

This PDF is a selection from a published volume from the National Bureau of Economic Research

Volume Title: Demography and the Economy

Volume Author/Editor: John B. Shoven, editor

Volume Publisher: University of Chicago Press

Volume ISBN: 0-226-75472-3

ISBN13: 978-0-226-75472-7

Volume URL: <http://www.nber.org/books/shov08-1>

Conference Date: April 11-12, 2008

Publication Date: November 2010

Chapter Title: Old Europe Ages: Reforms and Reform Backlashes

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Chapter URL: <http://www.nber.org/chapters/c8412>

Chapter pages in book: (169 - 204)

Old Europe Ages

Reforms and Reform Backlashes

Axel Börsch-Supan and Alexander Ludwig

5.1 Introduction

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, in turn, are aging faster than France and Great Britain. Italy and Germany are projected to shrink in population size; even more dramatic is the shrinkage of the labor force between 2010 and 2035 when the German and Italian baby boom generations will retire. To the extent that labor force shrinkage precedes population shrinkage, these countries will face steeply falling support ratios (workers per consumers). One likely 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 chapter has two broad aims. First, it shows that pension and labor market reforms have the potential to mitigate much of the negative implications of population aging. Hence, there is a good reason to bear the short-run costs of reforms in exchange for the long-run benefits. Second, the chapter models potential backlashes to reform in order to provide a more realistic

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This chapter was prepared for the NBER Conference on Demography and the Economy, Yountville, California, 11–12 April 2008. We thank Alan Auerbach, Francesco Billari, John Pencavel, Sam Preston, Warren Sanderson, Syl Schieber, John Shoven, Guido Tabellini, and Michele Tertilt for helpful comments on an earlier version. Financial support was provided by the Deutsche Forschungsgemeinschaft, the Land Baden Württemberg, and the German Association of Insurers. The usual disclaimer applies.

assessment of what might be the outcome of the politically complicated reform process in Europe.

The chapter is part of a research agenda that analyzes the aging process and its macroeconomic implications in continental Europe, focusing on its three largest countries—France, Germany, and Italy, the core of Old Europe. 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 manage to push such reforms through parliament, workers may thus react adversely and undo at least some of the expected effects of the reforms. Thus the main questions posed in this chapter are: What can pension and labor market reforms ideally achieve? What are possible behavioral reactions to reform policies? Which direction will they take and how large are they? And, ultimately, can Old Europe maintain its high living standards even if behavioral reactions offset some of the 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; for example, 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 (e.g., Finland and 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—for example, through public provision of day care facilities—may precipitate a decrease in male labor supply. This within-household substitution would be perfectly rational if households desire joint leisure and joint household production.

Little is known about these behavioral reactions. Therefore, one of the key issues taken up in this chapter is to model and calibrate behavioral reactions to reform. Which behavioral reactions will strengthen, and which will weaken reform policies? What are their quantitative effects?

We will build a simple model of reforms and reform backlashes into an overlapping generations (OLG) model of the Auerbach, Kotlikoff, and Skin-

ner (1983)/Auerbach and Kotlikoff (1987) type, extended to a multicountry version (Börsch-Supan, Ludwig, and Winter 2006).¹ As a particular feature of our model, we add to the model the distinction between exogenous labor supply components (as key results of labor market and pension reform) and endogenous labor supply components (in order to represent possible reform backlash). To keep the language simple, we call the exogenous labor supply component “labor force participation,” and the endogenous labor supply component “working hours.” This language is metaphorical as we are well aware that both labor force participation and working hours have endogenous as well as exogenous components.

The metaphorical language chosen comes from our thinking of labor market and pension reforms as lifting institutional constraints. Typical constraints are a minimum labor market entry age generated by the school system, constraining the labor force participation of the young; an early labor market exit age generated by the pension system, effectively constraining the labor force participation of the old; and inflexible working hours and unavailable day care facilities, constraining female labor force participation. This view of lifting restrictions motivates our modeling strategy and the language behind it: labor market and pension reforms are represented by exogenous changes of labor supply at the extensive margin (the number of working persons in an economy).

Households then are modeled to respond to the changes of labor supply by changing their working hours (the intensive margin of labor supply). Endogenous hours supply may increase, for example, if distorting social security taxes and contributions decline as an implication of pension reform. The opposite reaction is also possible: endogenous hours supply may decrease in response to an exogenous change of the number of working persons if there is intrahousehold substitution between the number of persons working and the hours worked by each person.

Another important feature of our model is its multicountry 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. These provide a second source of opportunities during the global aging process: not all income needs to come from domestic production, and the gross national product (GNP) may become substantially larger than the gross domestic product (GDP) if foreign direct investments create large returns. We compliment France, Germany, and Italy as countries that save more than they invest, with the United States representing the rest of the world currently absorbing the continental European savings.

1. Similar multicountry OLG models have been developed, among others, by Feroli (2002); Henriksen (2002); Brooks (2003); Domeij and Floden (2006); Attanasio, Kitao, and Violante (2006, 2007); and Krüger and Ludwig (2007).

While this feature is important for a credible quantification of our pension and labor market reform analysis, it is not the main focus of this chapter. We refer to a sister paper, Börsch-Supan, Ludwig, and Winter (2006), which analyzes the resulting international capital flows and the associated rate of return developments, including the “asset meltdown hypothesis.”

The key results of our chapter rest on a set of three-way comparisons that are best imagined by a two-by-two-by-two table. The first dimension reflects labor market policies. One extreme is the complete failure to adapt those institutional restrictions that keep labor force participation so low in France, Germany, and Italy. The result is 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.

As a second dimension, we model 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.

Finally, the third dimension in these comparisons isolates behavioral effects. One extreme is a fixed hours supply by each working individual. As in the polar case, we derive a supply function of working hours that is responsive to wages net of taxes and contributions, but also to household labor participation.

Our chapter 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 chapter is structured as follows. Section 5.2 briefly sets the demographic background. Section 5.3 describes the current labor market situation and our labor market reform scenarios. Section 5.4 presents the multicountry computational general equilibrium model with a combination of exogenous and endogenous labor supply components. Section 5.5 delivers our main results in the two-by-two-by-two table set up. We vary the institutional framework of labor markets and pensions in order to investigate the interactions between pension and employment policies and the behavioral reactions to pension and labor market reform. Since higher old-age labor

force participation raises issues of age-specific productivity, they are briefly addressed in section 5.6. Section 5.7 concludes.

5.2 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 European Union (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 5.1.

The differences are startling. While the U.S. population pyramid in 2050 features the normal large base, Germany and Italy have strongly inverted population pyramids. The French pyramids change little between 2000 and 2050, with relatively small differences in cohort sizes up to age seventy. These differences can largely be attributed to different fertility rates (France and the United States have fertility rates close to the replacement level; see table 5.1), while Germany and Italy lose about a third of their population from generation to generation due to fertility rates that are below 1.4.

Life expectancy also differs remarkably among the four countries. This is 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 United States. Note that in Europe healthy life expectancy is about ten years higher than the average retirement age, providing some room for an increase in retirement age; see section 5.3.

We compute the future demography of the four countries based on three key assumptions. First, we provide projections of mortality based on a Lee-Carter decomposition, using past mortality rate changes derived from the Human Mortality Database (2008). Table 5.1 shows the resulting life expectancies in 2050 (column [5]). They coincide with the current United Nations (UN) projections for Germany and the United States, but are slightly higher for France and Italy (the UN has age eighty-five compared while our projections yield ages eighty-six and eighty-seven, respectively).

Second, we assume that fertility rates are exogenous and remain constant as given by table 5.1. Third and similarly, we assume constant and exogenous migration flows, based on the current medium variant of the UN projections (the net migrants per year are France, 100,000; Germany, 150,000; Italy, 135,000; and the United States, 1,100,000), which is about the long-term average. It is important to note that these migration flows are small relative to the decline in the labor force projected in section 5.3.

Figure 5.2 shows the total population aged fifteen years and over, which will be the base of our projections and simulations. It reflects the stark

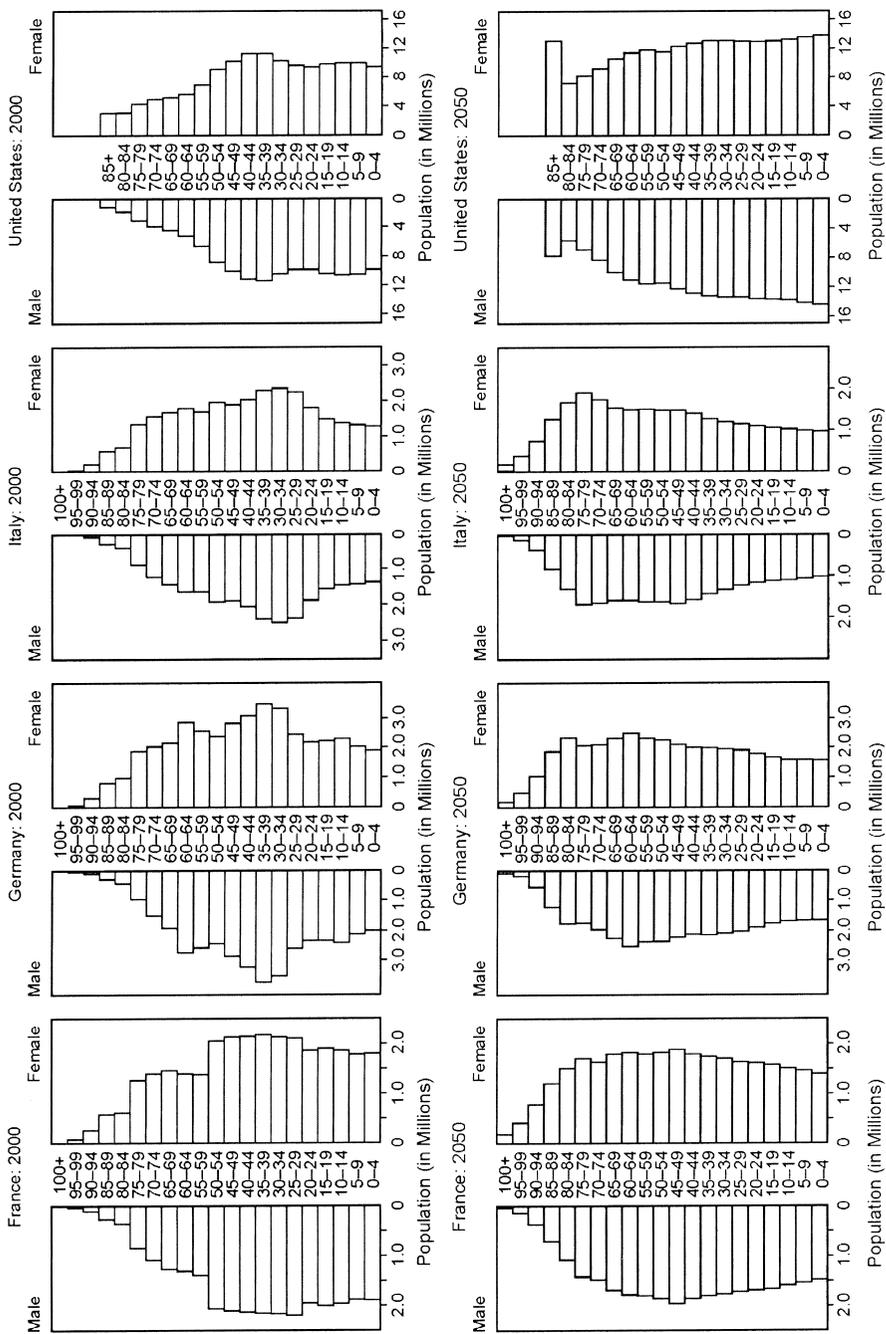


Fig. 5.1 Population aging in France, Germany, Italy, and the U.S., 2000 and 2050
 Source: U.S. Bureau of the Census, International Database, <http://www.census.gov/ipc/www/idb/pyramids.html>.

Table 5.1 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

Sources: European Commission and U.S. Census (2008); OECD Health Data 2007; WHO (2007); and own computations.

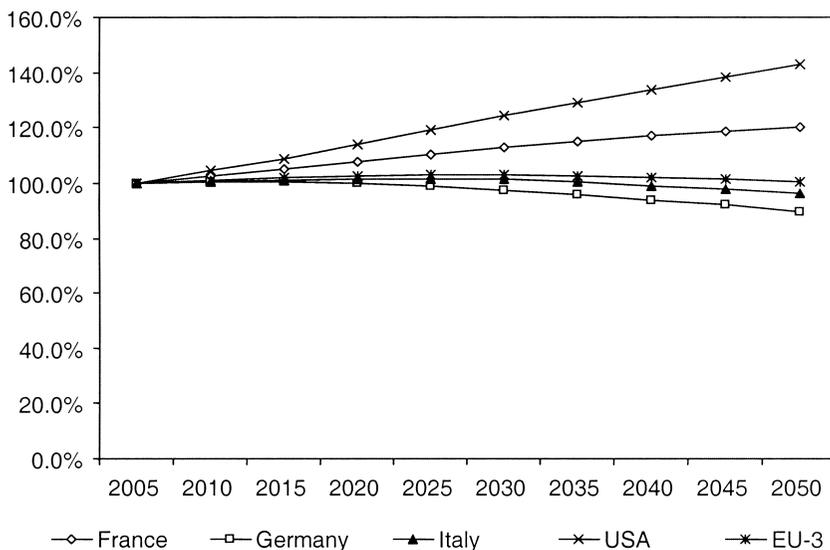


Fig. 5.2 Population fifteen years and older, indexed to 2005 = 100 percent

Source: Own projection based on assumptions detailed in text.

differences among the population pyramids that we have seen in figure 5.1. There will be population growth in France and the United States, but significant decline in Germany and a somewhat smaller decline in Italy after 2020, mainly due to the higher expected migration to Italy. The fifth line represents the aggregate of France, Germany, and Italy, which we will call EU-3 in order to represent the three largest continental European countries.

Truly remarkable is the decline of the working age population (aged twenty to sixty-four; see figure 5.3). Relative to total population aged fifteen and older, the United States will lose about 10 percent of their working age individuals between 2005 and 2050. In Italy, the loss is more than twice as high with 22 percent. France is closer to the United States and Germany closer to Italy, reflecting the fertility rates in table 5.1.

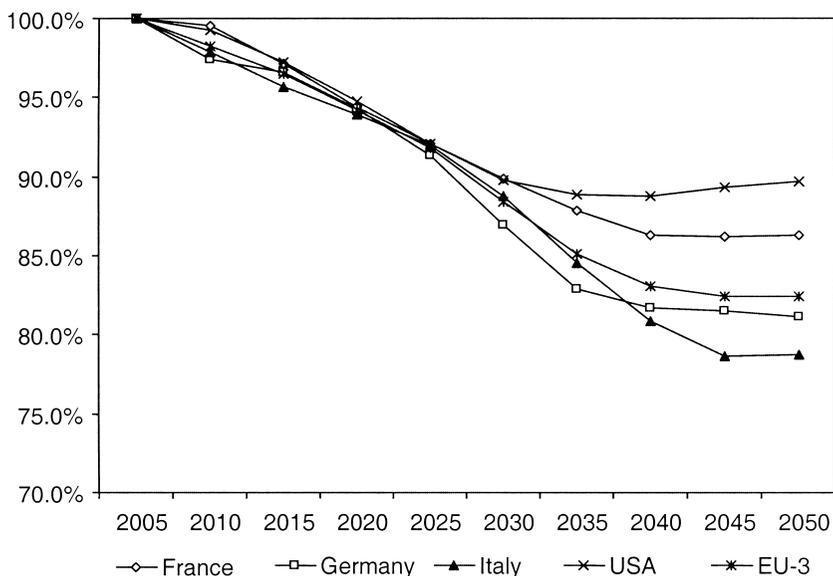


Fig. 5.3 Working age population as share of total population aged fifteen and over, 2005 = 100 percent

Source: Own projection based on assumptions detailed in text. Working age is age 20 to 64.

5.3 Employment and Labor Market Reforms

Working age population is not equal to employment. The demographic differences, in particular those between Italy and the United States, are dramatically amplified by the differences in labor force participation. Figure 5.4 shows the percentage of individuals employed in the population aged fifteen and older. This is a variant of the “support ratio” reflecting the number of workers per adult consumer. The United States’ support rates are much higher than the European ones. In Europe, Italy stands out with the lowest support ratio. Unlike 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 5.4 is based on the assumption of constant age- and gender-specific labor force participation rates. Given this assumption, Germany has about the same low support ratio in 2005 that the United States will have after 2040. In this sense, Germany is one generation ahead of the United States when it concerns the macroeconomic balance between individuals in production and individuals who consume.

Figure 5.4 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 United States (24.3 percent versus 15.0 per-

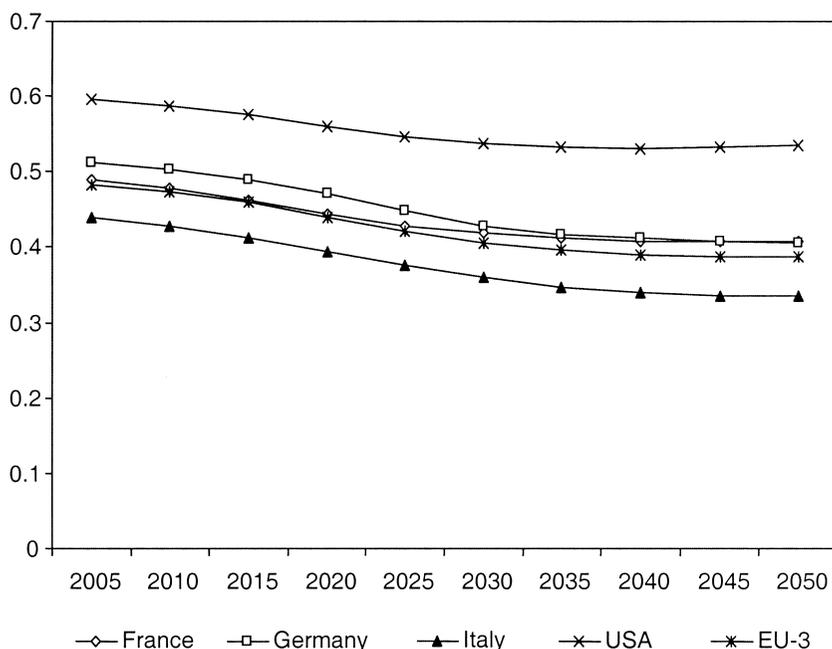


Fig. 5.4 Employed persons as share of total population aged fifteen and over, not indexed

Source: Own projection based on 2005 labor force participation rates.

cent between 2005 and 2050), aggravating the current differences of the support ratios among the four countries.

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

It is unlikely that these exogenous components remain unchanged over

the course of population aging and the general change of society over the next two decades. We therefore define two polar scenarios representing the potential changes in the institutional framework restricting households' labor supply decisions:

- In the status quo scenario (STATQUO), age- and gender-specific labor force participation rates will remain as they are at baseline in 2005; this was the scenario underlying figure 5.4.
- The labor market reform scenario (LREFORM) includes four reform steps:
 - RETAGE: an increase in the retirement age by two years.
 - JOBENTRY: a decrease in the job entry age by two years.
 - FEMLFP: an adaptation of female labor force participation rates to those of men.
 - UNEMP: a reduction of unemployment to 40 percent of its current level.

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

These reform steps will be phased in linearly between 2010 and 2050. 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 5.5).

Overall, these reform steps do not appear to be overly radical; in fact, their combination would lead in 2040 to labor force participation rates fairly similar to those in Denmark today. Nevertheless, attempts to actually execute reforms with those goals have faced stiff opposition in France and Italy, and more recently, and to a somewhat lesser extent, also in Germany.

Figure 5.6 displays the resulting trajectories of the number of working individuals. Each reform step is additive to the one before; hence, the trajectory labeled UNEMP corresponds to the LREFORM scenario of all four reform elements implemented.

The trajectories are very different across countries. France can easily compensate the slightly declining number of individuals of working age by a combination of two or three of the aforementioned policy changes, while Germany has no chance to offset the loss in working age population even with a combination of all four measures.

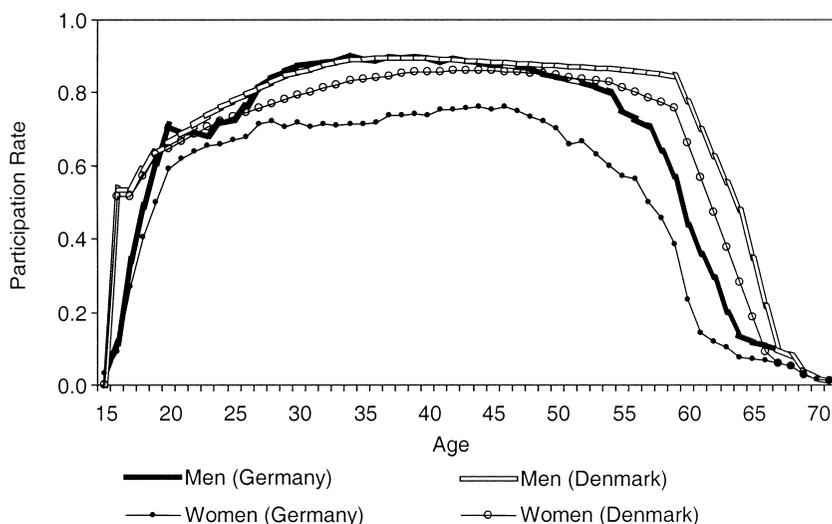


Fig. 5.5 German and Danish labor force participation rates

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

The three countries also differ in the efficacy of the four policy parameters. Note in particular Italy, with a large jump if female labor force participation adapts to that of men. This is due to the very low female labor force participation currently in Italy. The irony is, of course, that because Italy's pool of hitherto unused labor capacity (in particular women) is so large, tapping it provides a very large opportunity to counteract the effects of population aging. Italy, while aging more than Germany, is thus much better off than Germany, which has less room to increase labor force participation.

Lower labor input as indicated in these figures will most likely slow down Germany's, and possibly also Italy's, GDP growth.² However, since total population will also decline, this does not necessarily imply that standards of living will fall. Figure 5.7 therefore divides the number of working persons by the population aged fifteen 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. This is a very important message: lifting labor market constraints and tapping into the pool of currently unused labor can offset the force of aging in the three countries of Old Europe.

2. Given the large share of labor in output and the history of total factor productivity, it is unlikely that productivity growth and capital accumulation can overcompensate the decline in labor force.

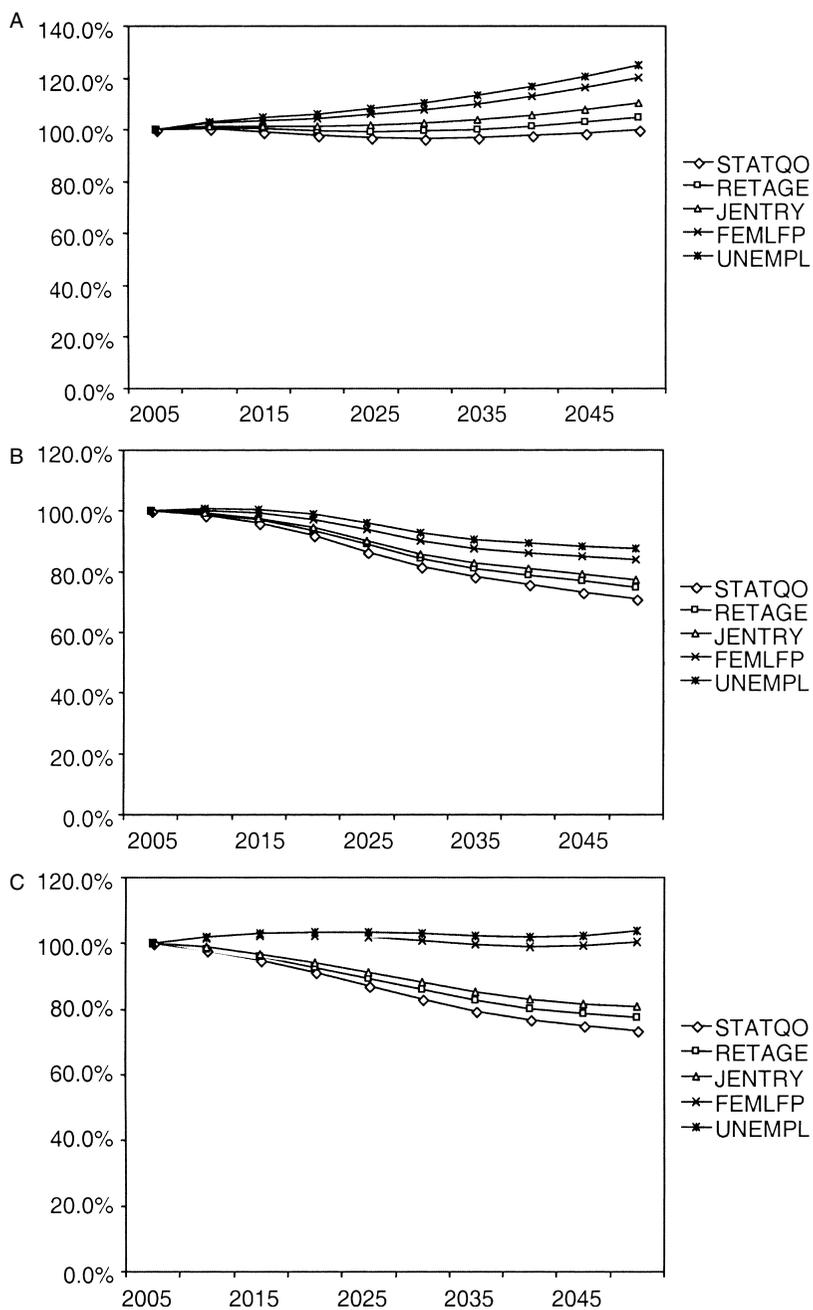


Fig. 5.6 Employment, indexed to 2005 = 100 percent: *A*, France; *B*, Germany; *C*, Italy

Source: Own calculations.

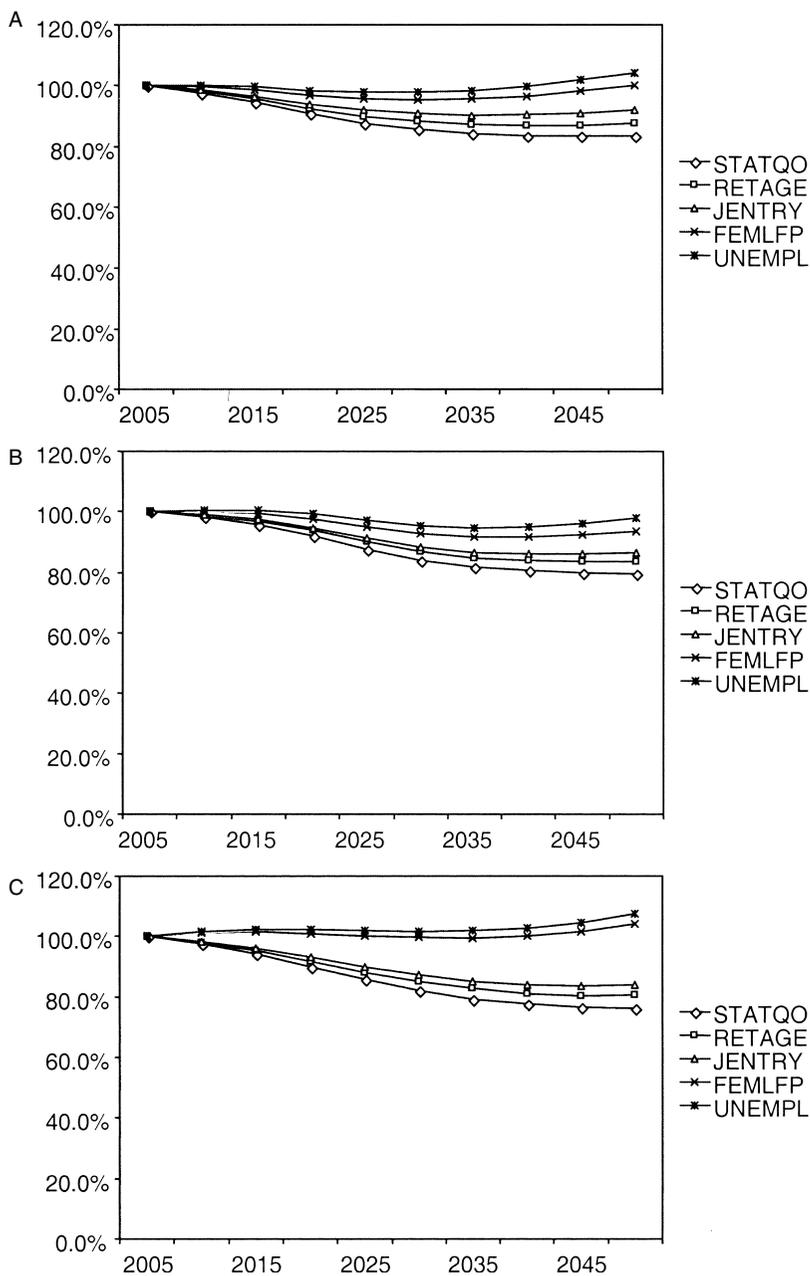


Fig. 5.7 Support ratio, indexed to 2005 = 100 percent: A, France; B, Germany; C, Italy

Note: Employment as share of population age fifteen and over, own calculations.

5.4 A Dynamic Open-economy Macroeconomic Model with Exogenous Labor Force Participation and Endogenous Hours Supply

We now construct a dynamic open-economy macroeconomic model that allows us to analyze the effects of the labor market reforms described in the previous section on the GDP and consumption per capita in an aging Europe. As described in the introduction, labor supply has an endogenous and an exogenous component. While we treat the reforms and the resulting variation in employment numbers as exogenous, households in our model endogenously adjust hours worked and may thus counteract parts of the labor market reforms.

Our main assumptions on this interplay between the exogenous variation of employment numbers and hours worked are as follows: We model the decision of a household with preferences over consumption and leisure. Total labor supply of a household of age j as derived from the household's optimization is the product of exogenous employment numbers l_j and the endogenous decision on hours worked at age j , h_j . The crucial difference between the two labor supply components is that hours worked may not exceed the time endowment (which we normalize to one), while employment numbers l_j can take any positive value.

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

5.4.1 Demography

Time in our model is discrete and extends from $t = 0, \dots, T$. Each model period t reflects a time interval of five years. Our demographic projections, however, are more detailed with an annual periodicity. These detailed demographic projections form the background of our analysis. 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 fifteen, which we denote by $j = 0$. The maximum age is one hundred years. Accordingly, the maximum economic age, denoted by J , is eighty-five. 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

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

where $\zeta_{t,j,i}$ denotes the age-specific conditional survival rate, and $f_{t,j,i}$ the age-specific fertility rate. The resulting total fertility rates and life expectancies have been summarized in table 5.1.

5.4.2 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.

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

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

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

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

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

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.³ 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 (PAYG) financed public pension system, and $p_{t,j,i}$ is pension income; see following.

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

5.4.4 Pensions and Pension Reform

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

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

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.

The main policy parameter is the net replacement rate ρ ; the contribution rate τ responds passively to balance the pension system's budget. If ρ is large, public pensions crowd out private saving through the households consumption/saving decision given by equations (5) and (6). Moreover, since the benefits are not related to individual earnings, we consider the contributions to the pension system as pure taxes, with the associated labor supply distortions that work through the households labor supply decision given by equations (5), (6), and (7).

3. 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.

If $\rho = 0$, all old-age provision will be private savings. This represents the textbook life cycle model in which intertemporal consumption smoothing over the life cycle provides the retirement income through saving in young age and dissaving after retirement.

Pension reform is modeled as a reduction of the net replacement rate ρ . We will consider two polar cases:

- FLATSS: maintaining the current country-specific replacement rates also in the future ($\rho_{t,i} = \rho_{2005,i}$ for $t > 2005$).
- SAVING: abolishing the public pension system altogether ($\rho_{t,i} = 0$) so that all age provision is private savings.

5.4.5 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, $\{w_{t,i}, \tau_{t,j}\}$; in each country i ; and a common world interest rate, $\{r_t\}$, such that:

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

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

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

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

5.4.6 Numerical Implementation

Our timeline 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 a calibration period in order to determine the structural parameters of the model. Our projections run from 2005 through 2100.⁴ The phase-out period after 2100 has two parts: a transition to a steady-state

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

population in 2200, and an additional one-hundred-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 (2004). 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.

5.4.7 Calibration

The current version of the chapter features a calibration that is based on an ad hoc choice of parameters by reference to other studies. In future versions of the chapter 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 5.2. These parameter values refer to an annual periodicity of the model.

5.5 Results

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

- Labor market reforms: no reform at all, resulting in future labor force participation rates that equal the current ones (STATQUO, abbreviated SQ) versus the implementation of all four reform steps described in section 5.3 (LREFORM, abbreviated RF).
- Pension reform: a prototypical pension system of continental Europe, purely pay-as-you-go, providing flat social security benefits financed by distorting contributions (FLATSS, abbreviated) versus a fully

Table 5.2 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_j : technology level	0.05–0.07
β : discount factor	0.99
θ : coefficient of relative risk aversion	2
φ : consumption share parameter	0.66

funded, voluntary private accounts system that generates no distortions (SAVING, abbreviated SV), as described in subsection 5.4.5.

- Labor supply reaction: fixed hours supply (EXOGENOUS, abbreviated EX) versus endogenous supply of working hours (ENDOGENOUS, abbreviated EN), as described in the households optimization problem, subsection 5.4.3, equations (5) to (7).

This set up yields a two-by-two-by-two table of underlying assumptions displayed in table 5.3. The eight resulting combinations are labeled: for example, by “FL-SQ-EX” to denote a flat benefit pay-as-you-go social security system (FL) with status quo labor force participation (SQ) and an exogenously given hours supply (EX); by “SV-RF-EN” to denote a fully funded private savings based old-age provision system (SV) with a comprehensive labor market reform (RF) and an hours supply that reacts endogenously to aging and policy changes (EN), and so forth.

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 described in section 5.3.
- A fundamental change in the type of pension system.

We begin with figures that display the evolution of employment, 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.

Table 5.3 Setup of scenarios

	Extensive margin: Labor market regime			
	Constant age- and gender-specific labor force participation (STATQUO, abbreviated SQ)		Increasing age- and gender-specific labor force participation (LREFORM, abbreviated LF)	
	Intensive margin: Hours' supply			
	EXOGENOUS hours supply (abbrev. EX)	ENDOGENOUS hours supply (abbrev. EN)	EXOGENOUS hours supply (abbrev. EX)	ENDOGENOUS hours supply (abbrev. EN)
Pension system				
Pay-as-you-go with flat benefits (FLATSS, abbrev. FL)	FL-SQ-EX	FL-SQ-EN	FL-RF-EX	FL-RF-EN
Fully funded voluntary accounts (SAVING, abbrev. SV)	SV-SQ-EX	SV-SQ-EN	SV-RF-EX	SV-RF-EN

All figures refer to the aggregate of France, Germany, and Italy (EU-3). The United States is modeled in the background with similar changes in retirement age and female labor force participation, but no other exogenous policy changes.

All figures have the same design (cf. table 5.3). 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.

5.5.1 Extensive Margin: Employment

Figure 5.8 corresponds to figure 5.6 in section 5.3 and depicts the evolution of labor supply at the extensive margin; that is, the exogenously given number of persons who participate in the labor market: $L_{t,i} = \sum_{j=0}^J l_{t,j,i} N_{t,j,i}$.

The STATQUO scenario is marked by diamonds. It shows a steady decline of the number of employed persons. The decline is about 20 percent between 2005 and 2050.

This is very different from the LREFORM scenario (marked by triangles). The increase in labor force participation due to all four reform steps—earlier entry in, and later exit from, the labor market, more women working and less unemployed—more or less stabilizes employment in the EU-3 area. Labor supply declines only slightly after 2015 but increases again after 2035, the peak of the aging process in continental Europe. Except for the time between 2015 and 2035, when the losses in employment created by the retirement of the baby boom generation are very large, the effects of labor market reforms and migration just compensate the aging effects.

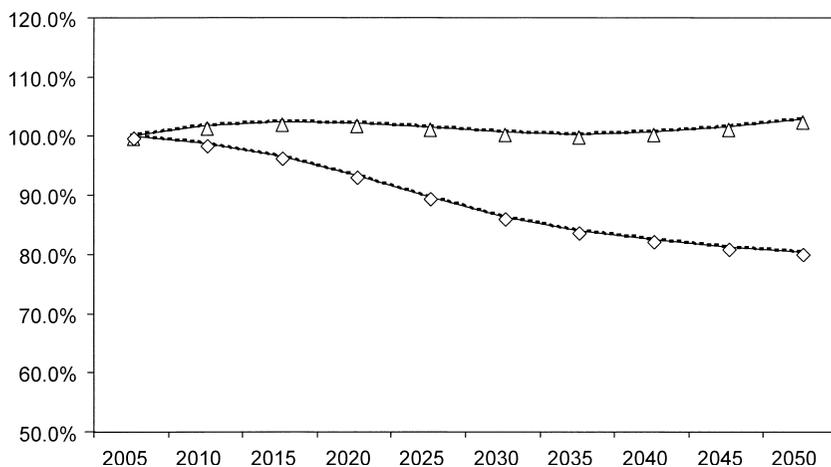


Fig. 5.8 Employment, indexed to 2005 = 100 percent, EU-3

5.5.2 Intensive Margin: The Supply of Hours for Given Labor Force Participation

The supply of working hours now reacts to the exogenous change in labor force participation according to the household's maximization problem as specified in subsection 5.4.3. We distinguish two cases: households that are constrained by the time endowment limit (equation [7] in section 5.4.3), and households that are not constrained.

Given the calibration parameters, about 58 percent of households are not constrained in 2005, mainly middle-aged households. The difference between France and Germany on one side, and Italy on the other side, is large: in France, 67 percent of all households are unconstrained, in Germany 63 percent, while only 43 percent of Italian households can work as much as they would like. These households fully undo exogenous policy changes by adjusting their working hours inversely, since for them hours h and persons l are perfect substitutes (equations [5] and [6] in section 5.4.3). One might think of these households as a couple. In the status quo regime, one person was restricted to work while the other person worked as much as the household needed for consumption and saving. Once the restriction for the first person was lifted, however, the couple distributes the work more equally between the two persons without increasing total hours supplied by the household.

Figure 5.9 shows this from a microeconomic perspective; that is, on the level of an individual representative household of each age class, separately for each country. For unconstrained households (hours less than one), the hours (marked by squares) respond inversely to the changes in participation (diamonds) when moving from the status quo (left panels) to the LREFORM regime (right panels).

The remaining 42 percent of households have been constrained under the labor market policy regimes in 2005. This is the majority in Italy, where 57 percent of all households are constrained, and roughly a third in France (33 percent) and Germany (37 percent). These households are shown in figure 5.9 as those households that have an hours supply of exactly one: the very young and the old. Releasing these constraints generates more hours supply when the policies are phased in over time. This is visible in the lower number of households on the hours = 1 line in the LREFORM scenarios (right panels) than under STATQUO labor force participation (left panels).

Taking both participation and hours together yields total labor supply of the household (marked by triangles in figure 5.9). It is much higher for the younger and older age groups in the LREFORM scenario as compared to the STATQUO scenario, but remains unchanged for the unconstrained middle-aged households, which perfectly substitute between participation and hours supply.

Figure 5.10 turns to the macroeconomic view. It shows the aggregate

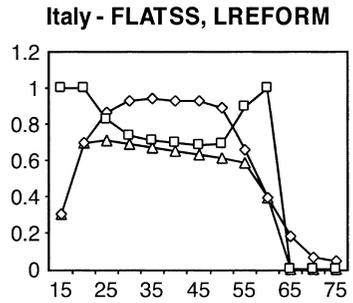
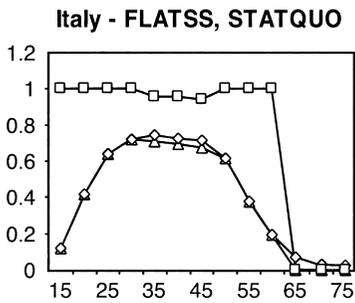
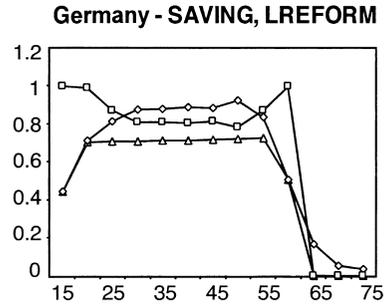
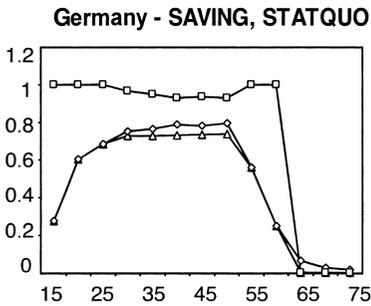
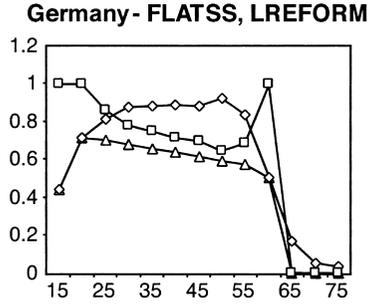
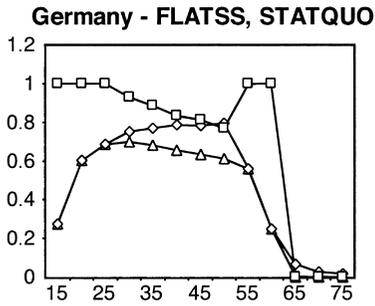
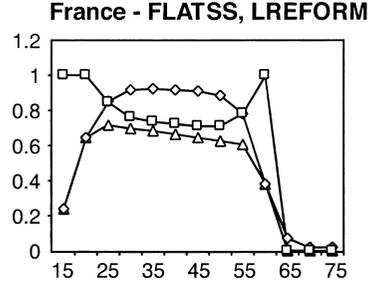
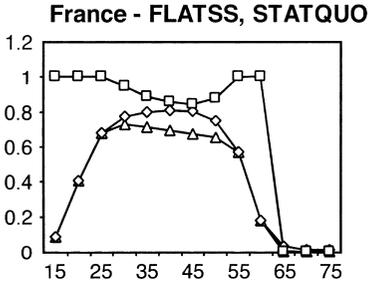
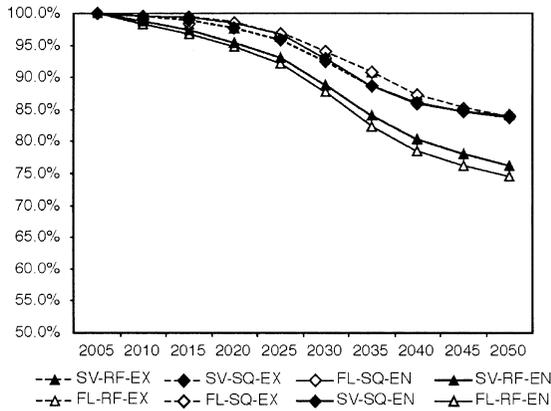
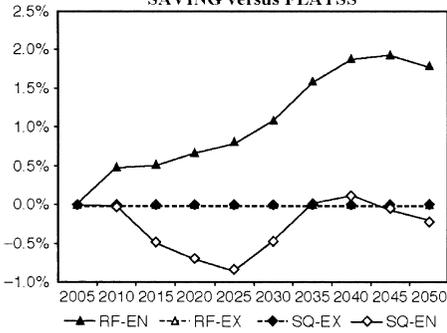


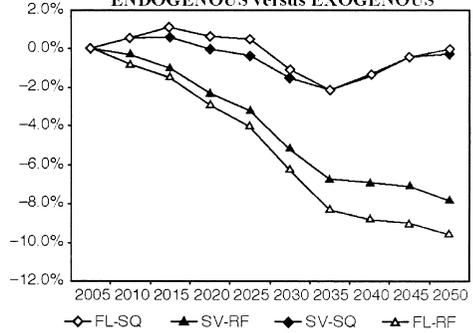
Fig. 5.9 Household labor force participation, hours supply and total labor supply



**Interaction effects with social security systems:
SAVING versus FLATSS**



**Interaction effects with type of hours' supply:
ENDOGENOUS versus EXOGENOUS**



**Interaction effects with labor market scenarios:
LREFORM versus STATQUO**

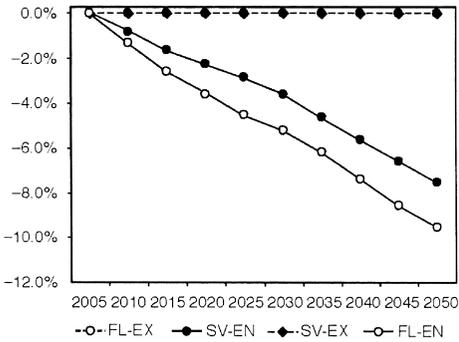


Fig. 5.10 Hours for fixed labor force participation, indexed to 2005 = 100 percent, EU-3

supply of working hours: $H_{t,i} = \sum_{j=0}^J h_{t,j,i} N_{t,j,i}$ for a labor force participation of one in all working-age households (aged twenty to sixty-four). Hours are normalized to 100 percent in 2005 within each scenario. Hence, they are adjusted for any level effects generated by pension and labor market policies that create cross-country differences already in 2005.

Figure 5.10 shows the hours result for the eight scenarios defined in table 5.3. Population aging generates declining hours in all scenarios. There is, of course, no difference among the four scenarios with exogenous hours supply as this is fixed to one. It can be interpreted as the baseline that reflects the decline in working-age population without any reaction in supplied working hours.

The reaction of the endogenous hours supply differs by labor market and pension scenario. Hours are much lower in the LREFORM scenarios (triangles) than under constant labor force participation rates (STATQUO, diamonds).

There are interesting interaction effects between labor market and pension reform. Without labor market reform, hours supply is almost identical in the FLATSS and SAVING pension scenarios; actually, hours supplied are a bit lower in the pension reform scenario. This relation reverts when the labor reforms are put in place. If labor market and pension reform concur, hours supply is higher than in the case when labor markets are reformed without a pension reform.

A microeconomic perspective of this interaction effect is given in figure 5.9 for the case of Germany. A comparison between the second and the third 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 LREFORM 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.

Another way to understand the interaction effects is first taking differences in the direction of each dimension of the two-by-two-by-two table 5.3. This is done in the three smaller panels of figure 5.10 labeled “interaction effects.” The first panel shows the impact of a radical social security reform. Hours increase under a funded system vis-à-vis the pay-as-you-go system if exogenous labor force participation also increases. The difference is zero if hours are exogenous, and very small, but negative if labor force participation remains at status quo.

The second panel displays the difference between higher and unchanged exogenous labor force participation. Hours react negatively because of intrahousehold 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 the following subsection. 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 lines denoted by SV 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 chapter.

5.5.3 Putting All Together: Total Effective Labor Supply

Total labor effective supply is the product of working persons (figure 5.8) and hours per person (figure 5.10), adjusted for age-specific productivity:

$$L_{t,i} = \sum_{j=0}^J \varepsilon_j l_{t,j,i} h_{t,j,i} N_{t,j,i}^5$$

Its evolution under the eight scenarios is displayed in figure 5.11. If hours are exogenous, there is no difference between figures 5.8 and 5.11, and there is no difference between the two pension scenarios. Hence, the lines for FL-RF-EX and SV-RF-EX at the very top overlap as well as the lines representing FL-SQ-EX and SV-SQ-EX at the very bottom. This is also visible in the first panel on interaction effects.

If hours are endogenous, the increase in the number of working persons in the LREFORM scenario is only partially reduced by the decline in hours supply that we have seen in figure 5.10. Figure 5.11 is the aggregate picture representing the total labor supply of the various age groups depicted in figure 5.9 (triangles).

The first panel on interaction effects shows again the 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 LREFORM scenario, while it declines if labor force participation remains unchanged.

5.5.4 Hourly Wage Rate

The hourly wage rate is depicted in figure 5.12. It more or less reflects the supply of total effective labor with some additional effects due to capital accumulation; see the following subsection.

The hourly wage increases more in the STATUSQUO (diamonds) than in the LREFORM (triangles) scenario, reflecting relative scarcity. It increases much stronger under a funded system (denoted by SV) than under pay-as-you-go (denoted by FL). The additional capital accumulation lowers inter-

5. See section 5.6. All graphs in section 5.4 are based on a flat age-productivity profile ($\varepsilon = 1$). Aggregate results are not sensitive to the age-productivity profile.

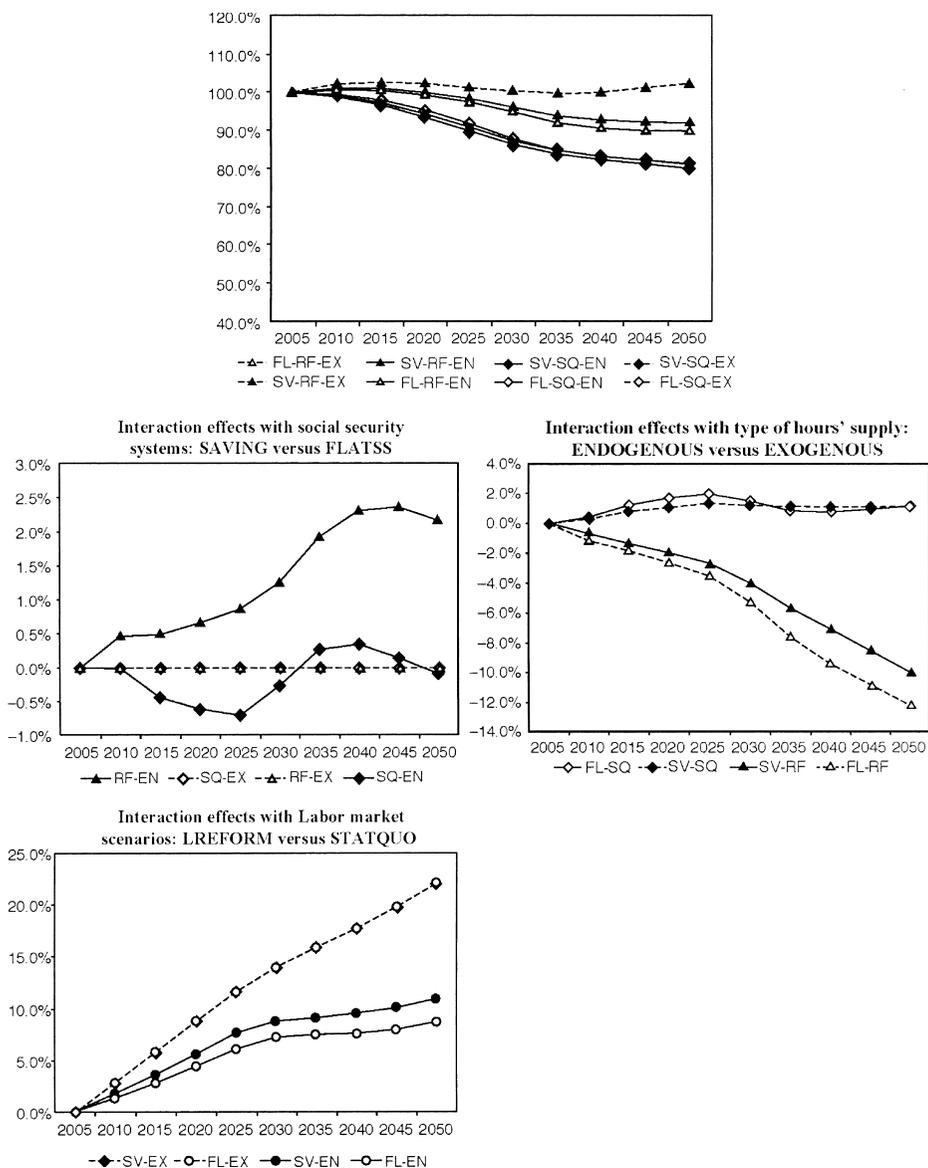


Fig. 5.11 Total labor supply, indexed to 2005 = 100 percent, EU-3

ests and raises labor productivity, thus also the wage rate. Finally, the wage rate increases 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 LREFORM scenario, when the hours' reaction is large.

Considering the massive decline in total labor supply, the hourly wage

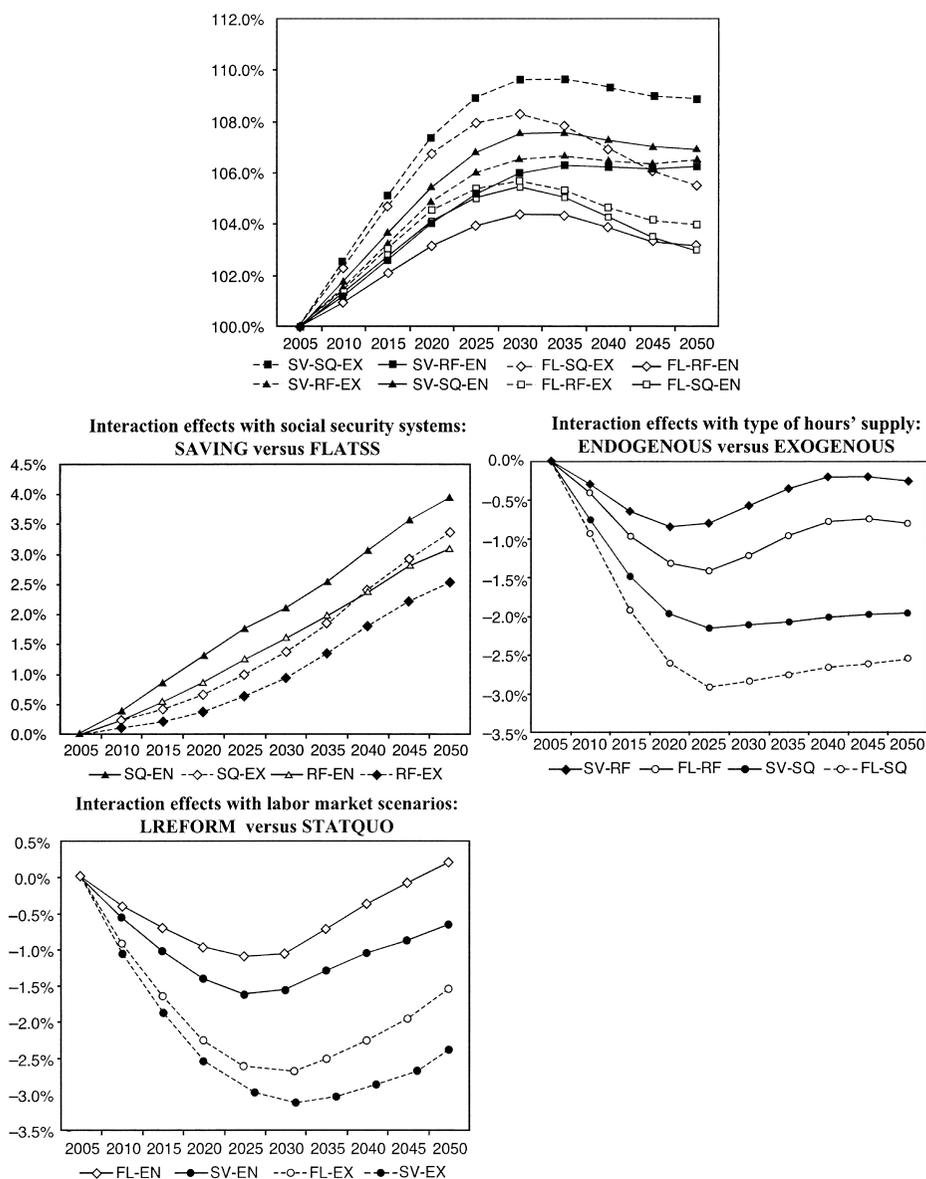


Fig. 5.12 Hourly wage rate, indexed to 2005 = 100 percent, EU-3

rate reacts somewhat dampened, with an elasticity of about 0.5 (compare figures 5.11 and 5.12).

5.5.5 Capital Accumulation

Figure 5.13 depicts the evolution of the combined domestic capital stock of France, Germany, and Italy. As expected, capital accumulation is much

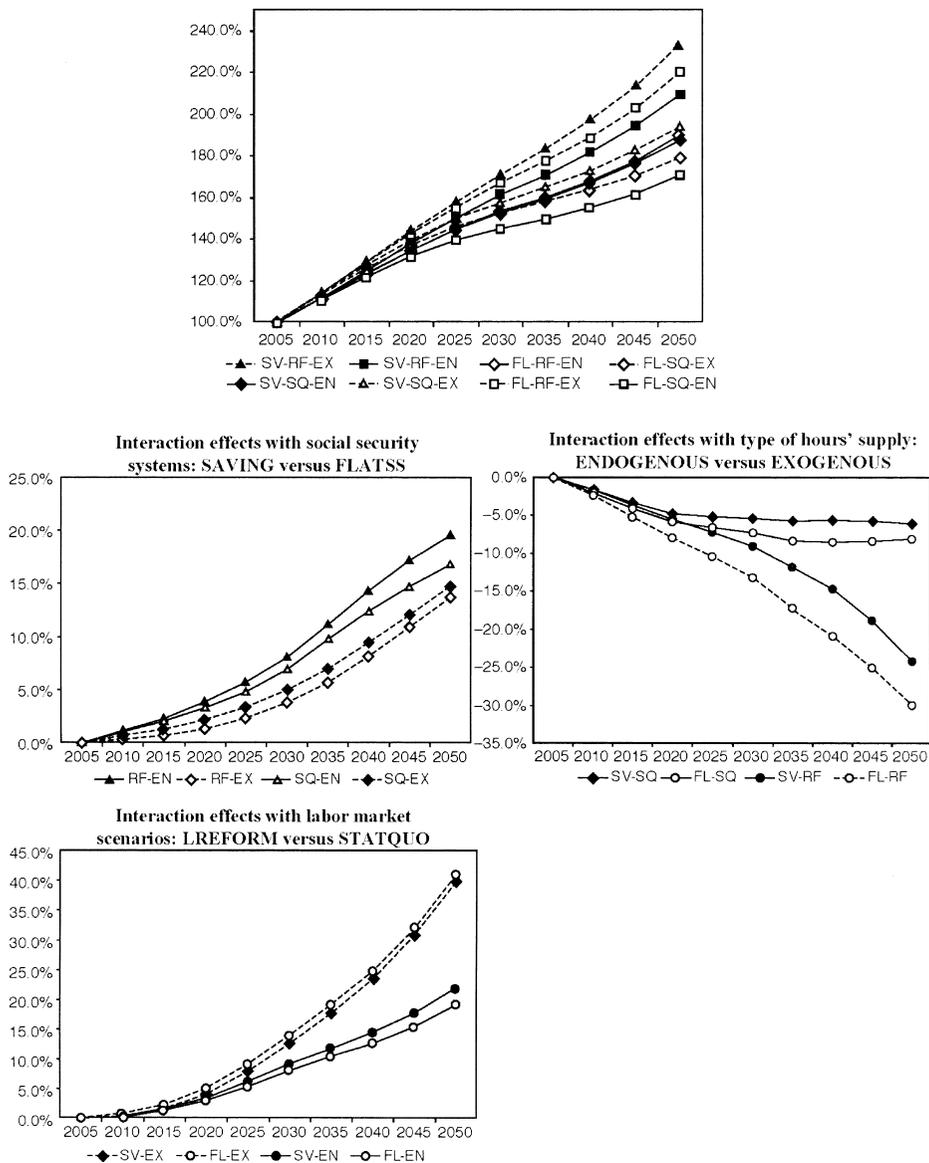


Fig. 5.13 Domestic capital stock, indexed to 2005 = 100 percent, EU-3

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 (LREFORM) as compared to constant participation (STATQUO). This is visible in the second panel on interaction effects. 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 5.13. Capital accumulation is highest under a fully funded system with high labor force participation and no dampening effect of endogenous hours (SV-RF-EX). It is lowest in a pay-as-you-go system with status quo labor force participation and the full force of negative incentive effects (FL-SQ-EN).

5.5.6 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 5.14. 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 total factor productivity [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 is about 20 percent in 2040, and 30 percent in 2050. This must be seen in comparison to total factor productivity growth, which is about 90 percent over the period from 2005 to 2050, almost doubling output.⁶ Remaining at status quo in terms of labor market and pension policy will “eat up” about a third of productivity growth. Reform backlash is about half of this: it reduces the effect of labor market reform on GDP per capita to about half the size with unchanged hours supply.

The eight output paths in figure 5.14 can be derived as a straightforward combination of labor and capital inputs displayed in figures 5.11 and 5.13. 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 (LREFORM) 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

6. The growth path with this productivity increase, without population aging and reform effects, is represented by the horizontal 100 percent line in figure 5.14.

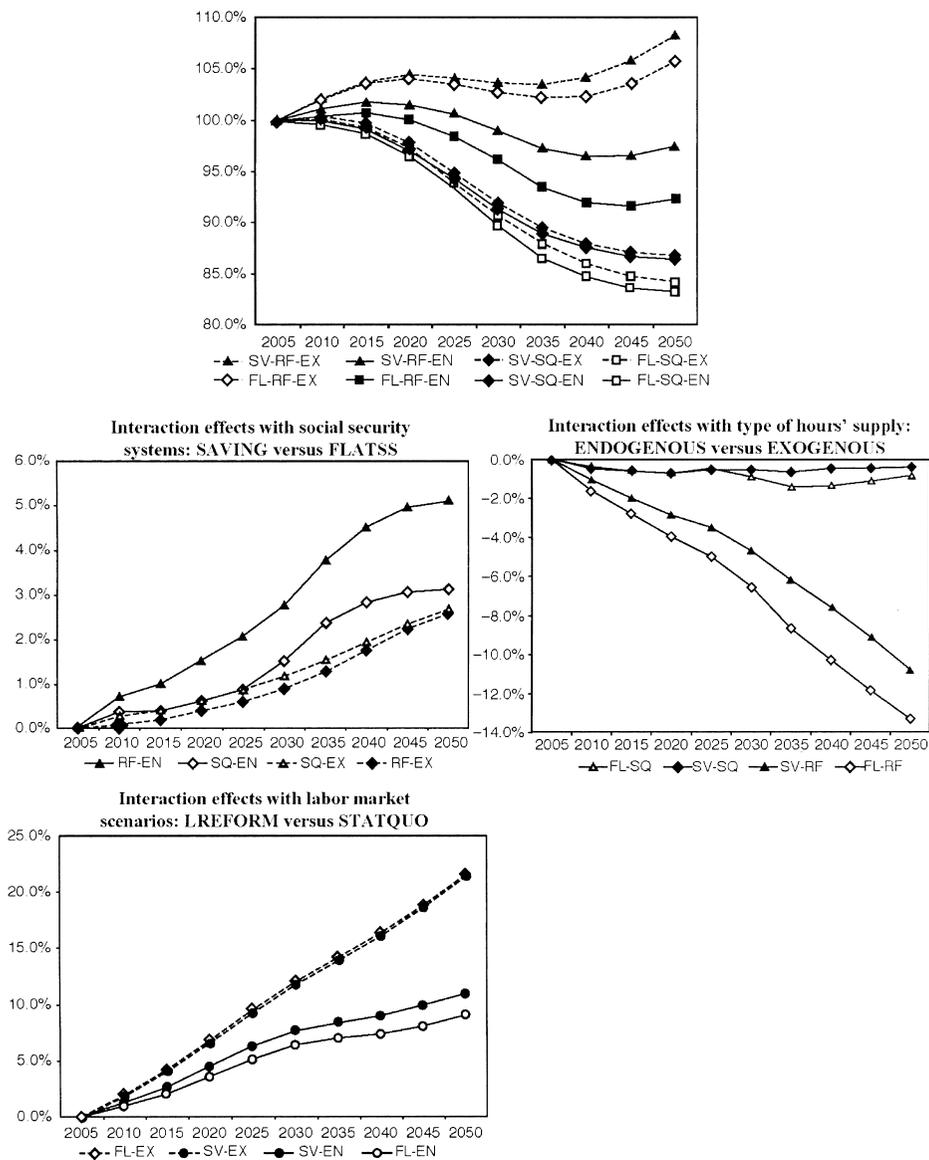


Fig. 5.14 GDP per capita, indexed to 2005 = 100 percent, EU-3

bottom of this graph (FL-RF and SV-RF). The effect, however, is smaller when the pension system is fully funded (SV-RF).

5.5.7 Consumption Per Capita

Finally, figure 5.15 displays our second target variable, living standards measured by consumption per capita. As we did for output, we normalize

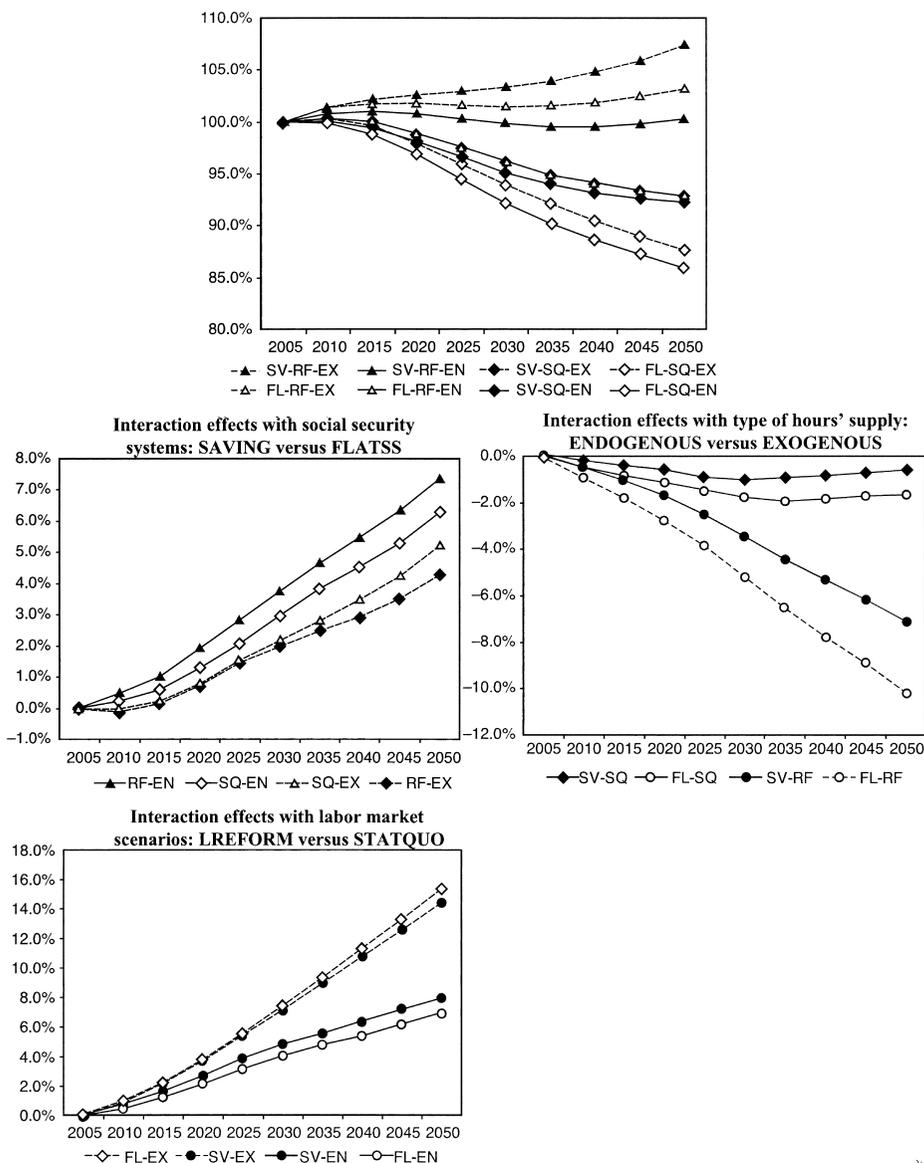


Fig. 5.15 Consumption per capita, indexed to 2005 = 100 percent, EU-3

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 5.14. A notable example is the evolution

of living standards in the fully funded pensions, high labor force participation, and endogenous hours supply scenario (SV-RF-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 5.3 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 stronger than aging. Living standards, however, will decline relative to all other countries that age less than continental Europe.

5.6 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 sixty, 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, McNaught, and Rizzi (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 an employer survey to address these issues because of justification bias. Kotlikoff and Wise (1989) evaluate confidential data originating from a major U.S. 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 that 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 (2008) use another approach. They used confidential data on error rates in a large assembly line-style car manufacturing factory. Output and

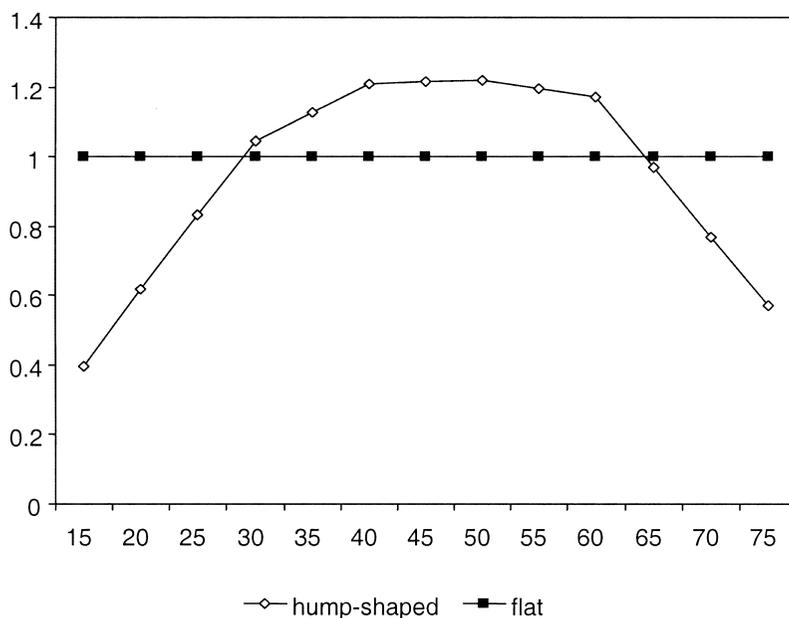


Fig. 5.16 Hump-shaped age productivity profile

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 sixty-three.

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 subsection 5.4.3). One profile is flat; the other imposes the sharp hump shape depicted in figure 5.16. It features a strong decline of productivity after age sixty. We treat these age profiles as exogenous.

Figure 5.17 describes what difference it makes whether the age productivity profile is flat or whether it is hump-shaped. Figure 5.17 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 LREFORM. In spite of the strong hump shape of figure 5.16, there is not much difference in the resulting GDP per capita; a surprising result.

5.7 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 compu-

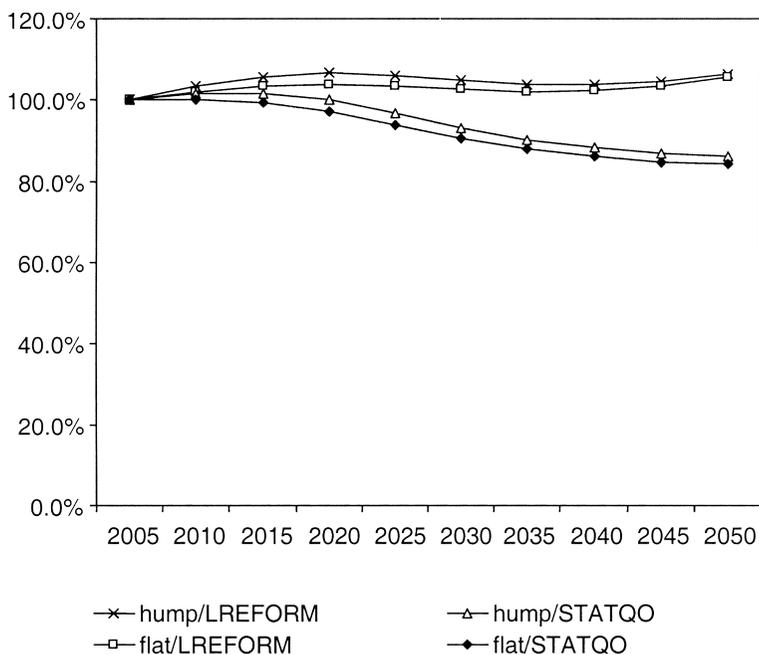


Fig. 5.17 GDP per capita, indexed to 2005 = 100 percent, different productivity assumptions

tational general equilibrium model is a combination of exogenous changes of labor supply at the extensive margin (metaphorically represented in our model by the number of working persons), and endogenous responses of labor supply at the intensive margin (metaphorically called 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. The endogenous component of labor supply (“hours” chosen by the household members) reacts to the exogenous component of labor supply (“working persons” freed from labor market restrictions), but also to social security taxes and to the aging process itself and its repercussions.

Our chapter 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 if there were no endogenous behavioral reactions. On balance, these behavioral effects dampen reform efforts, thus representing reform backlashes in our model. Taking 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, Old Europe can maintain her high living standards in spite of aging. This is an important message for the never-ending reform debate on the European continent.

The key to 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 produces 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 (expressed less metaphorically: the balance between what is exogenous and what is endogenous in labor supply). The current version of the chapter features a calibration that is based on an ad hoc choice of parameters by reference to other studies. In future versions of the chapter, 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 making the metaphorical distinction more realistic 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 Vandenberg (2005), and by explicitly modeling the institutions that determine households labor market participation decision; for example, along the lines of Garibaldi and Wasmer (2005) and Guner, Kaygusuz, and Ventura (2008). 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 to future research.

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