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, they 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?

Keywords: aging; pension reform; labor market reform; labor supply reactions
JEL classification: E27; F21; G15; H55; J11

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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 higher capital intensity, and might generate large international flows of labor, capital and goods from the faster 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 implies 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 alter 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 global, 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 have already 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 babyboom generation will decease. 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. Their unsustainability has already received prominent attention. In addition, these countries have labor markets characterized by low participation rates, high unemployment, and high wages. They 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 anyway manage to push such reforms through parliament, workers may thus react adversely and undo 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 they take and how large are they? And ultimately: Can Europe prosper even if behavioral reactions counter current reform efforts?

Some behavioral reactions will strengthen reform. A good example is raising the statutory retirement age. It 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 incentive effects generated by the tax and contribution burden that actuarially unfair 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 weaken policy reforms. To take up the same example, older workers, now forced to work longer, may exploit part-time opportunities given 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 taken up 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 their quantitative effects?

Our macroeconomic framework puts much emphasis on the crucial role of labor supply in an understanding of the effects of aging on economic growth and living standards. This 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 by an increase in total factor productivity A and/or an increase in the capital stock per worker, K/L, 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 from now. 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 taken up.

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 GNP may become substantially larger than GDP if foreign direct investments create large returns. We complement France, Germany, and Italy as countries which save more than they invest with the U.S. 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 for restrictions are a minimum labor market entry age generated by the school system; a maximum labor market exit age generated by the pen-

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[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.

sion system; a low female labor force participation generated by inflexible working hours and unavailable day care facilities. Endogenous hours react, 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 also in the future. The polar case, for some an extreme, is the adaptation 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.

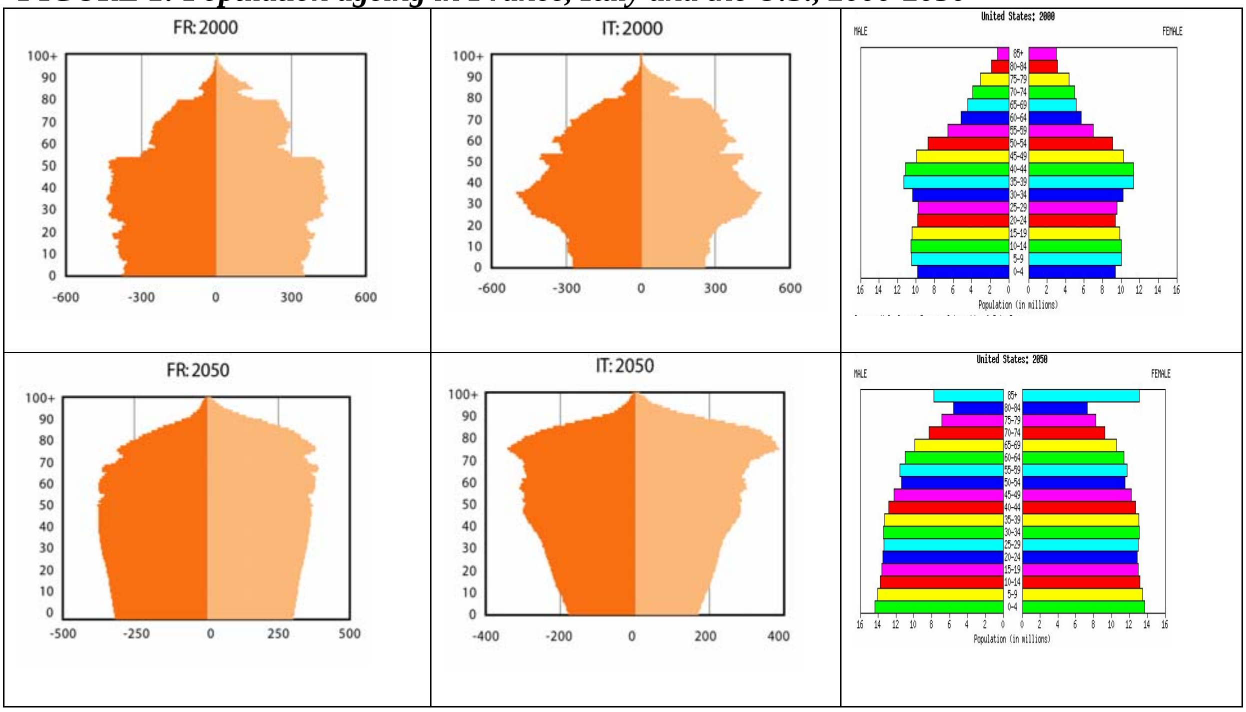
Our paper shows that direct quantity and indirect behavioral effects are large. They both significantly affect economic growth and living standards. Due to strong interaction effects between pension system and labor markets, a smart combination of pension policy and adaptation of institutions related to the labor market can do more than each policy in isolation. We show that they can offset the effects of population aging on economic growth and living standards. On balance, however, behavioral effects dampen 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, timing and extent differ substantially. The United States is considerably younger and will age later and to a slower extent than the EU, 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 ageing in France, Italy and the U.S., 2000-2050



Source: Eurostat and U.S. Census

The differences are startling. The French pyramid in 2050 features almost equal cohort sizes up to age 70, while Italy has a strongly inverted pyramid structure and the U.S., in turn, the population structure of a normal pyramid. They differences can largely be attributed to different fertility rates (France and the U.S. have fertility rates close to the replacement level, see table 1), while Germany and Italy loose about a 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 and U.S. Census (2008); OECD Health Data 2007; WHO (2006); and own computations.

Life expectancy also differs remarkably among the four countries. This is accentuated in the healthy life expectancy, a measure developed by 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 U.S. Note that in Europe healthy life expectancy is about 10 years higher than the average retirement age.

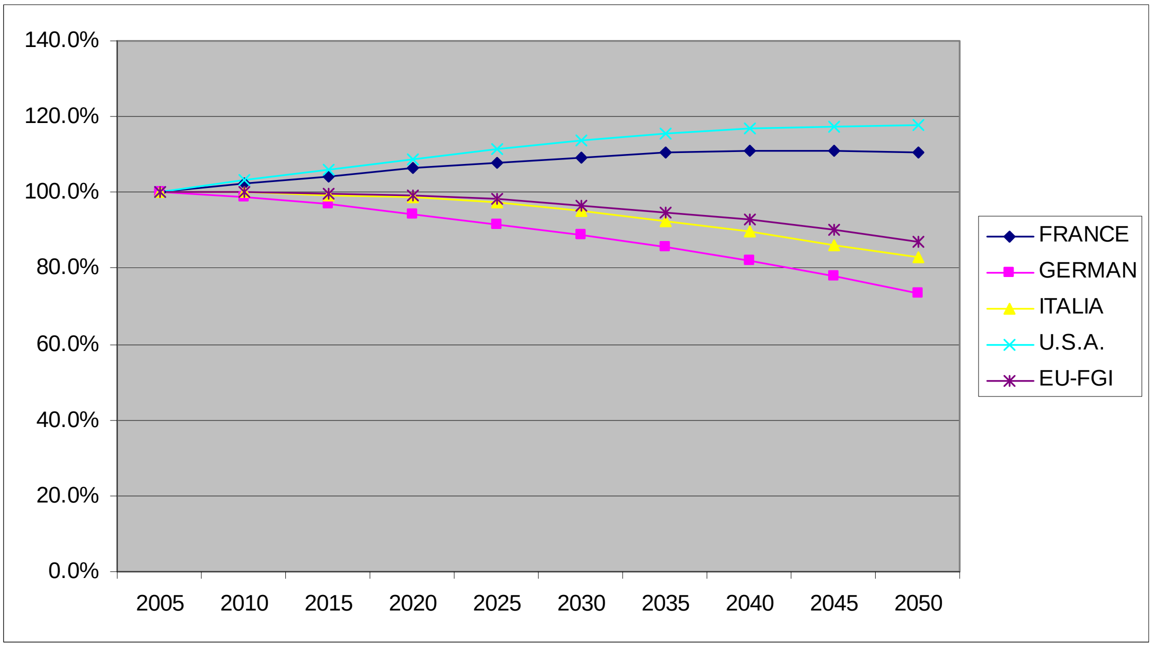
We compute the future demography of the four countries based on three key assumptions: constant fertility rates, no migration, and a Lee-Carter projection of mortality.[3] Fertility rates are taken from table 1. This table also shows the resulting life expectancy in 2050. They are slightly higher than the current UN projection (age 85 for France and Italy, same as table 1 for Germany and the U.S.).

One may object that the assumption of zero migration is counterfactual, and 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 more transparent to do this on a zero migration background. Second, current migration rates are small relative to the changes in working age population as they are expected in the future.

Figure 2 shows total population aged 15 years and over which will be the base of our projections and simulations. It reflects the stark differences of the population pyramids that we have seen in figure 1. There will be population growth in France and the U.S. but 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.

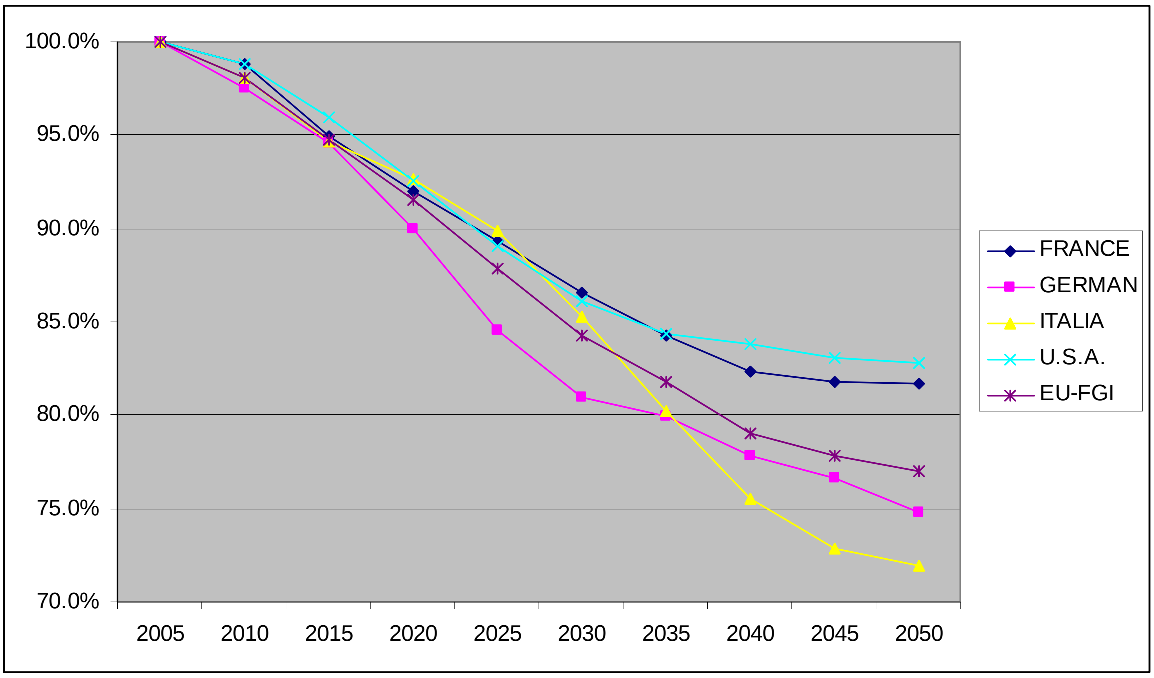
[3] The estimation procedure is based on the data provided by the Human Mortality Database (2008).

FIGURE 2: POP15+ indexed to 2005=100%



Even more remarkable is the change in the share of those who are in working age, see figure 3 below. Relative to total population aged 15 and older, the U.S. will loose about 17% of their working age individuals between 2005 and 2050. In Italy, the loss is almost twice as high with 28%. France and Germany are in between. France is closer to U.S. and Germany closer to Italy, reflecting the fertility rates in table 1.

FIGURE 3: WAP/POP15+ indexed to 2005=100%



3. Employment

The demographic differences, in particular those between Italy and the U.S., 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. U.S. support rates are much higher than the European ones. In Europe, Italy stands out with the lowest support ratio. Unlike to its demographic position, France shares the low labor force participation of Continental Europe; current French labor force participation rates are actually lower than the German ones.

FIGURE 4: RAWLAB/POP15+, not indexed

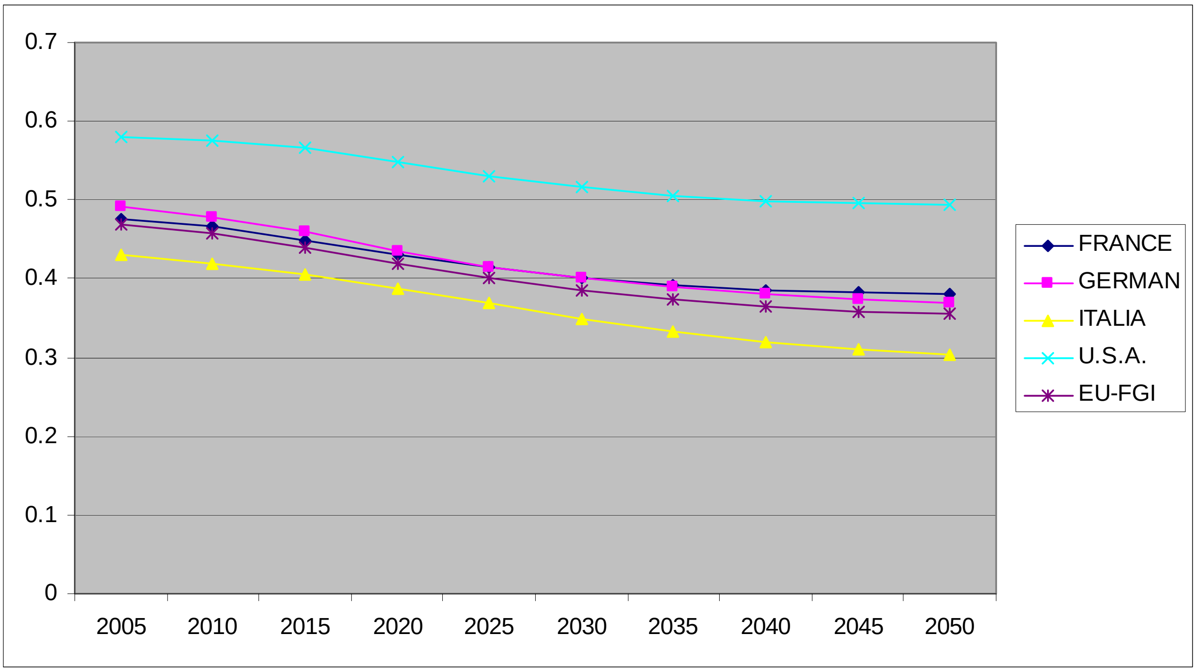


Figure 4 is based on the assumption of constant age and gender specific labor force participation rates. Given this assumption, Germany today (i.e., in 2005) has almost exactly the low support ratio which the U.S. will have after 2040. In this sense, Germany is one generation ahead of the US when it concerns 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 U.S. (24.3% vs. 15.0% between 2005 and 2050), aggravating the current differences of the support ratios among the four countries.

Aggregate employment is a results 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 a 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 six scenarios representing the potential changes in the institutional framework restricting households' labor supply decisions. In our OLG model (see section 4) we will model the changes in labor supply restrictions 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.

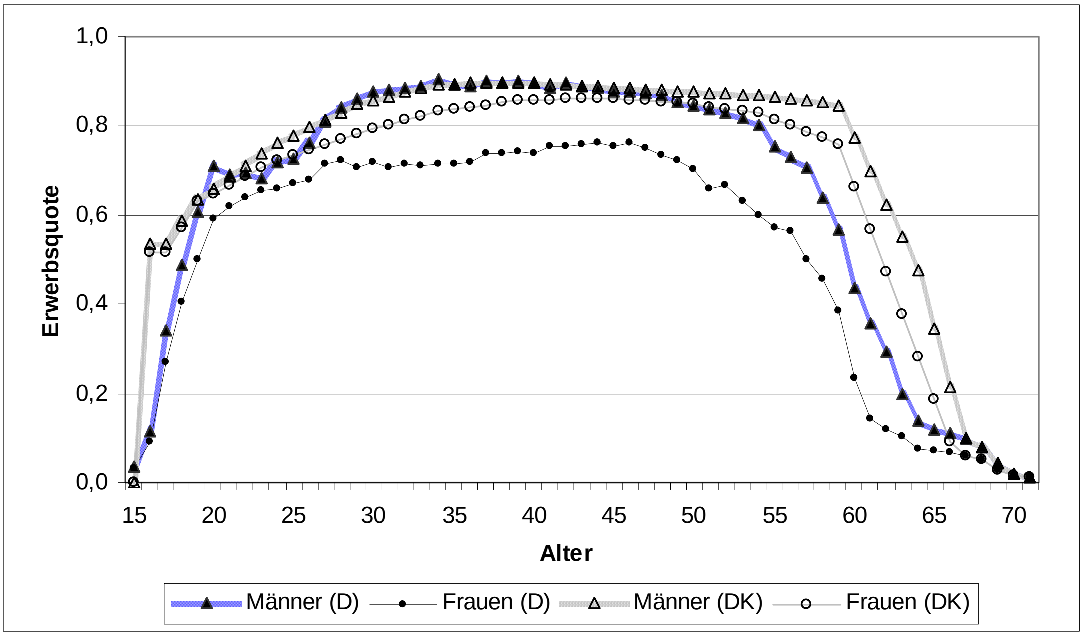
The six exogenous labor supply scenarios are:

- STATQUO: constant age and gender specific labor force participation rates;
- RETAGE: an increase in the retirement age by 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;
- 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, see figure 5. The increments are motivated by actual policy proposals: in Germany, the statutory retirement age has been raised from 65 to 67 years in a serious 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).

Overall, these scenarios appear to be not that extreme; in fact, their combination would lead in 2040 to labor force participation fairly similar to those in Denmark today (thus the name of the sixth scenario). Attempts to actually execute reforms with those goals have faced stiff opposition in France and Italy, to a somewhat lesser extent also in Germany.

FIGURE 5: German and Danish labor force participation rates



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

Figures 6 through 8 display the resulting trajectories of the number of working individuals. The trajectories are very different across countries. France can compensate the slightly declining number of individuals of working age easily by a combination of two or three of the above policy changes, while Germany and Italy will have no chance to offset the loss in working age population with those measures. The countries also differ in the efficacy of the four policy parameters. Note in particular the large jump due to an adaptation of female labor force participation that that of men in Italy, due to the low current rates of female labor force participation.

Lower labor input as indicated in these figures will invariably make Germany's and Italy's GDP decline. However, since total population will also decline, 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 message is that a combination of the four policy scenarios can in all countries, more or less also in Germany and Italy, stabilize these countries' support ratio. The ironic result of figure 11 is that, while Italy ages more than 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: RAWLAB indexed to 2005=100%, France]

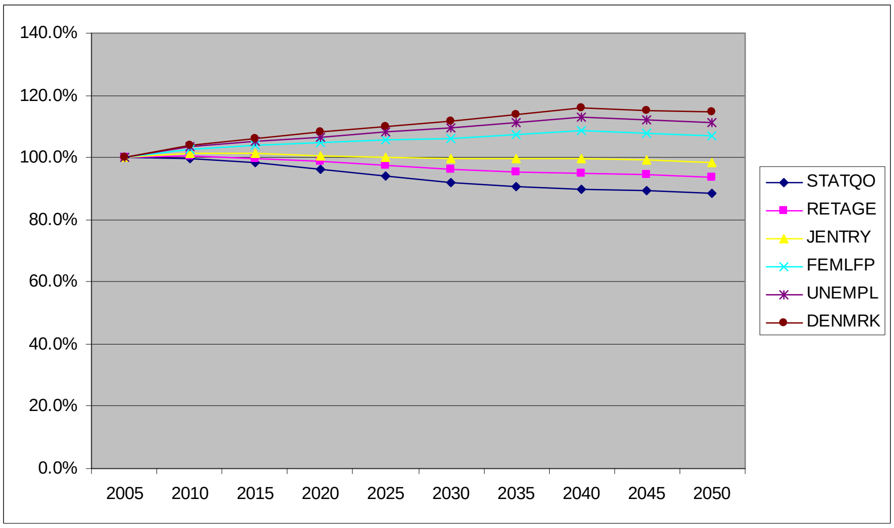


FIGURE 7: RAWLAB indexed to 2005=100%, Germany

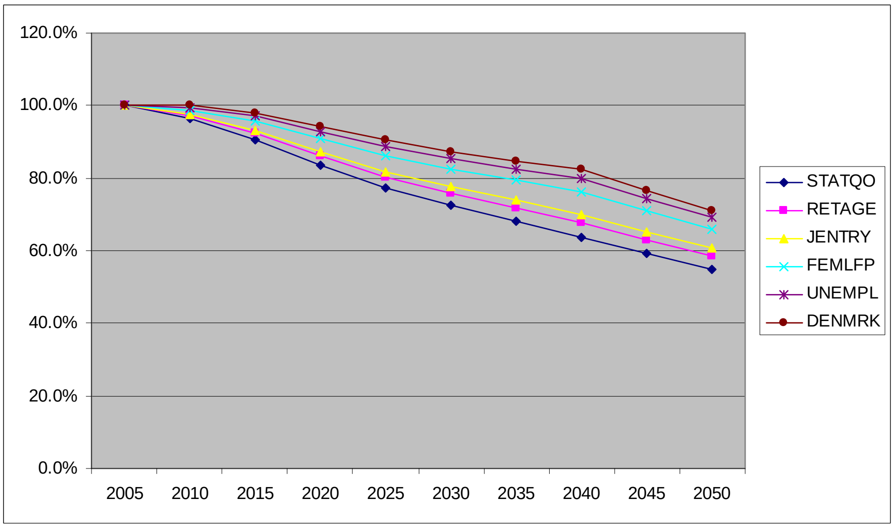


FIGURE 8: RAWLAB indexed to 2005=100%, Italy

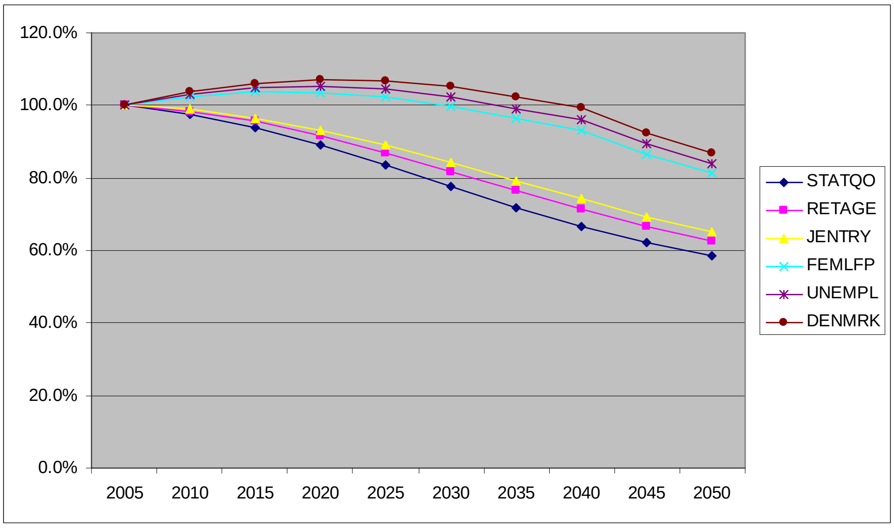


FIGURE 9: Support ratio RAWLAB/POP15+ indexed to 2005=100%, France

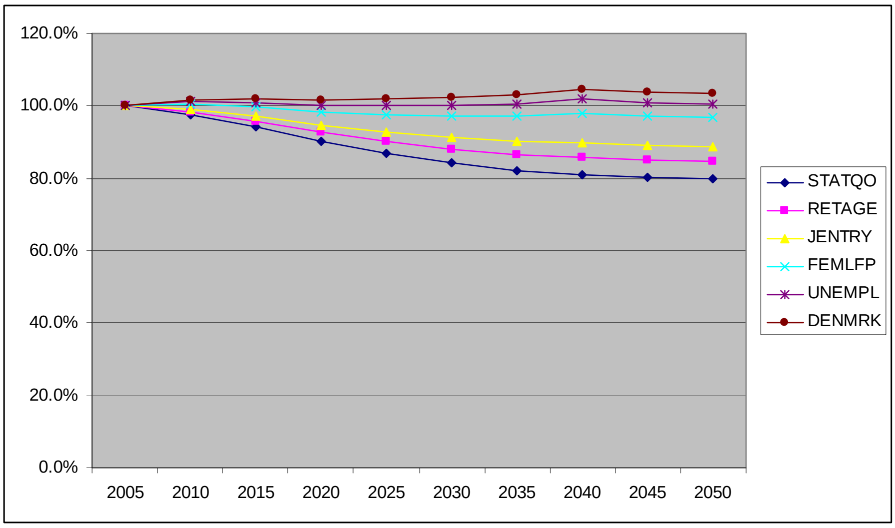


FIGURE 10: Support ratio RAWLAB/POP15+ indexed to 2005=100%, Germany

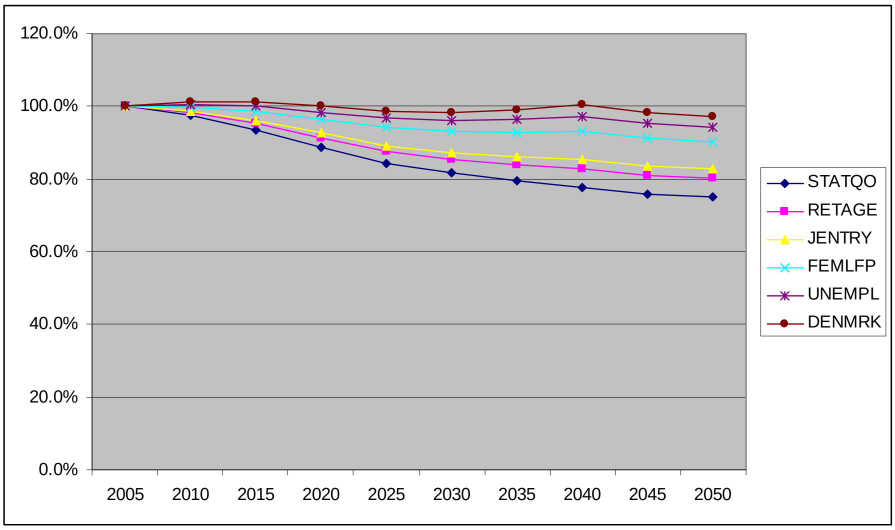
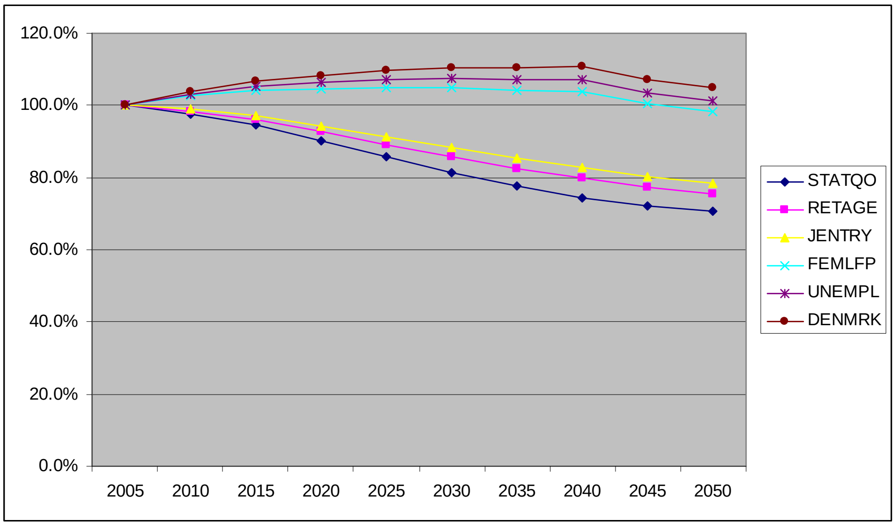


FIGURE 11: Support ratio RAWLAB/POP15+ indexed to 2005=100%, Italy



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 for whom the 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

4.1 Time

Time in our model is discrete and extends from $t=0,\ldots,T$. 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. They have been summarized by the parameters in table 1. Demography is taken as exogenous. It represents one of the main driving force 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,…,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

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

where $\varsigma_{t,j,i}$ 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

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

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

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

$$(4) \qquad r_t = \alpha k_t^{\alpha} - \delta,$$

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, $1\text{-}l_{t,j,I}$, 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 $1\text{-}l_{t,j,i} \cdot h_{t,j,i}$ whereby we restrict time endowment to one.

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

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

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

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

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

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

where $\lambda=1$ for $j=0,\ldots,jr$ 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,

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

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[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.

In the variant of our model with 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 PAYG financed pension system with flat pension benefits. We assume that the budget of the pension system is balanced in all *t,i* such that

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

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 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*.

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

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

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

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 time period between 1960 and 2004 is then used as calibration period in order 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 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.

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5 In the current version of the paper we do not calibrate structural model parameters in order to meat 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_i: technology level	0.05 - 0.07
β: discount factor	0.99
θ: coefficient of relative risk aversion	2
φ: consumption share parameter	0.66

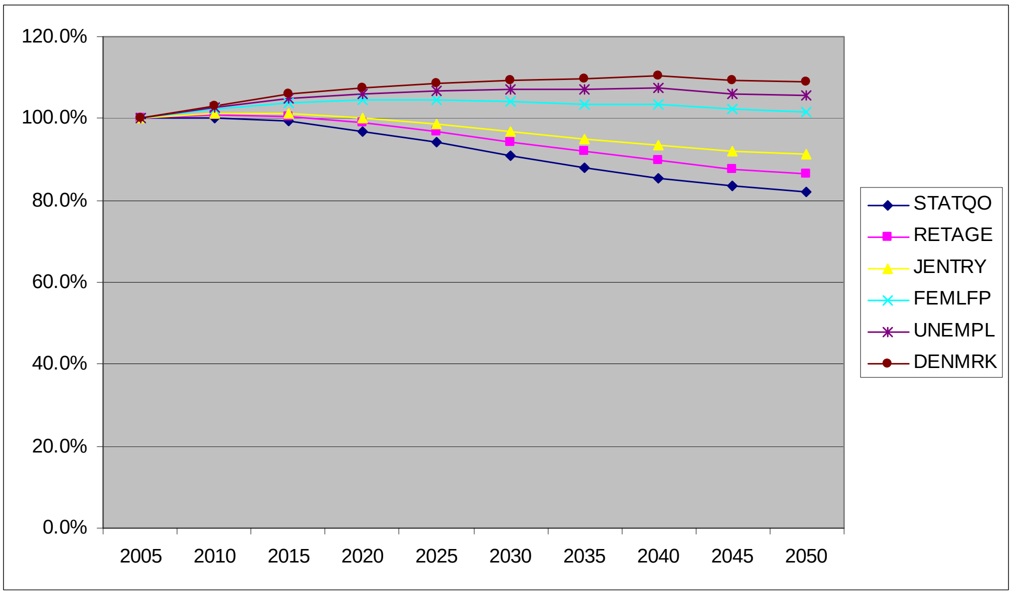
5. Changing institutions that affect labor force participation

We begin the presentation of our results with the effects of lifting 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 TFP which about doubles between 2005 and 2050. We also index all graphs to the base values attained in 2005.

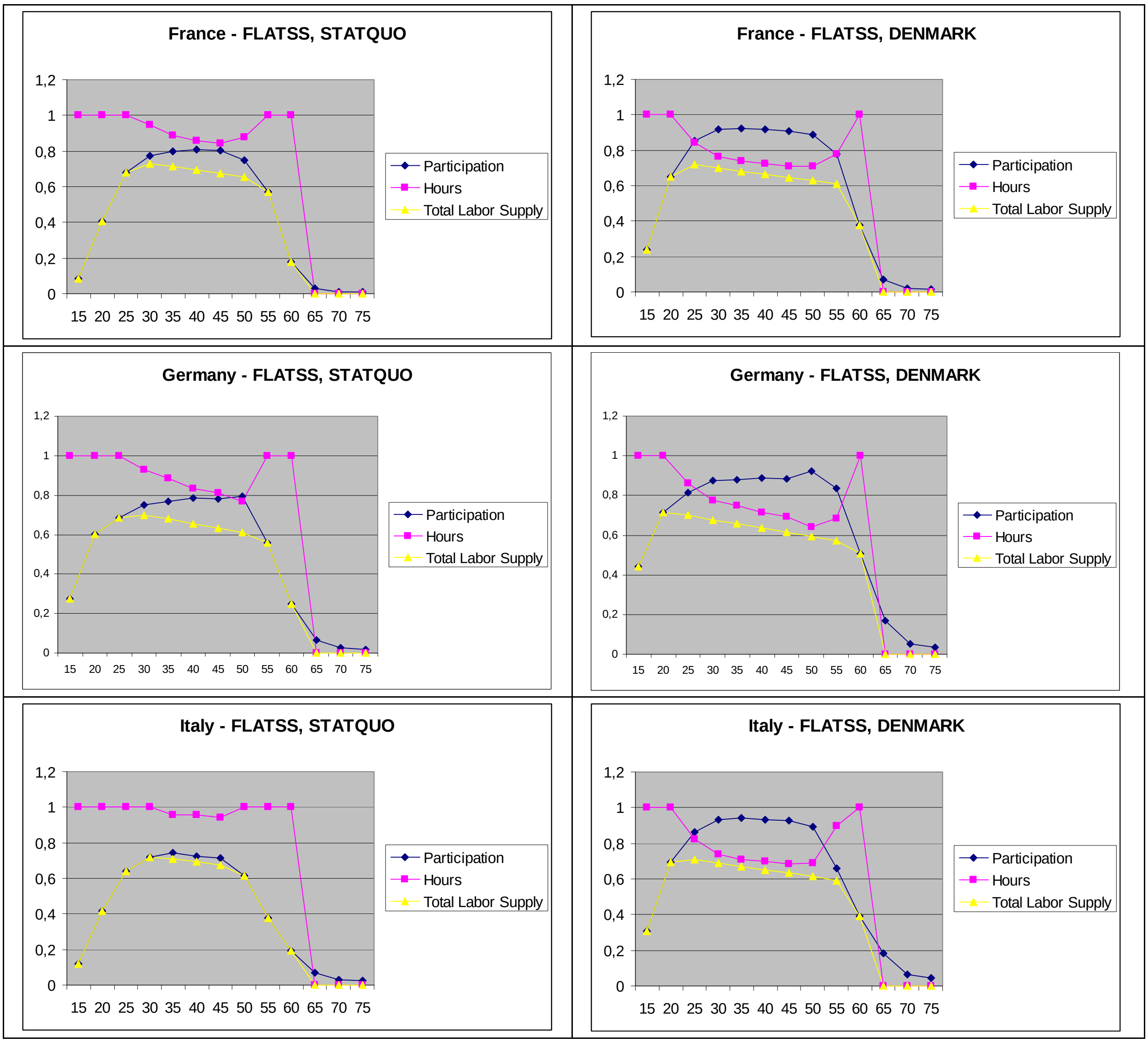
If hours do not respond to increasing social security taxes, exogenous increases in labor supply can actually fully compensate for population aging and stabilize economic growth per capita:

FIGURE 12: YperAN indexed to 2005=100%: EU-3, exogenous hours



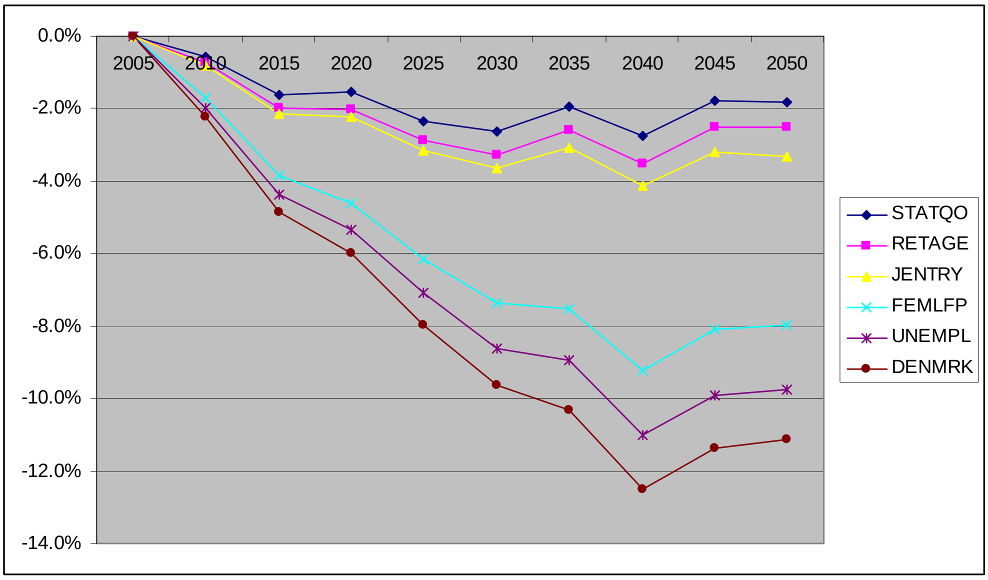
This is not the case if the hours supply is endogenous. Hours actually compensate a good deal of the exogenous increase in persons working. This is shown in figure 13 which displays labor force participation (diamonds), hours supply (squares) and the resulting total labor supply (triangles) for the three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

FIGURE 13: Labor force participation, hours supply and total labor supply



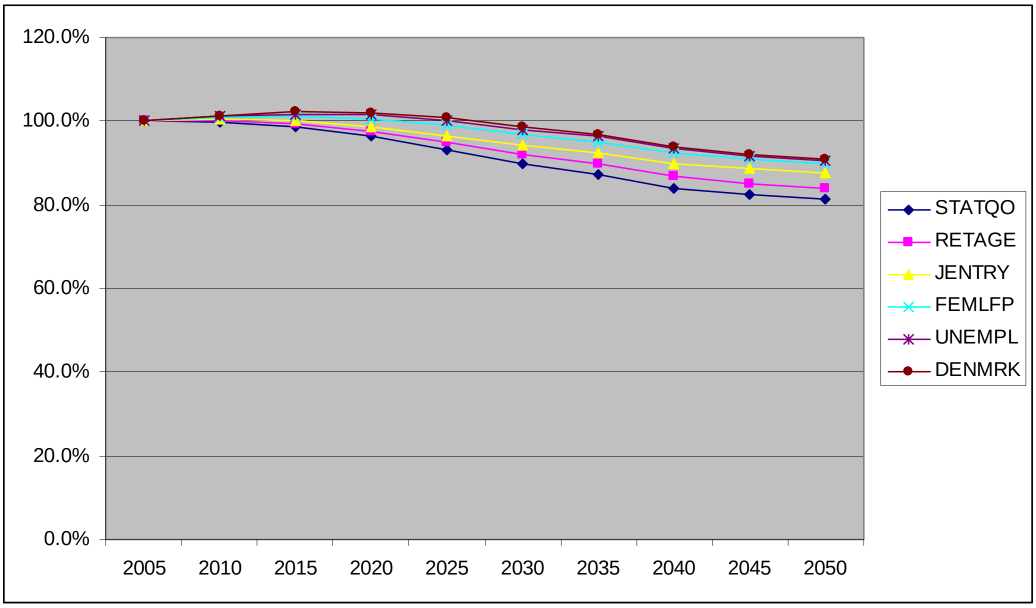
The reason can be inferred from the household's utility function as specified in section 4. Hours and persons are perfect substitutes as long as the household is not at a corner solution with its hours supply. About 58% are not constrained. These households undo exogenous policy changes by adjusting their working hours inversely. The remaining 42% of households have been constrained under the given labor market policy regime in 2005 (most in Italy, where 57% are constrained, in Germany 37% and in 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 shows up in figure 13 in a much higher total labor supply for the younger and older age groups in the DENMARK scenario as compared to the STATQUO scenario. Figure 14 shows the aggregate picture:

FIGURE 14: Hour supply indexed to 2005=100%: EU-3, endogenous hours



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: YperAN indexed to 2005=100%: EU-3, endogenous hours



Our second target variable is 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 stronger decline (or lesser increase) of the high employment scenarios. In these scenarios, saving increases slightly, while in the low employment scenarios saving declines from 2005 to 2050 in response to the differential change in the wage to interest ratio.

FIGURE 16: CperAN indexed to 2005=100%: EU-3, exogenous hours

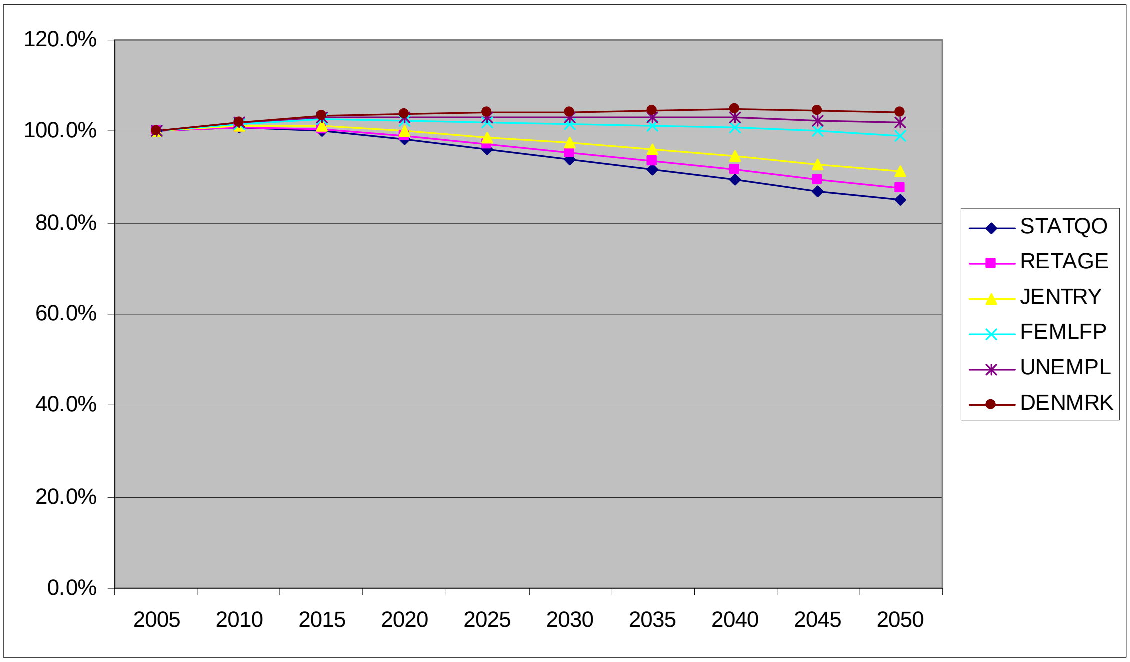
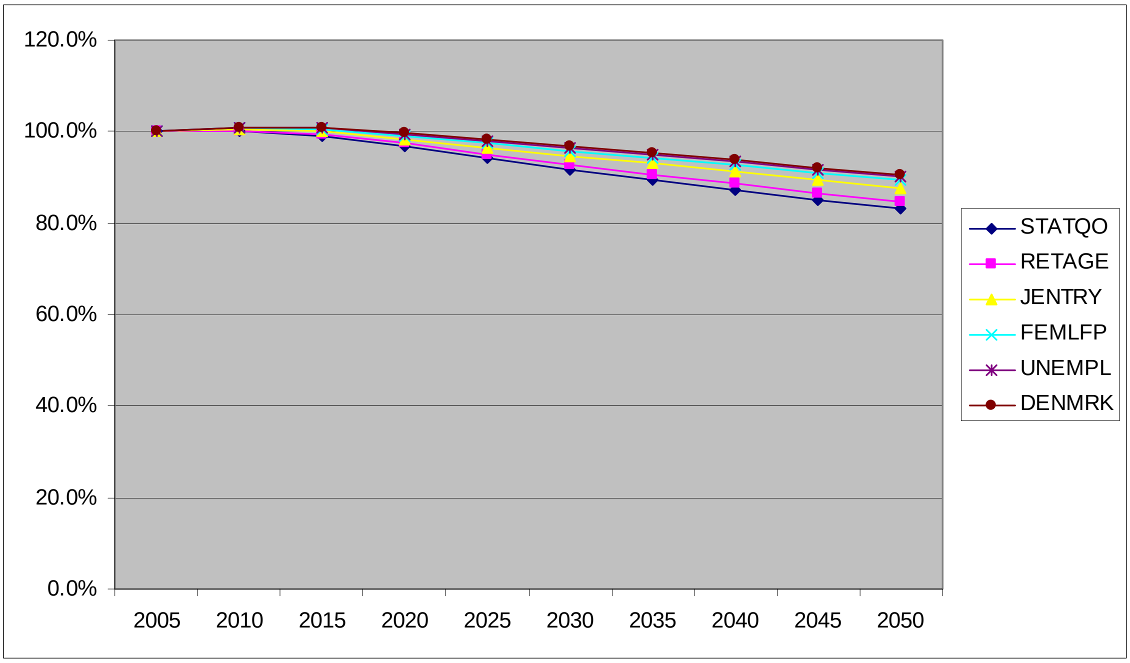


FIGURE 17: CperAN indexed to 2005=100%: EU-3, endogenous hours



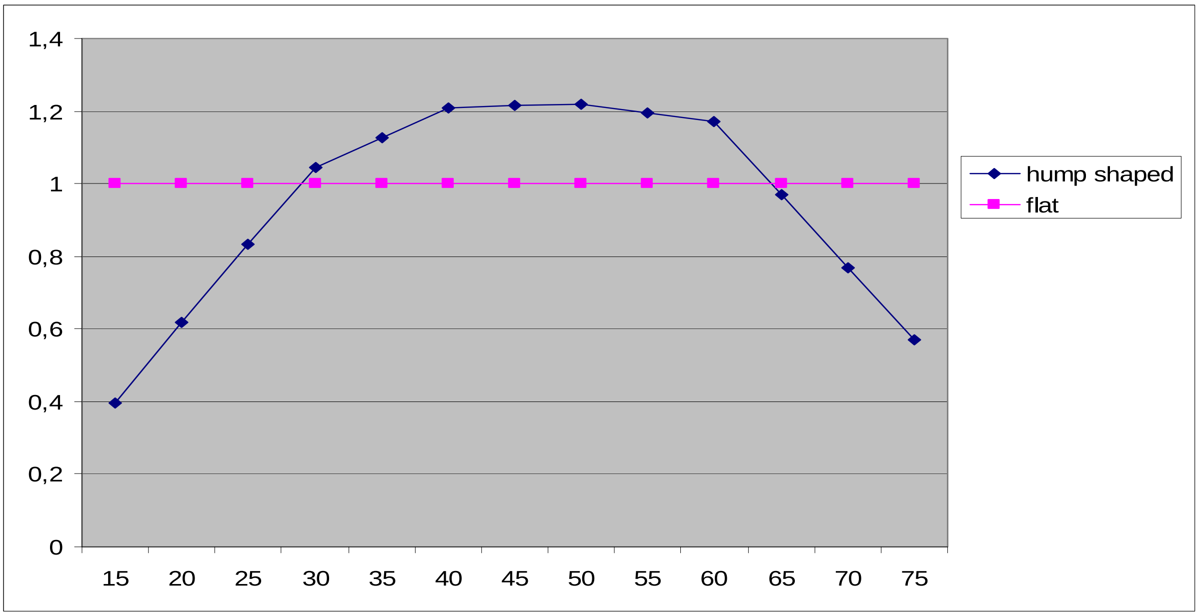
6. Productivity issues

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 survey to address these issues because of justification bias. Kotlikoff and Wise (1989) evaluate confidential data originating from a major US American service enterprise in which output is well defined. They provide two estimates which 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 shape. 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, such that the resulting productivity profile is essentially flat, with reliable observations until about age 63.

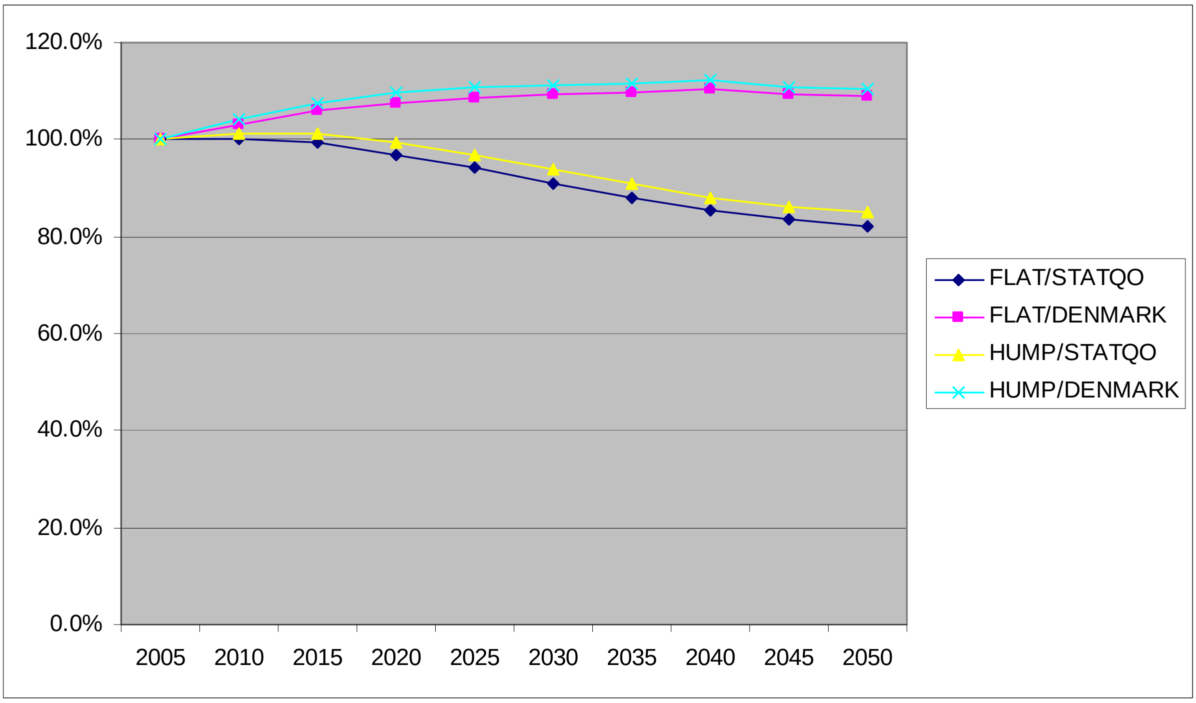
How do these microeconomic differences translate into macroeconomic differences? In order to get some feeling, we underlie our simulations with two alternative age-productivity profiles (in our model represented by ε_j, see section 4.6). One profile is flat; the other imposes the sharp hump shape depicted in figure 18. It features a strong decline of productivity after age 60. We treat these age profiles as exogenous.

FIGURE 18: Hump-shaped age productivity profile.



Figures 19 describes which difference it makes whether the age productivity profile is flat or whether it is 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: YperAN indexed to 2005=100%, different productivity assumptions, EU-3



7. Interactions between pension and labor market reform

So far, we have looked into a world with a prototypical pension system of Continental Europe. It is purely pay-as-you-go and provides flat benefits. They are 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 in 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 of underlying assumptions displayed in table 3.

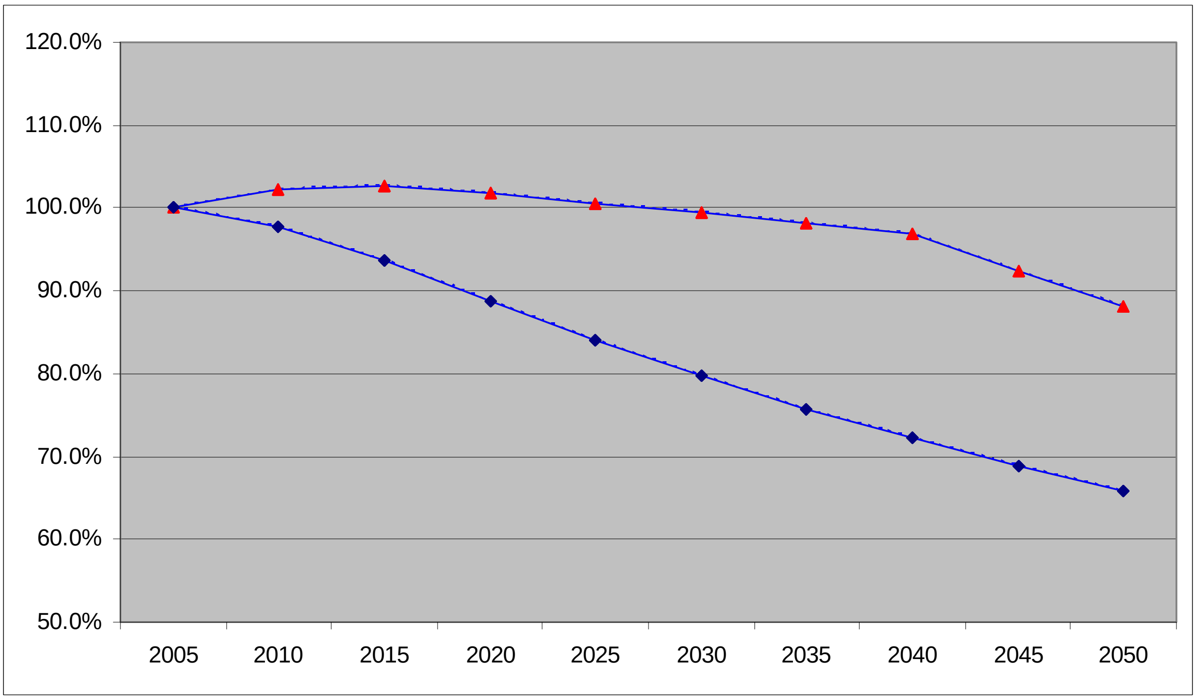
TABLE 3: Set up of scenarios

	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)	***FL-SQ-EX***	***FL-SQ-EN***	***FL-DK-EX***	***FL-DK-EN***
Fully funded voluntary accounts (SAVING, yellow line)	***SV-SQ-EX***	***SV-SQ-EN***	***SV-DK-EX***	***SV-DK-EN***

[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).

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: RAWLAB indexed to 2005=100%, EU-3[8]



The upper graph (marked by red triangles) shows the number of individuals participating in the labor market in the DENMARK scenario. In spite of the massive increase in labor force participation – earlier entry in, and later exit from, the labor market, 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 by much more than 30% steadily from 2005 onwards.

[8] Need to fix the decline in DENMRK scenario after 2040 in future version (visible in a steeper slope than in STATQUO after 2040), but for now helpful as a didactic device.

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,
- 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 U.S. is modeled in the background with similar changes in retirement age and female labor force participation, but no other exogenous policy changes.

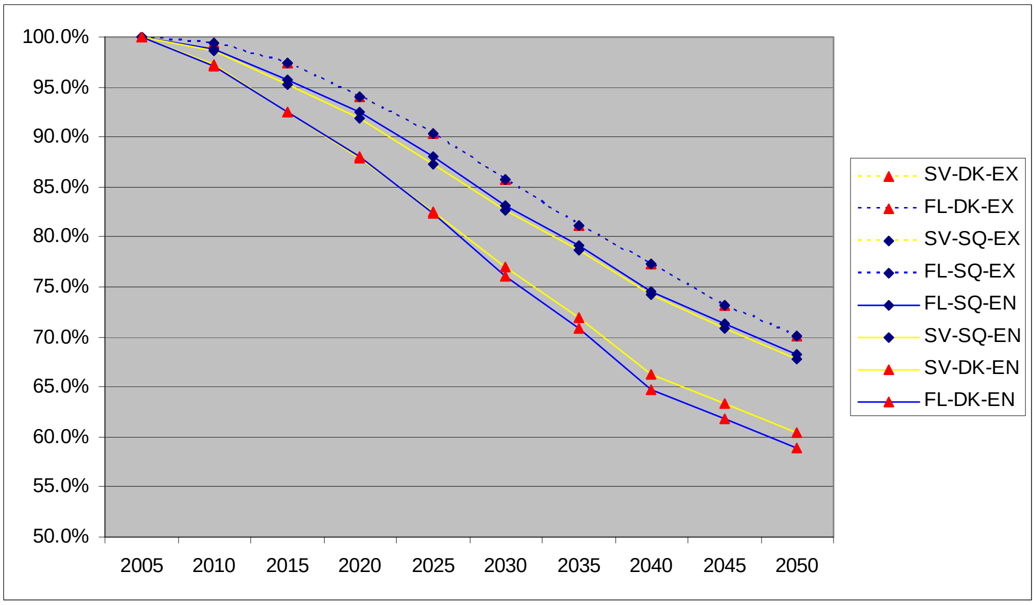
All figures have the same design. We denote exogenous labor supply by a dashed line and endogenous hours' supply by a solid line. The high labor force participation scenario (DENMARK) is marked by red triangles, the constant labor force participation scenario (STATQUO) by blue diamonds. Finally, the 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. The first diagram in each figure shows all eight combinations of the scenarios. The following three smaller panels show the differences in each of the three directions in order to identify interaction effects.

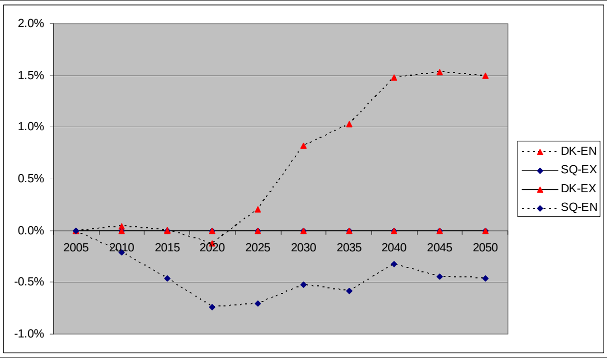
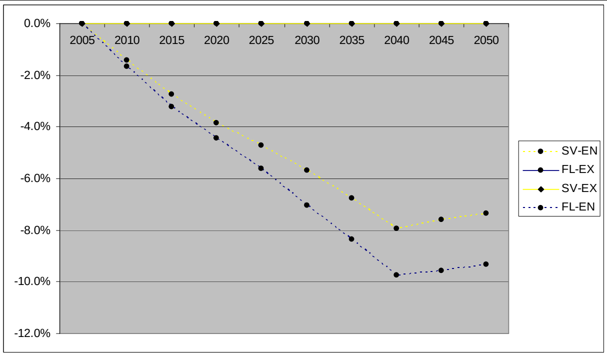
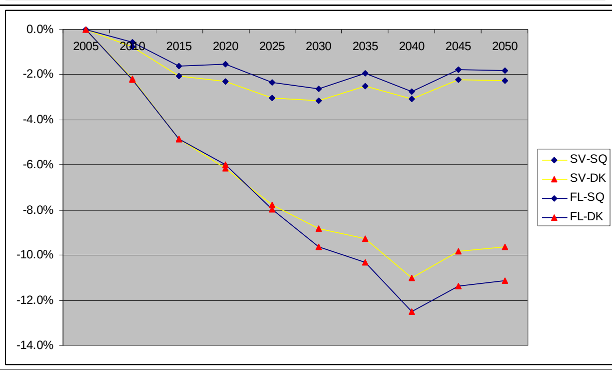
7.1 Intensive margin: the supply of hours

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 a individual savings regime (SAVING, yellow line).

FIGURE 21: Hours



Interaction effects with social security systems: **SAVING versus FLATSS**	
Interaction effects with labor market scenarios: **DENMARK versus STATQUO**	
Interaction effects with type of hours' supply: **ENDOGENOUS versus EXOGENOUS**	

These effects are best seen when one takes first differences in the direction of each specification dimension. This is done in the three panels of figure 21 labeled “interaction effects”. The first panel shows the difference between the two types of social security systems. Hours increase under a funded system via-a-vis 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.

The second panel displays the difference between higher and unchanged exogenous labor force participation. Hours 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 the additional difference between the two lines in the second interaction effect as an incentive effect due to distorting taxes, while the difference between the horizontal axis and the yellow line is the substitution effect between hours and labor force participation.

The third panel summarizes these effects as it displays the difference between endogenous and exogenous hours’ supply under the four combinations of pension and labor market regimes while the two former graphs can be interpreted as differences in differences. 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.

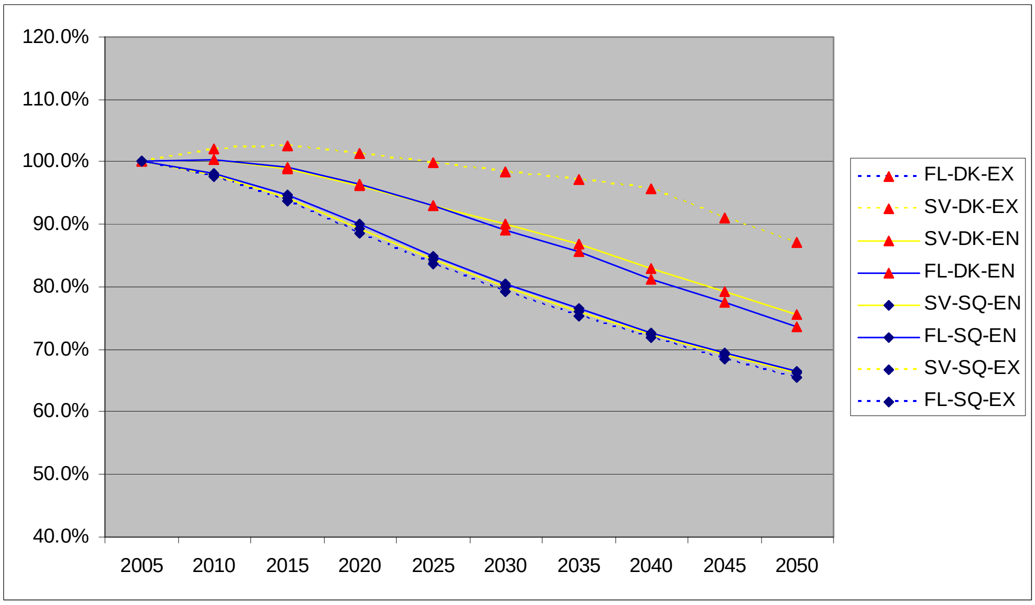
7.2 Total effective labor supply

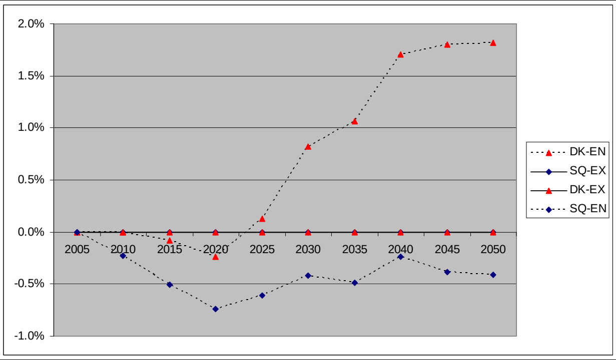
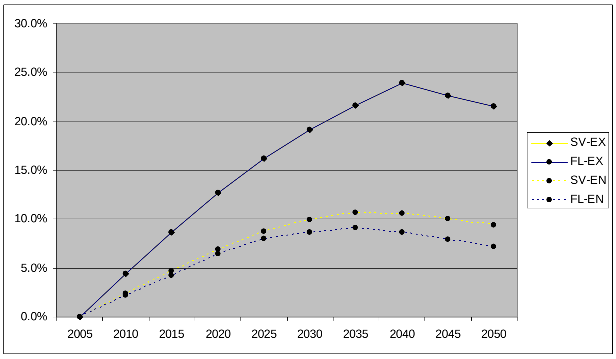
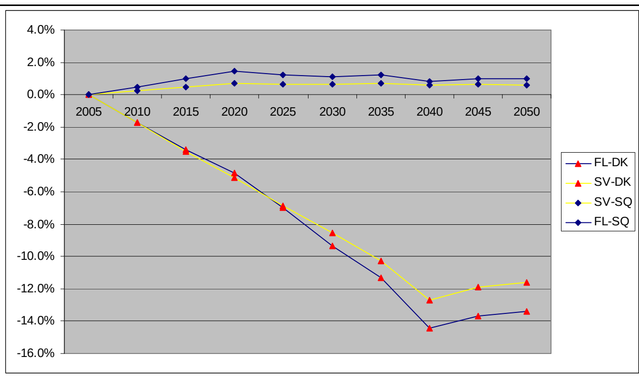
Total labor effective supply is the product of working persons (figure 20) and hours per person (figure 21), adjusted for age-specific productivity: $L_{t,i} = \sum_{j=0}^{J} \varepsilon_j l_{t,j,i} h_{t,j,i} N_{t,j,i}$.

Its evolution 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 hour’s supply 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

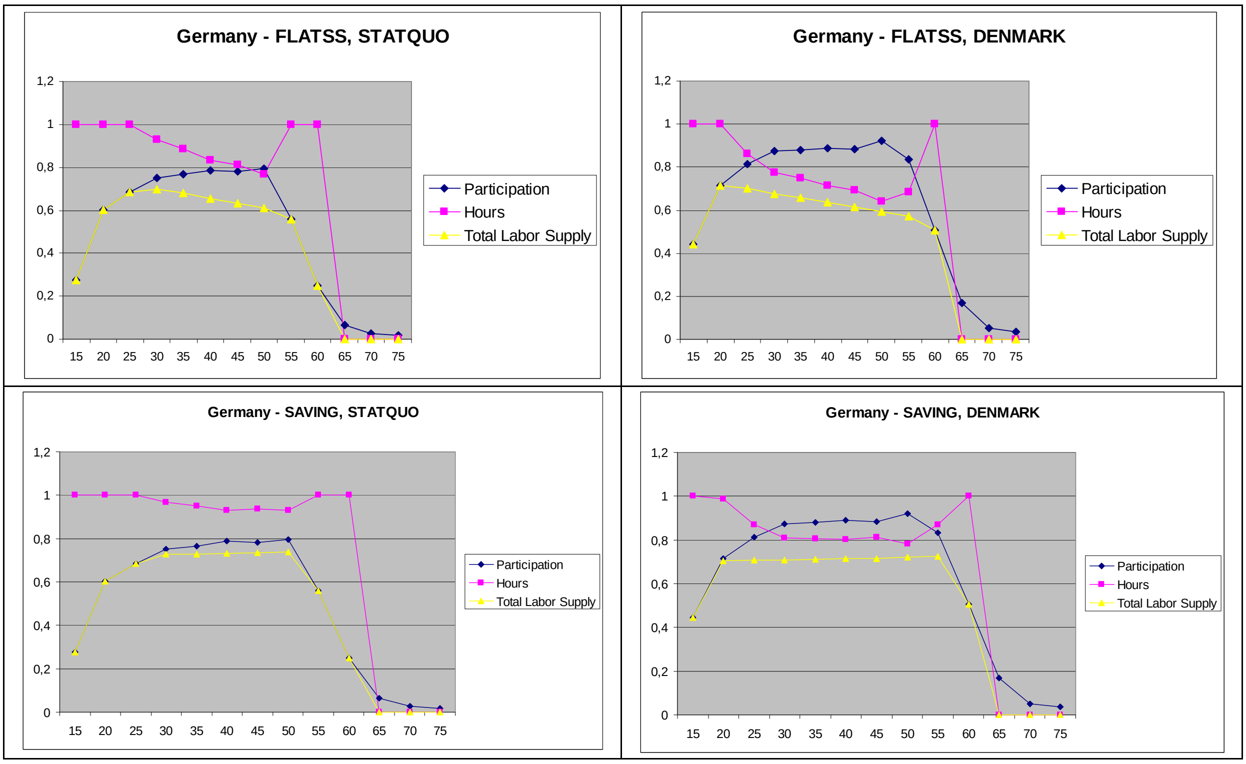


Interaction effects with social security systems: **SAVING versus FLATSS**	
Interaction effects with labor market scenarios: **DENMARK versus STATQUO**	
Interaction effects with type of hours' supply: **ENDOGENOUS versus EXOGENOUS**	

The first panel on interaction effects also nicely shows the strong interaction between pension reform and labor market reform: relative to the current pay-as-you-go system, total labor supply increase 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.

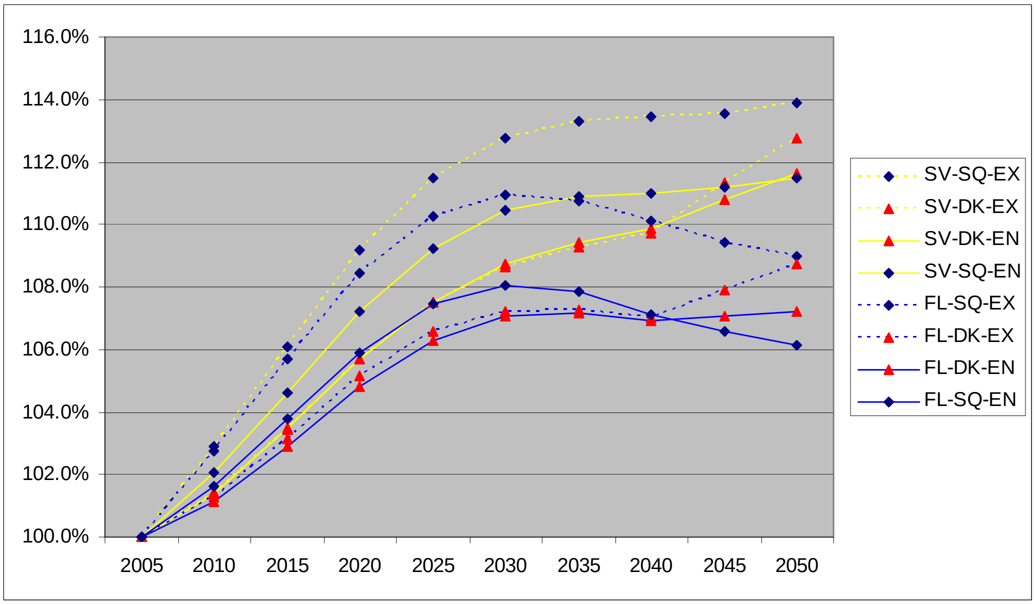
FIGURE 23: Labor force participation, hours supply and total labor supply

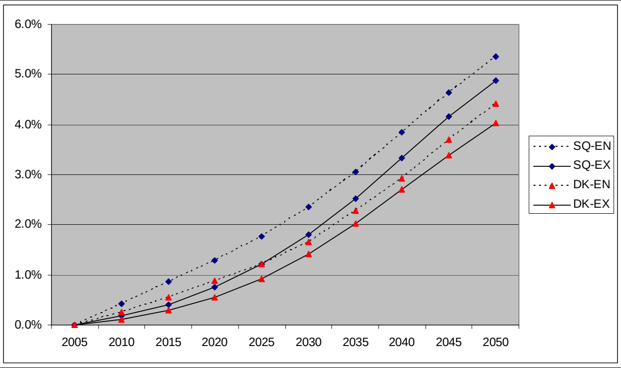
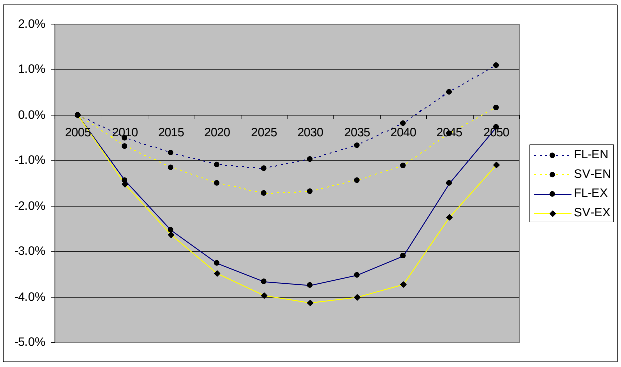
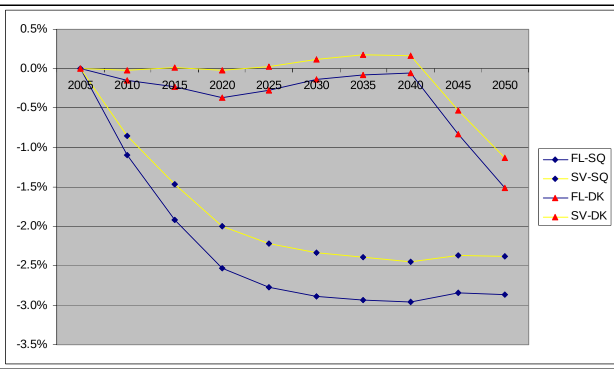


7.3 Wages

Wages are depicted in Figure 24. They more or less reflect total effective labor with some additional effects due to capital accumulation (see subsection 7.4). Considering the massive decline in total labor supply, wages react somewhat dampened with an elasticity of about 0.5.

FIGURE 24: Wages



Interaction effects with social security systems: **SAVING** **versus FLATSS**	
Interaction effects with labor market scenarios: **DENMARK** **versus STATQUO**	
Interaction effects with type of hours' supply: **ENDOGENOUS** **versus EXOGENOUS**	

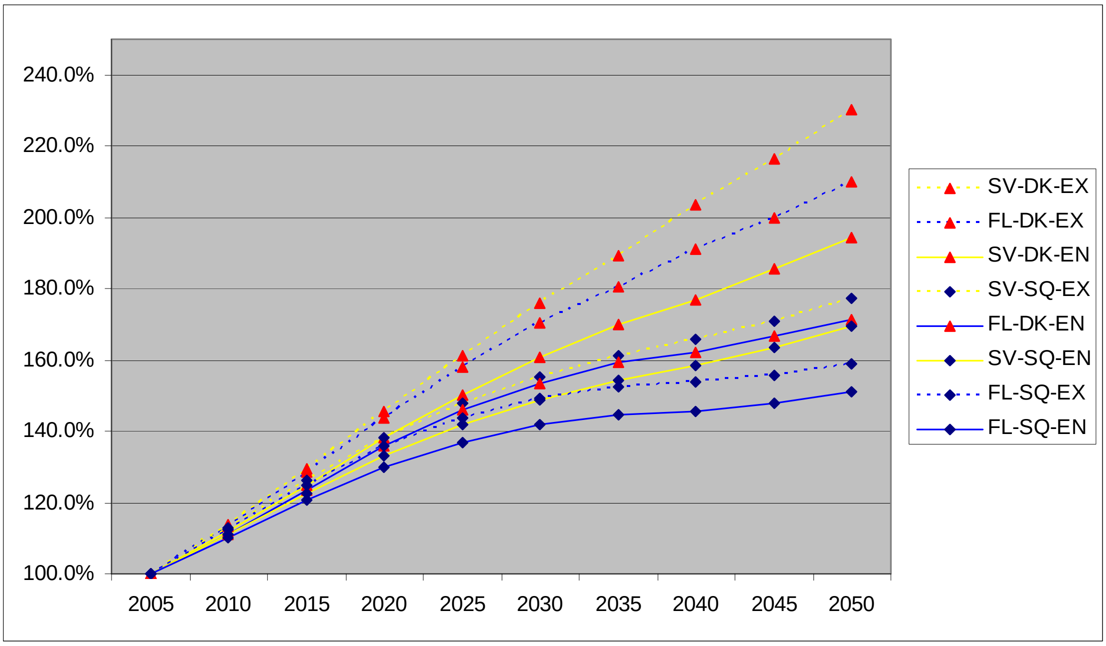
Wages increase more in the STATUSQUO (blue diamonds) than in the DENMARK (red triangles) scenario, reflecting relative scarcity. Wages increase much stronger under a funded system (yellow lines) than under pay-as-you-go (blue lines). The additional capital accumulation lowers interests and raises labor productivity, 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 hours reaction is large.

7.4 Capital accumulation

Figure 25 depicts 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 as can be seen in the first panel of interactions. There is also substantially more capital accumulation in the high labor force participation scenario (DENMARK) as compared to constant participation (STATQUO). This is visible in the second panel. Finally, the third panel shows that capital accumulation is higher if endogenous hours' supply is not dampening the effect of a higher labor force participation.

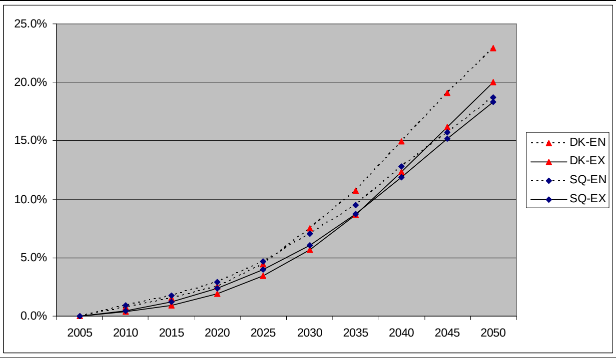
Combining these three effects yields the top diagram of figure 25. Capital accumulation is highest under a fully-funded system with high labor force participation and no dampening effect of endogenous hours (SV-DK-EX). It is lowest in a pay-as-you-go system with status-quo labor force participation and the full force of negative incentive effects (FL-SQ-EN).

FIGURE 25: Domestic capital stock



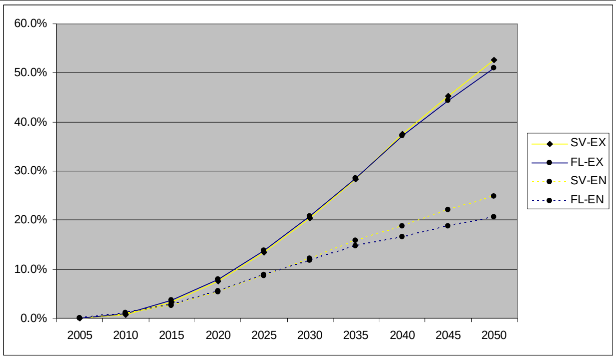
Interaction effects with social security systems:

SAVING versus FLATSS



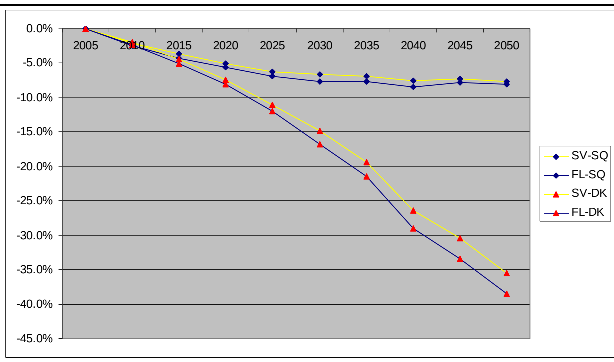
Interaction effects with labor market scenarios:

DENMARK versus STATQUO



Interaction effects with type of hours' supply:

ENDOGENOUS versus EXOGENOUS



7.5 GDP per capita

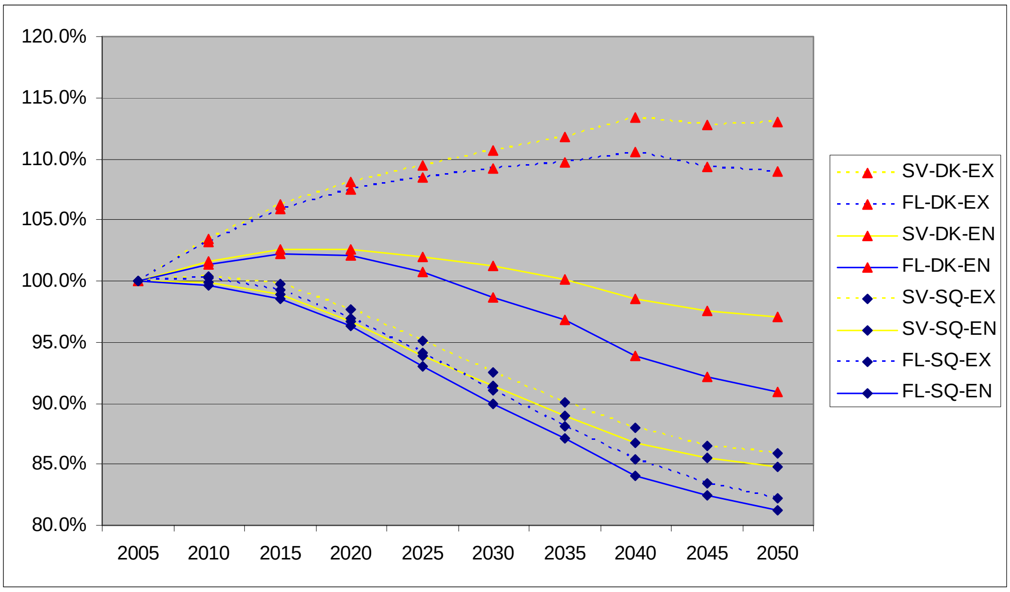
Our first target variable is economic growth, measured as the change in GDP per capita, net of exogenous growth in total factor productivity. This is displayed in figure 26. Economic growth relative to secular productivity growth is very much affected by the combination of pension and labor market policies. 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.

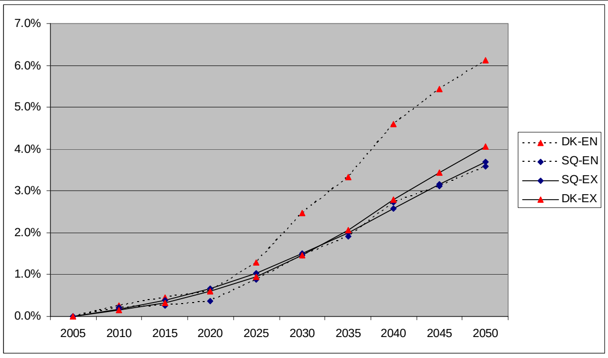
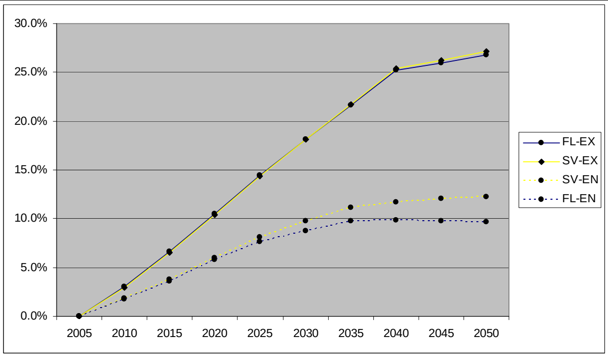
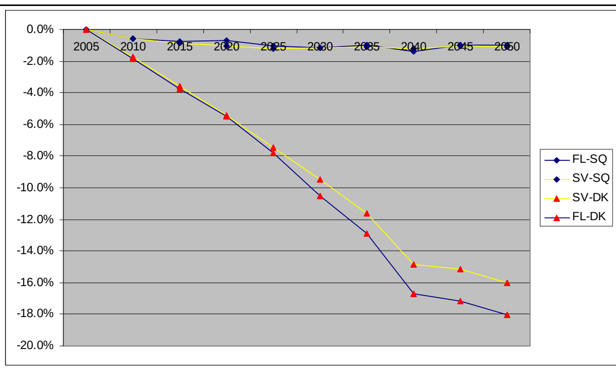
The quantities are large: the difference between the best and the worst scenario are more than 30%. The must be seen in comparison to total factor productivity growth which is about 90% over the period from 2005 to 2050. Aging, if unchecked through offsetting labor market and pension policies, will “eat up” about a third of total economic growth.

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. The latter two findings are clearly seen in the first two small panels below the large diagram.

The third panel shows the interaction between pension and labor market policies in the case of endogenous supply of working hours. Endogenous hours’ supply reduces growth relative to a situation when households cannot substitute more persons by less hours. This is shown by the two lines at the bottom of this graph (FL-DK and SV-DK). The effect, however, is smaller when the pension system is fully funded (SV-DK).

FIGURE 26: GDP per capita



Interaction effects with social security systems: **SAVING versus FLATSS**	
Interaction effects with labor market scenarios: **DENMARK versus STATQUO**	
Interaction effects with type of hours' supply: **ENDOGENOUS versus EXOGENOUS**	

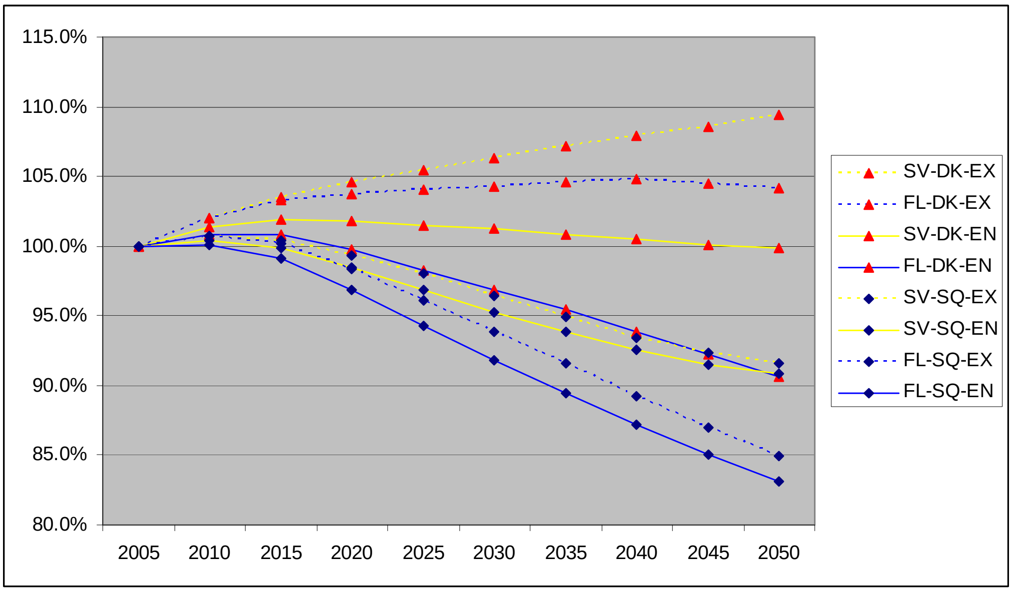
7.6 Consumption per capita

Finally, figure 27 displays our second target variable, living standards measured by consumption per capita. As we did it 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 as it concerns the relative position of the eight scenarios.

Saving in 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 smart 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 5 are needed in addition to a secular pension reform; other policy scenarios imply that living standards in Continental Europe will grow slower than what we have experienced in the past. Living standards will not decline because secular productivity growth is still stringer than aging. Living standards, however, will decline relative to all other countries that age less than Continental Europe.

FIGURE 27: Consumption per capita



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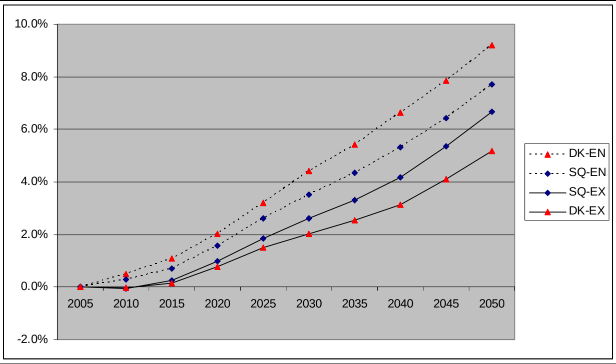
versus FLATSS</td>
<td>
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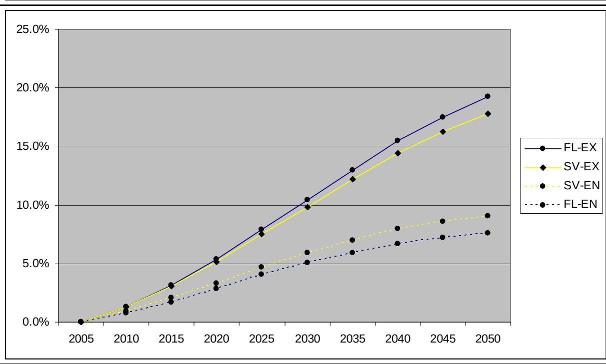
<td>
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<td>Interaction effects with type of hours' supply:

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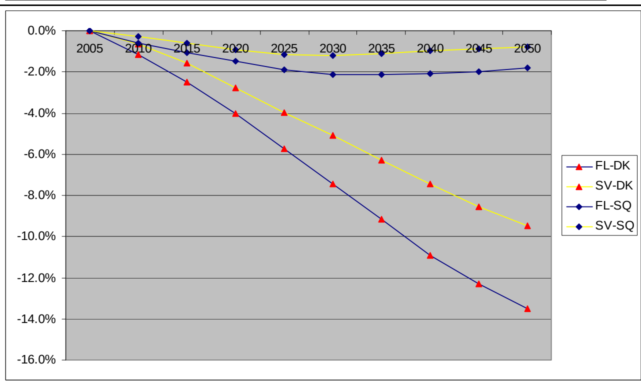
versus EXOGENOUS</td>
<td>
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8. Conclusions

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 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 generated by the school system, actuarially unfair pension systems, inflexible working hours, and unavailable day care facilities. Endogenous hours react, e.g., to social security taxes and contributions, but also to the exogenous changes of the number of working persons.

Our paper shows that direct quantity and indirect behavioral effects are large. They both significantly affect economic growth and living standards. Due to the 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 such policies in isolation. We show that they could easily offset the effects of population aging on economic growth and living standards. On balance, however, behavioral effects dampen 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 aging.

The key of our approach – 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. From an empirical point of view, this approach puts a lot of pressure 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 that is based on an *ad hoc* choice of parameters 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 decision (e.g., along the lines of the extensive search and matching literature reviewed in Ljungqvist and Sargent, Ch. 5, 2000). We speculate that removing these frictions would lead to stronger total labor supply reactions than in our model. Such extensions of our model are subject of future research.

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