Demographic Developments, Funded Pension Provision and Financial Stability

The following study analyzes the impact of demographic developments in Austria on the long-term average real interest rate, funded pension provision and the implications of demographic developments for the stability of the financial system. The key results of this study are twofold: (1) Households' net supply of savings and the demand for capital by the corporate sector both need to be integrated into the empirical and theoretical analysis of the impact of demographic developments on financial markets. (2) In addition, funded pension provision is exposed to demographic risks.

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The impact of demographic developments on financial stability is frequently discussed in the economic literature using the "asset meltdown" hypothesis. According to this theory, an increase in the share of pensioners as a percentage of the total population triggers a decline in asset prices, as pensioners dissave in old age and, owing to this demographic development, there might be fewer economically active persons who act as buyers in the capital markets. Following a methodological critique of this hypothesis, an alternative conceptual framework which is better suited to the current object of investigation is presented. Within this framework, variables are identified that are of cardinal importance for the relationship between demographic developments and the stability of both financial intermediaries and financial markets. Since some of the effects identified are diametrically opposed to each other, their relative significance within the conceptual framework is examined by means of quantitative simulations. The implications of the theoretical and quantitative results for both the stability of financial intermediaries in the arena of funded pension provision and financial stability will be analyzed in the final section. The key results of this study are twofold: (1) Households' net supply of savings and the demand for capital by the corporate sector both need to be integrated into the empirical and theoretical analysis of the impact of demographic developments on financial markets. (2) In addition, funded pension provision is exposed to demographic risks.

Demographic Developments in Austria

According to Statistics Austria (2003), the Austrian population is projected to grow modestly from 8.12 million to 8.21 million until 2050 thanks to positive net migration, in particular (table 1).

Table 1

Population Growth in Austria from 2000 to 2050

Age	Population structure in 1,000			Population structure in %		
	2000	2020	2050	2000	2020	2050
0 to 14	1,351	1,180	1,087	16.64	14.17	13.25
15 to 65	5,510	5,455	4,782	67.85	65.50	58.27
Over 65	1,260	1,693	2,337	15.51	20.33	28.48
Total population	8,121	8,328	8,206	100.00	100.00	100.00

Source: Statistics Austria, 2003.

Refereed by Elisabeth Springler, OeNB.

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Despite positive net migration, a dramatic change in the population's age structure is expected. The share of people of working age (15 to 65) will fall from 67.85% in 2000 to 65.5% in 2020 and amount to only 58.27% in 2050. In addition, the share of children and adolescents (aged 0 to 14) will decline from 16.64% (in 2000) to 14.17% (in 2020) and fall to 13.25% in 2050. According to Statistics Austria, the birth rate is expected to be constant between 2002 and 2050 with 1.4 births per woman aged 15 to 45. Until the year 2050, life expectancy at birth will increase from 75.8 years (for men) and 83 years (for women) in 2002 to 80.2 and 88 years, respectively. The life expectancy of 60-year-olds will rise from 20.1 (for men) and 24.2 (for women) to 25.5 and 29.4 years, respectively.

Two demographic factors are of particular interest for the following analysis: (1) the long-term average rise in the number of economically active people (i.e. employees and the self-employed) and (2) the ratio of not economically active persons (including the unemployed) to economically active persons. The average rise in the number of economically active persons over the respective preceding 20-year period will fall steadily from 0.3% (in 2000) to –0.16% (in 2030) to then rise back slightly to –0.05% by 2050. The ratio of not economically active to economically active persons will increase from about 83% (in 2000) to some 97% in 2050.

Funded Pension Provision in Austria

What is the extent of funded pension provision in Austria? Table 2 shows that, in the period from 1999 to 2004, passbooks on which a total of some EUR 115 billion were held were the most important savings vehicle (23.68 million savings accounts of domestic nonbanks, of which around 5.67 million were building loan contracts). However, no distinction can be made between long-term pension provision in the form of the passbook and short-term saving motives. Traditional life insurance with some 9.5 million individual and group policies (in 2003) and a premium reserve fund of around EUR 40 billion (in 2004) are widely used. Since 1999, pension products geared more to capital markets have gained in relative importance. In particular, demand for retail funds (about EUR 70 billion, including some 60,000 contracts of subsidized personal pension schemes (*Zukunftsvorsorge*) offered by investment

Table 2

Key Long-Term Saving Vehicles in Austria from 1999 to 2004

EUR million

	1999	2000	2001	2002	2003	2004
Pension funds (total assets)	7,300	7,833	8,037	7,876	9,122	10,126
Severance funds (assets of collective investment funds)	–	–	–	–	146	363
Life insurance premium reserve funds[1])	28,323	31,192	33,802	35,656	37,645	40,771
Savings excluding building loan contracts	105,869	102,942	108,180	110,481	114,472	112,806
Building loan contracts	15,998	16,278	16,644	16,504	16,923	17,680
Retail funds[2])	–	54,038	58,319	57,492	64,100	70,816
Of which pension investment funds	–	217	179	238	373	711

Source: FMA, OeNB, OeKB, Austrian occupational pension fund association, adapted by FMA 2004;

[1]) Estimated reinsurance values for 2004. Domestic insurance companies excluding small mutual insurance companies.

[2]) Retail funds minus investment by mutual funds in domestic investment certificates.

companies, KAGs), unit and index-linked life insurance policies (some EUR 3.3 billion, including around 420,000 subsidized personal pension contracts offered by insurance companies) and pension funds (about EUR 9.6 billion and some 413,000 beneficiaries, including prospective beneficiaries) has grown following the debate on the stability of the public pension system. At EUR 299 million, the volume of severance funds is still low despite some 2.2 million qualifying periods, as these funds were introduced only in 2003.

The volume of funded pension provision (in particular, pension funds, severance funds and subsidized personal pension schemes) is therefore relatively high overall, even if accumulated contributions and the number of contracts remain well below those of savings and building loan contracts, as many products were launched only recently. In the next few decades, however, funded pension provision will make considerable advances and gain in relative importance for financial stability.

To analyze the impact of demographic developments on financial stability, there are basically two starting points: (1) Consumption by not economically active persons arises from claims involving an economic interest and social security claims on national income that is generated by economically active persons, thereby inducing nonconsumption by the latter – provided the consumption is not funded by investment income. (2) The decline in the number of economically active persons impacts on economic growth, capital productivity and the demand for capital. The first correlation is generally discussed primarily within the framework of the "asset meltdown" hypothesis and largely in isolation from the second. In this study, a conceptual framework is developed to facilitate the integrated analysis of both these effects.

The "Asset Meltdown" Hypothesis

The "asset meltdown" hypothesis is based on expectations about the medium- to long-term momentum of both total saving by economically active persons and dissaving (due to consumption) by pensioners. The impact of these expectations on financial markets is examined within the conceptual framework of overlapping generations (overlapping generations or OLG models).[2] According to this model, the baby boom generation – i.e. the wave of children born in 1957–70 – will be in a very productive phase of their working life in the period from 1990 to 2020, which will be marked by relatively high income and, consequently, relatively high net savings. Insecurity about future pensions funded by public contribution systems will also boost net savings. In the period from 2020 to 2030, the baby boom generation will enter retirement. Baby boomers will defray a portion of their consumption from savings invested for this purpose and thus sell their assets. Since the next generation to enter a particularly productive phase of economic activity in this period will be smaller owing to demographic developments, the balance between buyers and sellers will be skewed toward the latter. When the baby boom generation reaches retirement, this will trigger a slump in the prices of assets traded in financial markets. The impact of

[2] *Inter alia Toporowski (2000); England (2002); Geanakoplos et al. (2002).*

demographic developments on both the demand for real capital and marginal capital productivity is not accounted for by the "asset meltdown" hypothesis.

The "asset meltdown" hypothesis is considered to be a highly unlikely scenario in economic literature, as pricing in financial markets is seen to have sufficient flexibility to anticipate the price effects arising from baby boomers' dissaving. Instead of a one-off price effect arising from the transition between generations, price adjustment occurs over a relatively lengthy period, thereby preventing a sudden slump in prices. Many critics of the "asset meltdown" hypothesis contend that equity prices are determined primarily by the discounted present value of dividends expected in future and therefore do not depend on dissaving by pensioners. However, this counterargument does not hold water. In fact, the effect of falling equity prices also arises within the analytical framework of this study, as the discount factor and expected future returns are not independent of demographic developments.[3]

The empirical evidence for a historical correlation between demographic developments and *financial market prices* is not clear.[4]

– Econometric models generally disregard the interaction between the supply of savings and the demand for capital.[5] However, the latter is not independent of the rise in economically active persons, a demographic variable. If the demand for real capital is not integrated into the model, the corresponding effects will be wrongly interpreted as effects arising from pensioners' dissaving. The econometric models cannot differentiate between shifts in the supply curve along the demand curve and shifts in both curves. An equation of the demand for capital, accounting for the impact of demographic developments on the demand curve, should also be integrated into these estimations.
– Price formation in financial markets is frequently modeled as based on rational expectations. Demographic developments can be extrapolated relatively far into the future as soon as the relevant cohorts are born. This is why the price effects arising from the retirement of the baby boom generation should have already taken place many years ago. However, there is no empirical evidence for this.[6]
– Frequently, in addition to demographic variables, control variables (e.g. the long-term real interest rate, dividend growth) are included in the estimation equations.[7] Since, however, these variables are not independent of demographic developments, the estimations of the parameters and their standard deviation can be distorted owing to the multicolinearity of the independent variables.

[3] *Lueg et al. (2003).*
[4] *Poterba (2004).*
[5] *These econometric analyses are implicitly based on an interest rate theory, according to which real interest rates and asset prices are determined by both saving and dissaving decisions within the household sector and not in capital markets by households' net savings and the corporate (and public) sector's demand for capital as in the neoclassical loanable funds theory, or in money markets as in accordance with Keynesian theory.*
[6] *Davis and Li (2003); Poterba (2004).*
[7] *Davis and Li (2003).*

- The specification of the variables representing demographic development (e.g. absolute or relative cohort sizes, average age) is not trivial and strongly influences the results.
- In addition, the growing global integration of financial markets since the end of the Bretton Woods system does not facilitate this analysis, as the impact of national demographic developments on national equity and bond prices is becoming weaker.[8] This is why, in empirical studies, this phenomenon should be explicitly accounted for in the estimation equations.

Furthermore, the baby boom generation's expected *dissaving behavior* is not undisputed empirically. Empirical studies on a correlation between demographic developments and aggregated saving behavior at a macrolevel do not provide any clear results.[9]

- This lack of clear results is primarily due to the fact that identifying the effect of demographic changes requires very long horizons of observation. As a result, the number of observations appears to be much higher than the number of statistically utilizable independent observations actually is, so the effective degrees of freedom are reduced.[10] Saving behavior depends on several factors that evolve far more frequently than demographic developments and that can obscure the impact of these developments. In particular, the institutional framework of saving behavior (e.g. confidence in the public pension system, government measures to promote wealth accumulation) has undergone a sea change since 1950.
- In addition, in the empirical analysis of saving behavior, different specifications of demographic variables have an impact on the results.
- The inclusion of bequest motives also makes the analysis of saving behavior in old age problematic. Bequests can increase the total savings of pensioners and reduce that of potential heirs.
- The small size of annuity markets generates a further saving motive in retirement as well – the precautionary motive, which is positive owing to uncertainty surrounding the time of death.
- Households' unequal distribution of assets makes statistical analysis at a microlevel difficult, as wealthy households are often underrepresented in samples.[11]
- Many empirical studies go as far as identifying a positive saving rate among pensioners. This can be explained primarily by the fact that transfer income, which pensioners receive owing to their claims on a pension fund or on the public pension system, is classified as aggregate income instead of aggregate dissaving.
- In addition, a significant statistical correlation between the aging of society and saving behavior does not indicate direct causality unless all control variables are included. The aging of society can have an indirect effect on saving behavior (e.g. lower net marginal capital productivity).[12]

8 *Davis and Li (2003).*
9 *Dirschmid and Glatzer (2004).*
10 *Poterba (2004).*
11 *Bosworth et al. (2004).*
12 *McCarthy and Neuberger (2003).*

This study is not based on the conceptual framework of overlapping generations, as this framework frequently limits price effects to the transition between consecutive generations and so does not do justice to the pricing mechanism in financial markets. Furthermore, the results are very sensitive to the assumptions and the structure of certain models.[13] Instead, the real impact of demographic developments and the dissaving momentum of different generations are integrated into a growth theory framework. Since empirical studies on the correlation between age and saving behavior do not provide any clear results, reference is made to consumption by not economically active persons and not to their saving behavior. Furthermore, this conceptual framework integrates contrary effects arising from both the change in demographic structure (growing overall consumption by pensioners) and the decline in population (demand for real capital) on the long-term average real interest rate.

Demographic Developments and Real Interest Rates

The impact of demographic developments on the real interest rate can be conceptually represented by a neoclassical growth model.[14] Since primarily the effects on real variables of a change in the rise of the number of economically active persons are to be tested, a supply-oriented conceptual framework is best suited to the problem. The model is guided by a large number of simplifying assumptions: In the long term, prices are assumed as having sufficient flexibility to ensure an equilibrium in goods, finance and labor markets in each period. In addition, the analysis disregards many other possible influencing factors for real interest rates. Since this model operates with real parameters only, potential monetary factors do not play a role. In other words, above all, monetary policy, inflationary expectations and financial market volatility are excluded on heuristic grounds. Moreover, a closed economy is assumed. The analysis confines itself to the correlation between demographic developments and output potential, as well as to marginal capital productivity. It is also assumed that technological progress is exogenous and not factor-related, i.e. that it is solely a function of time and increases the productivity of the overall stock of the relevant factor and not only that of the flow in the latest period.

What Is the Correlation between Demographic Variables and the Real Interest Rate in the Neoclassical Growth Model?

The equilibrium growth path for exogenous, not factor-related Harrod-neutral technological progress is derived from an output function of a general form as follows:

$$Y(t) = F[A^K(t)K(t), A^L(t)L(t)] \quad (1)$$

This function is continuously differentiable and satisfies some additional conditions: output per unit of labor and marginal capital productivity stock per unit of labor are defined as y and k so that $y = f(k)$. In addition, marginal capital productivity per unit of labor is positive $f'(k) > 0$ but decreases as the capital stock per

[13] *McCarthy and Neuberger (2003).*

[14] *The corresponding model can be found in any textbook on macroeconomics and growth theory. The representation selected here follows Mankiw (1997) and Frenkel and Hemmer (1999).*

unit of labor increases ($f''(k) < 0$) and as $\lim_{k\to 0} f'(k) = \infty$, $\lim_{k\to\infty} f'(k) = 0$.

Output $Y(t)$ in period t is a function of (1) the level of technological knowledge $A^K(t)$ determining capital productivity, (2) capital stock $K(t)$, (3) the level of technological knowledge $A^L(t)$ determining labor productivity, and (4) labor supply $L(t)$ in the period. Only Harrod-neutral technological progress satisfies the conditions of equilibrium growth: technological progress leaves both the capital coefficient $k/f(k)$ and the functional income distribution between labor and capital unchanged. Harrod-neutral technological progress is defined as labor-boosting technological progress that leaves the capital productivity unchanged but increases the productivity of the stock of the factor labor. From this it follows that $\partial A^K(t)/\partial t = 0$. If $A^K(t)$ is normalized to 1, a starting point for the analysis is derived as follows:

$$Y(t) = F[K(t), A^L(t)L(t)] \qquad (2)$$

$$\frac{Y(t)}{A^L(t)L(t)} = f\left[\frac{K(t)}{A^L(t)L(t)}\right] \qquad (3)$$

Due to the linear homogeneity of the output function, $\hat{y} = Y(t)/A^L(t)L(t)$ – labor productivity per efficiency unit – can be given as a function $f[\bullet]$ of capital intensity per efficiency unit $\hat{k} = K(t)/A^L(t)L(t)$ and simplified to the labor productivity function per efficiency unit $\hat{y}(t) = f[\hat{k}(t)]$. Capital productivity per efficiency unit is defined as $\hat{y}(t)/\hat{k}(t) = [Y(t)/A^L(t)L(t)]/[K(t)/A^L(t)L(t)]$.

Let us analyze the long-term equilibrium growth rate, defined as constant capital stock over time per efficiency unit. If the capital intensity per efficiency unit is differentiated by time, is remodeled and set to equal zero, this yields the relationship between total national saving and national investment in a state of equilibrium growth (equations 4 to 6). A constant saving rate $0 < s < 1$, a constant rise in the number of economically active persons with the rate $g_L = \partial L(t)/\partial t$ a constant national depreciation rate of δ, and Harrod-neutral technological progress of $g_A = \partial A^L(t)/\partial t$ are assumed:

$$\hat{k}(t) = \frac{K(t)}{A^L(t)L(t)} \qquad (4)$$

$$\frac{\partial \hat{k}}{\partial t} = sf(\hat{k}) - (g_L + g_A + \delta)\hat{k} = 0 \qquad (5)$$

$$s\hat{y} = (g_L + g_A + \delta)\hat{k} \qquad (6)$$

Sufficient levels of total national saving are required to keep the capital stock per efficiency unit constant. In other words, depreciation needs to be financed from this as does additionally required capital stock for additional efficiency units, which consist of both additional labor owing to the rise in the number of economically active persons and technological progress (equation 6). Along the equilibrium growth path, national output per efficiency unit and capital stock per efficiency unit are constant over time. Output per unit of labor and per capita income Y/L increase with the labor productivity that is equal to the rate of technological progress g_A, $g_{Y/L} = g_A$. National income Y increases with both labor productivity and the rise in the number of economically active persons ($g_Y = g_A + g_L$).

How Can Structural Population Growth Be Integrated into the Model?

The standard model assumes that the population consists solely of economically active persons. This conceptual framework is not suitable for analyzing the economic effects of structural population growth. Consumption by not economically active persons also needs to be financed from national income, irrespective of the form of underlying claim thereon. This could be social security legislation and the Pension Fund Act, as well as a claim involving an economic interest. The national dependency ratio *dep*, the ratio of not economically active to economically active persons, is multiplied by real consumption *rep* per not economically active person relative to national income per economically active person. From this the share of consumption by not economically active persons as a percentage of national income per efficiency unit can be calculated. The constancy of the variable *rep* is assumed on heuristic grounds, so that the real consumption per not economically active person increases in proportion to national income per economically active person.[15] National income per efficiency unit can therefore be broken down into the individual components of consumption per efficiency unit $\hat{c}$, consumption by not economically active persons $dep \times rep \times f(\hat{k})$ and saving per efficiency unit $[f(\hat{k}) - dep \times rep \times f(\hat{k})] \times s$. It is assumed on heuristic grounds that not economically active persons do not save. It follows from equation (6) that total saving has to be equal to the demand for real capital. Consequently, for consumption per efficiency unit accounting for structural population growth, equation 7 can be derived as:

$$
\begin{aligned}
& f(\hat{k}) - dep \times rep \times f(\hat{k}) - \\
& - [f(\hat{k}) - dep \times rep \times f(\hat{k})]^{*} s = \\
& = \hat{c} = (1 - dep \times rep) f(\hat{k}) - \\
& - (g_L + g_A + \delta)\hat{k} \qquad (7)
\end{aligned}
$$

Is There A Saving Rate for which Long-Term Consumption per Efficiency Unit Is Maximized?

For any saving rate, there is a constant capital stock per efficiency unit and constant income per efficiency unit which satisfy equation (6). Consumption by not economically active persons is determined by social security legislation, political considerations, and holdings of financial and real assets. On this basis, the share of income of economically active persons can be calculated as a percentage of national income, a portion of which the latter save. Economically active persons are not indifferent to the level of the saving rate. They make their saving decision such that their long-term level of consumption is maximized. If the saving rate is too high, the capital stock is too large and their consumption is lower despite higher output, as more output needs to be invested in maintaining equilibrium capital stock. If the saving rate is too low, gross marginal capital productivity will exceed the level required to maintain the equilibrium capital stock and, by increasing the saving rate, additional capital can be saved until maximum consumption is attained.

[15] *The variable "rep" is determined primarily in accordance with social security legislation and social policy. Constancy assumes that cuts in the public pension system will basically be compensated by private provision. Only a small portion (consumption by beneficiaries from funded pension provision) depends on the real interest rate. Roughly 50% of not economically active persons will be pensioners in 2020. If around half of these receive from the second or third pillar a supplementary pension covering a quarter of their average consumption, this will be equivalent to only 6.25% of the consumption by not economically active persons.*

In equations (8) and (9), therefore, consumption per efficiency unit $\hat{c}^*$ is derived in accordance with $\hat{k}^*$, abstracting from a potentially positive time preference rate of households:

$$\frac{\partial \hat{c}^*}{\partial \hat{k}^*} = (1 - dep \times rep)\frac{\partial f(\hat{k}^*)}{\partial \hat{k}^*} - -(g_L + g_A + \delta) = 0 \quad (8)$$

$$\frac{\partial f(\hat{k}^*)}{\partial \hat{k}^*} = \frac{g_L + g_A + \delta}{(1 - dep \times rep)} \quad (9)$$

Equation (9) shows that gross marginal capital productivity must be equal to the sum of the growth in the number of economically active persons g_L, technological progress g_A and depreciation δ, divided by the share of national income available for both consumption and saving by economically active persons in percent so that the latter do not have to spend more than is necessary to maintain the capital stock and can consume more.

What Impact Do Demographic Developments Have on Gross Marginal Capital Productivity?

The decline in growth in the number of economically active persons is included in the model by $g_{L1} < g_L$. Structural growth is integrated into the conceptual framework by the rise in consumption by not economically active persons owing to the dependency ratio dep increasing to dep_1 (including increased "dissaving" by pensioners).

As equations (10) and (11) show, the impact of demographic developments on the long-term average real interest rate is ambiguous:

$$\partial \frac{\left(\frac{\partial f(\hat{k}^*)}{\partial \hat{k}^*}\right)}{\partial g_L} = (1 - dep \times rep)^{-1} > 0 \quad (10)$$

$$\partial \frac{\left(\frac{\partial f(\hat{k}^*)}{\partial \hat{k}^*}\right)}{\partial dep} = (g_L + g_A + \delta)(dep)(1 - dep \times rep)^{-2} > 0 \quad (11)$$

The derivatives of gross marginal capital productivity with respect to both the rise in the number of economically active persons (equation 10) and the dependency ratio (equation 11) have the same positive sign. Since the former decreases and the latter increases, contrary effects on the long-term average real interest rate are generated. The heuristic assumption according to which not economically active persons do not save does not affect the result in principle.[16] It should be borne in mind that the dependency ratio for the economy as a whole increases less steeply than is frequently presented in debate. The increase in the participation rate of 15- to 65-year-olds partly offsets the increase in the old-age dependency ratio.[17] The increase in the participation rate has two effects on the share of not economically active persons as a percentage of the economically active, as it both increases the number of economically active persons and reduces the number of not economically active persons to the same extent. As a result, particularly the permanent effect of a higher participation rate counters

[16] *For equation (9), the inclusion of a positive saving rate of not economically active persons s_{dep} gives rise to only a minimal adjustment, which does not affect the results in equations (10) and (11):*

$$\frac{\partial f(\hat{k}^*)}{\partial \hat{k}^*} = \frac{g_L + g_A + \delta}{[1 - dep \times rep(1 - s_{dep})]}. \quad (9a)$$

[17] *Tichy (2005) underlines that the demographic development of the dependency ratio until 2050 is not unusual in historical terms, but that the low values of the 1990s were atypically low.*

not economically active persons' growing consumption induced by aging. By contrast, the transitory increase in the participation rate (but not the level thereof) has an impact on economic growth. The former affects growth only insofar as it influences the rise in the number of economically active persons, i.e. only until a new constant participation rate has been reached.

In short, in the neoclassical growth model, the following can be said for the effects of a decline in the rise of the number of economically active persons: the optimal capital intensity per efficiency unit increases, and the factor labor is partially substituted by the factor capital. The net marginal product of capital – i.e. the long-term average real interest rate – can, on the one hand, decline due to a broadening of the capital base but, on the other hand, can increase owing to structural change in the population. Dissaving by not economically active persons increases long-term average real interest rates, as this reduces the total net saving available for investment purposes. Which of the two effects prevails is further analyzed below by means of a simulation based on Austrian data. Total output per efficiency unit and capital stock per efficiency unit are constant over time. Output per economically active person and per capita income Y/L rise in tandem with labor productivity $g_{Y/L} = g_A$. National income Y increases in parallel with both labor productivity and the rise in the number of economically active persons ($g_Y = g_A + g_{L1}$). Hence, it now grows at a slower rate than when the number of economically active persons rises more rapidly. If $g_A < |g_{L1}|$ (for $g_{L1} < 0$), national income could also decline.

Although the model is technically not very sophisticated, it does indicate the most important influencing factors of demographic developments on the long-term average real interest rate. The key points of criticism about the neoclassical growth model relate to two assumptions, in particular: the rate of technological progress is exogenous, and the economy it applies to is a closed economy.

Neoclassical growth theory places considerable importance on the *exogenous rate of technological progress*, as this determines per capita income growth. The more recent growth theory[18] endogenizes the rate of technological progress. This is why quantitative analysis uses scenarios that assume future productivity growth fluctuating between 1.25% and 2.25% a year. In the model, it is assumed that the rate of technological progress is independent of demographic developments.

The model's most restrictive assumption is definitely that of a *closed economy*. As a result, the real interest rate may fall irrespective of demographic developments in the rest of the world. Since in many other OECD countries (e.g. Germany, Italy, Japan, Spain, the U.S.A., as well as the CEE countries) demographic developments are similar to Austria's, long-term average real interest rates are also expected to decline in these countries. In this way, the advantages of international diversification and integration are moderated. Idiosyncratic risks (country risks, currency risks and political risks) frequently associated with investments in the countries with the fastest population growth often render these coun-

[18] *Inter alia Romer (1986, 1990).*

tries rather unattractive for long-term pension provision in Austria.[19] However, even if pension provision were fully diversified internationally, this would not be enough to avert the impact of demographic developments on the real interest rate in Austria. If annuities that have benefited from internationally diversified assets are issued in Austria, they will increase the aggregate price level and, consequently, lower real consumption by economically active persons, which will lead to a rise in real interest rates in the model. As Börsch-Supan et al. (2003) therefore explain, both investment and consumption should be internationally diversified, i.e. especially in the form of capital exports and goods imports. If, however, the hypothesis of fully integrated global financial and real capital markets is assumed, a globally uniform net marginal capital productivity would result. It would be independent of demographic developments in Austria. If Austria's net marginal capital productivity cannot fall below the standard international level, the capital deepening required will not therefore take place. The result is a suboptimal capital stock and a suboptimal level of Austrian national income. The relatively low degree of financial and real capital market integration is known in economics as the Feldstein-Horioka puzzle. In addition, the extent of investment portfolios' international diversification is surprisingly low.[20]

Real Interest Rates and Funded Pension Provision

The funding principle facilitates intertemporal income transfer between years of economic activity and those of retirement by the acquisition of assets (especially securities). Assets are acquired from current savings over the period of economic activity. At the end of this period, annuities are acquired using the accumulated wealth. What is the relationship between future annuities and net marginal capital productivity?

With real constant annual individual net savings S and an expected long-term average real interest rate r (after tax and additional asset management costs), after t_A years pension capital PC can be derived from equation (12):

$$PC = \frac{(1+r)^{t_A} - 1}{r} S \qquad \forall r, t_A : r \neq 0, t_A \in N_+ \qquad (12)$$

With given real constant annual individual net savings S, the pension capital PC attained after t_A years decreases if the expected long-term average real interest rate r (after tax and additional asset management costs) is reduced:

$$\frac{\partial PC}{\partial r} = \frac{(1+r)^{t_A} - 1 - rt_A(1+r)^{t_A-1}}{r^2} S < 0 \qquad \forall r, t_A : r > 0; t_A > 1, t_A \in N_+ \qquad (13)$$

$$\Leftrightarrow \frac{(1+r)^{t_A} - 1}{t_A} < r(1+r)^{t_A-1} \qquad (14)$$

Inequality (14) is valid, as the annual average net return is smaller than the last period's interest income discounted over a single period. This results from the compound interest effect, whereby the capital stock is far higher at the start of the last period compared with the first period. If the expected long-term average real interest rate r (after tax and additional asset management costs) is reduced, the required real constant net savings

[19] *Bosworth et al. (2004).*
[20] *Obstfeld and Rogoff (2001).*

s has to increase in order to attain the given target pension capital PC after t_A years. $\partial S/\partial r > 0$ is also valid under the same conditions; constant real net savings have to be higher for a lower expected long-term average real interest rate so that the same target pension capital is attained at the end of the saving period.

For an expected long-term average real interest rate r (after tax and additional asset management costs), pension capital PC, which is required to receive a constant real annual annuity A over t_R years, can be obtained from equation (15):[21]

$$PC = \frac{(1+r)^{t_R}-1}{(1+r)^{t_R} r} A \qquad \forall r, t_R : r > 0; t_R \in N_+ \qquad (15)$$

If, before entering retirement, one has saved a capital stock of PC at the end of the saving period and the expected real interest rate r (after tax and additional asset management costs) falls owing to demographic developments, this will affect the constant real annuity A:

$$A = \frac{(1+r)^{t_R}}{(1+r)^{t_R}-1} PC \qquad \forall r, t_R : r > 0; t_R \in N_+ \qquad (16)$$

$$\frac{\partial A}{\partial r} = \frac{(1+r)^{t_R}[-1 - r t_R (1+r)^{-1} + (1+r)^{t_R}]}{[(1+r)^{t_R}-1]^2} PC > 0 \qquad \forall r, t_R : r > 0; t_R \in N_+ \qquad (17)$$

$$\Leftrightarrow \frac{(1+r)^{t_R}-1}{t_R} > \frac{r}{(1+r)} \qquad (18)$$

Inequality (18) is valid, as the annual average net return is greater than the discounted real interest rate of a single period due to the compound interest effect. If the long-term average real interest rate r (after tax and additional asset management costs) falls owing to demographic developments, the annual annuity A will also fall for a given pension capital PC. A decline in the long-term average real interest rate has a twofold effect on funded pension provision, decreasing both the pension capital saved and the resulting annuity.

Demographic Developments, Real Interest Rates and Funded Pension Provision: Quantitative Results

A simulation for 2020 based on equations (9), (12) and (16), using demographic data provided by Statistics Austria (2003) and the Austrian Committee for Long-Term Pension Sustainability (2002), shows the following key results:[22]

In the model, however, demographic developments trigger a decrease in long-term average real interest rates in Austria. This decrease is a long-term phenomenon. The simulation results in the model are therefore not fundamentally dependent on the choice of year (2020).

– In the scenario to which the highest probability of event is allocated, future productivity growth will fall to 1.75% a year and the participation rate will rise to

[21] The costs of both capital accumulation and annuities are abstracted from in this analysis. Although they reduce the level of the annuity for a given amount of savings, they do not directly affect the relationship between changes in the real interest rate and pension capital, and changes in the real interest rate and the annuity.

[22] The quantitative results of the impact of demographic developments on long-term average real interest rates and funded pension provision which are derived from the model are used to represent two things: first, the magnitude of the contrary effects arising from capital deepening and growing consumption by not economically active persons on long-term average real interest rates and, second, the demographic risk of funded pension provision. These results are not a forecast of future trends in Austrian real interest rates.

75%. Despite international diversification in the investment of funded pension provision and in consumption by pensioners as well as partial integration of financial and real capital markets, demographic developments will have a negative impact on funded pension provision: the long-term average real interest rate will fall by around 0.3 percentage point, the pension capital at the end of the saving period will be some 2.6% lower compared with the initial scenario with a positive rise in the number of economically active persons and the annual pension will be down by approximately 6%. Funded pension provision is very sensitive to interest rates.

– International diversification and integration reduce the demographic risk of funded pension provision. However, its dependency on international long-term average real interest rates increases correspondingly.
– Sensitivity analyses show that the impact of demographic developments on funded pension provision is reduced by a rise in productivity growth and strengthened by an increase in the participation rate.
– Since in many other OECD countries (e.g. Germany, Italy, Japan, Spain, the U.S.A. and the CEE countries), demographic developments are similar to Austria's, a decline in the long-term average real interest rate is also anticipated in these countries, thus moderating the merits of international diversification and integration.[23] This is supported by a study on the impact of demographic developments on the European real interest rate by Miles (2002), in which the European real interest rate of 3.95% (2000) falls to 3.66% in 2020 and to around 3.50% in 2050. If the degree of international diversification and integration is significant, the dependency of funded pension provision on international real interest rate trends is very high. In the simulation, a decline in the international real interest rate by 0.5 percentage point increases losses to around 10% of the annual pension, compared with the initial scenario.

Impact of Demographic Developments on Financial Stability

The impact of the decline in long-term average real interest rates in Austria on funded pension provision and financial stability depends primarily on the diversification of risk in funded pension provision, which depends, in turn, on certain products' institutional characteristics. The following analysis therefore confines itself to pension funds, severance funds and the subsidized personal pension schemes. As a rule, other saving products cannot be clearly classified under pension provision (e.g. building loan contracts, passbooks, life insurance policies including residual debt insurance, death insurance). The implications for the general interest rate exposure of financial intermediaries cannot be included in this analysis. The extent to which demographic developments increase the risk for financial intermediaries within the framework of funded pension provision (in particular, pension funds, severance funds, banks and insurance companies), from which potential risks for

[23] *Poterba (2004).*

the financial system could arise, is analyzed.

As far as *pension funds* are concerned, two types of contracts should be distinguished: defined benefit and defined contribution contracts. For the former, the employer bears the investment risk. For the latter, the beneficiaries (including prospective beneficiaries) bear the risk. Defined contribution contracts make up a large portion of Austrian pension fund contracts. In both cases, the risk is limited due to the fact that pension funds are legally obliged to guarantee a specified minimum income. The amendment of the Austrian Pension Fund Act in 2003[24] substantially reduced the amount of the minimum return guarantee in view of pension funds' insufficient capital backing, stipulating that the actual payout (but not the value of the asset), which would be equivalent to the minimum return, is guaranteed. In addition, the calculation period of 60 months was extended until the minimum return is attained, or until the prospective beneficiary becomes the beneficiary, i.e. eligible to receive the pension benefits. The minimum return is relatively low and is defined as half of the average secondary market return for Austrian government bonds minus 0.75 percentage point, with the average being accumulated over 60 months (Article 2 paragraph 2 Austrian Pension Fund Act). The minimum return is therefore influenced by the level of domestic long-term average real interest rates. This is why the impact of demographic developments also reduces the minimum return. Hence, demographic developments do not directly increase the likelihood that the relevant guarantee becomes applicable. For pension funds, therefore, lower long-term average real interest rates do not generate any additional risks. The amendment of the Austrian Pension Fund Act in 2005 will also provide for the possibility of contracting out the minimum return guarantee, which has in the past proved to be unreliable in the long term.[25] For defined benefit contracts, demographic risks are borne by employers in the form of additional contributions and, for defined contribution contracts (most pension fund contracts), by the beneficiaries themselves in the form of lower pensions. Since pension funds have promised unrealistically high levels of calculated interest rates in the past, it is likely therefore that pensions with lower long-term average real interest rates will fall short of expectations on conclusion of the contract.

In the case of *severance funds*, the investment risk is largely borne by beneficiaries. Under Article 24 paragraph 1, the Austrian act governing employee retirement and severance pay provision provides for a guarantee of the sum of severance pay contributions in stipulated circumstances.[26] Although demographic developments trigger a decline in average real interest rates, this does not mean negative values. This is why there is no fundamental future risk that the guarantee would become applicable due to demographic developments. As a rule, the guarantee is valued by means of stochastic methods that use historical price data. As these methods do not take future trends into account, the valuation may suffer

[24] *Austrian Federal Law Gazette Part I 71/2003.*

[25] *790 of the Enclosures XXII. Legislative Period, Committee Report, Article 2 Amendment of the Austrian Pension Fund Act.*

[26] *Austrian Federal Law Gazette Part I 100/2002.*

slight distortions if the long-term average real interest rate is lower. The guarantee could be valued at too low a level. Furthermore, severance funds can also guarantee a fixed interest rate. However, this can be amended in the (fiscal) years to follow, i.e. they can be adjusted to new market conditions. An appropriate response can therefore be made to a decline in long-term average real interest rates so as to prevent additional risks for severance funds arising within the framework of an optional interest rate guarantee.

Investors themselves bear the risk of *subsidized personal pension schemes.* However, a guarantee of the capital invested is stipulated by law for this product under Article 108h paragraph 1 line 3 of the Austrian Income Tax Act.[27] This guarantee relates to the nominal value of the sum of the contributions paid minus the government premia credited. Although demographic developments trigger a decline in average real interest rates, this does not mean negative values. This is why there is no fundamental future risk that the guarantee would become applicable due to demographic developments. As a rule, the pricing of this guarantee is based on stochastic simulations that are, in turn, based on historical price developments in the financial markets. Not taking account of the impact of demographic developments on future long-term average real interest rates could therefore give rise to a systematic distortion in the price for this guarantee. Since international diversification is of the utmost importance for mitigating the impact of demographic developments on funded pension provision, investment restriction under Article 108h paragraph 1 line 1 of the 1988 Austrian Income Tax Act[28] should be subjected to critical review.

In short, it can be said that the risks arising from demographic developments and lower long-term average real interest rates have to be borne by beneficiaries, in particular, in the form of lower pensions. No significant additional risks arise for the stability of financial intermediaries and hence for the financial system.

Summary

The "asset meltdown" hypothesis is considered from a highly critical perspective in empirical literature. This study does not use the conceptual framework of overlapping generations, as the price effect is restricted to the transition between consecutive generations and so does not do justice to financial markets' pricing mechanism. Instead, real effects arising from demographic developments and the wealth dynamics of different generations are integrated into a growth theory framework.

In short, the following can be said about the impact of a decline in the growth in the number of economically active persons in the model: optimal capital intensity per efficiency unit increases, and the factor labor is partially substituted by the factor capital. Long-term average real interest rates can either fall by an increase in capital intensity or rise owing to structural change in the population (dissaving by pensioners). An analysis of the impact of demographic developments on financial market prices and real interest rates therefore needs to include the impact of demographic develop-

[27] *Austrian Federal Law Gazette Part I 155/2002.*
[28] *Austrian Federal Law Gazette Part I 10/2003.*

ments on both households' net supply of savings and the demand for capital by the corporate sector. Among the underlying data for Austria, the initial effect prevails and the long-term average real interest rate falls. Within the framework of funded pension provision, a decline in the long-term average real interest rate reduces both the pension capital saved and the resulting pension. The key factors of influence on the long-term average real interest rate are (1) the rise in the number of economically active persons, (2) the ratio of the consumption of not economically active persons (including dissaving by pensioners) to national income, (3) the international average real interest rate and (4) productivity growth.

In the scenario to which the highest probability of event is allocated, future productivity growth will shrink to 1.75% a year and the participation rate will climb to 75%. Despite international diversification in the investment of funded pension provision, consumption by pensioners and the partial integration of financial and real capital markets, demographic developments will have a negative impact on funded pension provision: compared to the initial scenario with a positive rise in the number of economically active persons, pension capital at the end of the saving period will fall by about 2.6% and the annual annuity will follow suit, declining by some 6%. Dependency on international real interest rate trends will be very high. If the international real interest rate falls by 0.5 percentage point, pension losses will increase to some 10% relative to the initial scenario.

The impact of demographic developments on financial stability will depend primarily on the diversification of risk. Beneficiaries, above all, will have to bear the risk of lower long-term average real interest rates in the form of lower pensions. No significant additional risks will arise within the framework of funded pension provision for the stability of financial intermediaries and hence for the financial system.

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