Demographic changes, migration and economic growth in the euro area

Axel Börsch-Supan [abc], Duarte Nuno Leite[ad] and Johannes Rausch[a]

Abstract

This paper describes how population aging will shape long run economic development in the euro zone. We argue that the extent of the demographic changes is dramatic and will deeply affect future labor, financial and goods markets. The expected strain on public budgets – especially public pension, health and long-term care systems – has received prominent attention, but population aging poses many other economic challenges that threaten productivity and growth if they remain unaddressed, thereby also putting central banks under pressure.

While aging is global, there are marked differences in the underlying causes, speed and extent of aging across countries, even within the euro zone. These differences will generate different growth paths and change the international pecking order. Thanks to the globalization of labor, financial and goods markets, however, these differential demographic developments can be exploited together with higher capital intensity and digitalization. This offers large chances during the aging process.

1 Overview

The expected change in the age structure in virtually all industrialized countries – but also in many developing countries – is dramatic and will lead to a substantially higher proportion of older people in the world. This will happen even in spite of the large current migration streams and even if fertility were to increase as Section 2 of this paper will show.

The aging process will deeply affect future labor, financial and commodity markets. On a macroeconomic level, labor will become relatively scarce in the aging countries while capital will become relatively more abundant. 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. On a microeconomic level, the age composition of the labor force will change which might affect labor productivity. Consumption and savings patterns

a: Munich Center for the Economics of Aging (MEA) at the Max Planck Institute for Social Law and Social Policy, Munich, Germany; b: Department of Economics and Business, Technical University of Munich (TUM), Munich, Germany; c: National Bureau of Economic Research (NBER), Cambridge, Mass.; d: Center for Economics and Finance at University of Porto (CEF-UP)

are likely to alter when the elderly become a larger proportion of consumers and savers, with widespread implications for goods and financial markets.

Section 2 sets the demographic stage by showing that, while aging is global, there are marked international differences in the speed and the extent of the aging processes. Europe and Japan have already much older populations than North America. In Asia, some countries start from a relatively young population, but aging there is very quick. A particular dramatic example is China. Differences are large even within the euro zone. E.g., Italy and Germany are aging much faster than France. Due to the globalization of our economies, we cannot disregard these differential changes. International flows of capital, goods and services, and labor – in descending order of mobility – will be important mechanisms which are able to moderate the effects of population aging in the euro zone.

Quantifying these mechanisms and their effects is the aim of Section 3, the core of this paper. It uses a multi-country overlapping generations (OLG) model to assess the orders of magnitudes involved during the aging process. Starting point are the fundamental components that determine the euro zone's output and income. Let output Y (GDP) be

$$Y = A \cdot F(L, K).$$

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. We refer to this as "structure effect". In some countries, the labor force L will even decline in absolute size. We call population decline the "size effect". Unless this is compensated by an increase in total factor productivity A and/or an increase in the capital stock K, output will decline. Since L is changing quite differently across countries, it is important to distinguish between the structure and the size effect in order to understand potential cleavages within the euro zone.

From a more individualistic point of view, per capital output is

$$Y/N = A \cdot f(L/N, K/L).$$

Per capita output Y/N may stay constant or even increase, in spite of a shrinking population N (and a decreasing total output Y along with it) if labor force participation L/N and capital intensity K/L increase. Such increases may come endogenously or by policy action; they are a source of chances during the aging process. Herein also lays the insight that digitalization and aging may actually help rather than harm each other.

Finally, not all income needs to come from domestic production. In addition to wages and capital income from domestic production, equivalent to Y, foreign direct investment may create capital income from foreign production. GNP may become substantially larger than GDP if foreign direct investment creates large returns. Here are major chances during the global aging process. We will show that for a stylized euro zone economy, a substantial part of the aging burden would be endogenously compensated by higher capital intensity, e.g. via digitalization, and international exchange if these forces were free to move.

The remainder, however, needs to be addressed by active reform. Here, public pension systems play a key role. Section 5, after a short digression on housing markets and asset returns in Section 4, is devoted to their critical role. The paper will not deal in any narrow sense with the many detailed issues of pension reform but shows that pension reform may have important macroeconomic implications for future rates of return and international capital flows.

While the core of paper addresses macroeconomic issues, some fundamental elements such as the propensity to save and the productivity of an aging work force require a microeconomic view to be fully understood. This will be done in Section 6.

While the paper mainly addresses issues in the real economy, Section 7 will provide a brief overview on the controversial issue whether, and if how, population aging affects inflation. There is no firm answer for the euro zone since there are forces which create deflationary pressures and other forces which increase inflation. Again, these forces differ as much across countries as their demographic features vary. Distinguishing the structure from the size effect is important as well as the policy reactions to the increasing burden of financing pensions and healthcare.

Section 8 therefore concludes with a discussion of policy options for central banks in the light of current policy backlashes in the euro zone and the significant differences in the demographic developments across member countries.

2 Demographics

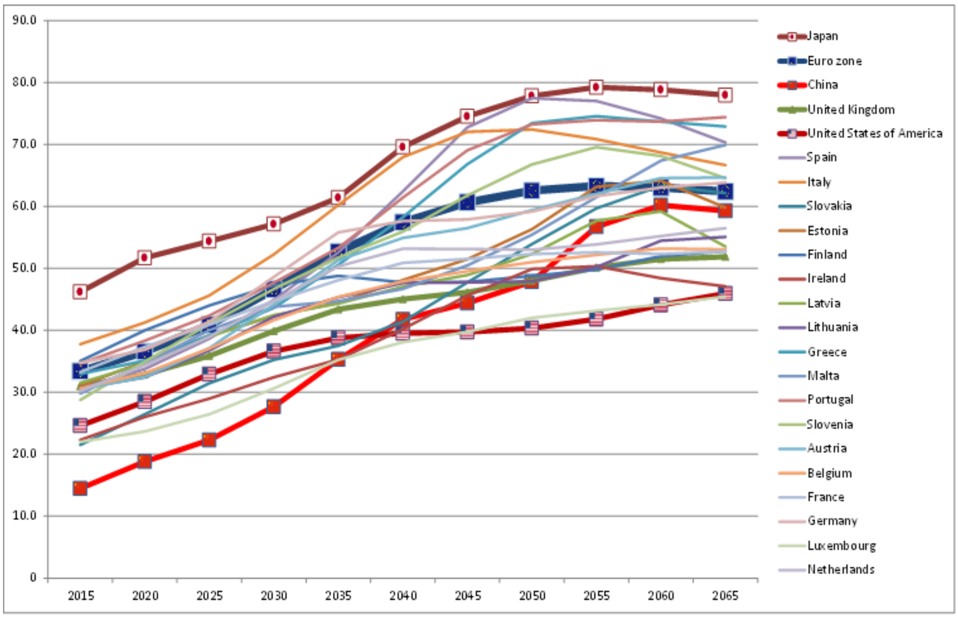
Throughout the world, demographic processes are determined by the so-called demographic transition which is characterized by falling mortality rates followed by a decline in birth rates, resulting in population aging and thereby reducing the population growth rate or turning it to negative. While this basic mechanism of population aging is similar in most countries, extent and timing differs substantially. Europe and some Asian countries have almost passed the closing stages of the demographic transition process while Latin America is only at the beginning stages (Bloom and Williamson, 1998).

2.1 Demographic forces and the heterogeneity of population aging

In order to understand the heterogeneity of population aging, it is helpful to distinguish between four demographic forces: the secular increase of life expectancy, the historically given babyboom-babybust transition, current and future fertility, and migration. Depending on their relative magnitude, these forces may or may not imply population decline (the size effect); in any case will they change the structure of the population, best captured by the old-age dependency ratio which relates the number of people deemed old (say 65+ years of age) to the number of people deemed being in workable age (say age 20-64).[2]

Chart 1

Old-age dependency ratio (65+/20-64) in the euro zone, China, Japan, US and UK



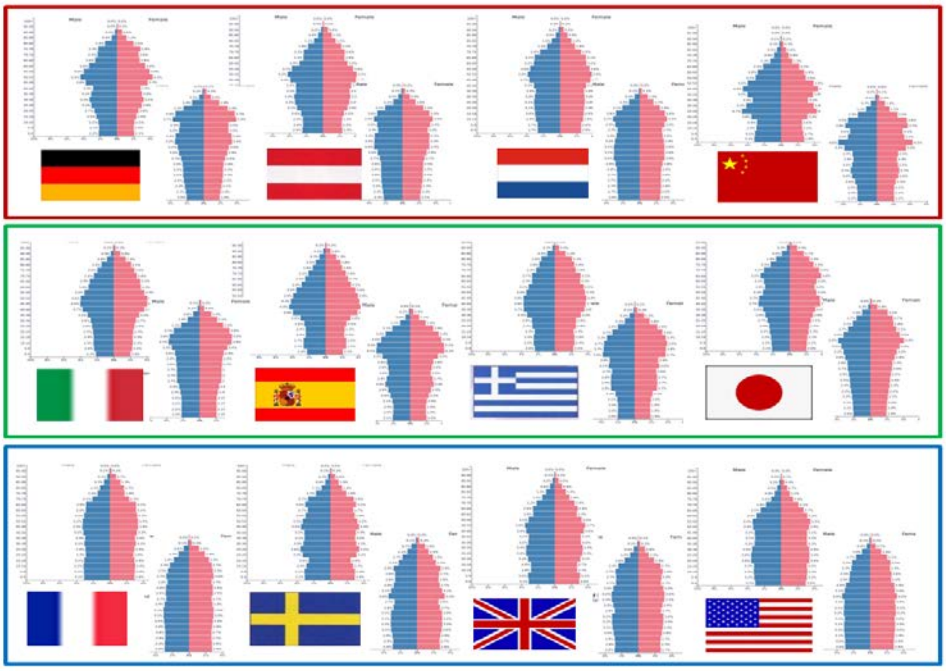
Source: UN World Population Projections, Revision 2017.

Chart 1 shows that Japan has the highest old-age dependency ratio, while first China and later the US have the lowest old-age dependency. It is remarkable that the countries in the euro zone fill almost the entire range in between, with Italy and Spain as the oldest and Ireland and Luxembourg as the youngest countries. The reason for these large differences is the different relative magnitude of the four demographic forces. This can best be seen in the population pyramids drawn in Chart 2, referring to 12 countries and 2 points in time, 2017 and 2040.

[2] We will address the arbitrariness of these definitions in Section 6.3. Especially critical is the assumption that old age begins at a fixed age which remains constant although longevity increases.

Chart 2

Demographic forces and population structure, 2017 and 2040



Source: https://www.populationpyramid.net, downloaded 26.04.2019

The first row of countries (Germany, Austria, The Netherlands) shows the large effect of the babyboom-babybust transition. This transition is larger than in other countries due to the aftermath of World War II which lasted longer in these countries than in others. What some call “age wave” will therefore happen later than e.g. in the US. China, due to other historical reasons during the Mao era, also features marked demographic peaks and troughs.

The second row shows countries (Italy, Spain, Greece, and Japan) which had for quite some time a combination of high life expectancy and persistently low fertility. This is reflected in the large proportion of older individuals which dominates the population pyramid.

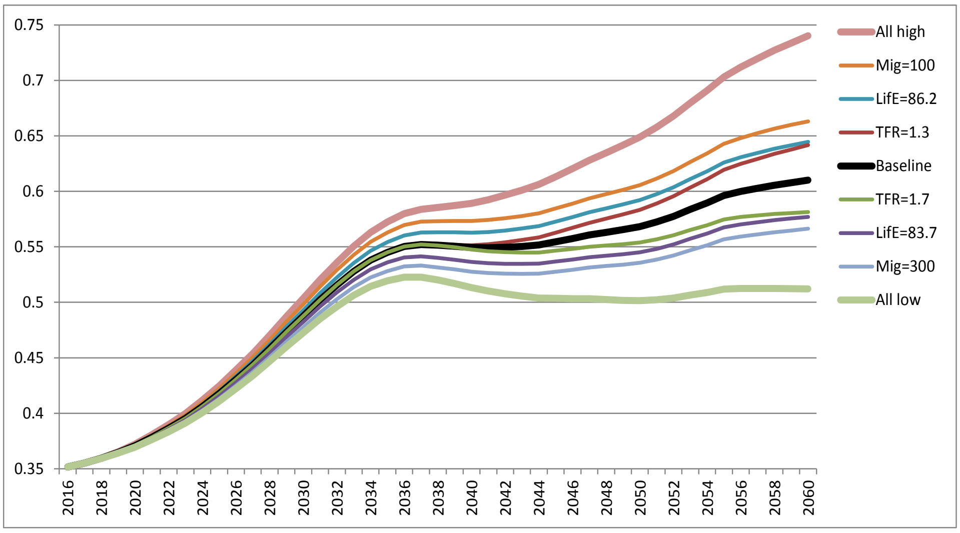
Finally, there are also countries with relative high fertility and thus mild aging. Chart 2 takes France, Sweden, the UK, and the US as examples. Their aging process is mainly generated by the secular increase in life expectancy, and their pyramids do not exhibit the “stem of a mushroom” clearly visible for the countries in the first two rows.

2.2 Reliability of demographic projections

These historically given international differences will also dominate in the future (Chart 1). Mortality and fertility patterns rarely change dramatically within the time span of a generation. Exceptions such as the babyboom-babybust transition are due to dramatic events like World War II. Thus, compared to economic projections, medium run demographic projections (i.e., one generation ahead until the 2040s) are reasonably precise because most of the population one generation ahead is already alive. Formidable challenges, however, are longer run projections and a satisfactory description of the uncertainty involved in these projections. The usual procedure is to create scenarios with plausible medium and extreme assumptions. Chart 3 shows an example taken for Germany. It depicts deviations from the baseline in all three demographic dimensions (migration, life expectancy and total fertility rate) and their extreme combinations. The main message from these exercises is that population aging will have large (here: increase of dependency by 50%) or even very large effects (here: more than double the dependency) but most probably not only small effects, and we can exclude with certainty that there will be no effects.

Chart 3

Old-age dependency ratio (65+/20-64) in Germany under alternative assumptions



Source: Own computation based on PENSIM model (Börsch-Supan and Rausch, 2019).

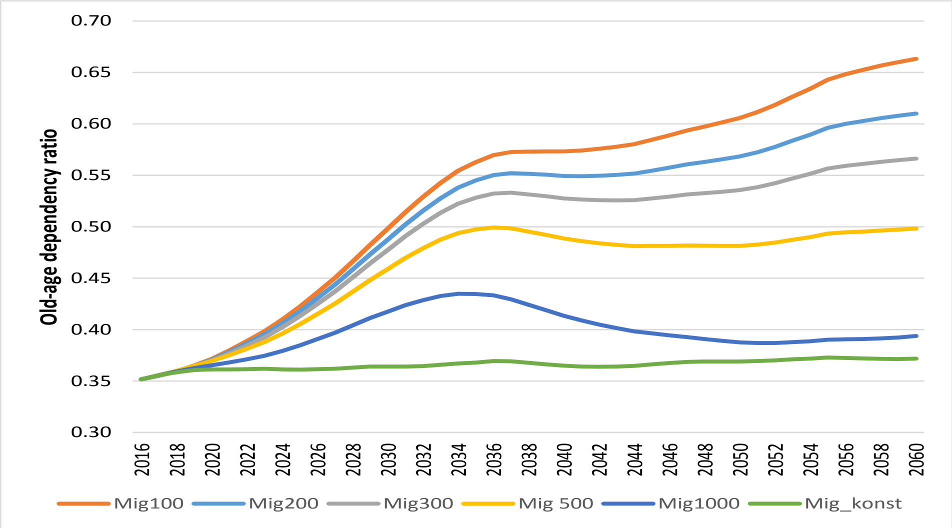
2.3 Can migration compensate for population aging?

This also holds with respect to the largest wild card in demographic projections, namely migration. Taking again Germany as an example, its statistical office has predicted a decline in the German population in each projection since the early 1980s. It has never occurred because migration was always larger than predicted. While we have many theoretical models describing the link between economic circumstances and migration, we do not have quantitative models that are able to predict how aging and other future events will affect migration.

Similarly to Chart 3, we can run counterfactual simulations of population size and dependency ratios for various assumptions about the number and age structure of migrants. The result of these exercises is threefold: First, migration has stabilized population size in many euro zone countries contradicting earlier projections; second, however, even very large migration waves are unlikely to compensate the population shrinkage that will occur when the babyboom generation will die; third, even extremely large migration waves will not undo the structural effect of a change in the dependency ratio, whatever the size of the population may be. This is depicted in Chart 4 for Germany.

Chart 4

Effect of migration on dependency ratio (Germany)



Source: Own computation based on PENSIM model (Börsch-Supan and Rausch, 2019).

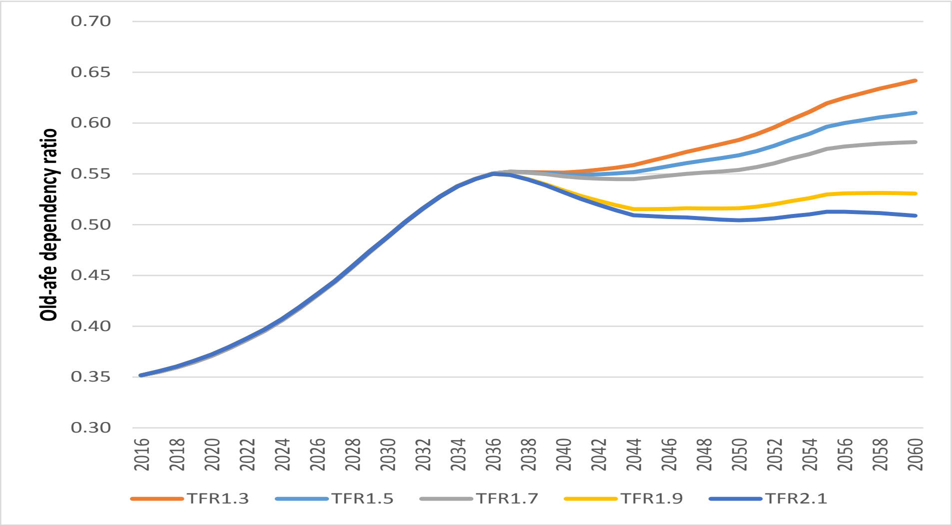
Even if net migration ("Mig" in Chart 4) would be 500,000 individuals per year for the next decades (yellow line, this is 2.5 times the long-run average of about 200,000 individuals, light blue line), it would not stop the increase in the German dependency ratio. To do so, net migration would need to be about 1.5 million individuals on average for the next 15 years, peaking at 2.1 million in 2021 (green line). This should be compared with the exceptional migration into Germany in 2015 which was about 950,000 individuals (net). In 2017, net migration into Germany was 417,000 individuals.

2.4 Short- vs. long-run effects of a fertility increase

A sufficiently large increase in fertility will reduce the old-age dependency ratio in the long run. It has, however, no impact on the old-age dependency ratio and labor supply for almost one generation (Chart 5). The simple reason is that newborns have to grow and be educated until they are able to enter the labor market. Since the babyboom-babybust transition is the main demographic challenge in the euro zone and strains resources particularly between 2020 and 2040, even a new babyboom in the immediate future would not alleviate this transitional burden. Even with a total fertility rate ("TFR" in Chart 5) of 2.1 which exactly replaces the current population, the old-age dependency would remain at a much elevated level even in the distant future.

Chart 5

Effect of a fertility increase on the dependency ratio (Germany)



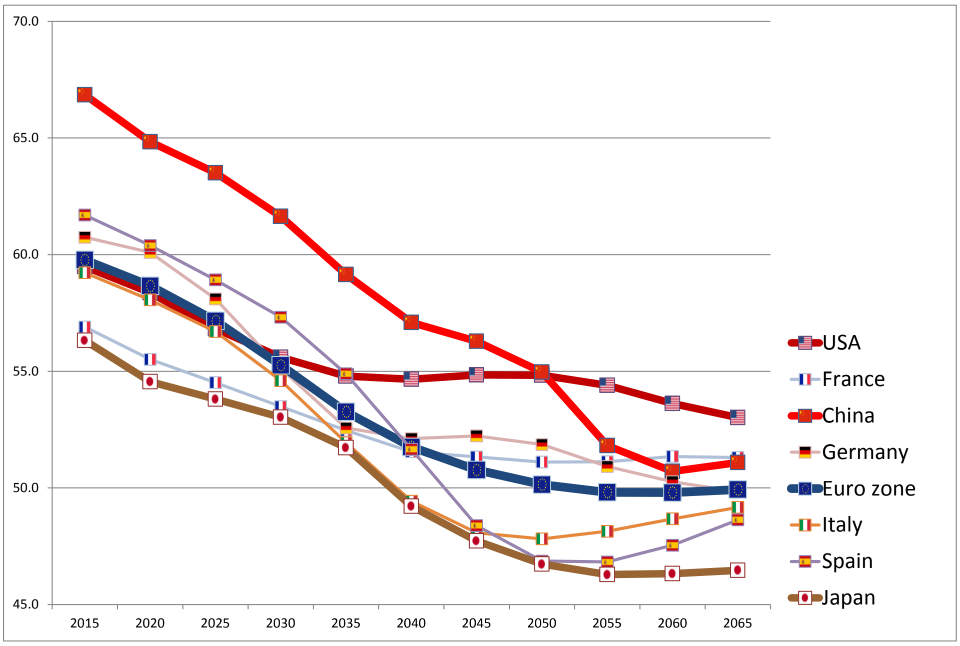
Source: Own computations based on PENSIM model, (Börsch-Supan and Rausch, 2019).

2.5 Labor supply projections

In addition to demography, understanding the development of the labor force during the next decades is crucial for the analysis of the effect of population aging on economic growth, wages and asset returns because the long run macroeconomic development is dominated by fundamentals such as the relative scarcity of labor and the relative abundance of capital. A first indication is the size of the working age population (say, defined as age 20-64). Their decline is truly remarkable, see Chart 6, and even more so the difference across countries. Relative to total population, the U.S. will lose about 7.8% of their working age population between 2015 and 2050. In the euro zone, the loss is more than twice as high (16.1%). The loss is particularly high in Spain and Italy (24.0 and 19.3%).

Chart 6

Working age population of France, Germany, Italy and US, 2005-2050

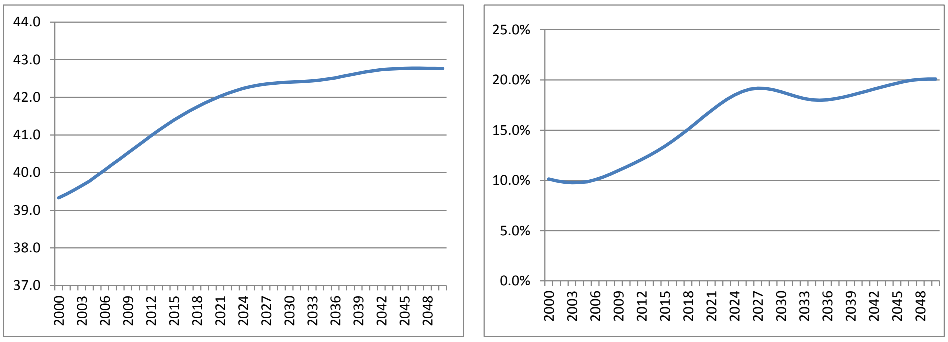


Source: UN World Population Projections, Revision 2017.

Slightly more sophisticated predictions of labor supply build on such demographic projections by multiplying their population counts with labor force participation rates specific to age, gender, etc. Chart 7 depicts the results of such an exercise on the structure of the German labor force. It shows that the average age of the labor force is strongly increasing until the babyboom is reaching retirement age which will be between 2020 and 2030. Note that the strong increase of the elderly share in the work force between 2000 and now does not appear to have damaged much the German economy, in spite of opposite predictions which have been based on the assumption of a strongly declining productivity with age. Section 6.3 will briefly explain this outcome.

Chart 7

Average age and share of older workers in Germany's labor force



Source: Statistisches Bundesamt (German Statistical Office) 2003.

While these exercises provide a good indication for the challenges to come, they have severe limitations. First, labor force participation rates are policy related; for example, they heavily depend on the rules determining labor market entry (e.g., through the education system) and exit (e.g., through pension rules such as the statutory retirement age). Second, actual employment is endogenously determined by labor supply and demand both of which depend on the prevailing wage which in turn is affected by demographic change since the scarcity of individuals in working age relative to population size will exert upwards pressures on wages.

3 Implications for labor and capital markets in the euro zone: a GE-OLG approach

We therefore use a multi-country overlapping generations model with endogenous labor supply and demand to study the general equilibrium effects of population aging on economic growth, savings, wages, international capital flows and rates of return to capital. We do not model the entire euro zone but represent it by a population-weighted aggregate of its three largest economies, France, Germany and Italy ("EU3").

3.1 The model

Börsch-Supan, Härtl and Ludwig (2014) extend the overlapping generations model of the Auerbach and Kotlikoff (1987) type in several dimensions: they acknowledge the international trade and capital flows of European countries by a multi-country version of the model (Börsch-Supan, Ludwig and Winter 2007); they model the large frictions in European labor markets via a the distinction between exogenous and endogenous labor supply components (Börsch-Supan and Ludwig 2010); and, relevant for Section 5 of this paper, they add a model of an earnings-related pay-as-you-go public pension scheme typical for France, Germany and Italy which combines aspects of a defined contribution system with those of defined benefits. Section 6 will justify some of the model's assumptions. Section 7 adds money in the utility function in order to study the effect of aging on inflation (Härtl and Leite 2018).

3.1.1 Household behavior

Households have standard preferences over consumption and leisure. As a non-standard feature, we model total labor supply of a household of age j is the product of an exogenous component l_j, and an endogenous component h_j. The exogenous component l_j can be thought of as the maximum life-time number of hours possible for a household, given by restrictions in labor market entry (e.g., due to length of mandatory schooling), restrictions during main working life (e.g., by the availability of day care facilities for families, or the 35-hour week in France), and in older age by restrictions through mandatory retirement. Households have some ability to choose their preferred labor supply by choosing h_j, the endogenous component of labor supply. They can be thought of hours within the maximum life-time number of labor hours l_j. This ability, however, is limited and asymmetrical as h_j may not exceed an upper limit ħ.

More formally, a household of age j at time t in country i derives utility from consumption $c_{t,j,i}$ and leisure $1 - l_{t,j,i} \cdot h_{t,j,i}$ where the household's per period utility function is given by

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

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

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

where β is the pure time discount factor. In addition to pure time discounting, households discount future utility with their unconditional survival probability,

$$\pi_{t,j,i} = \prod_{k=0}^{j} s_{t+k,k,i}.$$

Here, $s_{t+k,k,i}$ denotes the probability to survive from period $t + k$, age k to period $t + k + 1$, age $k + 1$ in country i with $s_{t,0,i} = 1$. Since the time of death is uncertain, 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.

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

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

where $\lambda = 1$ for $j = 0, \dots, R$ and $\lambda = 0$ for $j > R$ and R is the exogenous retirement age. $\tau_{t,i}$ denotes the contribution rate to the pay-as-you-go financed public pension system and $p_{t,j,i}$ the pension income, see below.

As pointed out above, maximization is subject to the constraint that the endogenous component of labor supply ("hours worked within the limit") are positive and may not exceed the upper limit ħ. Since the model cannot distinguish between the limit ħ and the exogenous labor supply component, we normalize ħ to one:

(4) $$0 \le h_{t,j,i} \le 1.$$

In those variants of our model in which the labor supply is fully exogenous, we replace the constraint (4) with the constraint that $h_{t,j,i} = 1$ for all t, j, i.

3.1.2 Pension system

The government organizes a prototypical European earnings-related pay-as-you-go financed pension system. Benefits are given by

$$p_{t,i} = \rho_{t,i} \cdot w_{t,i} \cdot (1-\tau_{t,i}) \cdot EP_{t,j,i} \quad (5)$$

where $\rho_{t,i}$ denotes the net replacement rate (generosity of the pension system) and $\tau_{t,i}$ the contribution rate of the pension system in country i at time t. Earnings points $EP_{t,j,i}$ accumulate over the life-cycle according to

$$EP_{t+1,j+1,i} = EP_{t,j,i} + l_{t,j,i} h_{t,j,i} \quad (6)$$

Households thus earn one earnings point if they receive average wage income in a given period.

Our model households understand the linkage between contributions to the pension system and pension payments in old age. Therefore, relative to a flat benefit pension system, labor supply distortions are smaller but not zero because the rate of return on the capital market exceeds the implicit return of the pension system. The main policy parameters of the pension system are either the net replacement rate ρ or the contribution rate τ. The other parameter is determined endogenously since the pension system's budget is assumed to always be balanced. If ρ is large, public pensions substantially crowd out private saving through the households' saving decision given by (1) and (2).

3.1.3 International capital flows

The euro zone has strong trade and corresponding international capital flows especially with the US and China. We model these flows by assuming that saving and investment decisions are governed by a common global interest rate which, via international capital flows, equalizes the return to capital across countries. Assets held by households in country i therefore do not necessarily equal the capital stock in country i nor does saving necessarily equal investment in a single country.

3.1.4 Equilibrium

The main driver of the model is demography. It is exogenously determined by main-stream assumptions about fertility, mortality and migration (United Nations 2017). The demographic model determines cohort sizes and thus both the size of the total population and the age structure of it, thus the two main elements of population aging. Production and wage setting in each country is neoclassical. Equilibrium is achieved if supply equals demand in the national labor markets and in the global capital market. Numerical solution and calibration follows Börsch-Supan, Härtl and Ludwig (2014).

3.2 Results

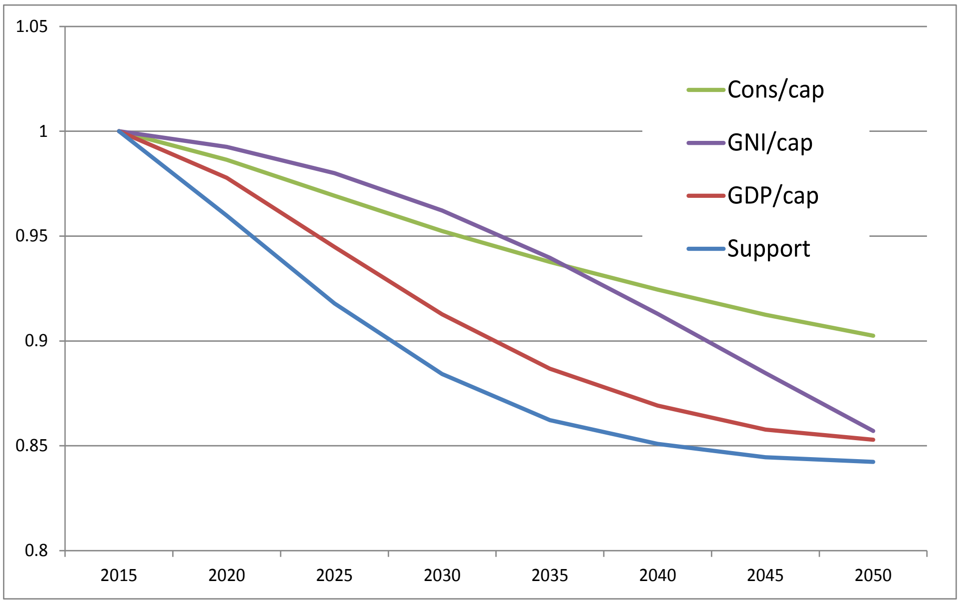
We present results on labor supply, GDP and GNP growth, per capita consumption, international capital flows, wages and return to productive capital in three steps. Step 1 is a baseline with exogenous labor supply based on current labor force participation rates. Step 2 keeps labor supply exogenous but gradually increases retirement age and female labor force participation. At the same time, labor market entry age as well as unemployment is decreased. Finally, step 3 endogenizes labor supply.

3.2.1 Baseline economic growth

Our baseline is defined as status quo in terms of labor market and pension system. We assume constant age and gender-specific labor force participation rates and a constant replacement rate $\rho_{t,i}$, see equation (5). Initially, we also assume equal productivity for all ages. All results refer to the euro zone as represented by EU3, the population-weighted aggregate of France, Germany and Italy. As their populations age, the support ratio declines by 11.6 percent from 2015 until 2030. As a consequence, GDP per capita would decline by 8.7 percent and consumption per capita by about 4.8 percent relative to a non-aging economy with the same total factor productivity if policies and behavior were to remain at the current status quo (Chart 8). All variables are normalized to 100% in 2015 and net of an underlying TFP trend. Chart 8 therefore represents the pure effect of population aging on these aggregates.

Chart 8

De-trended growth of GDP, GNP and consumption per capita, EU3, 2005-2050

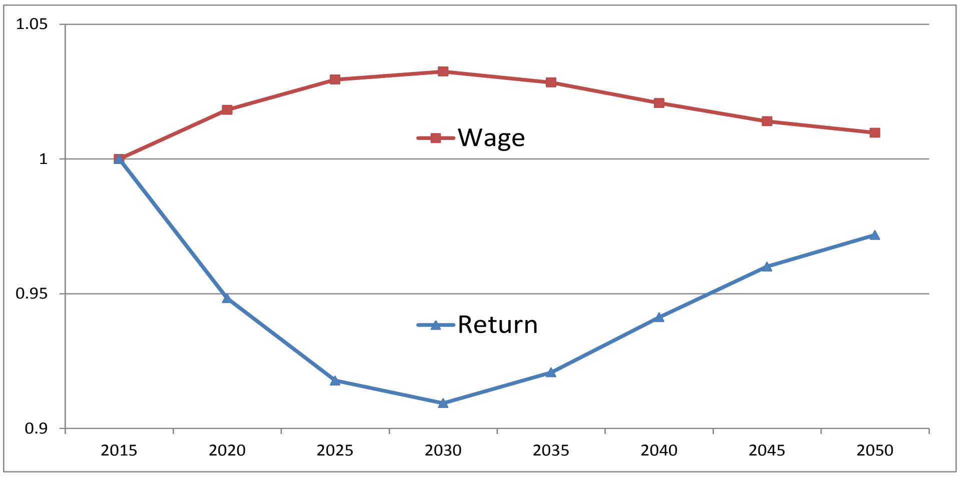


Source: Updated from Börsch-Supan, Härtl and Ludwig (2014). Note: Variables are normalized to 100% in 2005 and net of TFP trend.

A first observation is that the decline of GDP per capita is smaller than the decline of the support ratio. This is because scarce labor due to population aging is partially substituted by additional capital. This adaptation occurs in response to rising wages and falling rates of return to capital depicted in Chart 9, to be discussed further in Subsection 3.2.5.

Chart 9

Wages and rates of return to productive capital, EU3, 2005-2050



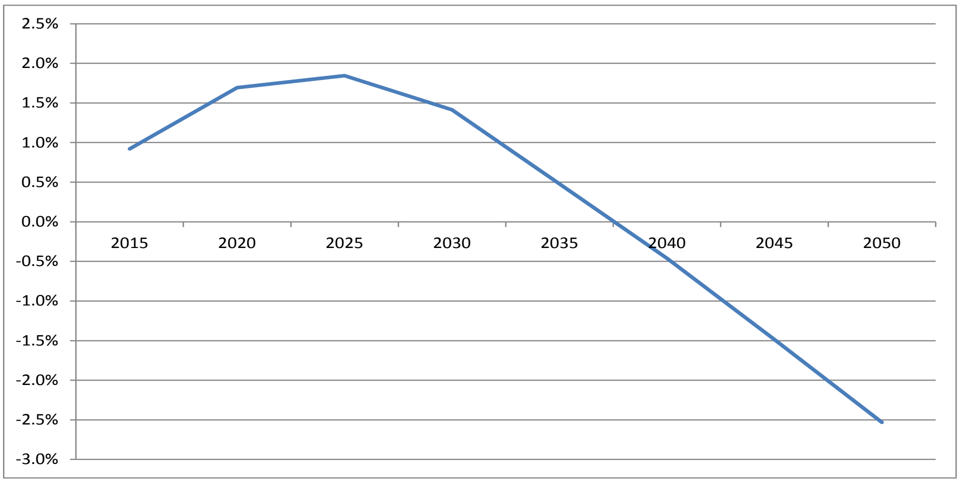
Source: Updated from Börsch-Supan, Härtl and Ludwig (2014). Note: Variables are normalized to 100% in 2015.

3.2.2 International capital flows

The second observation is the difference between GDP and GNI per capita. Since the US is aging much less than Europe, the return to capital would fall less (and wages increase less) than in Europe if these two regions were economically isolated. In an open economy setting, however, European households will invest in foreign capital deriving higher returns until a common interest rate is achieved in equilibrium. From a life-cycle point of view, such behavior differs according to age: eventually, households will repatriate their foreign savings and, according to the life-cycle mechanism underlying equations (1) and (2), enjoy their retirement consumption. The aggregate effect depends on demography. The large cohort sizes born in the 60s and 70s lead to first rising, then falling net capital outflows, until they turn negative after about the year 2035 (Chart 10).

Chart 10

International capital flows from EU3 to US, 2005-2050



Source: Updated from Börsch-Supan, Härtl and Ludwig (2014). Note: Capital flows are saving minus domestic investment in Europe, relative to GDP and normalized to a balance of 0.91% in 2015 (IMF, 2017).

These international capital flows reach almost 2% of GDP and are substantial in the sense that consumption per capita falls by about 5 percentage points less than GDP per capita in 2050. It also implies that de-trended GNI per capita is substantially larger than de-trended GDP per capita until about 2055 (Chart 7). In the short run, these capital flows become even larger if the rest of the world, seen from Europe, includes the large Asian economies. This is shown by Börsch-Supan and Ludwig (2009). It is noteworthy, however, that the long-term effect is smaller than maybe expected because the higher speed of the population aging process in Asia will generate convergence of population structures between Asia and Europe.

3.2.3 Exogenous increase of labor force participation

Keeping age and gender-specific labor force participation rates constant during the demographic transition is counterfactual. Between 2000 and 2010, several major policy changes happened. The Monti government in Italy dramatically increased the Italian retirement age. In Germany, the statutory retirement age is gradually raising from 65 in 2011 to 67 years in 2029. In France, the minimum pensionable age of 60 has been raised to 62. The change in the European high school and university system (the so-called Bologna process) is expected to decrease schooling duration by about 2 years. Labor force participation of women has changed in a secular fashion. Structural unemployment in the euro zone has fallen until the financial crisis hit. We therefore model the following four changes in labor force participation:

- increase in the retirement age by 2 years;
- decrease in the job entry age by 2 years;
- convergence of female labor force participation to 90 percent of the rate for men;

- reduction of unemployment to the NAIRU rate (Ball and Mankiw, 2002).

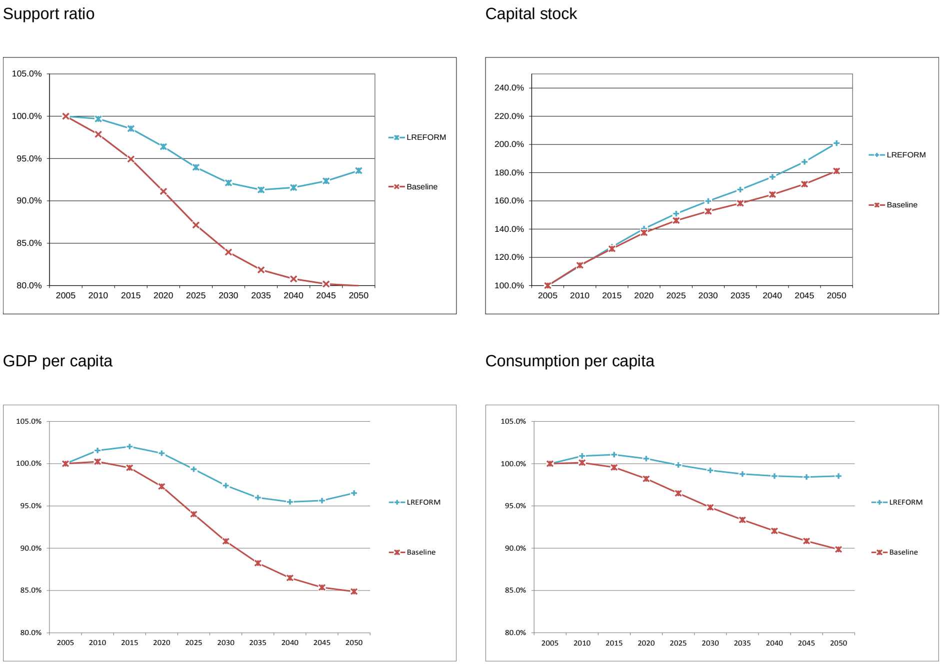
These changes are assumed to occur gradually (linearly) between 2005 and 2030; hence the base year of the following projections is 10 years earlier than in the preceding section.

Chart 11 summarizes the effects of these exogenous changes (“LREFORM”), comparing it to a baseline without any changes, starting with the assumption that hours’ supply h_j is exogenous. In this case, the economy increases its capacity accordingly and the decline in the support ratio is offset to about 94% (upper left panel in Chart 11). In addition, saving and investment behavior react leading to a small increase in the domestic capital stock relative to the baseline scenario (upper right panel), thereby increasing GDP per capita slightly above the trend of the support ratio (lower left panel). Furthermore, added saving flows to abroad increase consumption per capita stronger than per capita GDP (lower right panel). As a result, economic living standards, here measured as per capita consumption, can essentially be stabilized in spite of population aging in the EU3 countries representing the euro zone.

This is an important result. In spite of population aging, the euro zone does not necessarily have to experience declining growth. Demography as such is not destiny, rather the euro zone’s ability to make and sustain reforms that better activate the available working-age population.

Chart 11

Exogenous increase of labor force participation in the EU3 countries, 2005-2050



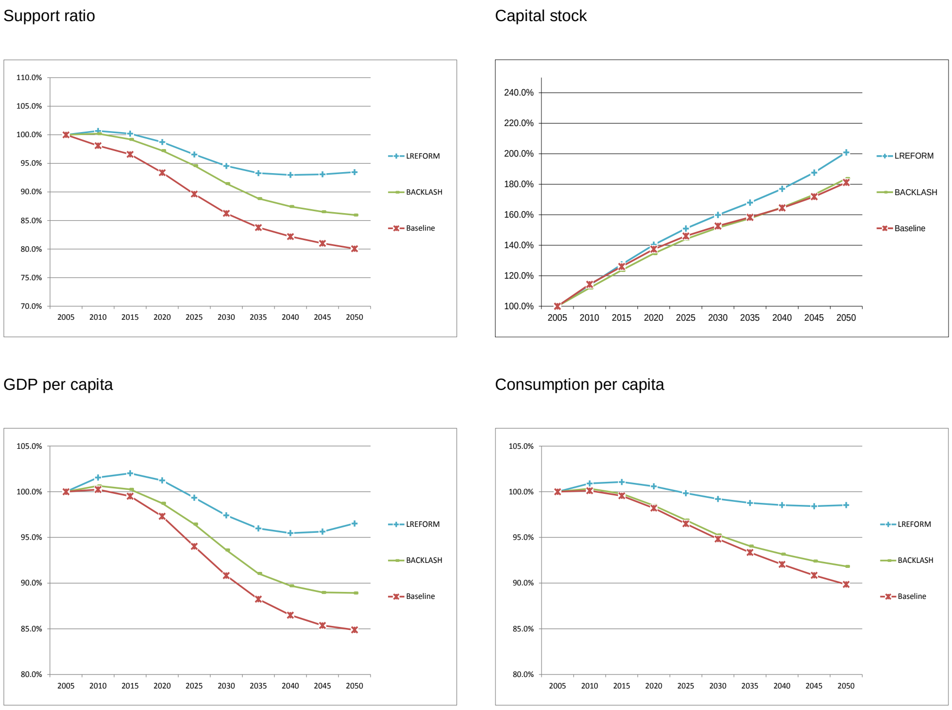
Note: Based on Börsch-Supan, Härtl and Ludwig (2014). All series normalized to 100% in 2005. GDP and consumption per capita are net of TFP growth.

3.2.4 Endogenous labor supply

Attempts to execute the policies delineated in the preceding subsection, however, have faced stiff opposition in all three EU3 countries. Hence, the exogenous increase in labor force participation depicted in Chart 11 may be wishful thinking. We model such opposition and eventual policy backlash as substitution between the endogenous component h_j and the exogenous component l_j. In the absence of 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: as the age-specific employment lj is exogenously increased, the household endogenously decreases hours worked, h_j. The exogenous variation of l_j affects total effective labor supply, however, for those households for whom the time endowment constraint ħ is binding. As a consequence, the exogenous employment variation of l_j has a positive effect on labor supply but the overall effect is substantially smaller than in the previous section where labor supply was fully exogenous. This is indicated in the middle trajectories in Chart 12. The behavioral backlash to labor market reform in Europe is large: labor supply now increases less than a half of what it would have been when hours were exogenous (upper left panel). Accordingly, GDP and consumption per capita do not even closely achieve the level of an otherwise comparable non-aging economy as it did in Chart 11.

Chart 12

Growth with endogenous labor supply in the EU3 countries, 2005-2050



Note: Based on Börsch-Supan, Härtl and Ludwig (2014). All series normalized to 100% in 2005. GDP and consumption per capita are net of TFP growth.

The size of the backlash effect is large. It is driven by a perfect substitution between the exogenous and the endogenous components of labor supply among the unrestricted households. Stricter labor supply restrictions (such as minimum hours' constraints) will generate smaller backlash effects.

The exercise in this section shows that the euro zone not only needs to initiate structural reforms but that it is essential to also sustain them over long periods of time.

3.2.5 Asset meltdown

Several articles in the popular press have raised the fear that an asset meltdown might occur when the babyboomers will decumulate their assets. The academic literature is less alarmistic, see e.g. Poterba (2001), Abel (2001) or Brooks (2002).

Poterba (2001, p.582) finds it "difficult to find a robust relationship between asset returns on stocks, bonds, or bills, and the age structure of the U.S. population over the last seventy years. The correlations that do emerge are stronger between Treasury bill returns, and long-term government bond returns, and demographic variables, than between stock returns and demography. Most measures of demographic structure, however, do not show a statistically significant correlation with asset returns. These findings stand in contrast to the results of general equilibrium models for asset returns, which suggest a clear link between age structure and returns. One possible interpretation of these findings is that, even though changes in age structure do affect asset demand, these effects are simply too small to be detected among the other shocks to asset markets."

Abel (2001) criticizes Poterba's approach by pointing out missing saving motives, especially bequests. Brooks (2002, p.405) picks up this critique and estimates that "baby boomers can expect returns on retirement saving about 100 basis points below current returns."

Our own work as depicted in Chart 9 predicts a rather modest decrease in the rate of return in the euro zone due to population aging: approximately 9% or 45 basis points on a basis of an average rate of return on productive capital of 5%. This modest decline in the returns of assets due to demographic transition has been repeatedly observed by several studies in the last decades (Arnott and Chaves, 2012; National Research Council, 2012). More recently, Carvalho et al. (2016) found that demographic change in developed countries caused a drop of at least 150 basis points between 1990 and 2014. Projections for the years 2005/2010 to 2030 are in the range from 79 basis points to 180 basis points (Aksoy et al., 2019; Gagnon et al., 2016). Long-run projections until 2080, as the ones in Krueger and Ludwig (2007) and Attanasio et al. (2007), show that the decline on rates of return on capital could range from 79 to 330 basis points depending on the openness of the economy.

There are several aspects worth noting. First, closed-economy models like Brooks (2002) miss the important fact of international capital flows under global aging. The return on capital can be improved by international diversification, that is, by investing pension savings in countries with more favorable demographic transition paths. This is the point made also by Krueger and Ludwig (2007) and Attanasio et al. (2007).

Second, this effect depends on the relative size of the domestic and the international capital market, thus on the perimeter of international capital flows. Third, the size of the domestic capital market depends on the nature of the pension system and reforms that decrease pay-as-you-go pensions in favor of funded pensions (often called "fundamental pension reform", see Section 5.1).

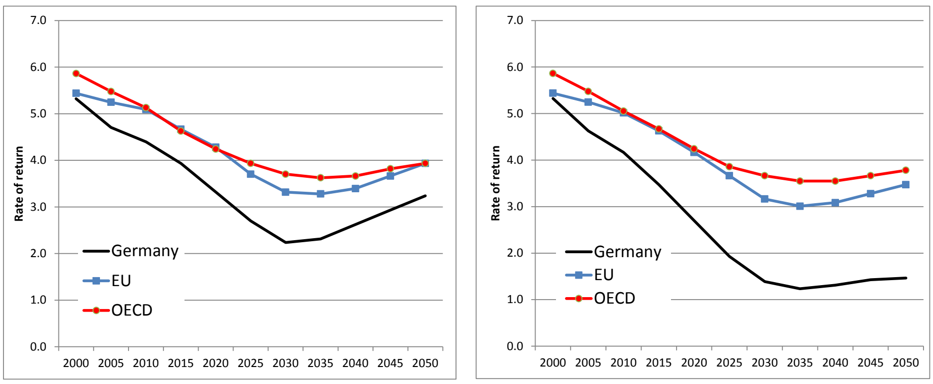
These aspects are depicted in Chart 13 where we model six hypothetical scenarios, namely the interaction of three perimeter and two pension reform scenarios: (a) Germany as a closed economy, (b) free capital flows between Germany and the rest of the EU, and (c) free capital flows between Germany and the rest of the OECD, interacted with (A) current PAYG pension systems and (B) fundamental pension reform. Note that the domestic market in Chart 13 is Germany, while it was the EU3 in Chart 9, hence effects are larger in Chart 13 as compared to those in Chart 9.

Chart 13

Projections of the rate of return to capital under alternative pension systems and capital mobility scenarios

A: Current PAYG-DB pension systems

B: After fundamental pension reform



Notes: This chart shows projections of the rate of return to capital. Germany: Germany as a closed economy, EU: perfect capital mobility in the EU area, OECD: perfect capital mobility in the OECD area. Panel B: Pension reform only in Germany. Source: Updated, based on Börsch-Supan, Ludwig and Winter (2007).

Panel A shows that a decrease in the rate of return on capital is evident for both the closed-economy and the two open-economy scenarios. However, the decrease is modest. Even in the closed-economy case, a decrease of the rate of return of about 1.4 percentage points – as measured by the difference between the rate of return in 2000 and the minimum for the period 2030-2040 – is closer to the upper bound values in the literature (Aksoy et al., 2019) and, still, much less than claimed in the public press. Moreover, it is apparent that closed-economy models overestimate this reduction of the rate of return: its projected decrease is only about 1 percentage point for both capital mobility scenarios. We observe two effects: first, the level of returns is higher, and second, the decline is smaller and smoother than in the closed-economy scenario.

The beneficial effects of openness to international capital markets become even more evident when we analyze the effects of a fundamental pension reform (Panel B). If a fundamental pension reform were implemented in Germany and if Germany were a closed economy, then the additional decrease of the rate of return to capital would be about 0.8 percentage points. However, as the right panel shows, there is virtually no difference of the rate of return between the two pension system scenarios if capital is freely mobile within the OECD. In the intermediate case, when capital mobility is restricted to the EU area, the decrease would only be around 0.2 percentage points.

This interaction between global aging and pension reform is an important finding. It suggests that household savings induced by a fundamental pension reform should be invested internationally, not only for reasons of risk diversification but also for the sake of higher returns that are available in other countries with different aging processes and more favorable capital/labor ratios.

4 A brief digression on housing markets

The asset meltdown hypothesis has earned particularly attention by the forecast of Mankiw and Weil (1989) who estimated that housing prices will drop between 1990 and 2010 to half of their original levels. We now know that this has not materialized. The main problem with this analysis is the use of cross-sectional data to infer aging effects. In a cross-section, the consumption of living space appears to fall with age. If this effect were real, population aging implies a decline of housing demand with an associated drop in house prices. This conclusion is wrong for several reasons. First, there are strong cohort effects: young birth cohorts entering the housing market have been more prosperous than the current generation of pensioners. Even if incomes and assets are likely to grow more slowly in the future than in previous decades, housing demand will increase during the next 20 years simply because individuals from richer post-war generations make up a larger proportion of the overall population. A third trend, which can also be viewed as a cohort effect and is likely to increase demand, is the move way from multi-generation homes to households occupied by single people, linked to the desire of pensioners to remain independent for as long as possible. In addition to these cohort trends, there are scale effects: smaller households typically have a higher floor area per person. Demand for residential space will therefore fall less than might be feared on the basis of pure population forecasts. Finally, rising life expectancy will induce higher demand for living space. Medical progress is improving the health of people of pensionable age and will enable more pensioners to live independently within their own four walls for longer. Healthy life expectancy has been increasing by about 2.5 years per decade. This effect alone will increase housing demand by more than 3% per decade.

5 The critical role of pension reform

The simulations in Chart 11 contain an increase of the retirement age by two years. This is an important first and in our view the most important component of a pension reform designed to adapt the pay-as-you-go (PAYG) pension systems typical in the euro zone (see Subsection 3.1.2) to demographic change – here to longer lives. In addition, pension reform needs to address the sudden transition between babyboom and babybust which generates a sudden increase in pension expenditures. This is particularly pronounced in those countries that were depicted in the upper row of Chart 2, as can be seen in Chart 3 for Germany between 2020 and 2035. If PAYG systems are defined benefit (DB) systems with a politically determined relatively high replacement rate, then such a sudden increase will generate an equally sudden increase of the contribution rate necessary to balance the budget. This has been the case in many public pension systems in the euro zone, especially in France, Germany and Italy.

Recently, however, reforms have initiated a process which introduces elements of notional defined contribution (NDC) systems in these DB systems. Such reforms will smooth the increase of the contribution rate at the expense of a slower increase in pension benefits. Italy introduced a formal NDC system of the Swedish type for new entrants. Germany introduced a "sustainability factor" which adjusts pension benefits not only to productivity increases, but also to the ratio of pensioners to workers, effectively transiting to a mixed system with DB and defined contribution (DC) features within the PAYG systems. This section models this second component of pension reform, using the model of Section 3.1.

5.1 Transition towards DC

We simulate two policies to set the replacement and the contribution rate which bracket the current mixture of DB and DC:

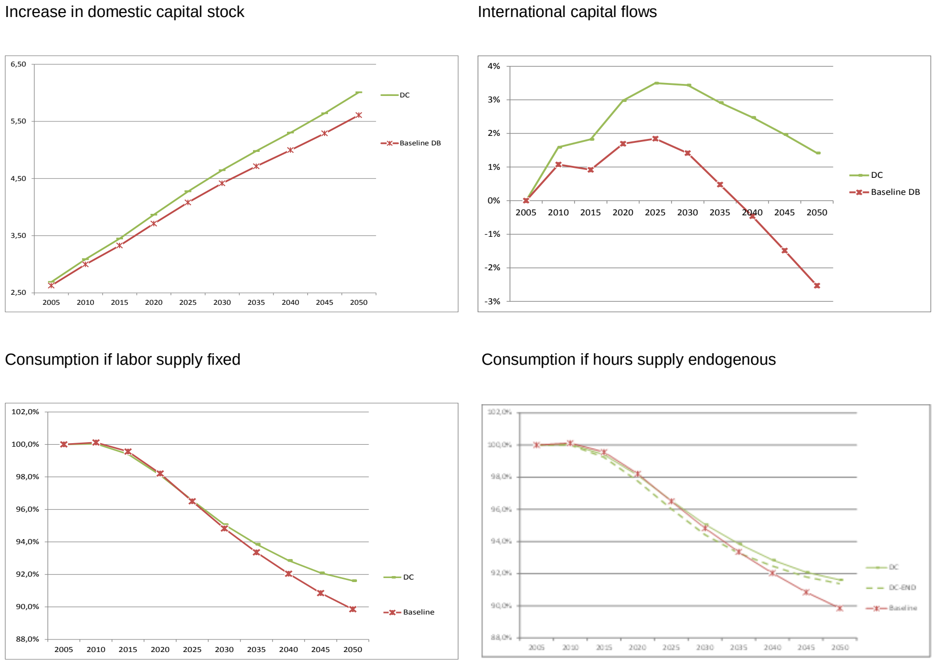
- the replacement rates are constant and roughly correspond to the 2010 levels (OECD, 2013). This corresponds to a PAYG-DB system; the contribution rate adjusts accordingly to maintain a balanced budget;
- the contribution rates are frozen at their 2010 levels corresponding to a PAYG-DC system; the replacement rate adjusts accordingly to maintain a balanced budget.

As in Section 3.2.3, these changes are assumed to occur gradually (linearly) between 2005 and 2030.

Chart 14 shows the resulting increase in the EU3's capital stock, expressed in relation to GDP and for the case of exogenous labor supply. The base case is a PAYG-DB system in which the replacement rate is fixed. In a PAYG-DC system, the declining replacement rate induces workers to save more for their retirement, resulting in a larger domestic capital stock. Moreover, also international capital flows increase substantially to about 3.5 percent of GDP, more than offsetting the reversal after 2035 in the baseline scenario since the new young cohorts keep building up assets to finance their retirement consumption. The higher capital stock plus the larger foreign assets lead to higher consumption per capita. Such pension reform steps will not only generate reaction in saving behavior but also influence labor supply. However, compared to the reactions to labor market reform, the negative behavioral responses are small as can be seen in the lower panels of Chart 14.

Chart 14

Pension reform



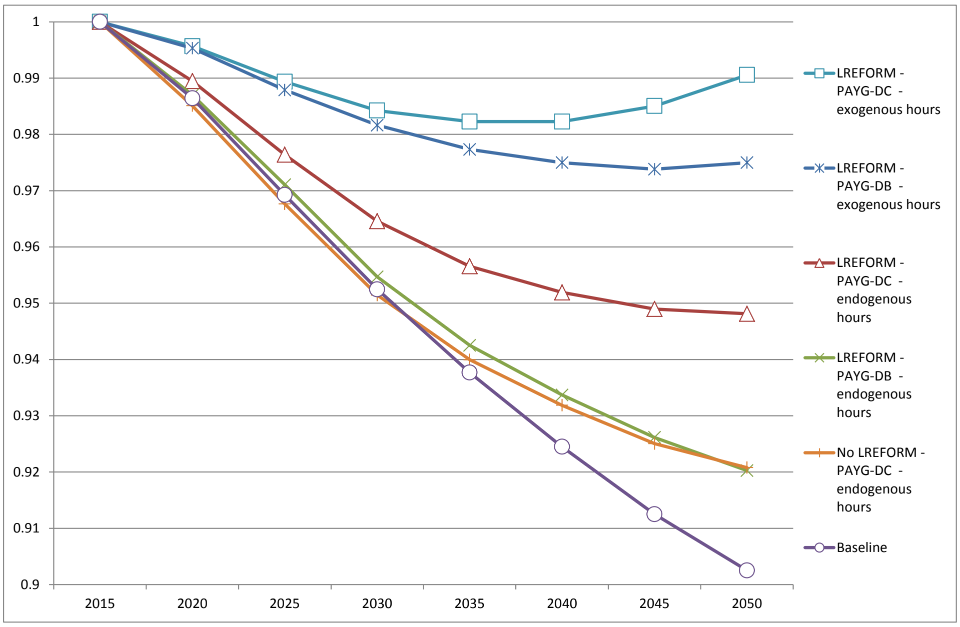
Note: Based on Börsch-Supan, Härtl and Ludwig (2014). Capital stock is a multiple of GDP. Capital flows are saving minus domestic investment in Europe, normalized to a balance of 0.91% in 2015. All other series normalized to 100% in 2005. All figures net of TFP growth.

5.2 Policy interactions

Due to the interaction effects between pension system and labor markets, a smart combination of pension and labor market policies can do more than each of such policies in isolation. These interaction effects are shown in Chart 15. It combines the reform steps in Section 3.2.3 with those of Section 5.1. Such a combination will reduce the baseline decline of consumption per capita (circles in Chart 15) to about a half (triangles in the chart). While creating more labor supply and switching from a DB to a DC pension system would increase de-trended consumption per capita each by about 1.8 percentage points, the combined effect of labor market and pension reform is 4.8 percentage points, including their interactions which are about 25% of the total effect.

Chart 15

Consumption per capita when policies are combined



Source: Updated from Börsch-Supan, Härtl and Ludwig (2014). Note: Variables are normalized to 100% in 2005 and net of TFP trend.

The biggest obstacle to further reductions are the backlash effects generated by the high preference for leisure and other incentives captured by the interplay between the hours' limit $\bar{h}$ and the exogenous labor volume l_j (difference between triangles and squares in Chart 15).

While the strong substitution between endogenous hours h_j and exogenous labor volume l_j in our model may generate too pessimistic an estimate of the reform backlash and its effects on economic growth, the fact that France, Germany and Italy are currently reverting pension and labor market reforms enacted by their predecessors shows how real the governments' fear of resistance to reform is. Institutions with a long-run view of the economy – such as central banks – may see as one of their tasks to strengthen long-run views also in fearful governments.

6 Microeconomic underpinnings

While the core of paper addresses macroeconomic issues, the behavioral assumptions of our basic model rely on microeconomic underpinnings and need micro data to be understood and justified. We address four fundamental aspects: the propensity to save, the forward view of households, and the productivity and health of an aging work force.

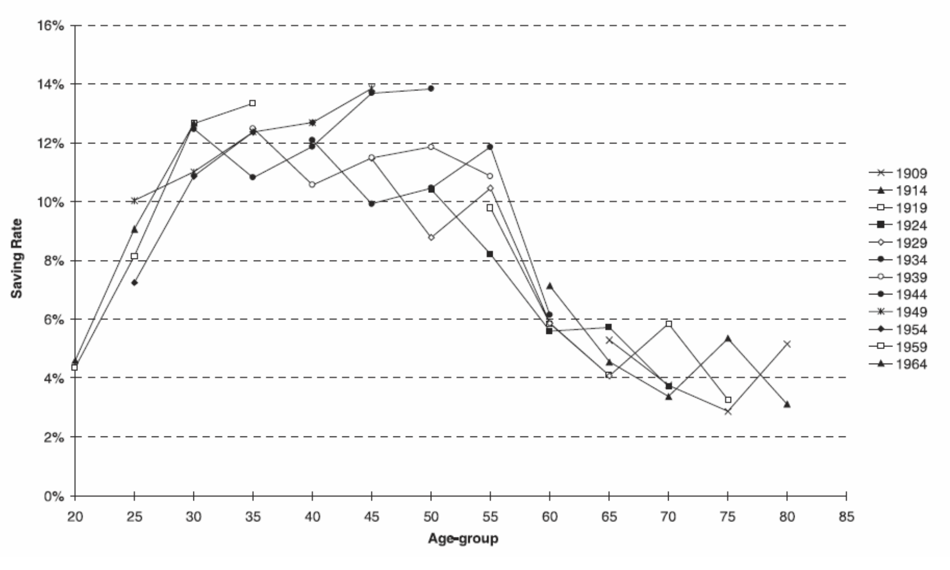
6.1 Life-cycle saving behavior

Does population aging decrease household saving? Theoretical arguments that establish this link build on the well-known life-cycle theory of consumption and savings by Modigliani, Ando and Brumberg (Modigliani and Brumberg, 1954; Ando and Modigliani, 1963). The aggregation of individual, cohort-specific life-cycle savings profiles leads to a decrease of national saving rates in an aging economy. In a general equilibrium model of forward-looking individuals, it is not only the current demographic structure that alters the time path of aggregate savings, but also future demographic developments. There are two main channels for effects of demographic change on domestic capital formation. First, decreasing labor supply reduces demand for investment goods since less capital is needed. Second, in a closed economy, a decline in national savings leads to a decline in investment by definition. In an open economy, the link between these two aggregates is broken to the extent that capital is internationally mobile.

While the theory is straightforward, it is less clear to which extent the stylized microeconomic savings theory by Modigliani applies to reality. Chart 16 shows German saving rates by age (corrected for cohort effects). While we recognize the hump-shape predicted by Modigliani, we do not observe any dissaving in old age.

Chart 16

Age-specific saving rates by age and cohort



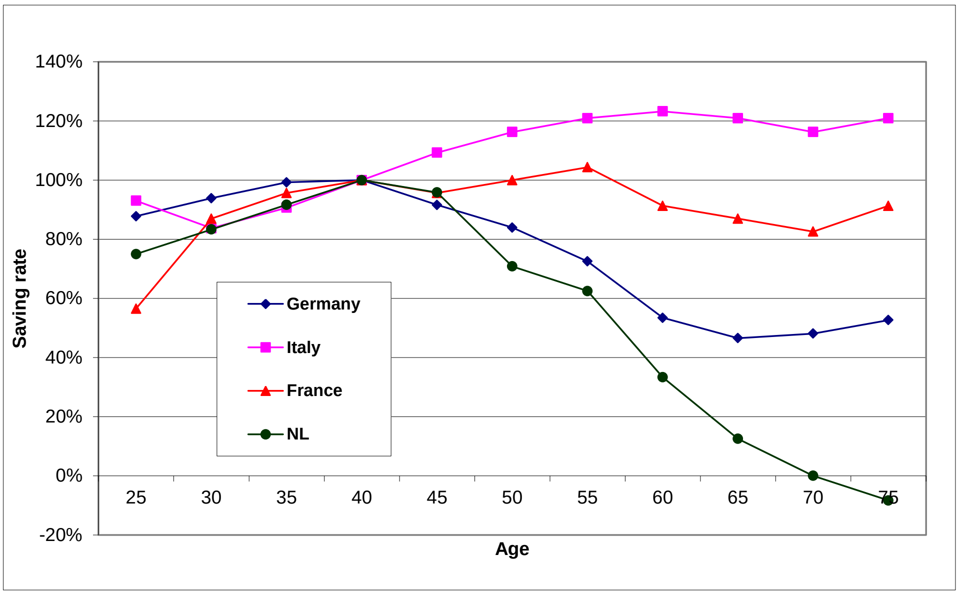
Source: Börsch-Supan, Reil-Held and Schnabel (2003).

This sheds considerable doubt on the realism of predictions based on the simple life cycle hypothesis. Such predictions are likely to overestimate the decline of saving rates if the true saving behavior looks more like Chart 16. We do not know much, however, about how the current saving behavior might change in the face of global aging. In particular, pension reform away from pay-as-you-go-financed pensions towards funded pensions might change saving behavior because it revives the retirement saving motive. To understand this, we need cross-national studies on saving behavior, since only international comparisons provide the policy variation needed for such analysis.

The power of such studies can be seen in Chart 17 which shows, by age group, median saving rates in France, Germany, Italy and the Netherlands. They are based on a comparable longitudinal framework, represent life-cycle saving purged from cohort effects, and employ comparable variable definitions and data sources as part of the International Saving Comparisons Project (Börsch-Supan, 2003). Newer data is currently collected as part of the Eurosystem's Household Finance and Consumption Survey (HFCS). At this point, the HFCS has still too few waves to construct similar cohort-corrected saving profiles by age.

Chart 17

Age-specific saving rates (cohort corrected)



Source: Börsch-Supan (2003).

The saving profiles in France, Germany and Italy are rather flat and show no dissaving in old age. One possible explanation is that the high replacement rates of the public pension systems in these countries have made private retirement income largely unnecessary. If other saving motives, such as precaution and intergenerational transfers, are more important than retirement saving, age-saving profiles are likely to be much flatter than under the textbook life-cycle hypotheses which predicts saving in young and dissaving in old age. This explanation is in line with the work by Jappelli and Modigliani (1998) who argue that the main mechanism for "retirement saving" in Italy is the PAYG system. While we lack the most appropriate counterfactual – French, German and Italian data from times when these countries had no PAYG systems – Chart 17 depicts the case of the Netherlands which have, as opposed to France, Germany and Italy, only a small base pension provided by their PAYG public pension system. All additional retirement income in the Netherlands has to be provided by (mandatory) savings plans, commonly provided through occupational pension plans. Chart 17 shows that the median Dutch household has a much more pronounced hump-shaped life-cycle savings profile than the median French, German and Italian households, and it exhibits dissaving among the elderly as they draw down their mandatory saving accounts.

This cross-national microeconomic evidence suggests that the consumption-smoothing mechanism employed in the OLG model may be a quite appropriate prediction device. A pension reform towards a multi-pillar system with a substantial portion of funded retirement income will revive the retirement motive for saving in France, Germany and Italy. In fact, these systems will look very similar to the current Dutch system. Hence, it is likely that saving rates among the young will increase (to accumulate retirement savings), and saving rates among the elderly will decline sharply (because they will dissolve their retirement savings).

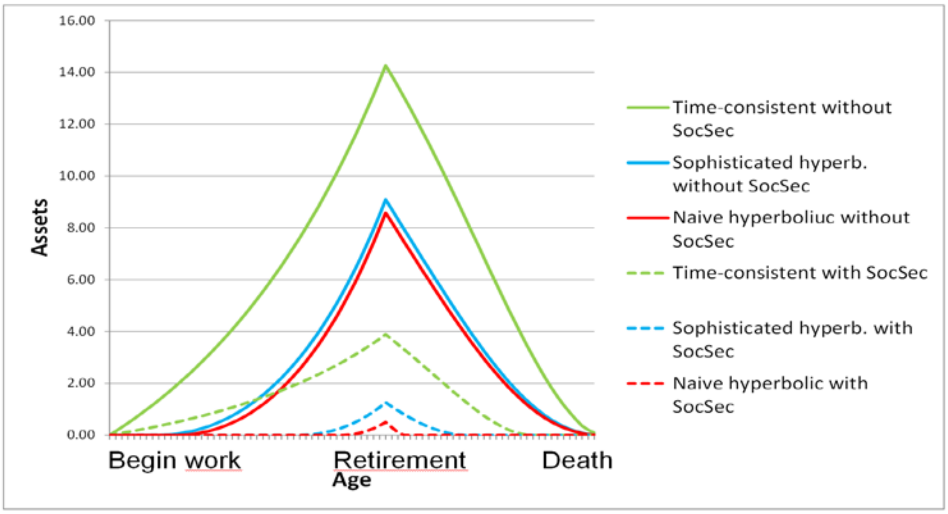
6.2 Myopia and procrastination

Another key assumption is the forward look implicit in the formulation of the households' optimization. Will our conclusions change if human behavior is less rational than assumed so far? Börsch-Supan, Härtl and Leite (2017) have developed multi-country OLG models with households who exhibit time-inconsistent behavior by postponing saving decisions.

The main implication of such behavior is that saving rates will be lower. Hence, assets at retirement (Chart 18) and, as a consequence, also international capital flows (Chart 19) will be lower if procrastinating behavior ("pb") prevails. The basic patterns, however, remain qualitatively unchanged relative to time-consistent ("tc") behavior. Hence, our main conclusions drawn in Sections 3 and 5 are relatively robust even if one deviates from the neo-classical life-cycle hypothesis/permanent income paradigm.

Chart 18

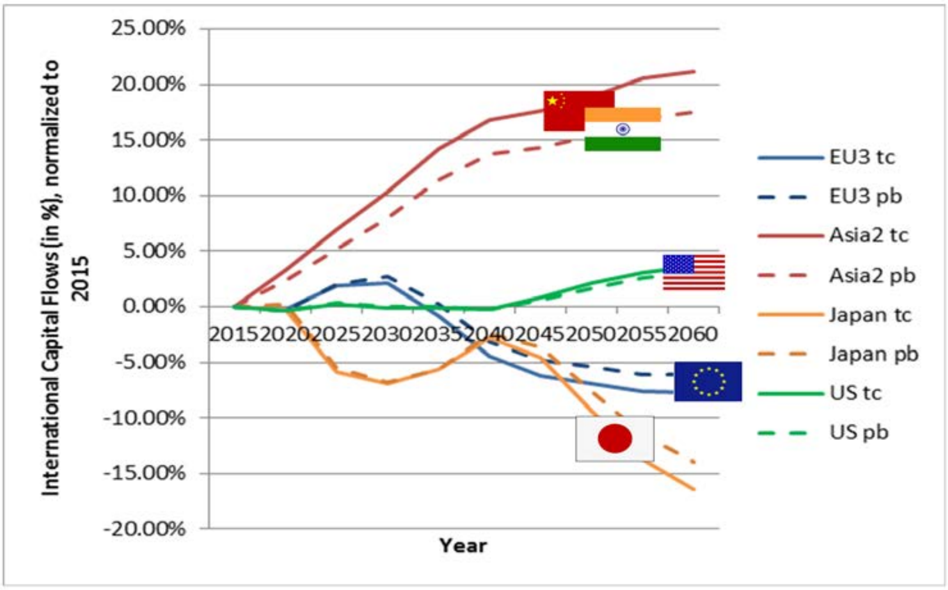
Asset accumulation and decumulation for time-consistent and procrastinating individuals, with and without a pay-as-you-go system



Source: Börsch-Supan/Härtl/Leite 2017.

Chart 19

International capital flows under time-consistency and procrastination



Source: Börsch-Supan/Härtl/Leite 2017.

6.3 Age, productivity and health

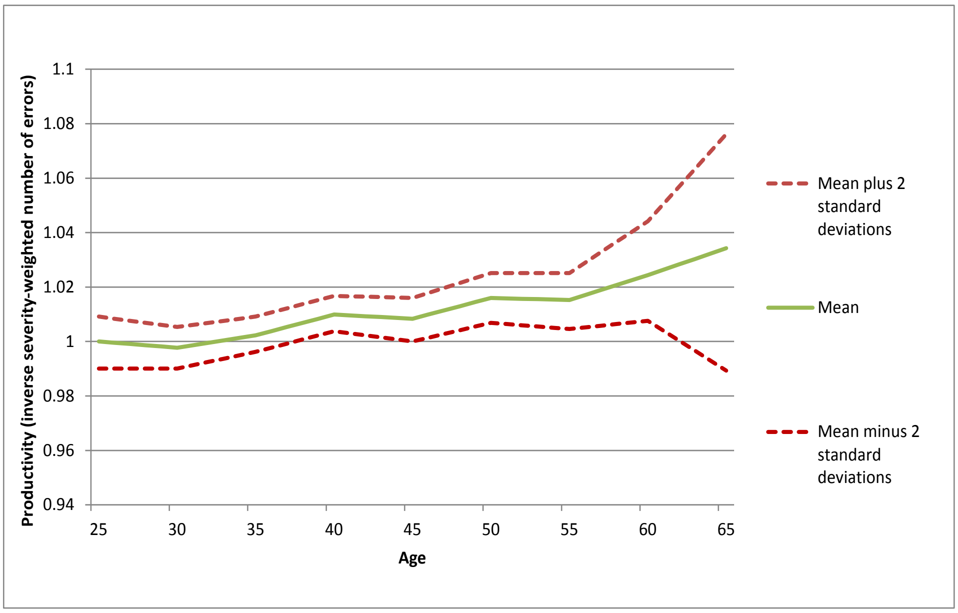
Our basic macroeconomic model distinguishes cohorts only by their size. Age per se, however, and its implications on productivity and health, is absent in our abstract model. The implicit assumption is that health and productivity are flat across the relevant age range.

This is a controversial assumption. With regards to productivity, the macroeconomic literature usually assumes an increasing and then decreasing profile with a peak somewhere between age 30 and 45 (e.g., the seminal work by Altig et al. 2001). Similarly, health is assumed to decline sharply around retirement age.

Recent microeconomic evidence differs from these assumptions that are often dubbed as “stylized facts”. Börsch-Supan and Weiss (2016) and Börsch-Supan, Hunkler and Weiss (2019) have observed productivity in taylorized production processes in the manufacturing and service industry using very big data sets and econometric methods avoiding artefacts from the omnipresent selection effects in labor demand and supply. As opposed to the frequently taken view, productivity is essentially flat over the relevant age range. This holds both for the manufacturing (automotive assembly, Chart 20) and the service industry (insurance, Chart 21).

Chart 20

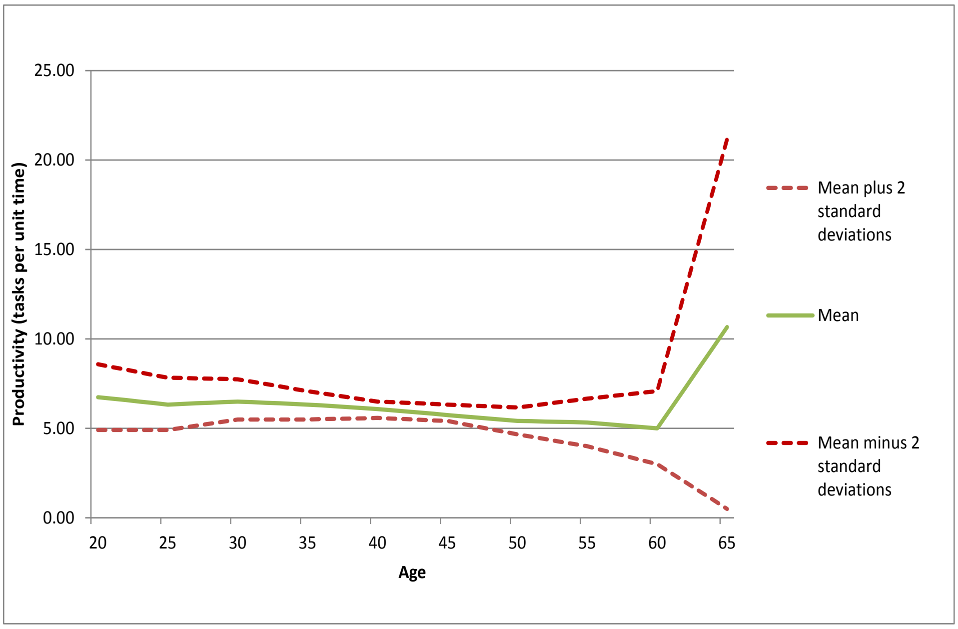
Age-specific productivity in automotive assembly



Source: Börsch-Supan and Weiss, 2016.

Chart 21

Age-specific productivity in the insurance industry

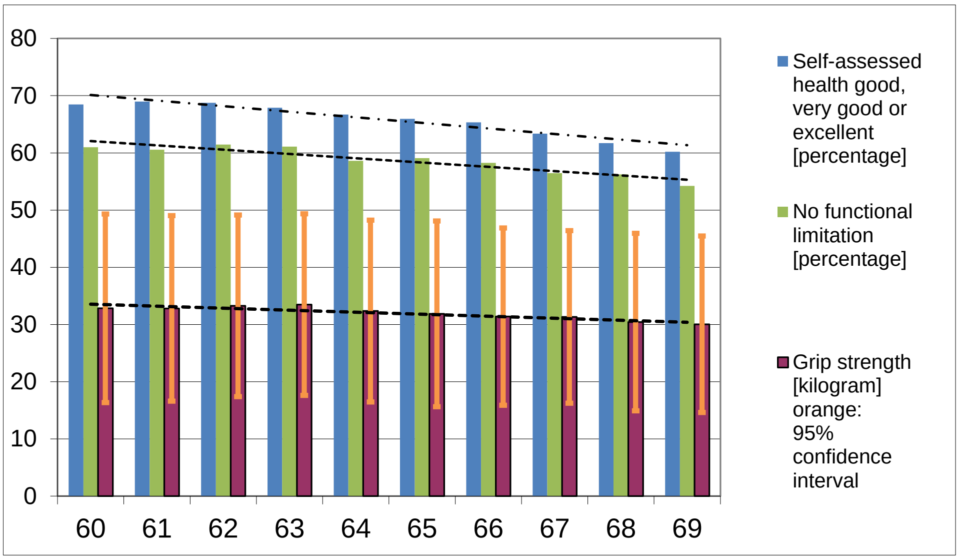


Source: Börsch-Supan, Hunkler and Weiss, 2019.

Data from the Survey of Health, Ageing and Retirement in Europe (SHARE) show that health changes less with age than often assumed (Börsch-Supan et al. 2013). Chart 22 shows the development of self-rated health (blue bars), functional health (green bars) and muscular strength (red bars). They decline very slowly during the "retirement window". The error bands on the red bars show that within cohort variation is much larger than the difference in average health between 60 and 69 year old persons.

Chart 22

Subjective and functional health by age in 11 euro-zone countries



Source: Own computation using data from the Survey of Health, Ageing and Retirement in Europe.

Charts 20-22 show that there is no such thing as a fixed age at which old-age begins as suggested by the definition of old-age dependency ratios (e.g., in Section 2.1 and Chart 1). The false belief in a fixed beginning of old age also underlies the resistance against increasing the retirement age: on the employers' side the belief that productivity is low for older workers; on the employees' side the belief that health is already bad during the retirement window. Our evidence shows that productivity does not decrease measurably between age 55 and 65, and that health is declining only very slowly and smoothly during the retirement window between age 60 and 69.

7 Aging and inflation

So far, this paper has focused on the real economy. However, population aging may also affect inflation. A controversial discussion has emerged on this topic during the last decade. Especially the Japanese experience shows a striking connection between a steady increase of the age dependency ratio and a steady decline in inflation since its peak in the 1970s.

Robert Gordon, Alvin Hansen and Larry Summers called the attention to these twin patterns, which seem to fit in with the idea of that slower population growth and change of population structure are connected and are one of the causes for lower inflation and stagnant growth (Hansen, 1939; Summers, 2014 and Gordon, 2014). The absence of upward pressure of price and wage inflation during the recovery from the Great Recession, also called the “missing inflation puzzle”, has called extra attention to this debate (IMF 2016, 2017; see also Constâncio 2015).

In spite of the suggestive power of the Japanese experience, the current literature does not find a consensus. Results so far show a puzzling mix of contradicting empirical findings. Lindh and Malmberg (1998; 2000) and Juselius and Takáts (2016) look at age structure and inflation and find a robust correlation between the share of net savers (workers) and lower inflation while a higher share of dis-savers (young retirees) boosts inflation. Nishimura and Takáts (2012) find opposite outcomes and state that a larger base of working age people has a positive impact on inflation. Similarly, Gajewski (2015) and Yoon et al. (2014) find a negative relation between the share of older people and inflation for different samples of OECD countries. Katagiri (2012) and Anderson et al. (2014) for Japan, and Bobeica et al. (2017) for the Euro Area, reinforce this view by demonstrating that population aging exhibits deflationary tendencies. Yoon et al. (2014) also find that population growth has a positive impact on inflation for Japan, the same positive correlation found for OECD countries by Shirakawa (2012). In contrast to these findings, McMillan and Baesel (1990) find a negative relation between total population growth and inflation, indicating that shrinkage in population due to aging would lead to inflationary tendencies.

Some papers have offered theoretical explanations of these mechanisms. Examples are Lindh and Malmberg (1998; 2000), Fujiwara and Teranishi (2008), and Galí (2017). These papers take a business-cycle view; the latter two by using Neo-Keynesian models. In this respect, they lack a long-run perspective, which seems necessary in order to understand the impacts of population aging on inflation since the demographic transition is a very slow moving process that takes several decades.

Härtl and Leite (2018) therefore formalize the mechanisms that may explain how demographic change influences inflation with the help of a Computational General Equilibrium (CGE) model based on a long-term OLG structure. A key point of their analysis is to distinguish two components of population aging: a change in the demographic structure and a change in population size. While the lack of population growth is a main driver of deflationary pressures, the change of the demographic structure has an ambiguous effect and shapes the dynamics of inflation. The structure effect depends on which age groups dominate aggregate saving and consumption. If the largest age group is in its high spending years, inflationary tendencies prevail; if the largest age group spends little, deflation dominates. The timing of the babyboom, which is different across countries even within the euro zone (see Charts 1 and 2 in Section 2), thus creates cross-national differences in the relation between simple demographic measures and inflation rates. This may explain some of the apparent contradictions in the above-cited empirical literature.

Chart 23 shows results of the model by Härtl and Leite (2018). It distinguishes total inflation (blue solid line), structure and size effects (dashed lines). The upper panel relate to Germany and France, the lower panels to China and the US. All four countries exhibit a downward trend of inflation (blue solid line). This is due to the size effect: A slowing trend in population growth or even population decline will lead in all countries to a decrease in aggregate consumption that reduces money demand and, hence, exerts deflationary pressures.

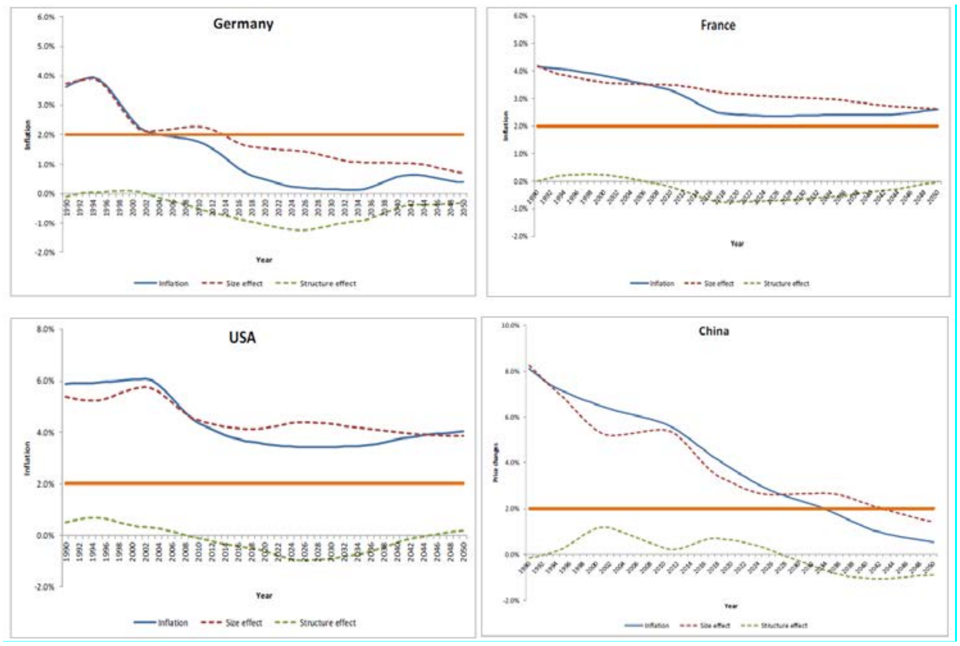
Countries which are far along in a strong demographic transition, such as Germany, already face deflationary pressures while France, with much weaker population aging, still features positive inflation. China will experience a similar trend as Germany in the next decades. Young countries, however, with high fertility rates like France and the US, will further go through inflationary pressures stemming mostly from the size effect. Nevertheless, also in these countries the baby-boom generation will soon approach old age (structure effect). Hence, while inflationary pressures will remain positive, they will be substantially dampened by demographic change in the next decades.

During the period from 2015 to 2025, the structure effect accounts for a reduction of inflation of around 50% relative to the equilibrium steady state in all countries except for China, which still benefits from a higher share of younger population. The decline in the relative size of the age groups, which are at the peak of lifecycle consumption, leads to a decline in consumption and money demand, negatively affecting inflation. This structure effect is especially prominent in the euro zone and the US during the next decade because first the baby-boom, then the baby-bust generations will then enter their retirement and dissaving phase.

The relative magnitudes of size and structure effect depend on the demographic history of a country and its stage in the demographic transition. Simple cross-national comparisons may confound size and structure effect, thereby leading to the contradicting results found in the empirical literature.

Chart 23

Aging and Inflation



Source: Härtl and Leite (2018).

Härtl and Leite (2018) do not claim that inflation dynamics only depend on demographic change. There may be other and dominating reasons for the Japanese experience or the “missing inflation” in spite of the monetary interventions in wake of the Great Recession. Nevertheless, they provide a consistent set of mechanisms, which show that demographic change has long-run impacts on inflation on the one hand and delivers insights on short-run phenomena observed nowadays on the other hand, for instance, the missing inflation puzzle.

8 Conclusions

Global aging will affect labor, product and capital markets in fundamental ways, which will change the growth path of GDP and the wealth of nations. We understand the basic mechanisms behind these changes, are able to trace some of the complex feedback effects in general equilibrium, and have presented some rough orders of magnitudes. Our central result is that economic growth is of course threatened by a declining total labor force and especially a declining ratio of workers to population, the support ratio. The decline of economic growth, however, is lower than the decline of the support ratio.

The first reason is that higher capital intensity, strengthened by digitalization, is a helpful mechanism to increase labor productivity in times of scarcity of labor. Partially, this will happen automatically as the supply of labor and capital will react to increasing wages and falling returns as response to the scarcity of labor relative to capital. While falling returns are far from an “asset meltdown”, they suffice to incentivize an increase in capital intensity.

The second reason is that capital markets can diversify the demographic risks generated by labor scarcity. They are therefore strategic markets in a globally aging world. International capital flows increase GNI relative to GDP for the next few decades and therefore dampen the decrease of economic growth as conventionally measured.

These two endogenous forces – higher capital intensity and larger international diversification – are neither sufficient to fully offset the effect of population aging on economic growth nor will they come as automatically as described by our model.

Public policy needs to take care and can offset the remaining effect of population aging on economic growth. It can influence these slow moving, demographically-driven changes of labor, product and capital markets mainly on the microeconomic level – most directly by adapting labor markets to a situation in which labor is becoming increasingly scarce. The main policy tools in order to utilize labor reserves are retirement, education and child-care policies which increase old-age, young-age and female labor force participation.

However, increasing the retirement age, as natural as it sounds given longer lives, is the “third rail” in politics due to its unpopularity. Pension reforms have created backlashes in France, Italy and Germany, led to new early-retirement pathways and thereby reduced labor supply especially among skilled workers. This paper has modelled these backlash effects; they are large. Section 6 has shown that they rest on wrong assumptions such as declining productivity and health during the relevant age ranges. While it is not the task of central banks to change labor market and pension policies, supporting all policies that strengthen economic growth and contributing to falsifying wrong assumptions is certainly a worthy cause.

Higher capital intensity and larger international diversification may not come as automatically as described by our model. While relying more on capital markets than on the pay-as-you-go mechanism has significant positive side effects on economic growth, bad governance, limited competition and lack of information and transparency have done a lot of damage to the acceptance of funded pension schemes. These problems need to be addressed – including by central banks – when one wants to exploit the positive effects of funding, including capital intensity and larger international diversification.

The international transmission mechanisms that generate the helpful effects of diversification also do not work smoothly. Understanding and minimizing the opposition to the free flow of capital, addressing the sources of instability in global financial markets, and fostering policies that reduce frictions and instability are important goals also for central banks in order to exploit the chances of population aging.

Important for central banks is the insight that aging and inflation are related through complex mechanisms than cannot be easily disentangled in the data by the simple descriptive methods that have produced the contradicting results of the empirical literature on this topic. A key point to understand whether ageing is inflationary or deflationary seems to be the distinction between size and structure effect. The size effect (a shrinking population) leads to lower aggregate demand and thus deflationary pressures. The structure effect depends on which age groups dominate aggregate saving and consumption and can therefore be inflationary or deflationary. The relative magnitude of size and structure effects depend on the demographic history of a country and its stage in the demographic transition, hence different countries can show opposing effects of aging on inflation even if observed at the same calendar time.

Our final point is therefore that the ECB and the central banks in the euro zone face the same dilemma in addressing population aging as in many other monetary policy areas, namely the dilemma between a homogenous policy and heterogeneity across the member countries. Economic growth, the leverage for structural reforms, the extent of policy backlashes, and even deflationary tendencies all depend to some degree on the demographic development which is significantly different even within the euro zone.

References

Abel, A.B. (2001), “Will Bequests Attenuate the Predicted Meltdown in Stock Prices when Baby Boomers Retire?”, *Review of Economics and Statistics*, 83(4), pp. 589–595.

Aksoy, Yunus, Henrique S. Basso, Ron P. Smith, and Tobias Grasl (2019), "Demographic Structure and Macroeconomic Trends," *American Economic Journal: Macroeconomics*, 11 (1): 193-222.

Altig, D. et al., 2001. Simulating fundamental tax reform in the United States. *American Economic Review*, Volume 3, pp. 574-595.

Ando, A. and Modigliani, F. (1963), “The ‘life-cycle’ hypothesis of saving: Aggregate implications and tests”, *American Economic Review*, 89(3), pp. 605–618.

Arnott, R.D., Chaves, D.B. (2012), “Demographic Changes, Financial Markets, and the Economy”, *Financial Analysts Journal*, Vol. 68, No. 1.

Attanasio, O., Kitao, S., and Violante, G.L. (2007), “Global demographic trends and social security reform”, *Journal of Monetary Economics*, 54(1), 144-198.

Auerbach, A.J. and Kotlikoff, L.J. (1987), *Dynamic Fiscal Policy*. Cambridge, MA: Cambridge University Press.

Ball, L. and Mankiw, N.G. (2002), “The NAIRU in Theory and Practice”, *Journal of Economic Perspectives* 16(4), pp. 115-136.

Bloom, D.E. and Williamson, J.G. (1998), “Demographic transitions and economic miracles in emerging Asia”, *World Bank Economic Review*, 12(3), pp. 419–455.

Bobeica, E., Lis, E., Nickel, C. and Sun, Y. (2017), “Demographics and inflation”. *ECB Working Paper* 2006, January, pp. 1-25.

Börsch-Supan, A. (ed.) (2003), *Life-Cycle Savings and Public Policy*, New York: Academic Press.

Börsch-Supan, A. and Ludwig, A. (2009), “Aging, Asset Markets, and Asset Returns: A View from Europe to Asia”, *Asian Economic Policy Review*, 4(1), pp. 69-92.

Börsch-Supan, A. and Ludwig, A. (2010), “Old Europe is Aging: Reforms and Reform Backlashes”, In: Shoven, J. (ed.): *Demography and the Economy*, University of Chicago Press, Chicago, pp. 169-204.

Börsch-Supan, A., Ludwig, A. and Winter, J. (2007), “Aging, Pension Reform, and Capital Flows: A Multi-Country Simulation Model”, *Economica*, 73, pp. 625-658.

Börsch-Supan, A., Reil-Held, A. and Schnabel, R. (2003), “Household Saving in Germany”, In: Börsch-Supan, A. (ed*.), Life Cycle Savings and Public Policy*, Elsevier Science, pp. 57-99.

Börsch-Supan, A., Härtl, K. and Ludwig, A. (2014), “Aging in Europe: Reforms, International Diversification, and Behavioral Reactions”, *American Economic Review* P&P 104, pp. 224-229.

Börsch-Supan, A., and Weiss, M. (2016), “Productivity and age: Evidence from work teams at the assembly line”, *The Journal of the Economics of Ageing* 7, pp. 30-42.

Börsch-Supan, A., Brandt, M., Hunkler, C., Kneip, T., Korbmacher, J., Malter, F., Schaan, B., Stuck, S. and Zuber, S. (2013), “Data Resource Profile: The Survey of Health, Ageing and Retirement in Europe (SHARE)”, *International Journal of Epidemiology*, 42(4), pp. 992-1001.

Börsch-Supan, A., and Rausch, J. (2019), “Zukünftige Leistungen und Kosten der gesetzlichen Rentenversicherung in Deutschland, 2020-2060”, MEA Discussion Paper.

Börsch-Supan, A., Hunkler, C., and Weiss, M. (2019), “Big Data at Work: Age and Labor Productivity in the Service Sector”, MEA Discussion Paper.

Brooks, R. (2002), “Asset-Market Effects of the Baby-Boom and Social-Security Reform”, *American Economic Review*, 92 (2), pp. 402-406.

Carvalho, C., Ferrero, A., and Nechio, F. (2016). Demographics and real interest rates: Inspecting the mechanism. *European Economic Review*, 88(C):208-226.

Constâncio, V. (2015). Understanding inflation dynamics and monetary policy. Speech at the Jackson Hole Economic Policy Symposium.

Fujiwara, I. and Teranishi, Y. (2008), “A dynamic new Keynesian life-cycle model: Societal aging, demographics, and monetary policy”, *Journal of Economics Dynamics & Control* 32(8), pp. 2507-2511.

Gagnon, E., Johannsen, B. K., and Lopez-Salido, J. D. (2016). Understanding the New Normal: The Role of Demographics. Finance and Economics Discussion Series 2016-080, Board of Governors of the Federal Reserve System (U.S.).

Gajewski, P. (2015), “Is ageing inflationary? Some evidence from OECD countries”, *Applied Economics Letters*, 22(11), pp. 916-919.

Galí, J. (2017), “Monetary Policy and Bubbles in a New Keynesian Model with Overlapping Generations”, *Working Papers* 959, Barcelona Graduate School of Economics.

Gordon, R.J. (2014), “The Demise of U.S. Economic Growth: Restatement, Rebuttal, and Reflections”, *NBER Working Paper* Series 19895, February, pp. 1-43.

Hansen, A.H. (1939), “Economic Progress and Declining Population Growth”, *The American Economic Review*, 29(1), pp. 1-15.

Härtl, K. and Leite, D.N. (2018), “The Aging-Inflation Puzzle: on the Interplay between Aging, Inflation and Pension Systems”, *MEA Discussion Papers*, 06-2018

Hutchens, R.M. (2001), “Employer Surveys, Employer Policies, and Future Demand for Older Workers”, *Paper prepared for the Roundtable on the Demand for Older Workers*, The Brookings Institution, March 2001.

IMF (2016), “Global Disinflation in an Era of Constrained Monetary Policy”, Chapter 2, *World Economic Outlook*, October.

IMF (2017), “Recent Wage Dynamics in Advanced Economies: Drivers and Implications”, Chapter 2, *World Economic Outlook*, October.

Jappelli, T. and Modigliani, F. (1998), “The age-saving profile and the life-cycle hypothesis”, *CSEF Working Paper* 4, University of Salerno.

Juselius, M. and Takáts, E. (2016), “The age-structure-inflation puzzle”, *Bank of Finland Research Discussion Paper* 4/2016.

Katagiri, M. (2012), “Economic Consequences of Population Aging in Japan: Effects through Changes in Demand Structure”, *IMES Discussion Paper* 2012-E-3.

Kruger, D., Ludwig, A. (2007), On the consequences of demographic change for rates of returns to capital, and the distribution of wealth and welfare, *Journal of Monetary Economics* 54 (1), 49–87.

Lindh, T. and Malmberg, B. (1998), “Age structure and inflation - a Wicksellian interpretation of the OECD data”, *Journal of Economic Behavior & Organization*, 36, pp. 19-37.

Lindh, T. and Malmberg, B. (2000), “Can Age Structure Forecast Inflation Trends?”, *Journal of Economics and Business*, 52, pp. 31-49.

Mankiw, Gregory N., and David N. Weil (1989): “The Baby-Boom, the Baby-Bust and the Housing Market,” *Regional Science and Urban Economics* 19, 235-258.

McMillan, H.M. and Baesel, J.B., (1990), “The Macroeconomic Impact of the Baby Boom Generation”, *Journal of Macroeconomics*, 12 (2), pp. 167-195.

Miles, D. (1999), “Modeling the impact of demographic change upon the economy”, *Economic Journal*, 109, pp. 1–36.

Modigliani, F. and Brumberg, R. (1954), “Utility analysis and the consumption function: An interpretation of cross-section data”, In: Kurihara, K.K. (ed.): *Post-Keynesian Economics*. New Brunswick: Rutgers University Press, pp. 388-436.

National Research Council (2012), *Aging and the Macroeconomy. Long-Term Implications of an Older Population,* National Academies Press, Washington, DC. Committee on the Long-Run Macroeconomic Effects of the Aging U.S. Population.

Nishimura, K. and Takát, E. (2012), “Ageing, property prices and money demand”, *BIS Working Paper* 385.

OECD (2013), *Pensions at a Glance 2013: OECD and G20 Indicators*, OECD Publishing.

Poterba, J.M. (2001), “Demographic structure and assets returns”, *Review of Economics and Statistics*, 83(4), pp. 565–584.

Shirakawa, M. (2012), “Demographic Changes and Macroeconomic Performance: Japanese Experiences”, *Opening Remark at 2012 BOJ-IMES Conference*.

Statistisches Bundesamt (German Statistical Office) (2003), *10. Koordinierte Bevölkerungsvorausschätzung*, Wiesbaden.

Summers, L.H. (2014), “Reflections on the 'New Secular Stagnation Hypothesis'”, In: Teulings, C. and Baldwin, R. (eds.) *Secular Stagnation: Facts, Causes, and Cures*. London, UK: CEPR, pp. 27-40.

United Nations Population Division (2017), *World Population Prospects: The 2017 Revision*. New York: United Nations, , retrieved 26.Apr.2019.

Yoon, J.-W., Kim, J. and Lee, J. (2014), “Impact of Demographic Changes on Inflation and the Macroeconomy”, *IMF Working Paper* 14-210.