNEMP: a reduction of unemployment to 40% of its current level; and
- DENMARK: a combination of the four preceding changes.

All changes will be phased in linearly between 2010 and 2040. The increase in retirement age (the decrease in the job entry age) is modeled as a shift of the distribution of labor force participation rates by age to the right (to the left, respectively), thereby increasing the flat part of the distribution in the middle (Figure 5). The changes used in the scenarios modeled were prompted by actual policy proposals. For example, in Germany, the statutory retirement age will be raised from 65 to 67 years in a series of stages until about 2020; in France and Italy, similar steps will happen shortly. Also the change in the European high school and university system (the so called Bologna process) is expected to result in a decrease in the duration in schooling by about two years. Finally, 40% of current unemployment represents the conventional estimate of the non-accelerating inflation rate of unemployment, or NAIRU (Ball and Mankiw 2002).

Overall, these scenarios appear to be reasonable and not that extreme; in fact, combining the four scenarios would lead to projections in 2040 of labor force participation rates that are fairly similar to those in Denmark today (thus the name of the sixth scenario). Attempts to actually execute reforms with the goal to achieve those results have faced stiff opposition in France and Italy, and to a somewhat lesser extent in Germany.

Figure 5: German and Danish Labor Force Participation Rates

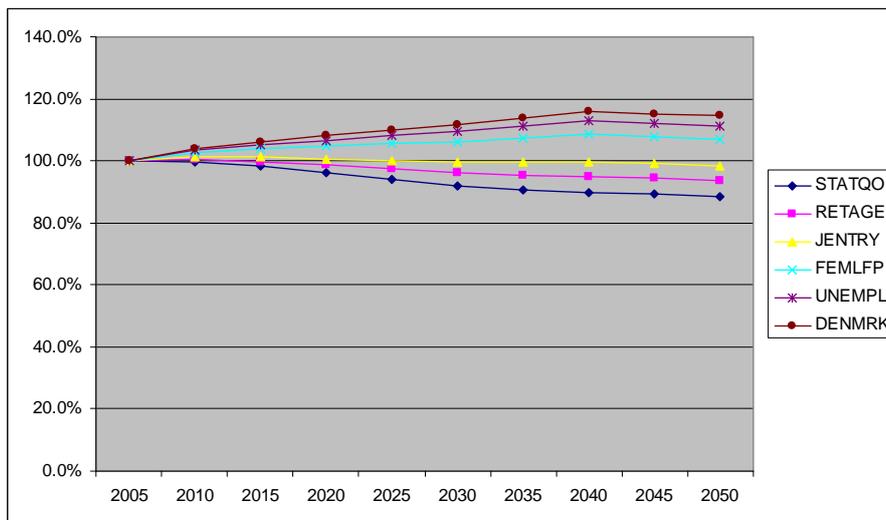
Notes: M= Male; F= Female; Ger. = Germany; DK= Denmark.

Source: Authors' own computations based on the German Mikrozensus (www.destatis.de) and Statistics Denmark (www.statbank.dk).

Figures 6 through 8 display the projected trajectories of the number of working individuals. The trajectories are very different across countries. France can compensate for the slight decline in the number of individuals of working age easily through a combination of two or three of the previously mentioned policy changes, while Germany and Italy will not be able to offset the loss in working age population with those measures. The countries also differ in the efficacy of the four policy parameters. For example, note in particular the large impact in Italy resulting from a change in the rate of female labor force participation so that it equals that of men, due to the low current rates of female labor force participation.

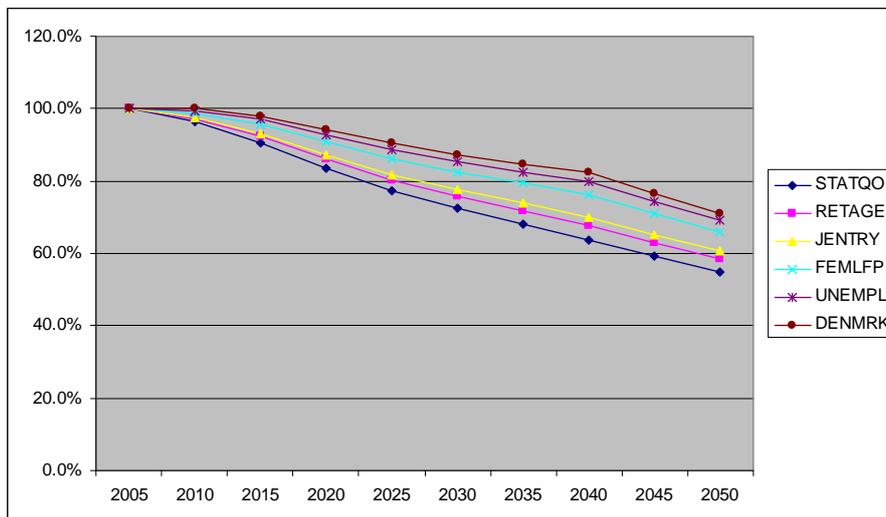
Lower labor input will invariably make Germany's and Italy's GDP decline, as indicated in these Figures. Since the total population is also projected to decline, however, this does not necessarily imply that standards of living will fall. Figures 9 through 11 therefore divide the number of working persons by the population aged 15 and older, our support ratio. The main finding is that a combination of the four policy scenarios can stabilize the support ratio in all countries. The ironic result shown in Figure 11 is that, while the population in Italy ages more than the populations of France and Germany, Italy's pool of hitherto unused labor capacity (in particular women) is so large that tapping it provides a large opportunity to counteract the effects of population aging.

Figure 6: Labor Force, Indexed to 2005=100%, France (in%)



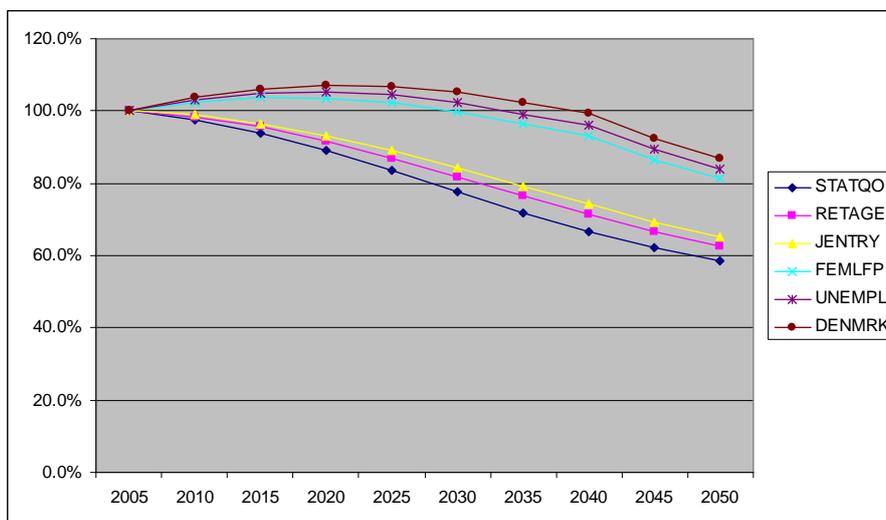
Source: Authors' calculations.

Figure 7: Labor Force, Indexed to 2005=100%, Germany (in%)



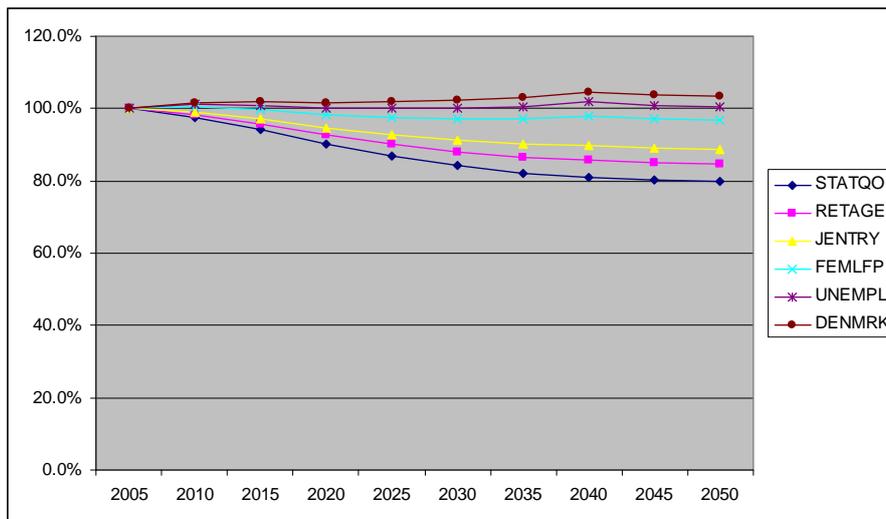
Source: Authors' calculations.

Figure 8: Labor Force, Indexed to 2005=100%, Italy (in%)



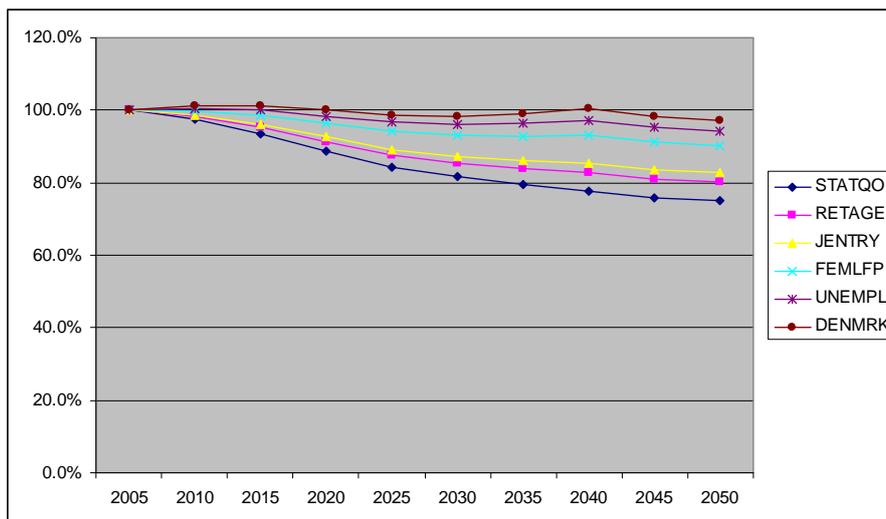
Source: Authors' calculations.

Figure 9: Support Ratio (Labor Force: Population Over 15), Indexed to 2005=100%, France (in %)



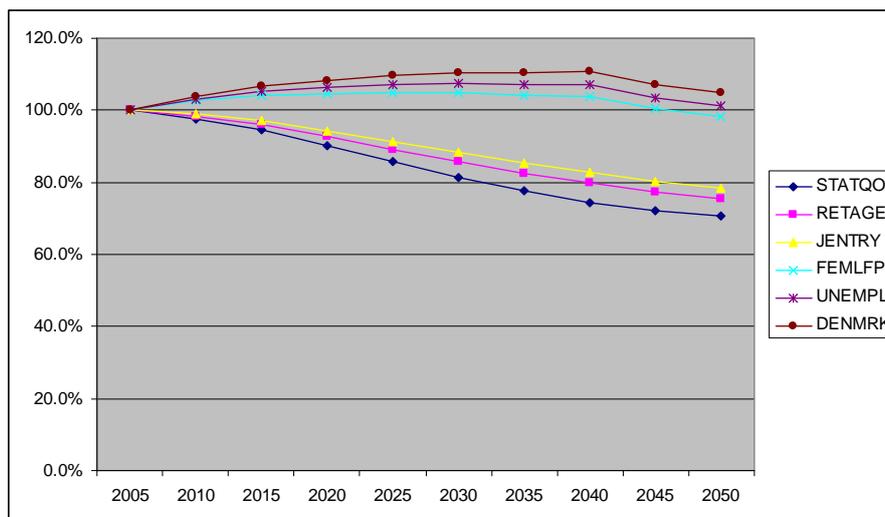
Source: Authors' calculations.

Figure 10: Support Ratio (Labor Force: Population Over 15), Indexed to 2005=100%, Germany (in %)



Source: Authors' calculations.

Figure 11: Support Ratio (Labor Force: Population Over 15), Indexed to 2005=100%, Italy (in %)



Source: Authors' calculations.

4. A DYNAMIC OPEN-ECONOMY MACROECONOMIC MODEL WITH EXOGENOUS LABOR FORCE PARTICIPATION AND ENDOGENOUS HOURS SUPPLY

We construct a dynamic open-economy macroeconomic model that allows us to analyze the effects of population aging and labor market reforms in Europe. We take as exogenous to our model general reforms of the labor market, that is, increases in retirement ages, decreasing lengths of schooling periods, and so forth as described in the preceding section. While we treat this variation in employment numbers as exogenous, households in our model endogenously adjust hours worked.

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 effective 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 . As the age-specific employment l_j is exogenously increased, the household endogenously decreases hours worked, h_j . In the absence of any constraints, these two components of effective labor supply are perfect substitutes such that the exogenous variation of l_j leaves effective labor supply of the household unaffected. However, there is an important constraint: h_j may not exceed time endowment (which we normalize to one). Therefore, the exogenous variation of l_j affects total effective labor supply for those households that are bound by the constraint. 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 our model with fully exogenous labor supply where h_j is restricted to one.

4.1 Time

Time in our model is discrete and extends from $t=0, \dots, T$. Each model period t reflects a time interval of 5 years.

4.2 The Demographic Projection Model

Detailed demographic projections form the background of our analysis. The projections have been summarized by the parameters in Table 1. Demography is taken as exogenous. It represents one of the main driving forces of our simulation model, in addition to exogenous changes in labor supply restrictions and pension policy changes.

Households in our model economies enter economic life at age 15 which we denote by $j=0$. The maximum age is 100 years. Accordingly the maximum economic age, denoted by J , is 85. We assume that households give birth between ages $0, \dots, jf$, the age of menopause. Accordingly, in each country i , the size of population of age j in period t , $N_{t,j,i}$, is given recursively by

$$(1) \quad N_{t+1,j+1,i} = N_{t,j,i} \zeta_{t,j,i} \quad \text{for } j > 0 \quad \text{and} \quad N_{t+1,0,i} = \sum_{j=0}^{jf} f_{t,j,i} N_{t,j,i}$$

where $\zeta_{t,j,i}$ denotes the age-specific conditional survival rate and $f_{t,j,i}$ the age-specific fertility rate.

4.3 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.

4.4 Households

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, $l_{t,j,i} h_{t,j,i}$ and total leisure is therefore $1-l_{t,j,i} h_{t,j,i}$ whereby we restrict time endowment to one.

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

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

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

$$(5) \quad \max \sum_{j=0}^J \beta^j \pi_{t,j,i} u(c_{t+j,j,i}, 1-l_{t+j,j,i}, h_{t+j,j,i}),$$

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

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 $w_{t,j,i} = w_{t,i} \cdot \varepsilon_j$.

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

$$(6) \quad a_{t+1,j+1,i} = a_{t,j} (1+r_t) + \lambda l_{t,j,i} h_{t,j,i} w_{t,j,i} (1-\tau_{t,i}) + (1-\lambda) p_{t,j,i} - c_{t,j,i},$$

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 pay-as-you-go 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,

$$(7) \quad 0 \leq h_{t,j,i} \leq 1.$$

In the variant of our model with a fully exogenous labor supply, we replace the constraint (7) with the constraint that $h_{t,j,i}=1$ for all t,j,i .

4.5 Government

The government organizes a pay-as-you-go financed pension system with flat pension benefits. We assume that the budget of the pension system is balanced in all t,i such that

$$(8) \quad \tau_{t,i} w_{t,i} L_{t,i} = \sum_{j=jr+1}^J p_{t,j,i} N_{t,j,i} = \rho_{t,i} w_{t,i} (1-\tau_{t,i}) \sum_{j=jr+1}^J N_{t,j,i},$$

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.

4.6 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

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.

pension system, $\{w_{t,i}, \tau_{t,i}\}$, in each country i , and a common world interest rate $\{r_t\}$ such that

1. Given prices and initial conditions, households maximize life-time utility in (5) subject to the constraints in (6) and (7).
2. Factor prices equal their marginal productivities as given in equations (3) and (4).
3. Government policies satisfy (8) in every period.
4. All markets clear in all t, i .

$$L_{t,i} = \sum_{j=0}^J \varepsilon_j l_{t,j,i} h_{t,j,i} N_{t,j,i} \text{ for all } t, i$$

$$\sum_{i=1}^I K_{t+1,i} = \sum_{i=1}^I \sum_{j=0}^J a_{t+1,j+1,i} N_{t,j,i}$$

$$\sum_{i=1}^I \sum_{j=0}^J c_{t,j,i} N_{t,j,i} + \sum_{i=1}^I K_{t+1,i} = \sum_{i=1}^I \Omega_{t,i} K_{t,i}^\alpha L_{t,i}^{1-\alpha} - (1-\delta) \sum_{i=1}^I K_{t,i}.$$

4.7 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 calibration period, from 1960 to 2004, is used to determine the structural parameters of the model.⁵ 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.

4.8 Calibration

The current version of the paper features a calibration that is based on an *ad hoc* choice of parameters selected by reference to other studies. In future versions of the paper we will specify certain calibration targets and determine deep structural model parameters by minimum distance methods. In particular, we will emphasize a careful calibration of 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 currently set $\varphi=0.66$ which corresponds with the value determined by minimum distance methods in Börsch-Supan, Ludwig, and Winter (2006).

The structural model parameters are summarized in Table 2. These parameter values refer to an annual periodicity of the model.

⁵ In the current version of the paper we do not calibrate structural model parameters in order to meet calibration targets for this period. Future versions of the paper will, however, feature a more careful calibration, also see below.

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

Table 2: Structural Model Parameters

α : capital share in production	0.4
g : growth rate of labor productivity	0.015
δ : depreciation rate of capital	0.05
Ω_t : technology level	0.05-0.07
β : discount factor	0.99
θ : coefficient of relative risk aversion	2
φ : consumption share parameter	0.66

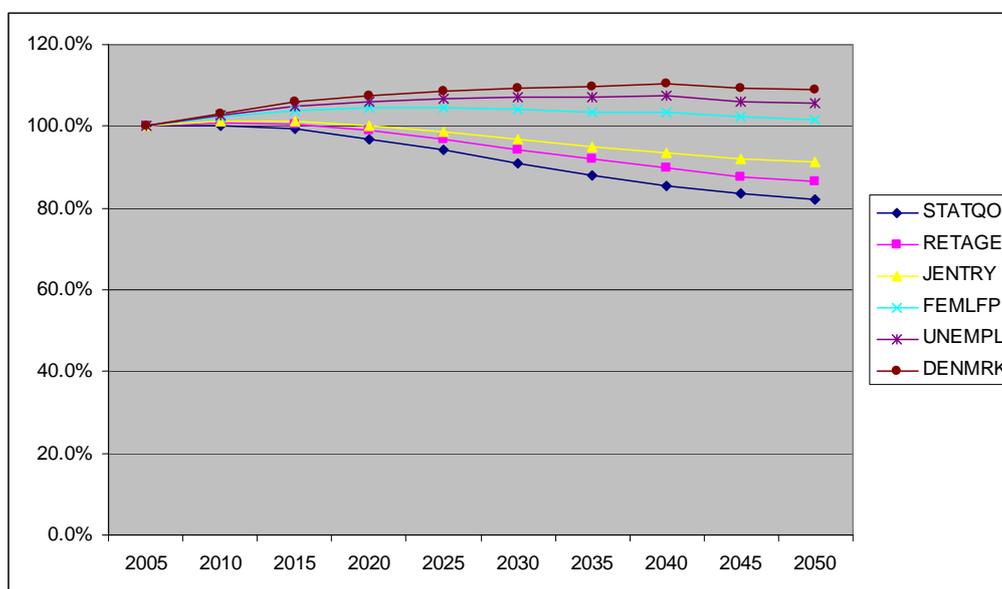
Source: Authors.

5. CHANGING INSTITUTIONS THAT AFFECT LABOR FORCE PARTICIPATION

We begin the presentation of our results with the effects of removing current labor supply restrictions. Since the effects are similar across countries, once the differences in employment quantities depicted in Section 3 are accounted for, we restrict the figures and tables to the aggregate of France, Germany, and Italy. We also concentrate on the case of the current pay-as-you-go public pension systems with large distorting taxes.

Figure 12 depicts our first target variable, GDP per capita. We adjust all outcomes by the (exogenous) change in total factor productivity (TFP) which approximately doubles between 2005 and 2050. We also index all graphs to the base values attained in 2005.

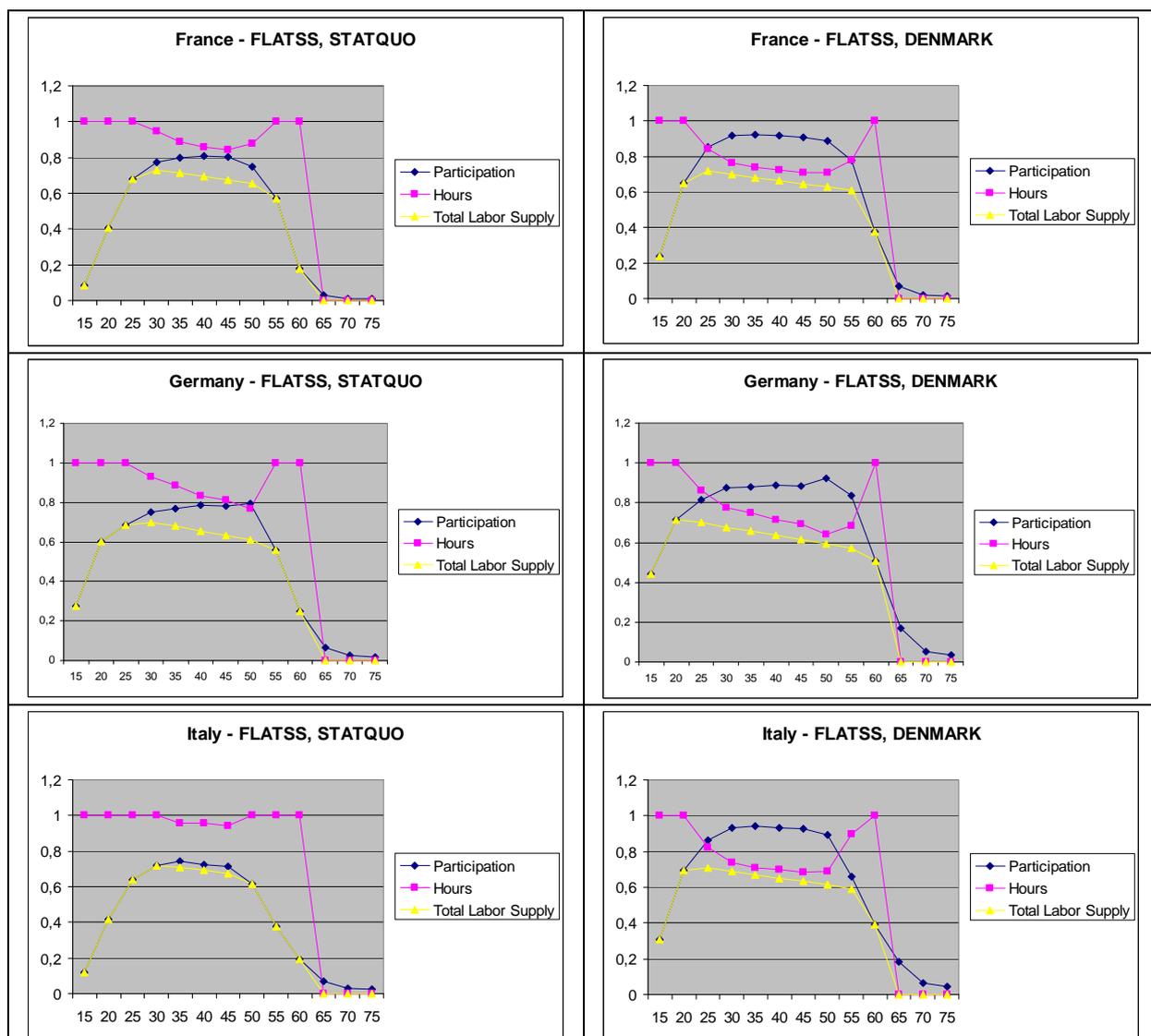
If hours do not respond to increasing social security taxes, exogenous increases in labor supply can actually fully compensate for population aging and stabilize economic growth per capita.

Figure 12: GDP Per Capita, Indexed to 2005=100%: EU-3, Exogenous Hours (in %)

Source: Authors' calculations.

This is not the case if the hours supply is endogenous. Hours supply changes can actually compensate to a large extent the effect of an exogenous increase in persons working. This is shown in Figure 13, which displays labor force participation (diamonds), hours supply (squares) and the resulting total labor supply (triangles) for the three countries and the two extreme labor market scenarios STATQUO and DENMARK.

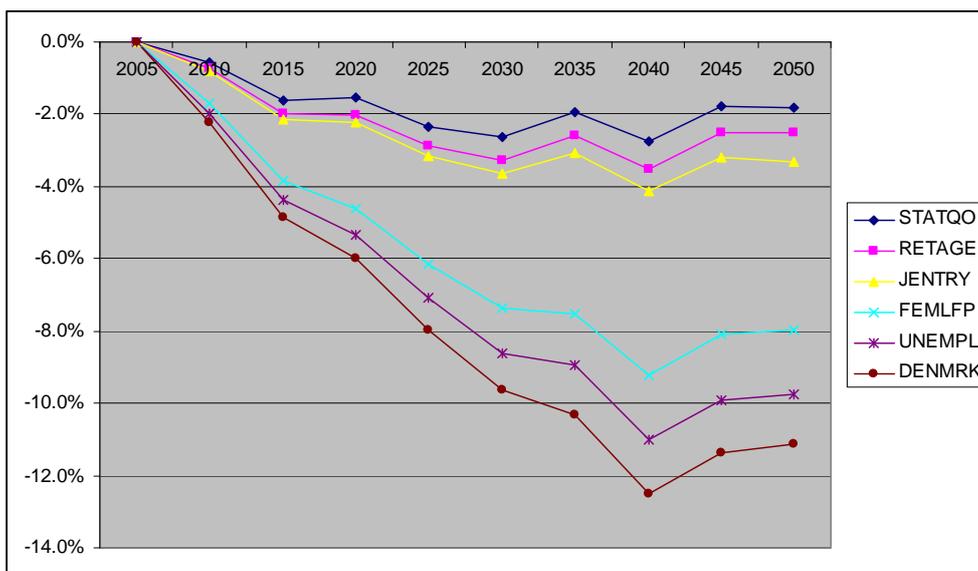
Figure 13: Labor Force Participation, Hours Supply, and Total Labor Supply



Source: Authors' calculations.

The reason that the change in the supply of hours could compensate for changes in the number of workers can be inferred from the household's utility function, as specified in Section 4. Hours and persons are perfect substitutes, as long as the household is not at a corner solution with its hours supply. About 58% are not constrained. These households reduce the effect of exogenous policy changes by adjusting their working hours inversely. The remaining 42% of households have been constrained under the given labor market policy regime in 2005 (ranging from Italy, (where 57% are constrained), to Germany (37%) and then France (33%)). They are shown in Figure 13 as those households which have an hours supply of exactly one. These are in particular the very young and the old. Releasing these constraints generates more hours supply when the policies are phased in over time. This is illustrated in Figure 13 by a much higher total labor supply for the younger and older age groups in the DENMARK scenario as compared with the STATQUO scenario. Figure 14 shows the aggregate picture.

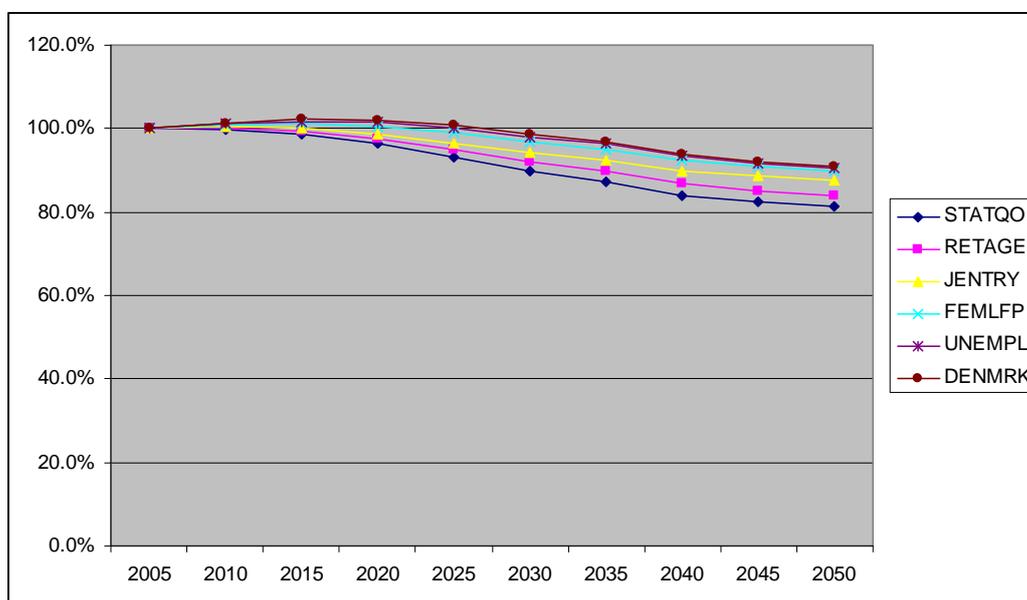
Figure 14: Hour Supply, Indexed to 2005=100%: EU-3, Endogenous Hours (% Change)



Source: Authors' calculations.

With a smaller number of constrained households in the scenarios with more persons working (e.g. DENMARK) as compared to the scenarios in which fewer persons are working (e.g. STATQUO), there is more substitution in the DENMARK scenario than in the STATQUO scenario. Hence, the differences between the six scenarios become smaller than in Figure 12. This is shown in Figure 15.

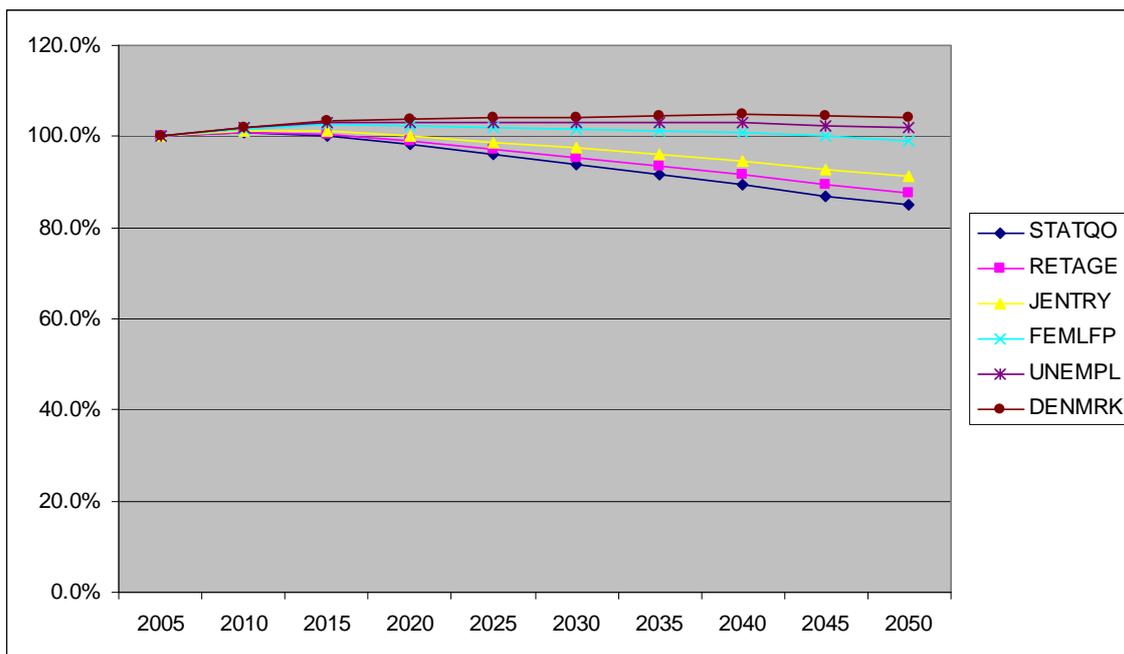
Figure 15: GDP Per Capita, Indexed to 2005=100%: EU-3, Endogenous Hours (in %)



Source: Authors' calculations.

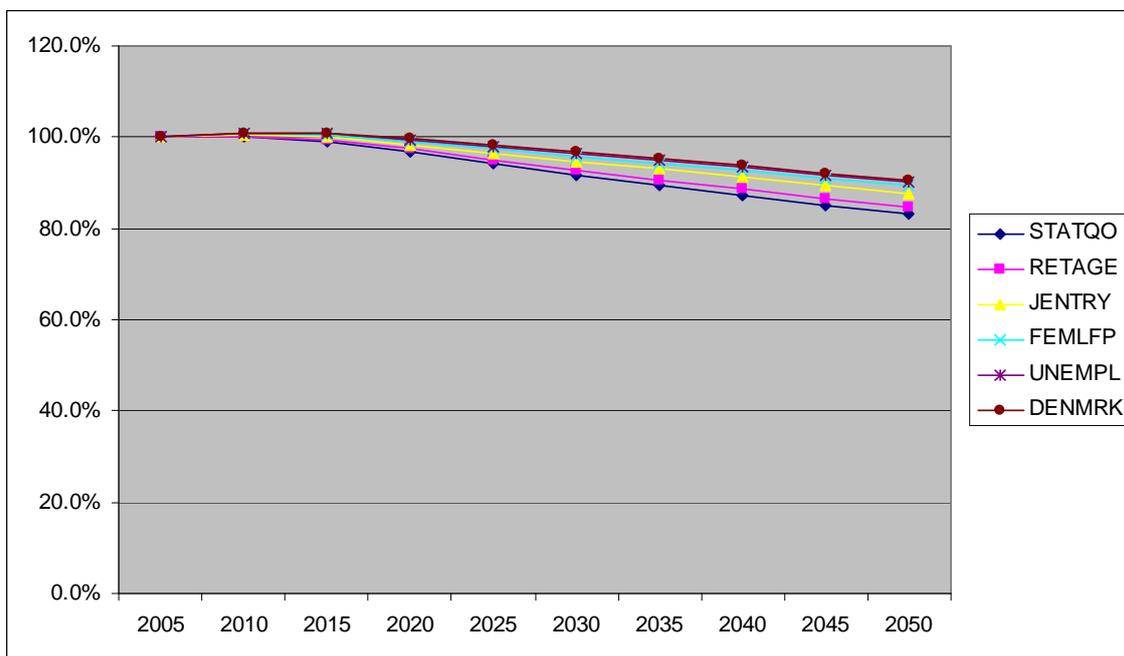
Our second target variable is the standard of living. Figures 16 and 17 depict consumption per capita. The patterns are very similar to GDP per capita. Per capita consumption features a slightly larger decline (or smaller increase) in the high employment scenarios. In these scenarios, savings increase slightly, while in the low employment scenarios savings decline from 2005 to 2050 in response to the differential change in the wage to interest ratio.

Figure 16: Consumption Per Capita, Indexed to 2005=100%: EU-3, Exogenous Hours, (in %)



Source: Authors' calculations.

Figure 17: Consumption Per Capita, Indexed to 2005=100%: EU-3, Endogenous Hours (in%)



Source: Authors' calculations.

6. PRODUCTIVITY ISSUES

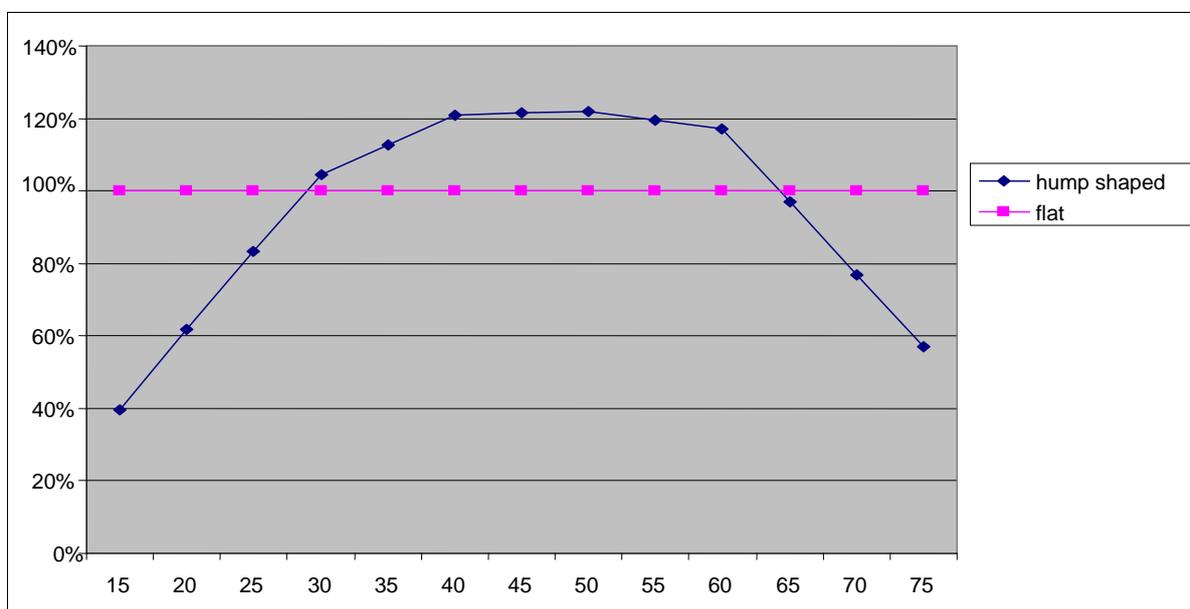
If labor productivity is age dependent, a shift in the age structure will also bring about a change in aggregate productivity, even if age-specific productivity were to remain constant. Moreover, if labor productivity declines strongly after, say, age 60, an increase in retirement

age will not have much effect on aggregate output. This brief section provides a gross estimate of the approximate magnitude of this effect.

This is not a simple task, however, as there is no reliable data available on age-specific labor productivity, see the review by Skirbekk (2004). Barth et al. (1993) conclude from a survey of human resource executives in 406 organizations that “Older workers were consistently rated as having more positive attitudes being more reliable and possessing better skills than the average worker; they were rated worse than the average worker when it comes to health care costs, flexibility in accepting new assignments, and suitability for training.” Hutchins (2001) questions the usefulness of such employer surveys to address these issues because of justification bias. Kotlikoff and Wise (1989) evaluate confidential data originating from a major US service enterprise in which output is well-defined. They provide two estimates that can be used to proxy productivity. One measure uses age and seniority-specific earnings of sales staff, which can be measured by the sale of insurance contracts, hence a kind of piece rate. Corrected for seniority, the age profile of these piece rates is relatively flat. Their second measure is the entry salary of clerks. This profile is much more hump-shaped. Both measures are likely to suffer from selection effects. Börsch-Supan, Düzgün, and Weiss (2006) use another approach. They used confidential data on error rates in a large assembly line style car manufacturing factory. Output and production times are perfectly controllable in this environment, permitting a direct estimate of productivity. They find that age and experience effects cancel each other, such that the resulting productivity profile is essentially flat, with reliable observations until about age 63.

How do these microeconomic differences translate into macroeconomic differences? In order to get a feel for this process, we support our simulations with two alternative age-productivity profiles (in our model represented by ε_j , see Section 4.6). One profile is flat; the other imposes the sharp hump shape depicted in Figure 18. This profile features a strong decline in productivity after age 60. We treat these age profiles as exogenous.

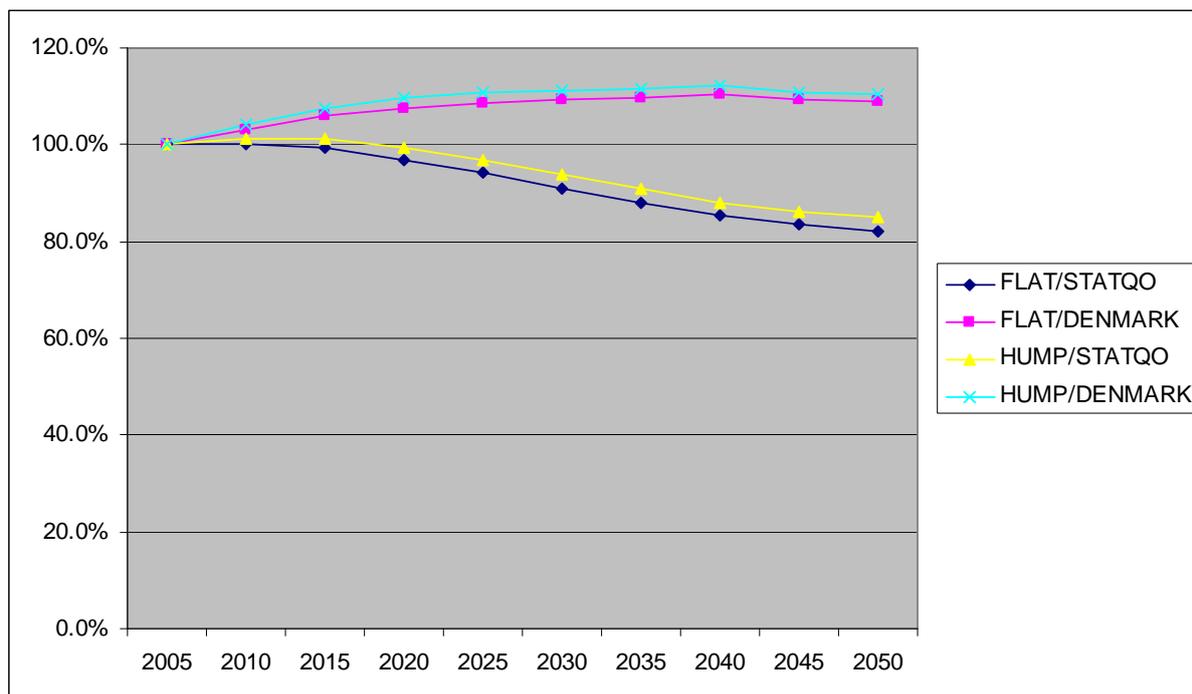
Figure 18: Hump-Shaped Age Productivity Profile



Source: Authors' calculations.

Figure 19 indicates the difference ascribed to whether the age productivity profile is flat or hump-shaped. Figure 19 is computed under the assumptions of exogenous hours supply and the current pay-as-you-go system. We display the two extreme employment scenarios, STATQUO and DENMARK. In spite of the strong hump shape of Figure 18, there is not much difference in the resulting GDP per capita, a result which may surprise.

**Figure 19: GDP Per Capita, Indexed to 2005=100%,
Different Productivity Assumptions, EU-3 (in %)**



Source: Authors' calculations.

7. INTERACTIONS BETWEEN PENSION AND LABOR MARKET REFORM

So far, we have looked into a world that has a prototypical Continental European style pension system. It is purely pay-as-you-go and provides flat benefits, and is financed by a contribution that is perceived as a pure tax, with all the associated labor supply distortions.

In order to isolate the distorting effects of the social security tax on labor supply from effects due to the substitution between the exogenous supply of working individuals and the endogenous hours supply, we now simulate GDP and consumption per capita given the other extreme of a pension system, namely a fully-funded, voluntary private accounts system which generates no distortions. This represents the textbook life-cycle model in which perfect intertemporal consumption smoothing over the life cycle provides the retirement income through saving at a young age and dissaving after retirement.⁷

We follow the logic of Section 5 where we looked at several labor market scenarios and investigated outcomes under exogenous and endogenous supply of working hours. We confine the labor market scenarios to the two extremes (STATQUO and DENMARK). We augment this two-by-two setup by a third dimension, namely the pension regime, to obtain the two-by-two-by-two table identifying the underlying assumptions displayed in Table 3.

⁷ We also modeled two less extreme pay-as-you-go scenarios resembling the German and Swedish pension systems. In these systems, benefits are proportional to contributions such that the only distorting effects are the expected rate of return differences (see Nataraj and Shoven [2003] for simulated return distributions).

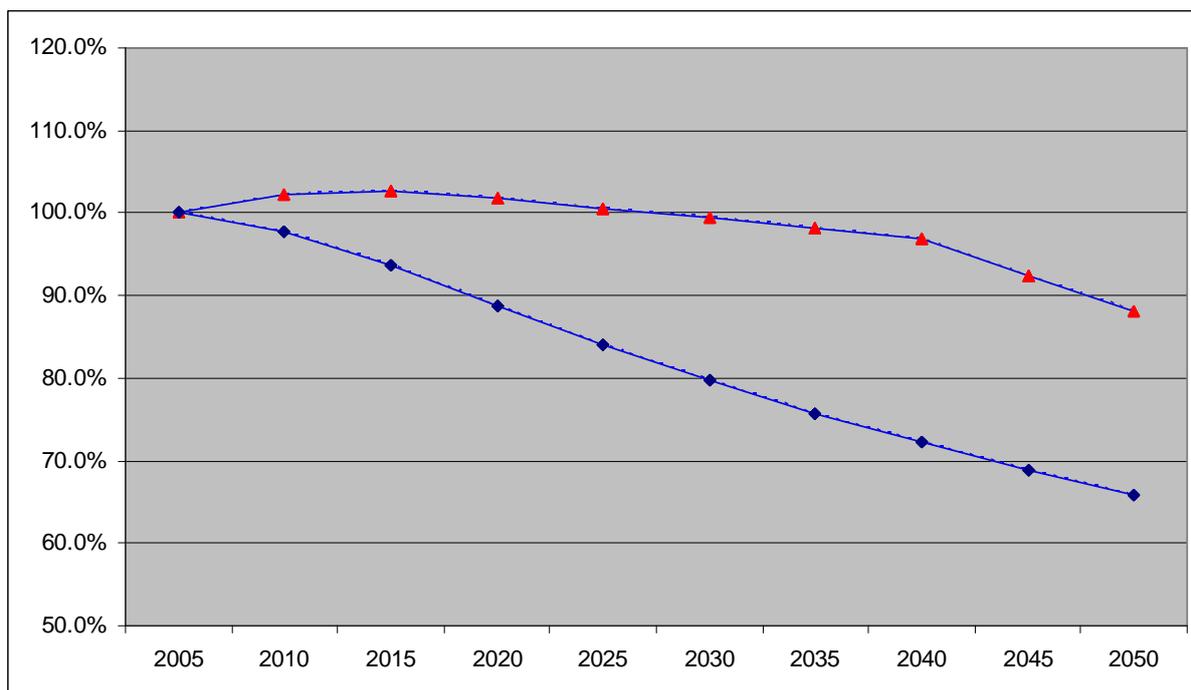
Table 3: Set Up of Scenarios

	Extensive Margin: Labor Market Regime			
	Constant age and gender specific labor force participation (STATQUO, blue diamonds)		Increasing age and gender specific labor force participation (DENMARK, red 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, blue line)	<i>FL-SQ-EX</i>	<i>FL-SQ-EN</i>	<i>FL-DK-EX</i>	<i>FL-DK-EN</i>
Fully funded voluntary accounts (SAVING, yellow line)	<i>SV-SQ-EX</i>	<i>SV-SQ-EN</i>	<i>SV-DK-EX</i>	<i>SV-DK-EN</i>

Source: Authors.

Figure 20 depicts the evolution of labor supply at the extensive margin, i.e. the exogenously given number of persons who participate in the labor market: $L_{t,i} = \sum_{j=0}^J l_{t,j,i} N_{t,j,i}$.

Figure 20: Labor Supply Indexed to 2005=100%, EU-3⁸



Source: Authors' calculations.

The upper graph (marked by red triangles) shows the number of individuals relative to 2005 participating in the labor market in the DENMARK scenario. In spite of the massive increase in labor force participation—due to earlier entry into, and later exit from, the labor market,

⁸ There is a need to fix the decline in DENMARK scenario after 2040 in future versions of this paper (visible in a steeper slope than in STATQUO after 2040), but for now the graph is helpful as a didactic device.

more women working and less unemployed—extensive labor supply declines after 2015 and end up about 12% lower in 2050 than in 2005. Of course, this decline is much less than in the pessimistic status-quo scenario (marked by blue diamonds) where exogenous labor supply declines steadily from 2005; the total decline is substantially more than 30% by 2050.

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

- the demographic aging process in the background,
- the lifting of labor supply restrictions as shown in Figure 20, and
- a fundamental change in the type of pension system.

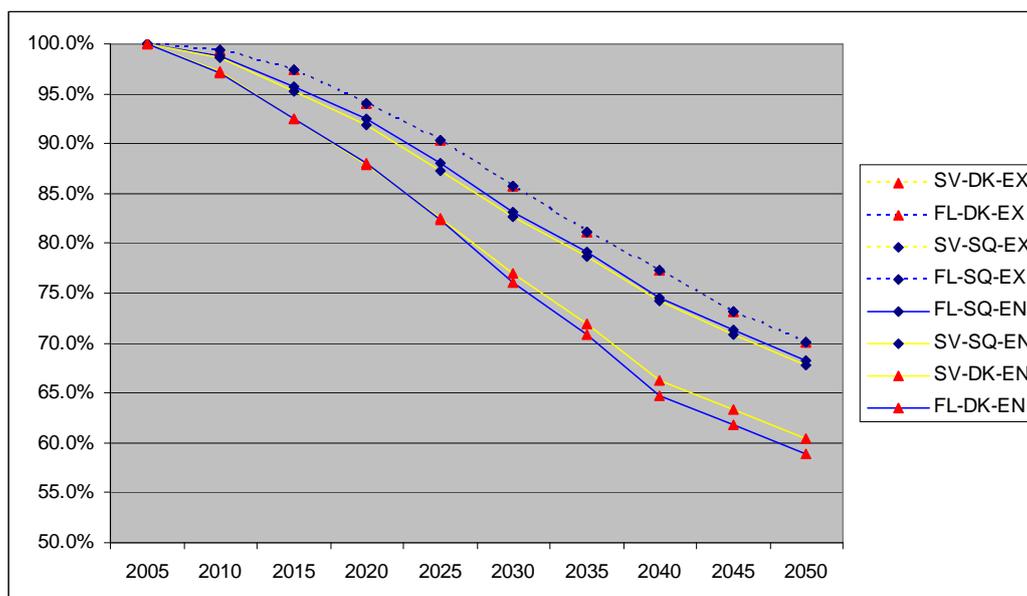
We begin with figures that display the evolution of the supply of hours, total labor supply, wages, and domestic capital stock. We then present the evolution of our two target variables, GDP and consumption per capita. All figures refer to the aggregate of France, Germany, and Italy (EU-3). The US is 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. We denote exogenous labor supply by a dashed line and endogenous hours supply by a solid line. The high labor force participation scenario (DENMARK) is marked by red triangles, the constant labor force participation scenario (STATQUO) by blue diamonds. Finally, the flat benefits pay-as-you-go social security system (FLATSS) features a blue line, while the fully funded pension regime (SAVING) is identified by a yellow line.

7.1 Intensive Margin: The Supply of Hours

Figure 21 shows the endogenous supply of working hours: $H_{t,i} = \sum_{j=0}^J h_{t,j,i} N_{t,j,i}$. Hours are normalized to 100% in 2005 within each scenario. Hence, they are adjusted for any level effects generated by pension and labor market policies already in 2005.

Population aging generates declining hours in all eight scenarios, reflecting the decline in working age population. All four scenarios with exogenous labor supply generate an identical evolution (dashed line), while the endogenous hours supply differs by labor market and pension scenarios. Hours are lower in the DENMARK scenario (red triangles) than under constant labor force participation rates (STATQUO, blue diamonds). They are also lower in a flat benefits pay-as-you-go social security system (FLATSS, blue line) than under an individual savings regime (SAVING, yellow line).

Figure 21: Hours, Indexed to 2005=100% (in %)

Source: Authors' calculations.

Hours increase under a funded system compared with the pay-as-go system, if exogenous labor force participation also increases. The difference is zero, if hours are also exogenous, and very small, but negative, if labor force participation is unchanged.

If hours are endogenous, they react negatively because of intra-household substitution between hours and labor force participation. This effect offsets some, but not all, of the higher labor force participation as we will see in Figures 22 and 23. The offsetting effect is higher in a distorting pay-as-you-go system. We may interpret this as an incentive effect due to distorting taxes, while the base difference (between the two yellow lines) is the substitution effect between hours and labor force participation.

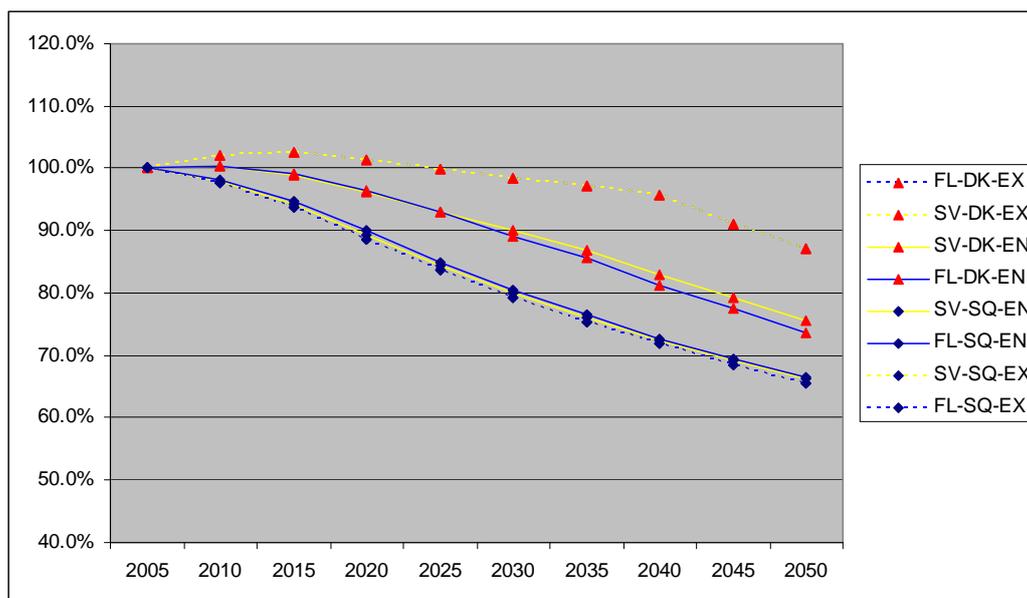
Quite clearly, there is a strong and beneficial interaction between changing the pension system and lifting labor market restrictions. This is an important result of our paper.

7.2 Total Effective Labor Supply

Total effective labor supply is the product of working persons (Figure 20) and hours worked per person (Figure 21), adjusted for age-specific productivity: $L_{t,i} = \sum_{j=0}^J \varepsilon_j l_{t,j,i} h_{t,j,i} N_{t,j,i}$.

The evolution of total effective labor supply under the eight scenarios is displayed in Figure 22. If hours are exogenous, there is no difference between Figures 20 and 22. If hours are endogenous, the increase in the number of working persons in the DENMARK scenario is only partially reduced by the strong decline in the supply of hours that we have seen in Figure 21.

If hours are exogenous, there is no difference between the two pension scenarios. Hence, the lines for FL-DK-EX and SV-DK-EX at the very top overlap as well as the lines representing FL-SQ-EX and SV-SQ-EX at the very bottom. This is also visible in the first panel on interaction effects.

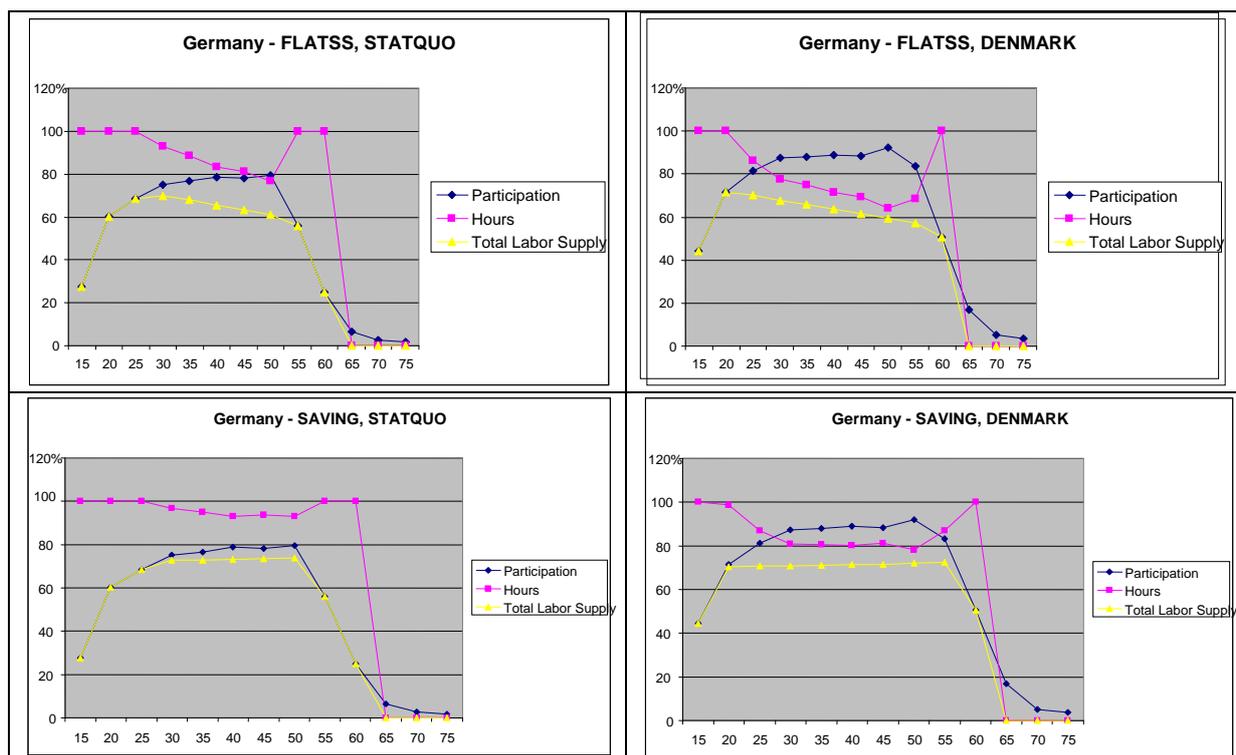
Figure 22: Total Labor Supply Growth from 2005 (in %)

Source: Authors' calculations.

There is a strong interaction between pension reform and labor market reform: relative to the current pay-as-you-go system, total labor supply increases strongly after 2020 in the DENMARK scenario, while it declines if labor force participation remains unchanged.

Figure 23 gives a more detailed picture by age group, using Germany as an example. A comparison between the upper and the lower left panels shows that the hours reduction is much smaller in a funded pension system than in a flat-benefits pay-as-you-go system. This reflects the negative incentive effect of high distorting taxes. Under the DENMARK scenario (right panels) fewer households are constrained by labor market institutions. More age groups therefore substitute hours for participation within a household. Since the hours reduction is much smaller in the funded pension system, more total labor supply remains.

Figure 23: Labor Force Participation, Hours Supply, and Total Labor Supply

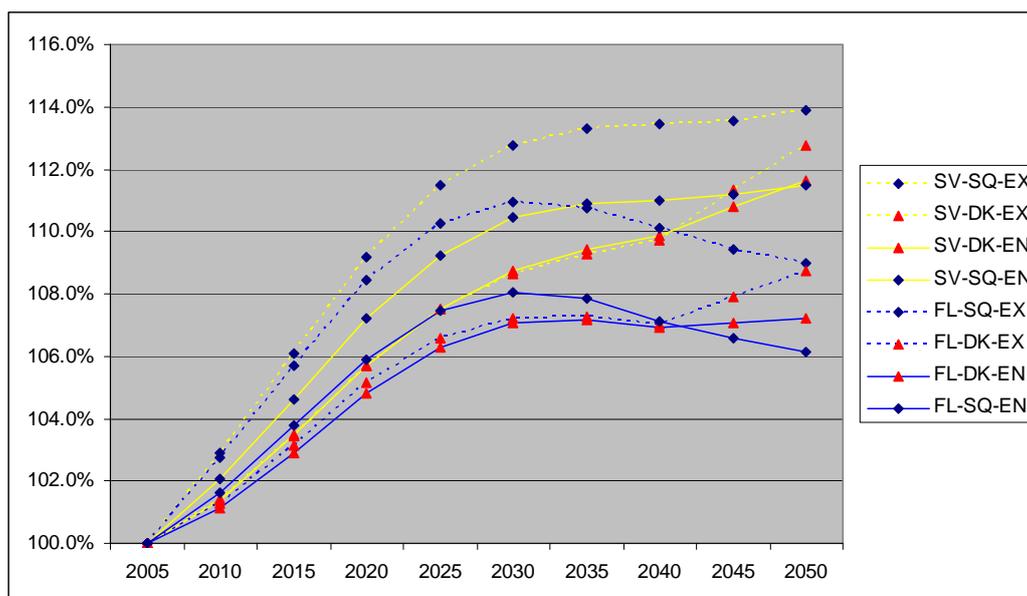


Source: Authors' calculations.

7.3 Wages

Wages are depicted in Figure 24. They generally reflect total effective labor with some additional effects due to capital accumulation (see Subsection 7.4). Considering the massive decline in total labor supply, the effect on wages is somewhat diminished, with an elasticity of about 0.5.

Figure 24: Wages



Source: Authors' calculations.

Wages increase more in the STATQUO (blue diamonds) than in the DENMARK (red triangles) scenario, reflecting relative scarcity. Wages increase much more rapidly under a

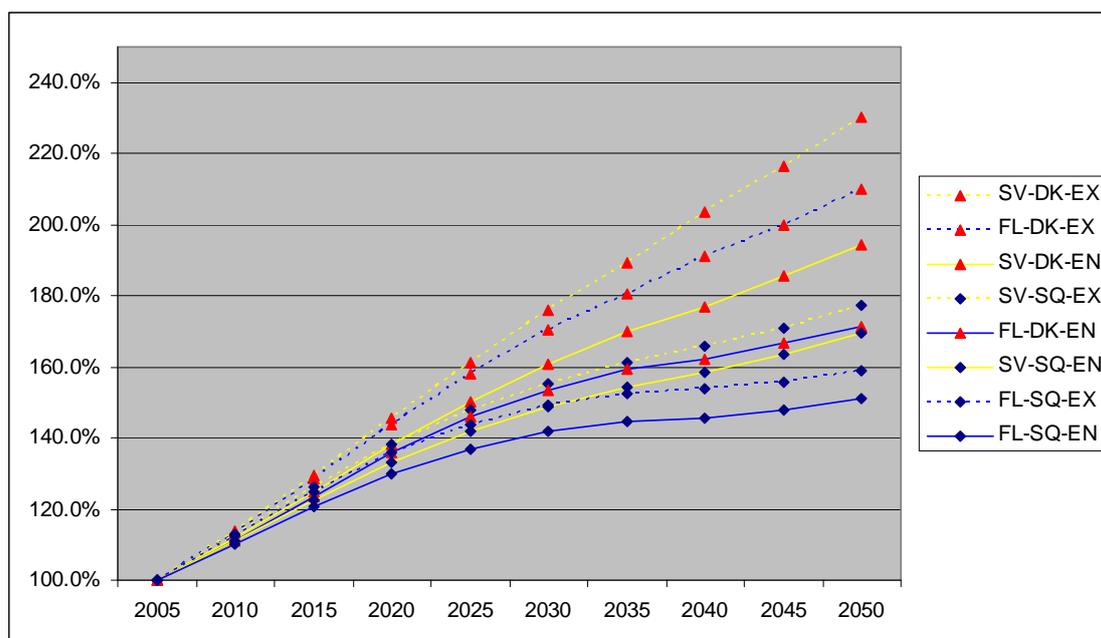
funded system (yellow lines) than under a pay-as-you-go system (blue lines). The additional capital accumulation lowers interest and raises labor productivity, and thus wages. Finally, wages increase more when hours are exogenous (dashed lines). This effect is very small when labor force participation rates do not change (STATQUO) but it is substantial in the DENMARK scenario, when the effect on hours is large.

7.4 Capital Accumulation

Figure 25 depicts the evolution of the combined domestic capital stock of France, Germany, and Italy under our scenarios. 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 (DENMARK) as compared with the constant participation scenario (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 result that capital accumulation is highest under a fully-funded system with high labor force participation and no dampening effect of endogenous hours (SV-DK-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 25: Domestic Capital Stock Growth (in %)



Source: Authors' calculations.

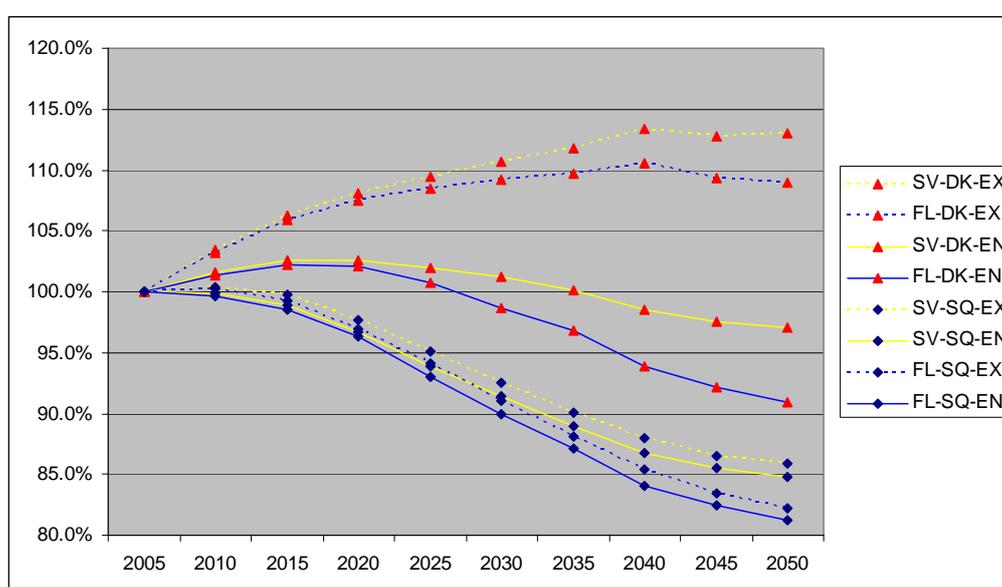
7.5 GDP Per Capita

Our first target variable is economic growth, measured as the change in GDP per capita, net of exogenous growth in total factor productivity. This is displayed in Figure 26. Economic growth relative to secular productivity growth is greatly affected by the combination of pension and labor market policies. With exogenous hours, growth is highest and always positive when labor supply restrictions are released and pensions are financed by a funded system. In turn, growth (after adjusting for TFP increases) is lowest and always negative under the opposite combination of policies. This is a strong message: in spite of aging, economic growth can be as high as historically given by the estimated long-run growth of total factor productivity. It can even be increased by a smart combination of pension and labor market policies. However, it can also secularly decline behind the path which we have experienced in the past.

The quantities are large: the difference between the best and the worst scenario are more than 30%. This must be seen in comparison to TFP growth of about 90% over the period from 2005 to 2050. Aging, if unchecked through offsetting labor market and pension policies, will reduce total economic growth by approximately one-third.

The eight output paths in Figure 26 can be derived as a straightforward combination of labor and capital inputs displayed in Figures 22 and 25. Output per capita is unequivocally higher in a fully-funded pension system without distorting taxes as compared to a pay-as-you-go pension system with flat benefits. Output per capita is similarly clearly higher when labor market restrictions are removed (DENMARK) than in the status-quo scenario. Again, the interaction between pension and labor market policies in the case of endogenous supply of working hours are clearly visible. Endogenous hours supply reduces growth relative to a situation when households cannot substitute more persons by less hours. The effect is smaller when the pension system is fully funded.

Figure 26: GDP Per Capita Growth from 2005 (in %)



Source: Authors' calculations.

7.6 Consumption Per Capita

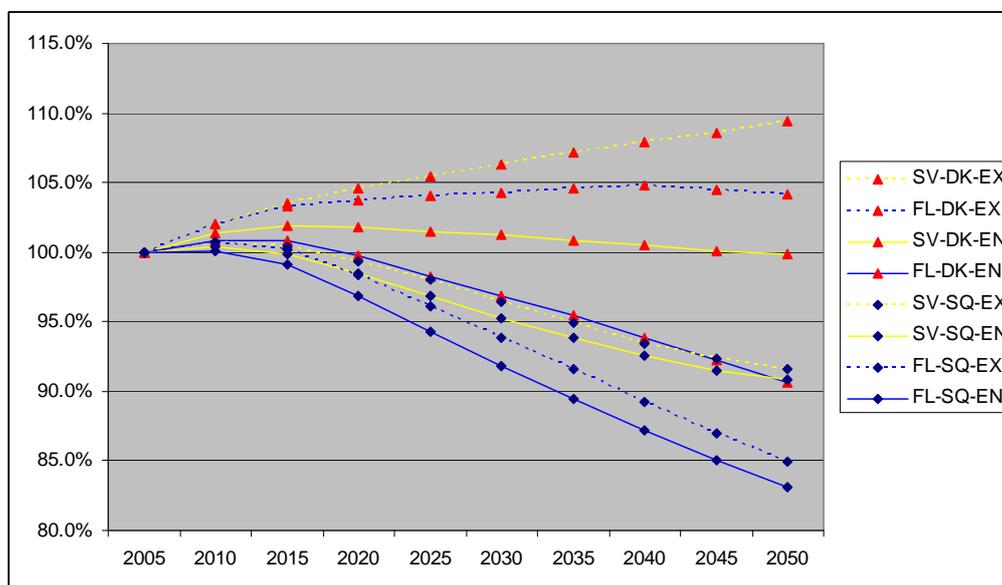
Finally, Figure 27 displays our second target variable, living standards measured by consumption per capita. As we did for output, we normalize consumption per capita by secular total productivity growth. The evolution of living standards very much parallels that of GDP per capita; there are no major deviations in the growth patterns of output and consumption with regard to the relative position of the eight scenarios.

Saving at a young age and dissaving in old age, however, smoothes some of the effects that we have seen in Figure 26. A notable example is the evolution of living standards in the fully-funded pensions, high labor force participation, and endogenous hours supply scenario (SV-DK-EN). Living standards remain very close to the secular growth path (the horizontal line), while the associated GDP per capita exhibited a stronger increase until 2020 followed by a strong decline.

This shows that a well-chosen combination of labor market and pension policies can stabilize living standards in Continental Europe in spite of population aging and an adverse behavioral reaction to the structural policy changes. In turn, this stabilization needs more than a half-hearted pension reform or a few adjustments in labor market restrictions. All labor market policies described in Section 3 are needed, in addition to a secular pension reform; other policy scenarios indicate that living standards in Continental Europe will grow slower

than what we have experienced in the past. Living standards will not decline, because the impact of secular productivity growth still has a stronger impact than aging does. Living standards, however, will decline relative to all other countries that age less than Continental Europe.

Figure 27: Consumption Per Capita Growth (in%)



Source: Authors' calculations.

8. CONCLUSIONS

We have simulated a set of far-reaching pension and labor market policies and investigated their impact on production and consumption per capita in three large Continental European countries. A new feature of our computational general equilibrium model that included a combination of both exogenous changes of labor supply at the extensive margin (working persons) and endogenous responses of labor supply at the intensive margin (working hours). We think of exogenous changes as lifting institutional restrictions, such as those generated by the school system, actuarially unfair pension systems, inflexible working hours, and unavailable day care facilities. The supply of hours react to endogenous changes, e.g., to social security taxes and contributions, but also to the exogenous changes of the number of working persons.

Our paper shows that changes in the pension system and labor markets can have a large impact on both direct effects, and indirect behavioral effects, which both significantly affect economic growth and living standards. Due to the strong interaction effects between pension system and labor markets, a well-chosen combination of pension policy reforms and modifications of institutions related to the labor market can do more than either of such changes in isolation, and we show that their impact could easily offset the effects of population aging on economic growth and living standards. On balance, however, behavioral effects diminish the impact of such reform efforts. Taking positive and negative behavioral effects into account, a combination of many policy measures is necessary in order to keep per capita consumption from falling behind the secular growth path. If these measures are taken, Europe can prosper in spite of an aging population.

The key of our approach – an analysis of the combination of an exogenous variation of employment rates with endogenous hours choice – has its advantages and disadvantages. It provides a theoretically consistent way to model the subtle balance between policy changes and individual reactions to them. From an empirical point of view, under this approach it is crucial to get the calibration right, in order to achieve a realistic number of households that

are constrained by labor market restrictions. The current version of the paper features a calibration method that is based on an *ad hoc* choice of parameters, selected by reference to other studies. In future versions of the paper we will specify certain calibration targets and determine deep structural model parameters by minimum distance methods as we have done in earlier work.

From a theoretical point of view, we do not model a motive for households to actually participate in the labor market. An alternative approach would be to model the decisions endogenously at both margins. This could be done by accounting for home production and preferences for leisure goods as in Greenwood and Vandenbroucke (2005) and by explicitly modeling the institutions that determine households labor market participation decisions, e.g., along the lines of the extensive search and matching literature reviewed in Ljungqvist and Sargent (2000: Ch. 5). We speculate that removing these frictions would lead to stronger total labor supply reactions than in our model. Such extensions of our model are the subject of future research.

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