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AGING AND ASSET PRICES

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Aging and Asset Prices

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Executive Summary

Aging has complex effects on global capital markets. If elderly people save less than younger people, an aging society saves less. This should increase interest rates since supply of funds gets tight. At the same time, the younger generation becomes ever smaller, so there is also less demand for new investment. The equilibrium effect is thus uncertain.

Pessimists believe in the so-called “asset meltdown” hypothesis: households demand for financial assets will plummet between 2030 and 2040, when the baby boomers retire and die, asset values will melt down dramatically and the return on financial investments will fall sharply.

Optimists stress economic mechanisms which soften or even reverse the negative impacts of aging on capital markets. One such important counter-mechanism is an aging society’s need for more capital since capital must increasingly replace labor and, as described, supply of funds will be scarce. This rising demand for real capital increases the return to capital at exactly the same time as pessimists fear the prospect of an asset meltdown.

This study will look at the general equilibrium outcome according to several quantitative studies from France, Germany and the US, plus corroborating evidence on saving behavior and investment demand.

Its main qualitative results are:

- (1) The shifts on capital markets due to demographics are neither a sudden nor an unexpected event. The baby-boomers will retire over a period of about 15 years. As the demographics are largely known (relatively speaking, at least, when compared to the possible profitability of a company in the future), the capital market will also anticipate this development. Consequently, the decline in returns discussed above is spread over approximately 20 years and is barely noticeable each year.
- (2) In 2030 funded old-age provision will not yet have achieved a balanced situation (what is termed "maturity status"). Many employees will continue to establish new funded old-age provision until approx. 2050. This will significantly cushion the effect of a withdrawal of capital by the baby-boomers.
- (3) It is also due to the two previous points that demographic factors will not cause too much of a fall in average returns but that also the holdings and returns for individual investments

(shares, fixed-interest bonds and safe investments where there are no interest and price factors) will only see minimal and very gradual shifts.

- (4) The reduction of around 8 million (approx. one third) in the active working population by the year 2040 will accelerate the capital intensification process. Capital (machines, computers, etc.) must be deployed to make up for the shrinking number of people working in the German economy because neither imports nor a sudden boost in productivity are likely to compensate to this extent. This will mean that the demand for real capital will rise at that point in time when labor will become particularly short, i.e. precisely at the time when the baby-boomers retire and it is said that the "asset meltdown" will take place.
- (5) In a global world returns on capital will not be dominated by individual countries. International diversification is of particular help to those countries that are aging greatly (Germany, Italy and Japan), enabling them to minimize demographic risk in respect of capital returns. Although the majority of industrial countries are aging, France, Great Britain and the USA do not share our problem of a rapidly shrinking working population.

This study goes an important step further and quantifies the potential effects of aging on asset prices using a sophisticated overlapping generations (OLG) model with international diversification reflecting the global nature of capital markets. The results from this MEA-OLGA model can be summarized as follows: Purely because of demographic factors, overall capital market returns on productive capital in the core aging European region will fall by around one percentage point by 2035, assuming optimal diversification in the EU area. If one takes the average over the last 25 years as a basis for calculating the relevant long-term returns on all types of investment in productive capital (equities, industrial bonds and direct placements invested by the corporate sector in plant and equipment), returns will fall from the current figure of 7.7% to 6.7% in the fourth decade of this century. If no international diversification takes place, this drop will be approximately 20 base points higher, whereas broader diversification across the whole of the OECD rather than just within the EU will reduce the decline caused by demographics by around 20 base points.

The decline in returns on capital purely as a result of demographic factors is naturally intensified when investments for funded pension provision resulting from the pensions reform rise, as the increase in capital available puts pressure on returns. If all the savings for funded pension provision are invested domestically, this effect will account for an additional decline in the return to productive capital by approximately 40 base points. However, this decline can be almost completely avoided through international diversification.

The long-term trends have less effect on equities than they do on fixed-interest securities. This reflects the fact that older households are less likely to take risks. The increased demand from this group for fixed-interest securities and safe investments puts additional pressure on the returns of such investments. Consequently, the equity premium, i.e. the difference in yields between equities and secure investments, will gradually increase over the next 25 years. However, this effect is temporary: it will fall again to the extent that the baby-boom generation will use the assets securely invested for old-age provision for consumption purposes.

Quantifying this effect is difficult. The MEA-PORTA model provides approximate orders of magnitude. The current yield to maturity of fixed-interest securities is likely to fall in real terms from 4.1% to around 2.8% over the next 25 years and the yields on secure investments, i.e. investments with no risk relating to price or interest, will decline from 3.3% to 1.8%. Over the same period, the equity premium will rise by around 70 base points.

The results so far relate to collateral in productive capital. The sector that will be affected most by the demographic trend will be returns on real estate, however, only in the very long term. The pessimism of Mankiw and Weil (1989) who made the asset meltdown hypothesis popular in the USA, appears to be misguided. This study provides evidence from Germany which is suggestive for France (probably more dampened) and Italy (probably somewhat stronger) as well. The main insight is that household size lags population size by about 20 years. One reason is that an older society features a smaller household size and thus, *ceteris paribus*, more households. Hence, housing demand will only begin to fall from 2025 onwards even if populations start declining today. Thereafter housing demand will only drop very gradually such that house prices will not fall dramatically over the next 30 years. Mankiw and Weil's (1989) estimate of a housing price drop between 1990 and 2010 to half of their original levels will certainly not materialize.

Taken all evidence together, capital markets are not immune to demography. Rates of return will decline in response to demographic forces, but only very moderately. There is no scientific reason to assume that a major “asset meltdown” will occur when the babyboom generation retires.

1. Introduction

The aging of populations is one of the most important big trends of the 21st centuries. It will affect not only our social security systems but also the working of our good, labor and capital markets. This study investigates the effects of aging on asset prices. Point of departure is the hypothesis of an "asset meltdown". This hypothesis, which is avidly discussed by academics and bankers alike, contends that in the fourth decade of this century the demand of households for financial investments will plummet, the value of assets will be in meltdown and consequently the return on capital will fall sharply.

If this hypothesis holds true, implications for the economy and social policy were immense already today. For instance, it destroys the rationale for using private saving to complement and partially substitute for the ailing pay-as-you-go social insurance systems. This is because, when asset values and returns on capital decline dramatically in the 2030s, the funds that savers have struggled to amass to support themselves in old age will then fall in value just at the time when they are needed the most.

The "asset meltdown" hypothesis may sound convincing – but only at first glance. Starting point of the "asset meltdown" hypothesis is the retirement of the baby-boomers. The large demographic group of the baby-boomers will start to retire around 2020/30 and will try to sell at least some of their assets to the younger generation, a much smaller group, in order to use the proceeds to finance part of their expenditure in old age. The argument is that, because there are a large number of sellers but only a few purchasers, the price of shares, securities and real estate will hit rock bottom. Those selling real estate will find things particularly tough: after 2040, the population in the core countries of continental Europe will gradually slump and - so it is argued - fewer apartments and owner-occupied homes will be required, with the result that many will not be sold or the prices they sell for will be disappointing.

This debate originally started in an environment where the complete opposite applied - the boom in the American residential property market of the 1970s and 1980s. The argument that more baby-boomers were piling into the property market and this group had greater purchasing power than their parents' generation was revived as one possible explanation for the boom in equities of the 1990s. This same generation, which 15 years previously was behind the rise in residential property prices, was now responsible for the boom in the equity markets within the context of provision for old age.

Now the atmosphere has reversed completely. Finally, when the bubble in the equity markets burst in 2000 followed by the years of the sustained bear market, parallels started to be drawn with the long period of stagnation in the Japanese stock market, which by then had lasted for over ten years. The doom merchants proclaimed that there would be no attractive returns from equity markets in the foreseeable future. Japan looks like an irrefutable example of the fatal influence of demography on capital markets because it is the country in the world that is aging the most rapidly and, at the same time, it is the OECD country with the most serious crisis in capital markets.

While this all may sound very plausible, the real world is more complicated and it is in no way clear whether we really need to be so fearful of the spectre of "asset meltdown". First of all, the reasons for both the drop in Japanese share prices and the more recent falls in European and American stock markets are not due to demographic changes. This is because shifts in the age structure of the population are slow and long-term changes and, as far as their impact on capital markets is concerned, these are currently overshadowed by much more powerful and short-term influences such as the banking crisis in Japan and the loss of trust resulting from the ENRON scandal.

Secondly, the current behavioral patterns do not support the argument that older people are divesting themselves of assets so dramatically that it will result in the worldwide drop in returns that everybody fears. Whereas numerous studies have shown that less is saved in old age, the older generations in almost all European countries and in Japan are not drawing on their savings. Although the wealth of older people is not rising as quickly as that of younger people, on average there is no significant reduction in asset values at the present time. The "asset meltdown" hypothesis therefore assumes that a radical change will occur in the way people behave to a degree that has not been observed to date. Consequently, the "asset meltdown" hypothesis is highly speculative.

Thirdly - and at least as important - there is a powerful trend in the other direction. An aging society needs more rather than less capital as it will increasingly need to substitute labor with capital. This boost in demand for productive capital (i.e. machines, computers, etc.) increases returns on capital, particularly in the phase critical for "asset meltdown" around 2030. It is a basic point of fundamental macroeconomic importance for private provision in old age (security in old age, health care, long-term care risk): productive capital is needed in an aging society, in particular, both to replace younger workers who are becoming more scarce and to make the (relatively fewer) members of the available labor force more productive.

After all, the aging process is by no means identical across the world. This will bring about shifts in international capital flows as capital basically tends to flow from countries where the population is aging more quickly to those with a relatively young population in which capital returns are higher. The global capital returns will not fall anything like as dramatically as might be suggested by a misleading study that examined demographic developments in isolation for rapidly aging countries (Germany, Italy and Japan). For these countries the interdependence of global capital markets is particularly helpful.

The impact of an aging population on capital markets is thus rather complex and can only be explained in terms of the equilibrium of forces and not by individual mechanisms. This complex interaction is the subject of the present study.

This study has the following structure: in section 2 we start with the reasons for the feared long-term changes in capital markets and present the central parameters of demographic change in an international context. This is followed in section 3 by a critical overview of existing studies on "asset meltdown" and the conclusions they draw. Here the analysis of which assumptions or procedures drive the respective results is particularly significant. Section 4 focuses on the macroeconomic development. We analyse how the demographic change will affect the overall economic returns on productive capital and saving. Section 5 differentiates this analysis using a dynamic portfolio model according to equities, fixed-interest securities and investments with no interest or price risk. Section 6 deals with the developments that can be expected on the property market. Finally, in section 7, we summarize our results with a view to assessing their significance for economic and social policy.

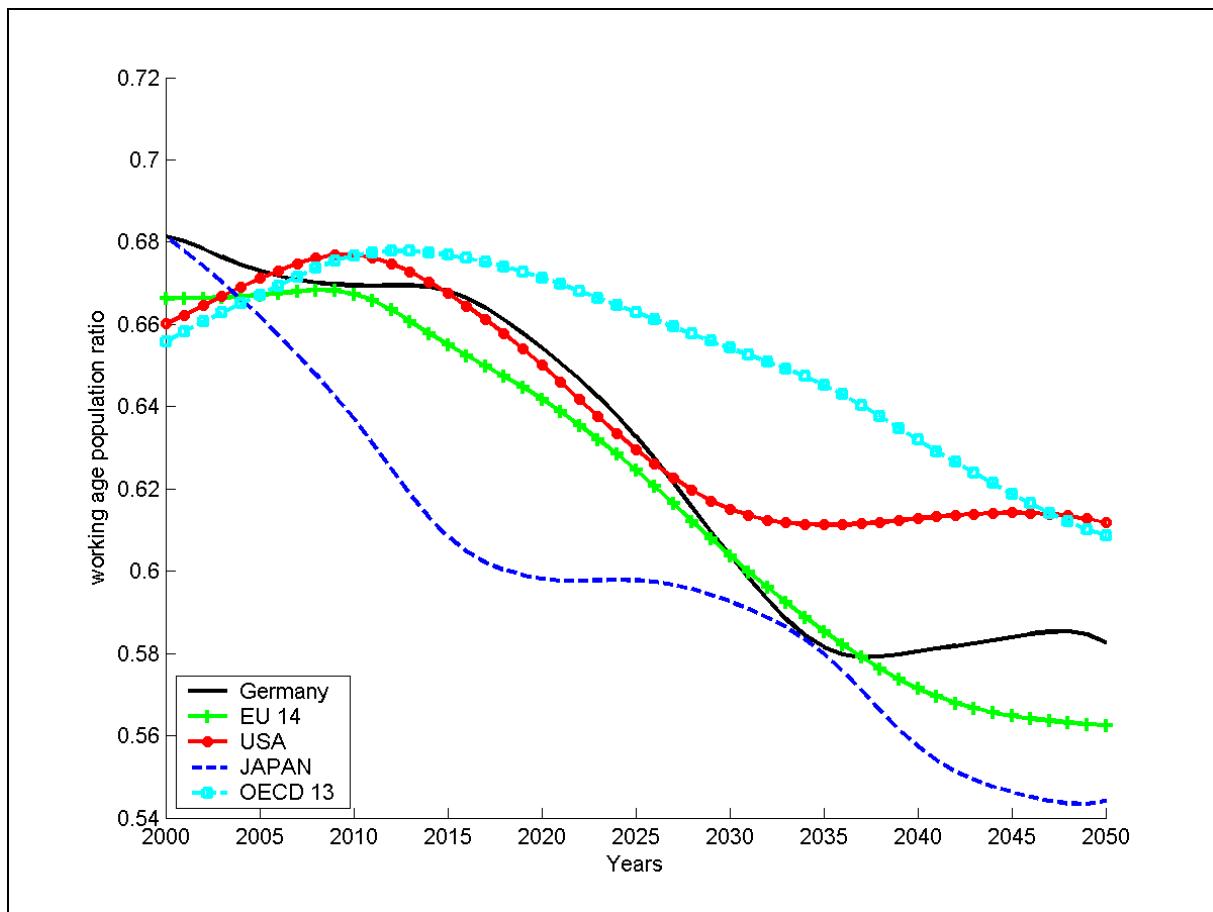
2. Demographic Changes in the OECD Countries

What will happen in the next 30 years? Initially, the significance of an aging population for Europe will be a change in the population structure because the decline in population over the next 30 years is not really significant. This holds even more strongly for the OECD countries. Europe's population will not see a sharp drop until after 2040, when the baby-boom generation starts to die. In contrast, there will be a massive drop in the number of people of working age for all OECD countries.

2.1 The demographic support ratio

This relative shift will be illustrated most clearly by the most important macroeconomic indicator of aging and that is the number of persons of working age in relation to the number of consumers, whose demand for goods and services has to be satisfied by those of working age. This indicator, the demographic "support ratio", is plotted in Figure 1, showing the five most important regions of the world from our economic perspective: apart from Germany, the other 14 EU member states, USA, Japan, and then the remaining 13 OECD states.

Figure 1: Demographic support ratio
 (proportion of persons in the total population of working age)



Source: Börsch-Supan, Ludwig and Winter (2003), based on the UN's demographic projections (2000). "Working age" covers all persons between the ages of 15 and 65.

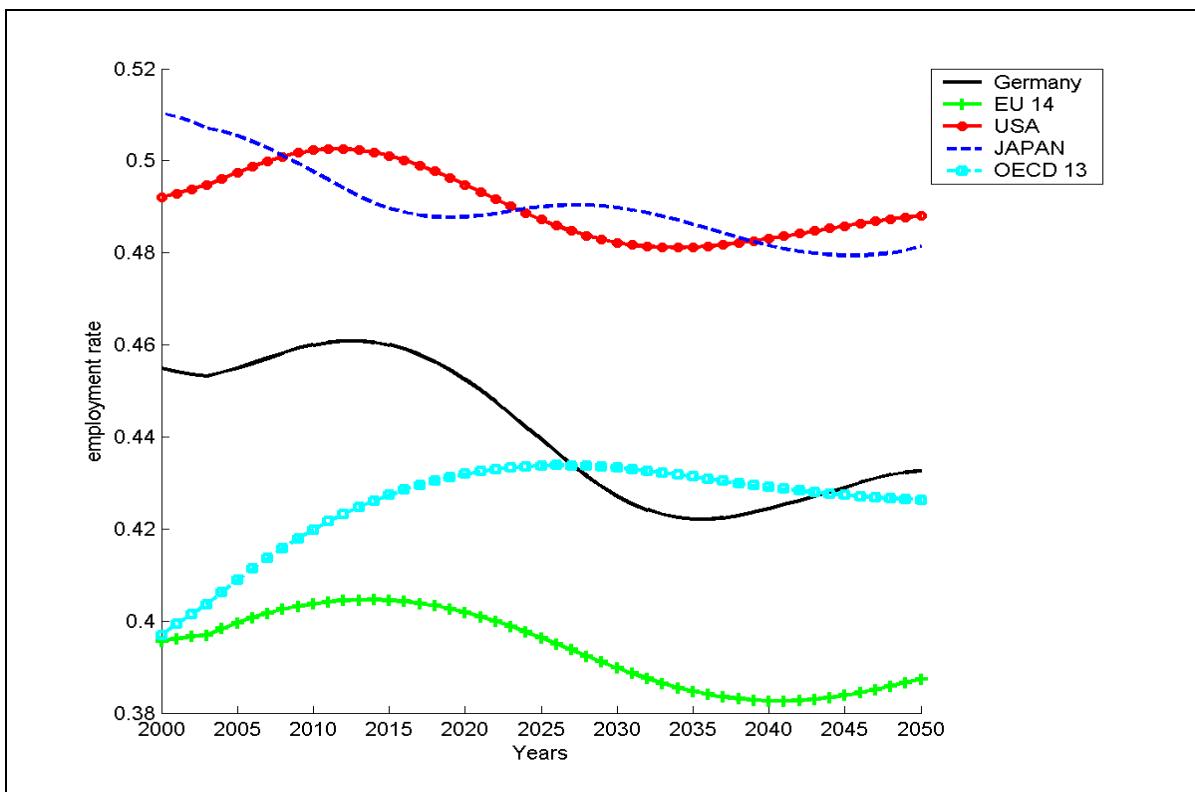
All regions in the world are aging, as can be seen from the decreasing proportion of persons of working age in the total population. However, it is possible to identify clear differences in both the extent and the time sequence with which the population is aging. Figure 1 shows the particularly instructive example of Germany and Japan. Until 2015, Japan will age at a considerably faster rate than Germany but then Germany will catch up. Germany's demographic crisis will reach its peak at around 2035; after this Japan will see another wave when the age will shoot up again and the potential labor force in the other EU countries will also dwindle compared to Germany.

2.2 Participation in the labor force and the economic support ratio

It must be said that this view of demographics does not take actual participation in the labor force into account. This is the only figure that determines the actual number of those economically active in the economy and who produce the consumer and capital goods as well

as services for the whole population. Participation in the labor force varies greatly internationally: see Figure 2 for comparison, which is based on the OECD's data on the active population (2002). As an analogy to Figure 1, this proportion of economically active persons in the overall population is the "economic support ratio" of an economy. This is the demographic basis for all our calculations below. Here we assume that the proportion of women employed will adjust to 50% in 2050, the retirement age will increase by two years and the unemployment for specific countries will reduce to a level that equates to the natural unemployment rate. Details can be found in Börsch-Supan, Ludwig and Winter (2003).

Figure 2: Economic support ratio
(Proportion of economically active persons in the total population)



Source: Börsch-Supan, Ludwig and Winter (2003), based on the UN's demographic projections (2000) and the OECD's age and gender-specific employment rates (2002).

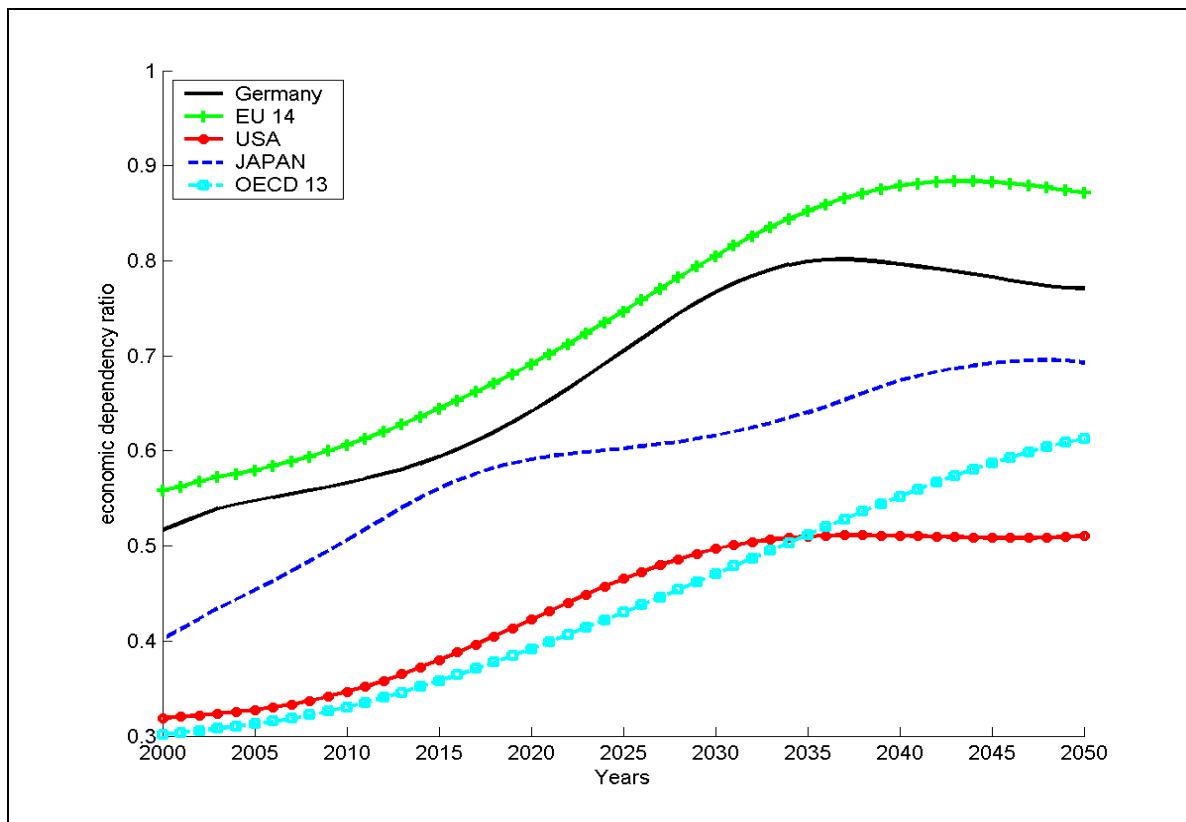
A comparison of Figures 1 and 2 provides an impressive demonstration of the important influence that gainful employment has on the basic forecast. As we know, the participation in the labor force is much higher in the USA and Japan, particularly in the 55 to 64 age range, which is particularly critical for demographic change. As a result of this, the overall economic support ratio of the USA and Japan is only falling slightly and at a very slow rate. In contrast, when it comes to participation in the labor force, Germany is only in the middle of the field. On top of this, Germany will see a steeper fall between 2015 and 2035 when, although the

baby-boomers will retire later than they do today, it will still be relatively early in international comparison. In spite of this, participation in the labor force in Germany is still clearly above the average in the other EU member states. This is because participation in the labor force is very low in countries such as France, Italy and Spain. However, the trend in other OECD countries is very different: here the employment rates will increase until 2025 and then they will only fall very slowly. Turkey will have an important effect on this development. Between 2020 and 2025 the size of this country's population will have overtaken that of Germany and it will have a high employment rate as a result of the younger age structure.

2.3 The age burden and the old-age dependency ratio

The "economic age burden ratio" or the "old-age dependency ratio", i.e. the number of pensioners per employed person, is based on the employment rate. This statistical parameter shown in Figure 3 is particularly familiar as a burden on social insurance systems. If we assume that each employed person produces the aggregate of his or her own consumption and capital goods, the statistical parameter also indicates how many additional persons production by employed persons has to cover.

Figure 3: Economic age burden ratio or old-age dependency ratio
 (Number of pensioners divided by the number of employed persons)



Source: Börsch-Supan, Ludwig and Winter (2003), based on the UN's demographic projections (2000) and the OECD's age and gender-specific employment rates (2002).

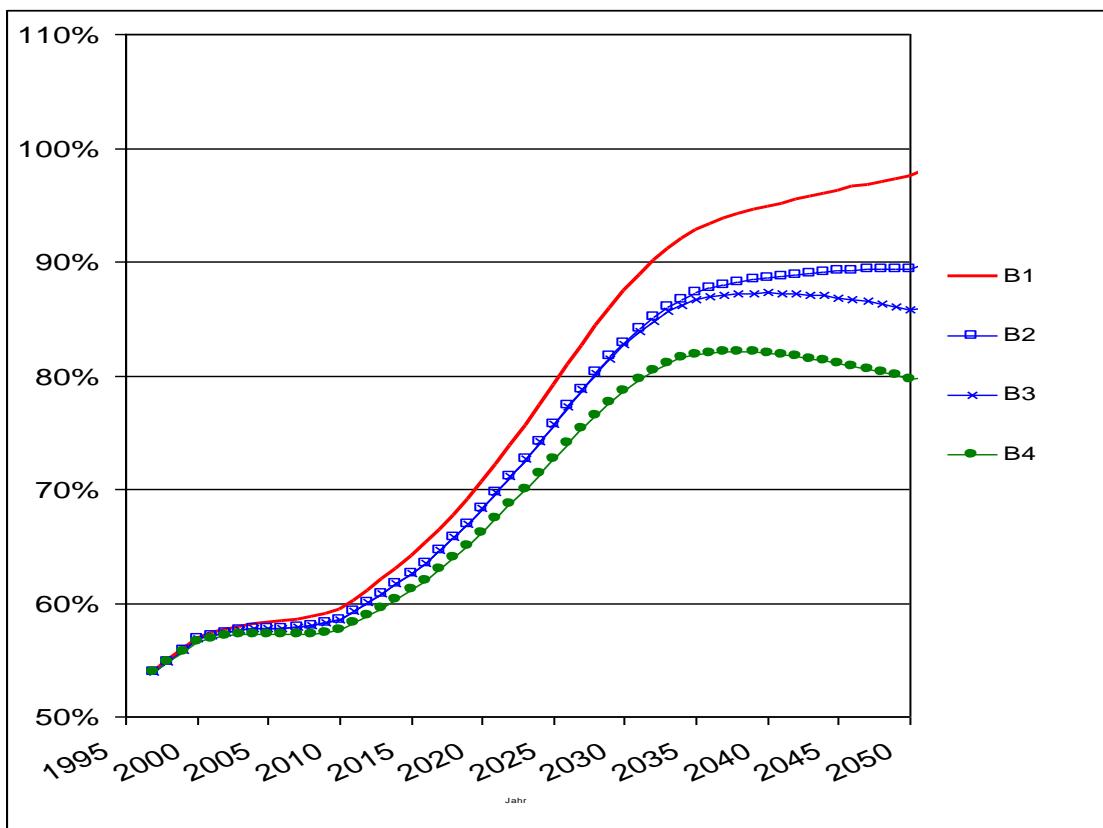
International demographic trends can therefore be summarized into three core points:

- Demographic development is in no way uniform within the OECD or even within the EU.
- In addition to this, employment rates vary greatly between different countries so that the long-term development of both factors - demography and employment - must be taken into account in the study.
- Thanks to its high employment rate, Japan - a country with a rapidly aging population - only has average economic old-age dependency; the USA - a country that is not aging quickly and has high employment - is in an excellent position, whereas Europe suffers from rapid aging and low employment.

2.4 How reliable are forecasts over such a long period of time?

Forecasts are by their nature unreliable. However, although demographic forecasts often cover long periods of time, they cover a much narrower range between extreme scenarios than do economic forecasts. The reason for this is that in the year 2000 we already know how many old people - let us say those over 65 years old - there will be in the year 2030, because they are the people who are aged over 35 today. Demographic forecasts that "only" look forward one generation are therefore largely projections and not really forecasts. Uncertainties are due to changes in medical developments and - above all - immigration, which is very difficult to forecast. In contrast, incorrect estimates of the birth rate only have very long-term effects. Appropriate scenarios are shown in Figure 4, applying to Germany, but similar ranges of deviations from the middle projection apply to the countries in Europe.

Figure 4: Old-age dependency ratio associated with various population forecasts for Germany



Source: Combination of Figure 3 for Germany with variants from Birg/Börsch-Supan (1999). Notes: B1: strong aging, constant fertility; B2: modest aging, constant fertility; B3: modest aging, increasing fertility; B4: weak aging, increasing fertility. Constant and increasing fertility respectively signifies a constant birth rate at 1.35 and an increasing birth rate at 1.64 by 2050; modest, weak and strong aging signifies an increase in life expectancy by 2050 of 6 years (4.5 years and 7.5 years, respectively) with annual net immigration of 120,000 persons (20,000 and 220,000 persons respectively). Employment: Scenario E2, cf. section 2.5.

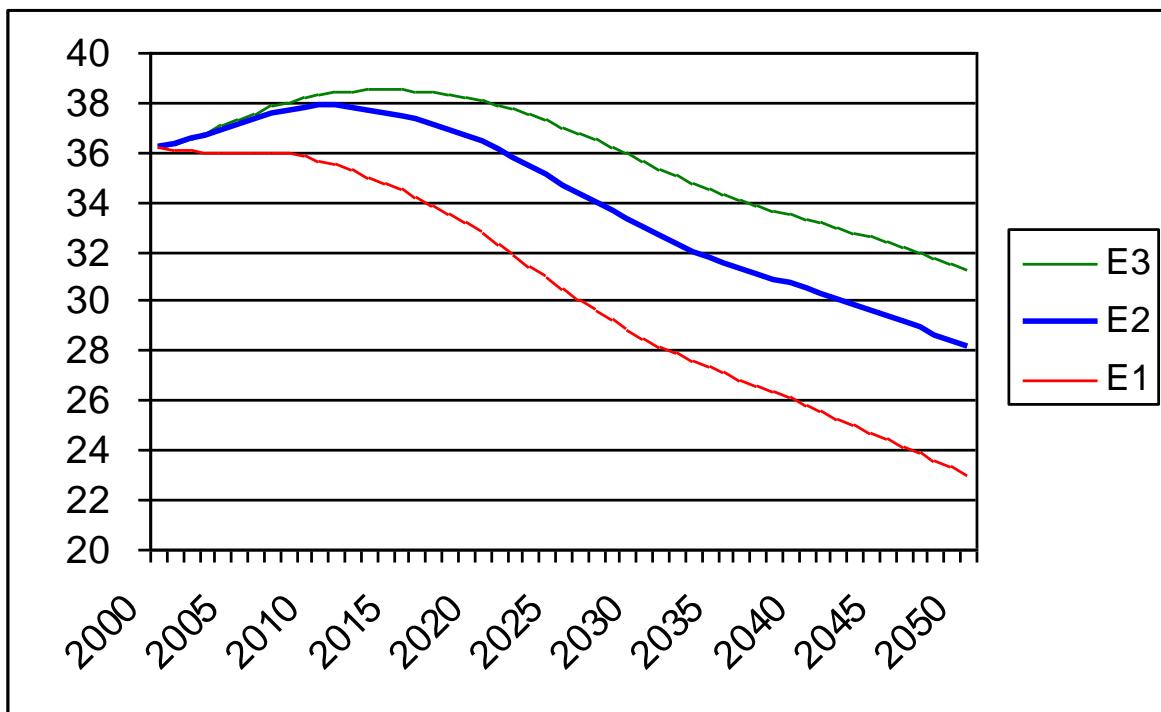
In spite of the range between demographic forecasts, which cannot be ignored, three characteristics of demographic trends are undisputable:

- At the moment, we are experiencing the calm before the storm and perhaps even a "following wind in demographic terms" because the baby-boomers are currently in the most productive phase of their lives.
- The actual aging phase will take place in the years between 2010 and 2030. Economic old-age dependency, which currently stands at approximately 56 pensioners per 100 economically active persons, will increase to 80 to 90 pensioners per 100 employed persons (i.e. around 45 - 70%).
- After this, the ratio will remain relatively stable for a long period. The influence of the birth rate will have very little effect until 2050. Under no circumstances will we return to today's conditions for the foreseeable future.

2.5 How will employment change?

One may argue that employment will adapt to the demographic development and the higher salaries in real terms that can be expected and consequently the information provided by mechanistic demographic forecasts only has limited validity when applied to the economy. Although it is correct that much higher employment can cushion the negative effects of an aging population, it is not sufficient to compensate for it because the demographic change here is much too far reaching (Börsch-Supan, 1998). This can be seen in Figure 5.

Figure 5: Labor force in Germany, 2000-2050 [in millions]



Source: Börsch-Supan (2000b). Note: Scenarios E1 - E3 correspond to the employment forecast variants explained in the text.

While the variant population projections only begin to diverge significantly after the year 2040, assumptions regarding the size of the working population are critical for estimating how the labor supply will develop in the coming decades (Börsch-Supan, 2002b). Figure 5 shows the probable trend ("E2 Scenario") between two extreme assumptions. In the pessimistic E1 scenario, we assume that current employment rates also apply in the future, whereas the E3 scenario represents a very optimistic trend in which the rate of employment for women almost converges with the rate for men, the retirement age increases from 60 to 65 and the unemployment rate falls to 4%. In our view, these two scenarios form the greatest range of possible developments. The probable E2 scenario lies in between. With this scenario, the rate of female employment increases from 64% to 74% and thus moves by just under two-thirds towards the current male employment rate of almost 80%. The retirement age will increase from 60 to 62.5 and the unemployment rate will drop to 5% by 2030.

Therefore, irrespective of which of these very different assumptions one feels is the most likely, the following facts remain: The number of economically active persons will fall sharply. And, even if the employment rates - as assumed in the middle E2 scenario - increase, the absolute figure for employed persons will be lower than the figure in 2000: in the long term approximately 8 million fewer persons will be in employment. The offering on the labor

market will contract, probably by more than twice the current number of unemployed. This decline will mainly take place in the 25 years between 2010 and 2035.

2.6 Demographic challenges

The macroeconomic challenges and the implications for capital markets are now becoming clear. In 20 - 30 years there will be the same number of consumers, who will also have become used to a considerably higher level of consumption than today's generation of pensioners, but the labor force to produce these consumer goods and services will be considerably smaller.¹ How can this be successfully managed? Firstly, we can import more from abroad. However, these imports must be financed so that in the long term this strategy will result in a reversal of the current flows for the balance of trade and payments. In this context, it helps if the imports are manufactured in companies which, although they are located abroad, are financed by German capital (direct investments). Within the domestic economy, higher consumption production per employee can only be achieved by considerably higher labor productivity. This, in turn, requires higher capital intensity and more highly qualified employees.²

The aging of the population as a result of the shortage of labor will therefore not only have repercussions for the employment market but it will also have far-reaching implications for capital markets. Firstly, capital must increasingly take the place of work and, secondly, we will invest greater amounts of capital abroad and, in turn, we will then import from these foreign production facilities and thus exploit the advantage of international diversification. As has already been highlighted in the introduction to this study, it demonstrates the complex background against which the "asset meltdown" effect has to be analysed.

In other respects, it should be pointed out here that the real purpose of the reforms to our social insurance systems must be seen within this context. It is not only about providing a social safety net for people in old age: it is also to prepare for a production structure that allows an increasingly high proportion of consumption by a diminishing number of people in the labor force. In 2030 the proportion of consumption by those who are not in paid

¹ We are proceeding under the assumption that demand essentially continues to be stable thanks to an income situation that remains favourable. Here income in retirement is supplemented by funded incomes to the same extent as the level as pay-as-you-go pensions decrease (Riester model). Cf. section 4.

² The relationship between aging, labor productivity and capital intensity is a complex process. It is not clear whether and to what extent labor productivity will fall because employees are getting older. On the one hand, physical strength and the speed of cognitive responses decline but this is balanced by more experience, organizational knowledge and similar "soft factors". In a knowledge-centric society, this plays an increasingly important role. In addition, greater capital intensity has a considerable impact on services, in particular through the use of information technology. Cf. Börsch-Supan (2002).

employment will be over 50%. This can only be financed by supplementing the pay-as-you-go process by a much more substantial funded pillar. Firstly, it helps to alleviate the demographic burden of the pension insurance system by spreading the load over time. Secondly, it goes some way to meeting the need to deploy capital in the German economy more intensively and to introduce global diversification. Capital markets help to reconcile the necessary microeconomic adjustments with the socio-political objectives.

Besides the dreaded "asset meltdown" hypothesis there are consequently also a considerable number of very positive aspects for capital markets. The overall context must be examined before one can draw a valid conclusion. It is intended that this study will make a contribution here.

3. Previous "Asset Meltdown" Studies

Different authors have investigated the implications of demographic change on capital markets from a variety of angles and especially the subject of "asset meltdown". Work first started on this subject in the late 1980s, when Mankiw and Weil (1989) predicted a drop in real estate prices in the USA as a result of demographics. In section 3.1 we will present this work and the lively discussion it provoked.

It is clear that banks and insurance companies are taking an interest and this is based on two main aspects. On the one hand, the demographic change alters the structure of the customer base with correspondingly different requirements. On the other hand, institutional investors, i.e. life insurance companies and the pension funds, require long-term growth forecasts for the various investment segments in order to advise their customers and for portfolio management. The "practical analyses", which we summarize in section 3.2, are designed, firstly, to forecast market segments that will grow in the future and, secondly, to make long-term forecasts of returns in the broadly defined investment categories of "equities", "bonds" and "real estate".

Empirical and theoretical research into the "asset meltdown" hypothesis has also been undertaken by the university sector. The critical point in the empirically based analyses presented in section 3.3 lies in the assumptions about the savings profile over the life cycle, the stability of which over the period of prediction is crucial for the results. These analyses are affected by additional problems on account of the database, which in some instances is not good. The more recent research therefore returns to theoretical economic models, particularly more complex dynamic portfolio models which have recently been given impetus through the increased use of more powerful computers. The inclusion of the demographic change in such theoretical models mainly occurs within the framework of models of overlapping generations (OLG models) and this will also be the procedure adopted in this study. The results of earlier work are summarized in section 3.4.

3.1 How it all began – Mankiw-Weil

A fall in the price of assets as a result of demographics was predicted for the first time in 1989 by Mankiw and Weil for the real estate market in the United States. Mankiw and Weil used cross-sectional data on real estate assets from the 1970 US census to develop an age profile of the demand for property. Their demand forecast is based on the assumption that this age

profile remains constant and it is only the size and age structure of the US population that will change. Based on the historical correlation for the growth in demand with the price index for investments in residential buildings (residential investment deflator) and corresponding regressions, Mankiw and Weil conclude that the demand for residential property must increase by approximately 1.5% per year to keep prices constant. However, the demographically controlled demand variable shows consistently lower growth rates for the period 1990 - 2010. This forecast discrepancy exercises enormous price pressure on the residential property market. The point estimate by Mankiw and Weil implies a 47% price fall within 20 years. These alarming results unleashed the agitation one would expect, especially in the daily newspapers.

The study provoked a large number of very critical comments, which ultimately cast considerable doubt on whether the forecasts by Mankiw and Weil (1989, 1992) are sustainable. Woodward (1991) grouped together the main points of criticism in the first series of responses refuting the study. For instance, both Hamilton (1991) and Hendershott (1991) criticized the fact that the estimates of Mankiw and Weil imply that, even if demand remains at a constant level, the prices would fall by 8%. This implausible linear time trend has a much greater influence on the forecast than the decline in the growth for demand from 1.6% at the start of the 1980s to around 0.6% in approximately 2000. Swan (1995) criticized that not only were the effects of a long-term rise in real income completely ignored but the supply side of the residential property market was also not taken into account³.

Engelhardt and Poterba (1991) also cast doubt on the findings of Mankiw and Weil. They made an equivalent analysis for Canada, a country with demographic trends that very largely mirror those in the USA. The age profile for real estate assets in Canada also broadly corresponds to the equivalent figures in the USA. In spite of this, Engelhardt and Poterba could not find that demography had any similar influence along the lines identified by Mankiw and Weil.

Börsch-Supan (1993) undertook for Germany a parallel study to Mankiw and Weil, which was similar to the Engelhardt and Poterba study in Canada. This analysis, too, was limited to the demand side of the property market but the areas where an aging society has an impact were covered in much greater detail than in the study by Mankiw and Weil. Börsch-Supan explained in detail the effect of the demographic change on the demand for residential

³ In the 1970s and 1980s the supply side of the real estate market was influenced by rising raw material prices, which - in addition to the increased demand from the baby boomers - could also have been responsible for the price movement observed.

property. Firstly, the increase in life expectancy boosts demand because each residential property is needed for a longer period before it becomes free for the next generation. Added to this is the fact that typically the average size of a household decreases when the occupants become old, thus increasing the living space required per person (also see section 6). The seventh coordinated population census carried out by the Federal Statistical Office and used by Börsch-Supan at the time does not show a reduction in household numbers until approx. 2020, using the corresponding age-specific household ratios, even though this population census forecasted a fall in the population as early as 2000. Thirdly, there is also what are called the cohort effects of demand for residential property. Greater demand for living space exists among cohorts born later, above all relating to income and assets. All in all, Börsch-Supan established that these effects will remain balanced at least until 2020 and what can be expected in the next two decades is at most a slight drop.

More recent research has shown how important this last effect is. When Mankiw and Weil used cross-sectional data to analyse the demand for residential property over the life cycle they ignored the effects of income and the cohort group, which have proved to be very important in quantitative terms. In cross-sectional data, i.e. in data from many people at a single point in time of observation, it is not possible to decide whether a person saves too much because they are old (age effect) or because they were born a long time ago at a time when, for instance, thrift was considered to be particularly virtuous (cohort effect). If one applies this approach to demand for residential property, it cannot be ascertained whether a person uses a small amount of living space because they do not need a large apartment when they are old or whether they do not need a large apartment in old age because at the time when they purchased their apartment they did not have enough real income to afford a large apartment. In their analysis, Mankiw and Weil present the cross-sectional profile of real estate assets in 1980 by way of comparison. However, the assets values of census data in 1980 were on average more than 50% above the 1970 sample group for each age group. When it comes to using demand profiles for fairly long-term forecasts, the order of magnitude of 50% shows the quantitative significance of income-related effects, in particular, but also other cohort effects. The increase in the assets profiles of all age groups between 1970 and 1980 illustrate the dimension in which the demand for real estate could also change in the future.

Studies made in the United States of America that adopt a more careful approach than Mankiw and Weil verify that, for just these reasons, the estimates of age-specific demand for residential accommodation are distorted and a possible "asset meltdown" effect is greatly exaggerated - for example, see Venti and Wise (1990), McFadden (1994), and Skinner (1996).

What can, however, be noted is that the forecast "asset meltdown" on the American market has not occurred to date, either during the boom in equity markets (which is easy to explain) or since the bubble burst (which is more significant).

3.2 Practitioners' studies

The effects of demographic change on capital markets were soon recognized as a possible problem by the financial services sector and it became a topic of discussion. By way of an example, we are presenting five studies here which provide a practical demonstration of the different aspects on which analysts focus.

The first practical study that we are aware of that deals with possible asset meltdown on the residential property market was made by Hypovereinsbank (Heigl, 2000). It is, however, limited to eastern Germany. On the one hand, the example of eastern German illustrates clearly how a drop in demand caused by aging and, above all, migration may cause a deterioration of asset values in the property market. On the other hand, it must be noted that the development in the eastern states of Germany over the last few years cannot be compared directly with the demographic change because they occurred much more suddenly and also their dimensions cannot be compared with the slow changes prompted by low birth rates and greater longevity.

A second publication by Hypovereinsbank (Heigl, 2001) that appeared in the German press became the subject of considerable attention. It remains the only study that warned about an asset meltdown in equity markets that needed to be taken seriously. The initial variable of the study is the numerical relationship of economically active persons between 30 and 59, who are identified as "savers", with the group aged over 60 and who it is assumed will draw on their savings, as they are pensioners. Heigl describes the curve showing these demography variables as the "Age Wave". It correlates these demographic variables with the annual net acquisition of financial assets. There is a strong positive correlation between the two time series - the coefficient of correlation is, according to Heigl, 86%.

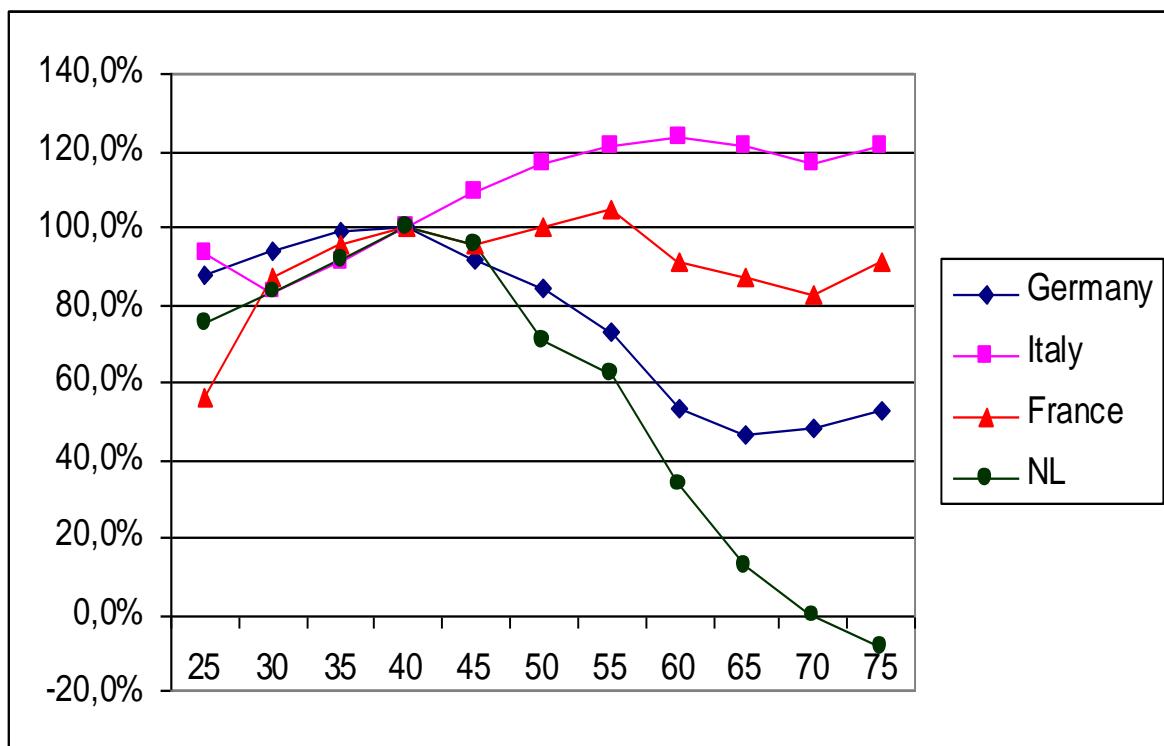
Heigl then compares the "Age Wave" with share prices. He selects a logarithmic form of the DAX in real terms and superimposes the "Age Wave" over this. For the period from 1964 to 1974 the two curves are flat curves, although they are not obviously correlated. Whereas the "Age Wave" rises sharply in two thrusts from 1974 to 1990, the DAX remains comparatively unchanged in real values until 1984, in other words ten years later. Then, between 1984 and 1999, the graph of the DAX shows a similarly steep rise as the "Age Wave" did ten years

earlier. Consequently, Heigl infers that the response of actual share prices to the "Age Wave" occurs with a time lag of around 10 years.

Heigl now applies this delayed response to future development. If the underlying conditions were to remain the same, the consequence of Heigl's demographic variables would be that by 2030 equity prices would fall in real terms to the level of 1964.⁴ Were the curve to continue to the year 2050, it would even imply negative values on the log DAX scale.

In our opinion, neither the analysis nor the forecast is tenable for several reasons. Firstly, the basic assumption - only those in the 30 - 59 age group who are economically active save whereas pensioners aged over 60 draw on their savings - agrees with some economic theories but it does not concur with the facts in the majority of other European countries, as is dramatically demonstrated in Figure 6. Only the Netherlands show some sign of dissaving, due to the large proportion of retirement income drawn from mandatory occupational pensions.

Figure 6: Cohort-corrected savings rates by age



Sources: Authors' calculations based on the International Savings Comparisons Project (Börsch-Supan, 2003). France: Fall, Loisy, and Talon (2001); Germany: Börsch-Supan, Reil-Held, Rodepeter, Schnabel, and Winter (2001); Italy: Brugia and Padula (2001); Netherlands: Alessie and Kapteyn (2001).

⁴ The demographic variables reach the 1964 level in 2020. The time lag of 10 years is then added to this.

Modern empirical savings research, which is summarized from an international viewpoint in studies such as Poterba (1992) and Börsch-Supan (2003), shows that, although pensioners save less than younger people, they do not draw on their savings, i.e. on average they make more new savings than they release in existing assets. For Germany this is clearly demonstrated in Börsch-Supan and Essig (2002) and in Börsch-Supan, Reil-Held and Schnabel (2003), which have been used as a basis for Figure 6. Here income and cohort effects are also taken into account.

Secondly, it remains unclear why it is specifically logarithmically scaled real share prices with a 10-year time lag from the absolute value of the ratio that should trigger from saving to drawing on savings. Although by superimposing two graphs it produces an impressive chart, it has no statistical basis, particularly as the logarithmic scale delivers meaningless results in the long term. If one were to select 5 or 15 years instead of 10 years, which would be just as arbitrary, the correlation would largely disappear.

Finally, it should be noted that the study is assuming the existence of a "catch-up effect" in equity markets, which will continue until around 2015 and is the result of the accumulation of funded old-age provision in Germany. However, the forecast ignores that the net effect of an across-the-board Riester pension set at 4% will persist until approx. 2050, cf. Birg und Börsch-Supan (1999). It is also unclear how strong the connection between the two effects - the catch-up effect and the "Age Wave" - is and to what extent this catch-up effect compensates for the forecast which is based on the "Age Wave" calculation alone.

The Goldman Sachs (Culhane, 2001) study has also been extensively quoted. This concentrates on the forecast of future market volumes and the volume factor in a potential "asset meltdown". In a comprehensive examination this places the future development in the context of global finance markets. After an extensive survey of the different course of demographic change in the industrial nations, an overview is provided of the different pension schemes that exist and how they are financed. Along similar lines to those adopted by Hypovereinsbank, Goldman Sachs also uses as the key variable the ratio of "Prime Savers" – defined as the 40-59 age group – to "dissavers" – defined as those aged over 60. A trend for the household sector's expected net savings is derived from this. Linked to the current and assumed future development of the pension provision system structure - fully funded (e.g. USA, UK), capital funding being implemented (e.g. Germany) or "pay as you go" (e.g. Italy) - this, in turn, forecasts net savings and portfolio restructuring in non-private old-age provision. These forecasts, which have largely deliberately restricted themselves to qualitative criteria, emphasize four important results. Firstly, Japan - as the economy that is aging the fastest -

will be affected the most. Secondly, in capital markets in countries in which funded old-age provision already plays a major role and where the proportion of equities is high (e.g. USA, UK), portfolios will be restructured to switch from equities into bonds. Thirdly, the study ascribes better development chances to the equity markets in countries where capital funded systems are only now gradually gaining significance, because demand generated in this way counteracts "desaving" processes determined by demographic factors. Lastly, the fourth forecast is the one made by Goldman Sachs that increasing use will be made of diversification opportunities on capital markets.

Although many basic assumptions of this study are similar to those made by the Hypovereinsbank, the results are much less alarming. The reason for this is essentially the long-term cushioning effect of the global options for diversification and the effect of accumulating funded old-age provision. The Goldman Sachs study does not however offer a quantitative calculation structure and it also assumes that capital returns will remain stable in the long term - an assumption which the "asset meltdown" hypothesis in particular casts doubt upon. An important task of our own study - and for this please see sections 4 to 6 below - is to assess not only the future volumes but also future returns by means of a model in which the quantitative aspects are transparent.

The Dresdner Bank study (Bulthaup et al., 2001) also only touched on the forecast of long-term returns. Above all, the study looks at the potential for developing the market for various products, in particular investment funds, life insurance policies and the various ways of organizing company pension schemes, which are arising in various European countries in the light of the urgent need for reform. What it has in common with the Goldman Sachs study is that both are emphasizing the role of globalisation on capital markets. In addition, the Dresdner Bank explicitly looks at the demand side of capital markets - an aspect which is ignored in many other studies. Bulthaup et al. argue that the concern about an "asset meltdown" is without foundation on account of the scope for international diversification. The Eastern European countries with their far lower per capita capital stock and other OECD countries, which are faced with a much less dramatic demographic change than Germany, are seen as attractive countries in which to invest. The countries that increasingly need to invest the capital for old-age provision are therefore exporters of capital, before capital imports take the upper hand after the baby-boomers retire. Evidence that international capital mobility can cushion the effects that an aging society has on capital returns when compared to a closed economy has been provided by researchers such as Börsch-Supan, Ludwig and Winter (2003) as part of an OLG model - also see section 4. However, their conclusion in no way implies

that the effects of demographic change will be fully compensated by international diversification within OECD countries. The extent to which this situation can be absorbed by the emerging markets and the newly industrialized countries of Eastern Europe in order to compensate for the residual effects is not answered by the Dresdner Bank study, particularly because their time frame up to 2010 at most only covers the medium term.

A study published by the German Insurance Association (Gesamtverband der deutschen Versicherungswirtschaft) (Lueg, Ruprecht and Wolgast, 2003) provides a comprehensive overview of the controversial discussion from an economic point of view, emphasizing the implications for funded pension schemes. It interprets - in a genuinely original way - the discussion on the feared "asset meltdown" as one facet of a revived variation of the "Mackenroth thesis". The quantitative arguments of this study have been evolved in parallel to those in section 4 and consequently reference is made to these.

A fundamental aspect of the practical studies is that the arguments they raise identify and discuss many important points. Only the Hypovereinsbank studies consider that the demographic change represents a serious risk for capital markets. The quantitative forecasts are however almost exclusively based on ad hoc assumptions and are limited to market volumes whereas they nearly always steer clear of forecasting how trends will develop. There is a lack of theoretical modelling or a reliable empirical foundation for saving and portfolio decisions over the life cycle. Where the forecasts are based on empirical data for savings behavior, all practical studies misinterpret the cross-sectional data used as life cycle profiles. This procedure ignores the empirical evidence of cohort and income effects, which may result in potentially serious incorrect forecasts. In sections 4 to 6 this study will attempt to pay greater attention to these points.

3.3 Scientific analyses on an empirical basis

The most familiar scientific study based on the empirical data of saving behavior over the life cycle is the analysis by Poterba (2001). He uses a procedure that is essentially similar to that used by Mankiw and Weil (1989). It derives a demand variable from the shift in the aging structure of the population, which is produced from an estimated life cycle savings profile. In contrast to Mankiw and Weil, Poterba estimates the demand from the various age classes in a model which permits explicit cohort effects. The estimated asset profile in old age is very largely flat - a result that has already been documented by other authors. Differential mortality (Attanasio and Hoynes, 1995), i.e. the fact that wealthy households live for longer than poor ones, is an important reason for this. Poterba uses a series of further demographic variables

which can explain the accumulation of savings in a society.⁵ For long time series he finds hardly any indications that demography influences returns on equity investments and only minimal indications of such influences on the market for secure interest-bearing securities. It was only for the price-earnings ratio of equities that Poterba found demography had historical influences but these were not stable.⁶ The estimated parameters led Poterba to the conclusion that a demographically induced fall in prices on financial markets, as had been predicted by Mankiw and Weil for the real estate market, is extremely unlikely.

Abel (2002) criticized the analysis by Poterba (2001) because, like Mankiw and Weil (1989), he did not include the supply side of capital markets. In a theoretical model in which the households are interested in the well-being of their heirs and thus possess an inheritance motive, he shows that it is entirely feasible for an asset meltdown to be consistent with a flat asset profile in old age. Abel's basic idea is as follows: Whereas the generation of parents deliberately do not use up all their assets in order to allow their children to inherit, the children save less in expectation of the forthcoming transfer of assets. On top of this, with declining numbers in the children's generation, the inheritance is divided between a smaller number so that each household in the small generation of heirs can reduce their savings by more than a household of the baby-boomer generation. Although the demand of the old generation for capital is not falling, a demographically induced fall in prices could be brought about through lower savings by the younger generation. However, quantitatively speaking, it is still unclear whether the amounts that will be inherited will fall with the number of children. Thus the counter mechanism to Poterba's analysis "discovered" by Abel would have less of an effect.

As was emphasized in Section 3.2, separate recording of age and cohort effects in the context of accumulating savings is of key importance for the reliability of empirically based forecasts on the future development of capital markets and equally it is of central importance for their dependence on the age structure of the population. Here there may be differences between the cohorts in respect of their assets or they may simply be influenced by other experiences which motivate their savings behavior.

Sommer (2002) uses a procedure developed by Deaton and Paxson (1994) to analyse savings behavior over the age profile, and cohort and year effects and he ascertained such cohort effects for various countries. The Italian data, in particular, indicated a flat age profile with

⁵ Also including old-age dependency ratios similar to those in the practice studies presented above.

⁶ Poterba used data for the USA, Canada, and Great Britain and also used partial time series, e.g. samples from 1926-1999, 1946-1999 and 1926-1975 for the USA.

considerable differences between the cohorts. In view of their order of magnitude, the estimated cohort effects are of very great importance for long-term forecasts of demand on the capital market.

For the USA Poterba and Samwick (1997) found strong cohort effects for the percentages of individual product groups in portfolios as well as for the proportion of households that have certain products in their portfolios (what are termed "participation rates"). Sommer (2003) also found strong cohort effects for Germany, in particular with respect to "participation rates". The extent to which these product-specific analyses can be used to forecast the extent of future demand is, however, limited because the data is generally restricted to the product level and investments held indirectly in insurance policies or investments held in mixed investment funds in the form of equities, bonds and real estate are not taken into account. It can however be established that neither Poterba and Samwick (1997) in the USA nor Sommer (2002) in Germany found significant evidence that households move into secure investments as they grow older. Within the context of the "asset meltdown" debate this means that there is not likely to be an excessive fall in average returns on account of demographics but also the returns on individual investments (in this case: equities and fixed-interest securities) are not likely to experience any excessive shifts.

Coincidentally, Poterba and Samwick established additional cohort effects through the distribution of new products. The stability of age profiles, which have been estimated with the help of cross-sectional data at an individual point in time, is further called into question because new products (e.g. share products with a capital guarantee and investment funds) may enhance the attractiveness of individual forms of investment for all age groups.

Finally, some authors have used time series data from the past to draw conclusions for the future, i.e. to extrapolate values for the future from historical demographic changes (Higgins, 1998; Lührmann, 2002; Eichengreen and Fifer, 2002). The results of these analyses provide evidence that demography has a clear influence on financial markets but some of this data is, however, contradictory and does not allow accurate projections to be made. The main reason for this is that the basis on which the projection is made is extremely weak. The demographic change that awaits us in the next few decades does not have any historical precedence. What is more, such projections in the past ignore the adaptive and feedback economic effects that are not activated, which usually exercise a moderating influence on the long-term development.

Overall, these empirically based scientific studies give the all-clear in respect of a catastrophic "asset meltdown". Nevertheless, the basis on which their projections are made do not

correspond to the expected demographic changes expected historically. This is the main reason why, in this study, we are using a simulated model supported by theory.

3.4 Theoretical modelling and simulation models

Initial approaches for using theoretically supported methods to estimate the effects of demographic changes on the development of the economy overall and thus also on wages and returns on capital can be found in Cutler et al. (1990), Börsch-Supan (1996), and Reisen (2000). More recent work is based on what are called the models of overlapping generations ("OLG models"), which were used for concrete political analysis for the first time in the leading-edge research by Auerbach and Kotlikoff (1987). Since then, such models have undergone considerable development processes, enabling them to mirror reality more closely. The models have thus increasingly developed from semi-theoretical analytical tools to genuine forecasting and simulation models (INGENUE, 2002). One of the important contributions in this respect was achieved by the implementation of realistic demographic data (Börsch-Supan, Heiss, Ludwig and Winter, 2003; Börsch-Supan, Ludwig and Winter, 2003).

The main outcome of these studies, which are strongly geared to the economy as a whole and thus describe a single, consolidated overall economic return on productive capital, i.e. not the difference between a return from risky equities and the secure interest from bonds, is a partial all-clear. Depending on the country, the demographic change will - in some cases - even have a very considerable effect on capital markets. The various mechanisms of effect counteract each other in some cases, thus cushioning or emphasizing their effects. They do not forecast a catastrophic "asset meltdown" and Cutler et al. even point out that, in addition to the well-known challenges, the demographic change also brings "opportunities". We will look at these again in section 4.

In the meantime, a small number of theoretically supported simulation models have been developed for portfolio selection, which can be used to analyse the effects of demographic change and estimate how great the risk of "asset meltdown" is. The analysis by Constantinides et al. (2002) helps us, even if only indirectly, to understand how households' portfolios alter during demographic change. It is of interest to the "asset meltdown" debate because it differentiates between the returns from more risky equities and the safe interest from bonds and examines how demand for these two types of investment depends on the age of the person concerned. It ultimately accords a higher priority to the risk premium of less certain

investments than it does to secure interest rates when considering optimum portfolio allocation over the life cycle.

Constantinides et al. use a greatly simplified model. An understanding of this model is very helpful for portfolio analysis because it provides an approach to explain the so-called "Equity Premium Puzzle", i.e. the higher return on equities relative to fixed-interest securities, a topic first raised by Mehra and Prescott (1985). We use this approach as a basis when in section 5 we model the returns from equities and fixed-interest securities and how these depend on demographic factors. In the model by Constantinides et al. the supply of fixed-interest bonds and equities is fixed, i.e. the corporate sector does not grow and it does not restructure its financing portfolio. Three generations, consisting of young employees, old employees and pensioners, each live simultaneously. The employed generations earn income, with the younger generation earning less than the older generation. Pensioners do not receive any income so each generation must save during their working life to finance their consumption in retirement. With no limit to taking out loans, the young generation consumes, in some cases through borrowing, and at the same invests in the higher-yielding equity market, again using loans. However, when the credit available to households is limited, the so-called "Equity Premium" kicks in. This is a higher rate of return on equities over and above the normal risk premium. With available credit limited, the young generation would now have to reduce their consumption to finance the involvement in the equity market that they actually want, but which they only do in part because their consumption brings considerable benefits. Whereas the young generation is hardly active at all on the capital market, the generation of pensioners does not find any suppliers for the fixed-interest bonds they would like to buy. Thus the returns on fixed-interest bonds falls, whereas - at the same time - companies have to offer their equities with higher returns. This creates the spread of returns - the "Equity Premium" - between shares and fixed-interest bonds.

Brooks (2002) takes up this theoretical model, extends it to include more flexible modelling on the supply side and applies it to the possible consequences the baby-boom may have for capital markets. When the baby-boomers reach the second phase of their working life, when they no longer have children to support but, at the same time, their work-related earnings are at their highest level, the "Equity Premium" shrinks considerably under the increased demand for equities for old-age provision, only to rise to a maximum after the baby-boomers retire. We present a similar analysis in section 6 but this time focussing on European financial markets. There, too, the "Equity Premium" is rising in the long term, whereas the returns for fixed-interest bonds falls as a result of the population aging. The effects we calculated are,

however, far less serious than those predicted by Brooks. This is due to the fact that, unlike Brooks, we did not map the demographic change as three generations but instead we mapped it on a year-by-year basis and thus were able to obtain a much more realistic result.

4. OLG Simulations: Rate of Return on Productive Capital

Based on the theories that we have taken from the groundwork summarized in the previous sections, in this section we are presenting a simulation model with which we are analysing how demographic change will affect the overall economic return on productive capital and savings. Section 5 then differentiates this analysis within the framework of a dynamic portfolio model according to risky equities, fixed-interest securities (with no interest rate risk but with a price risk) and secure investments (i.e. with no interest or price risk). Finally, section 6 deals with the developments that can be expected on the property market. The "MEA-OLGA" simulation model used here further develops the variant developed at the Mannheim research institute "The Economics of Aging" (MEA) (Börsch-Supan, Ludwig and Winter, 2002; Börsch-Supan, Heiss, Ludwig and Winter, 2003; Börsch-Supan, Ludwig and Winter, 2003).

4.1 A model of overlapping generations: The MEA-OLGA model

Savings, capital returns and international capital flows are the outcome of complex interactions between supply and demand on German and international capital markets, influenced by demography and the capital and goods markets. Our simulation model calculates this equilibrium by drawing on model households which mirror the various generations living together during the phase of demographic transformation ("overlapping generations", abbreviated as OLG). Such models have a long tradition. They were developed as theoretical models by Samuelson (1958) and Diamond (1964) and extended by Auerbach and Kotlikoff (1987) to be used for the first time in a near-reality computer simulation model. The MEA-OLGA simulation model on which the results of this section are based is the first such model that is not restricted to one country but also covers international trade and capital movements. Details, including a mathematical description, of the MEA-OLGA model can be found in Börsch-Supan, Ludwig and Winter (2003). Here we are limiting ourselves to the essential mechanisms of effect and equations for this model, which takes a long-term perspective and is thus neo-classical, abstaining from all short-term Keynesian considerations. This also justifies the assumption that exchange rates have no role to play in our real economic model.

(a) *How households behave:*

The model households in the MEA-OLGA model offer a fixed amount of work. They divide their income into consumption and savings but here we only map the long-term savings, i.e. the savings that are required to compensate for the drop in income upon retirement. The accumulation of savings is therefore mapped by the life cycle hypothesis model in which the household does not apportion distribution of income into consumption and saving each year but over a time scale that is only limited by the households' discount rate. Consumption C_t is smoothed by this long-term life planning so that it greatly depends on consumption in the preceding period C_{t-1} . Impatient consumers (their discount rate ρ exceeds the market rate r_t) initially consume a large amount but, in contrast, patient households initially save and their discount rate of ρ is lower than the market interest rate r_t . The development over time of consumption C_t is therefore produced from the following simple equation in which the ratio between the discount rate and the market interest rate is weighted by the parameter σ , which states the extent to which households react to deviations between the discount rate and the market interest rate:

$$C_t = C_{t-1} \cdot \left(\frac{1+r_t}{1+\rho} \right)^{1/\sigma}$$

This consumption equation implicitly also describes the savings decision because current income minus expenditure on consumption gives the figure for savings. This is added, with interest, to asset A_{t+1} of the next period:

$$A_{t+1} = A_t + r_t Y_t^n - C_t$$

The retirement insurance scheme has a crucial influence on savings decisions because this is the main source of income during retirement, albeit supplemented by cashing in household savings, for instance in the form of what is termed the "Riester pension". Our model only maps long-term savings in the form of provision for old age. If the pay-as-you-go retirement insurance scheme is so generous that the level of pension is 100%, no long-term savings at all occur in our model. If, at the other extreme, the level of pension falls to zero, all the income in old age must be provided from savings. Consumption is correspondingly lower in younger years.

Savings are invested in productive capital. These investments can either be in Germany or abroad. The international portfolio shows that capital moves to where the returns, after adjustment for risk and tax, are the highest and this remains so until the balance between risk- and tax-adjusted returns is the same in all countries.

(b) Production side, capital market and overall economic balance

On the production side, capital and work are used as a substitute so that the wages correspond to work productivity and the capital return corresponds to capital productivity. We are modelling this using a so-called Cobb-Douglas production function, which converts GNP $Y_{i,t}$, - work $L_{i,t}$ and capital $K_{i,t}$ in units of goods and services produced. Here the indices t and i stand for year t and country i .

$$Y_{i,t} = F(\Theta_{t,i}, \Theta_{t,i} L_{t,i}) = K_{t,i}^\alpha (\Theta_{t,i} \sum_{a=1}^{65} \varepsilon_a L_{t,a,i})^{1-\alpha}$$

All countries have the same production technology F , but labor productivity varies $\Theta_{i,t}$. Also, the entire workforce $L_{i,t}$ is composed of the various age groups $L_{i,a,t}$, whose age-specific productivities ε_a correspond to the average wage profile.⁷

The different productivity levels $\Theta_{i,t}$ correspond to the different per capita gross domestic products. The available quantity of work $L_{i,a,t}$ is derived from the demographic assumptions presented in section 2.

Wages and interest rates are determined in such a way that they correspond to work productivity and capital productivity, respectively. In particular, the interest is produced from the marginal productivity of the capital deployed minus the rate of depreciation δ :⁸

$$r_{t,i} = f'(\Theta_{t,i}) \delta$$

and the investments made in the domestic economy from the net change of the domestic capital stock:

$$I_{t,i} = K_{t+1,i} - (1 - \delta)K_{t,i}$$

Capital $K_{i,t}$, which is used in a country for production does not have to correspond to the assets that the inhabitants of this country have accumulated and which we have described as A_t . The difference

$$V_{i,t} = A_{i,t} - K_{i,t}$$

is represented by the assets abroad. If more is saved than invested, the capital flows abroad - for instance, in the form of direct investments - as described above, in other words until the

⁷ Rising until the age of 55 and then constant.

⁸ To be more precise: From the marginal productivity of capital deployed per efficiency unit of work, therefore $k = K/\Theta L$. The depreciation rate δ is assumed to be constant and uniform.

returns, adjusted for risk and tax, have converged in all countries. The current account surplus is therefore

$$CA_{t,i} = V_{t+1,i} - (1-\delta)V_{t,i} = S_{t,i} - I_{t,i}.$$

If one takes all the regions of the world together, both the international capital flows and the net external positions of the various countries must cancel each other out overall, because the regions of the world form a closed economy. This is one of the key conditions for the equilibrium of international trade and our model:

$$\sum_{i=1}^R V_{t,i} = 0$$

The MEA-OLGA model is matched to the overall economic pattern in Germany from 1970 to 1995, i.e. the model parameter is selected in such a way that the historical development is mapped as successfully as possible ("calibration"). The relevant parameters are listed and explained in the appendix.

(c) How international capital movements are modelled:

We first applied the MEAOLGA model to three scenarios for capital mobility: firstly, to Germany as a closed economy; secondly, to Germany as an open economy with perfect capital mobility within the other countries of the EU; thirdly, with perfect capital mobility within the other countries of the whole OECD. Perfect mobility of capital within the OECD may be an exaggerated assumption but not so within the EU, because by far most of the flows of capital are within the eurozone where there is free movement of capital. This also justifies the assumption that exchange rates have no role to play in the MEA-OLGA model. In addition, the model describes the very long-term trends in capital movements. Whereas the short-term exchange rate induces flows of capital movements which, although considerable, are of short duration and of less interest to us in the context of demography, the long-term exchange rate and the long-term capital flows are determined jointly by the fundamental variables of demography and overall economic development. This maps the MEA-OLGA model.

(d) How further capital is accumulated as a result of old-age provision

We mapped the potential scope of development of pension insurance with two scenarios: the curve to be expected after the Riester reform is between the two. The first scenario ("Retain the PAYG system in place prior to the Riester reform") keeps the net replacement rate (of approximately 70%) provided by the pay-as-you-go pension system. In this scenario the

contribution rate is raised from 19.5% to 25.7% in the year 2030 to finance aging-related additional costs. We call the second scenario the "freezing model". This systematic reform model stabilizes the contribution rate at 19.5%, so that the pay-as-you-go pension level falls to just under 51%; at the same time, the overall pension level remains constant with a resultant gradual transition to a pension system based on a substantially higher funded component. These are obviously two extreme scenarios. The present reform process will not permit a situation where the contribution rate rises to almost 26%; however, it is also unlikely that the contribution can be frozen so the most probable social policy development will be a figure between these two extremes.

If the gaps in the pay-as-you-go pension insurance are fully plugged by individual capital formation, this increase in individual private provision will have displacement effects on other forms of household savings. The calibration of the model to the development of household savings between 1970 and 1995 indirectly produces displacement of around one third. In other words, two thirds of the individual private provision induced by the reduction in the replacement rate represents genuine savings which enhance the capital stock in the economy.

4.2 The development of household savings

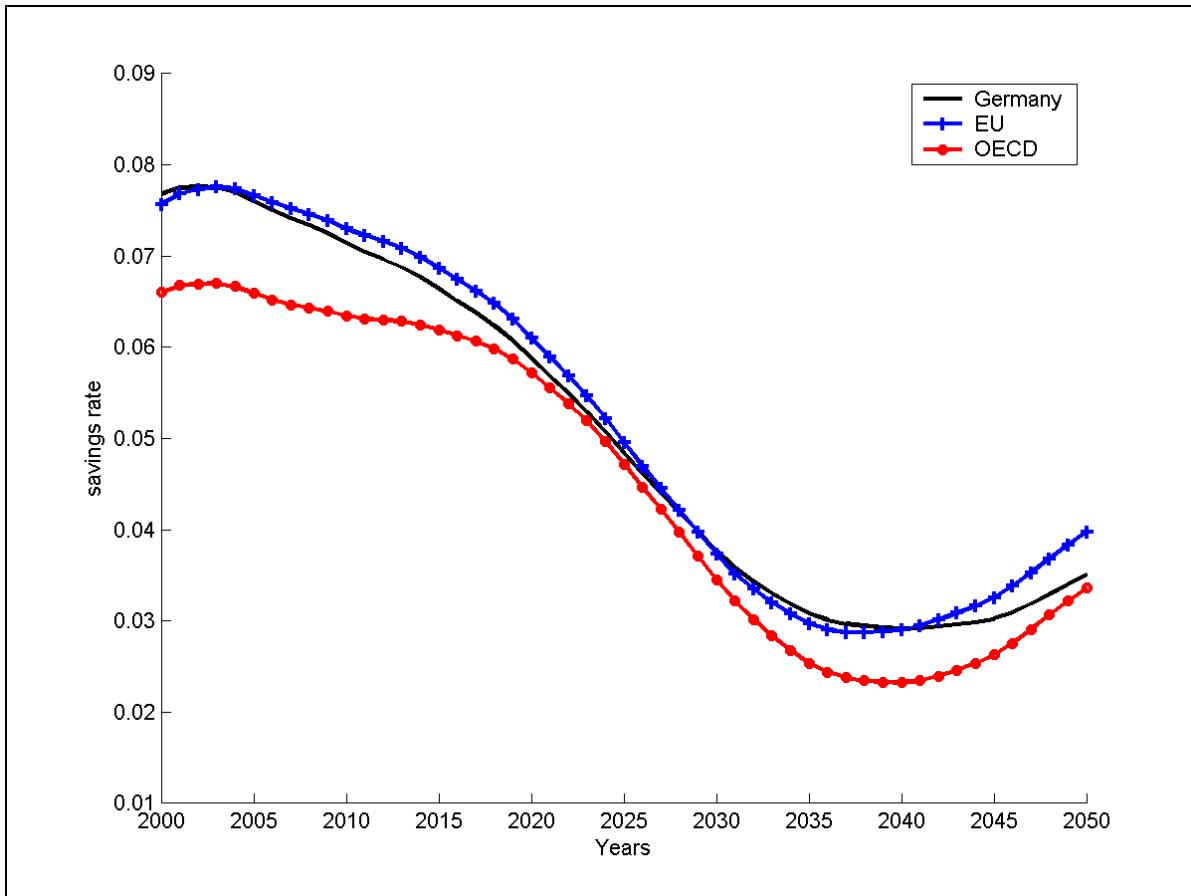
Figures 7 and 8 show the development of the long-term savings rate for the two pension reform scenarios (no reform, systematic reform) and these, again, in relation to the three different assumptions on capital mobility (Germany as a closed market, free movement of capital in the EU, free movement of capital throughout the entire OECD). The savings rate, which the simulation model calculates, is the proportion of long-term savings of private households in relation to the available income of the household. This percentage is lower than the savings rate usually measured, which is approximately five percentage points higher in Germany and includes short-term savings (for holidays, purchases of consumer durables, etc), which are not at all sensitive to demographic factors and are thus of secondary importance for our simulation calculations.

(a) The purely demographic effect

Let's start in Figure 7 with the scenario in which today's pension insurance system is not changed, i.e. under the fallacious assumption that the benefits of the current pay-as-you-go system will be continued at the present level and financed by increases in contributions, without employment being influenced by it. Figure 7 therefore shows the pure effect that an

aging population has on the resultant savings rate, without the additional effect of a pension reform.

Figure 7: Savings rate of private households, continuing with the current pay-as-you-go pension system (long-term savings of private households divided by available income of private households, the pension level of the pay-as-you-go system stays at 70%)



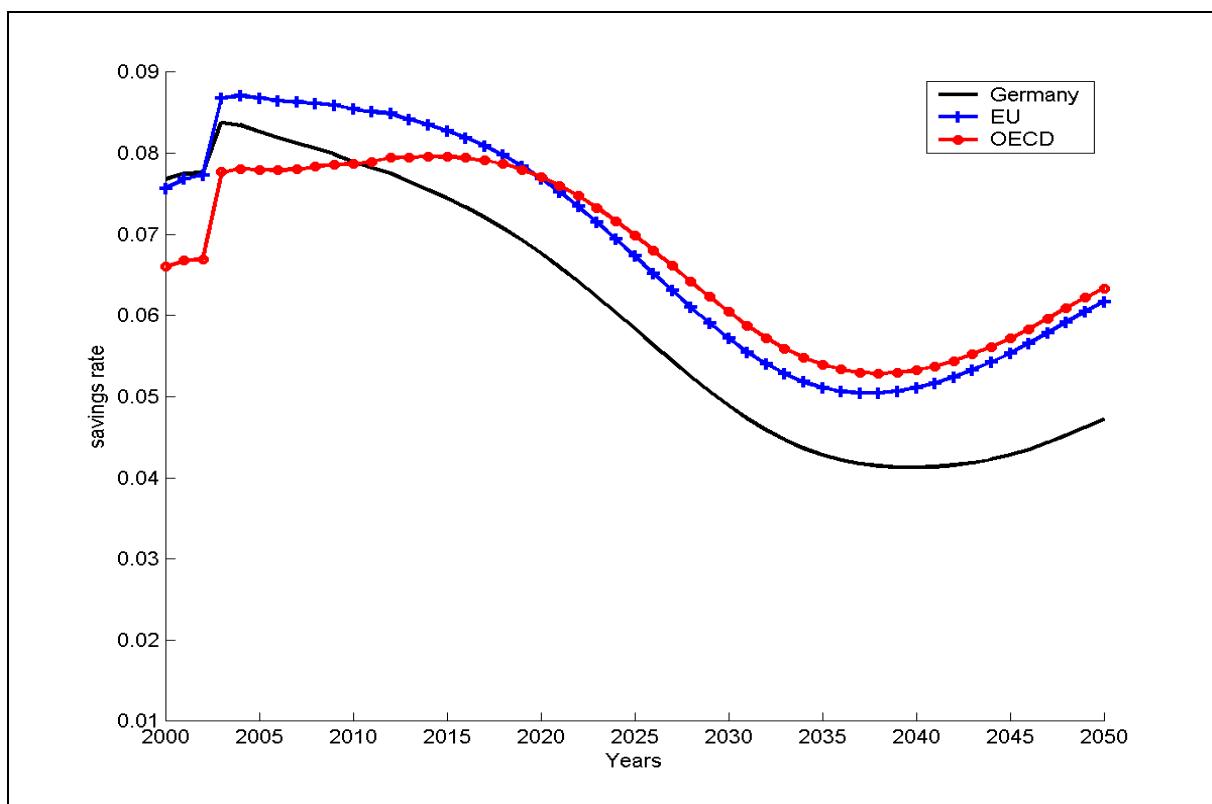
Source: MEA-OLGA model (Börsch-Supan, Ludwig and Winter, 2003). On the expression "long-term saving". See the "Germany" scenario in the text: All German savings are invested in Germany; "EU" scenario: All German savings are invested within the EU; "OECD" scenario: All German savings are invested in OECD countries.

The savings rate follows the demographics very closely. After a phase of very slow decline, during the years in which "baby-boomers" are receiving the highest income and thus also saving the most, a rapid, demographically induced decline will follow from 2020 onwards, when the first "baby-boomers" start to retire. Overall, the savings rate will fall in the long term by approx. 4 percentage points. This decline is not particularly affected by international diversification options.

(b) *The effect of a funded pension reform*

Figure 8 shows the effect of a systematic pension reform, i.e. if the contribution rate is stabilized at 19.5% and the income in old age is secured by a corresponding amount of private pension provision. Pension reform of this kind will increase the savings rate considerably. Figure 8 also clearly highlights the importance of international diversification options. If all the funds for old-age provision have to be invested in Germany, the return on capital will fall much more sharply than would be the case with international diversification - see Figure 9. This will reduce the savings. In contrast, with systematic pension reform and international diversification, household savings increase by approximately three percentage points as compared with the initial situation in Figure 7, thus compensating for a major part of the decline in the savings rate due to demographics.

Figure 8: Savings rate of private households with a partially capitalized pension reform
(long-term savings of private households divided by the available income of private households; contribution to the pay-as-you-go pension system is limited to 20%)



Source: MEA-OLGA model (Börsch-Supan, Ludwig and Winter, 2003). On the expression "long-term saving". See the "Germany" scenario in the text: All German savings are invested in Germany; "EU" scenario: All German savings are invested within the EU; "OECD" scenario: All German savings are invested in OECD countries. The "leap" represents the increase in savings as a consequence of introducing the multi-pillar model because in our model the households make the payments for old-age provision that are necessary to maintain the level of pensions at the accustomed level.

4.3 Trends in returns on capital

We now come to the central point of this section and that is the overall economic returns on productive capital, i.e. all machines ("equipment") and buildings ("plants") of the corporate sector. This return on capital falls when work is scarce and capital is relatively plentiful. Thus returns on capital tend to fall in countries that are aging. This effect is intensified by a pensions reform because then the supply of available capital increases. When the time comes that the invested assets are suddenly withdrawn as the baby-boomers retire and "consume" their accumulated assets, one may well conclude that the much cited "asset meltdown" with dramatic falls in returns will occur.

There are no grounds for fearing this and definitely not to such a dramatic extent. Firstly, we have seen that household saving remains relatively stable and is even likely to fall. Thus the supply of capital becomes scarce and with it the rate of return on capital offered by the corporate sector rises. The boost is particularly due to the fact that an aging economy needs capital to take the place of labor and increase productivity. Also, the reduction in aggregated households savings - as can be seen in Figures 7 and 8 - will take place over a long period and is anticipated by capital markets because the demographic data is already well known.

These aspects become clear in Figures 9 and 10. Once again, the first figure shows the actual effect of the aging population and the following figure shows the effect of a systematic pension reform. The most important finding however is that, although capital returns do actually fall with the demographics, the quantitative effects are relatively minor.

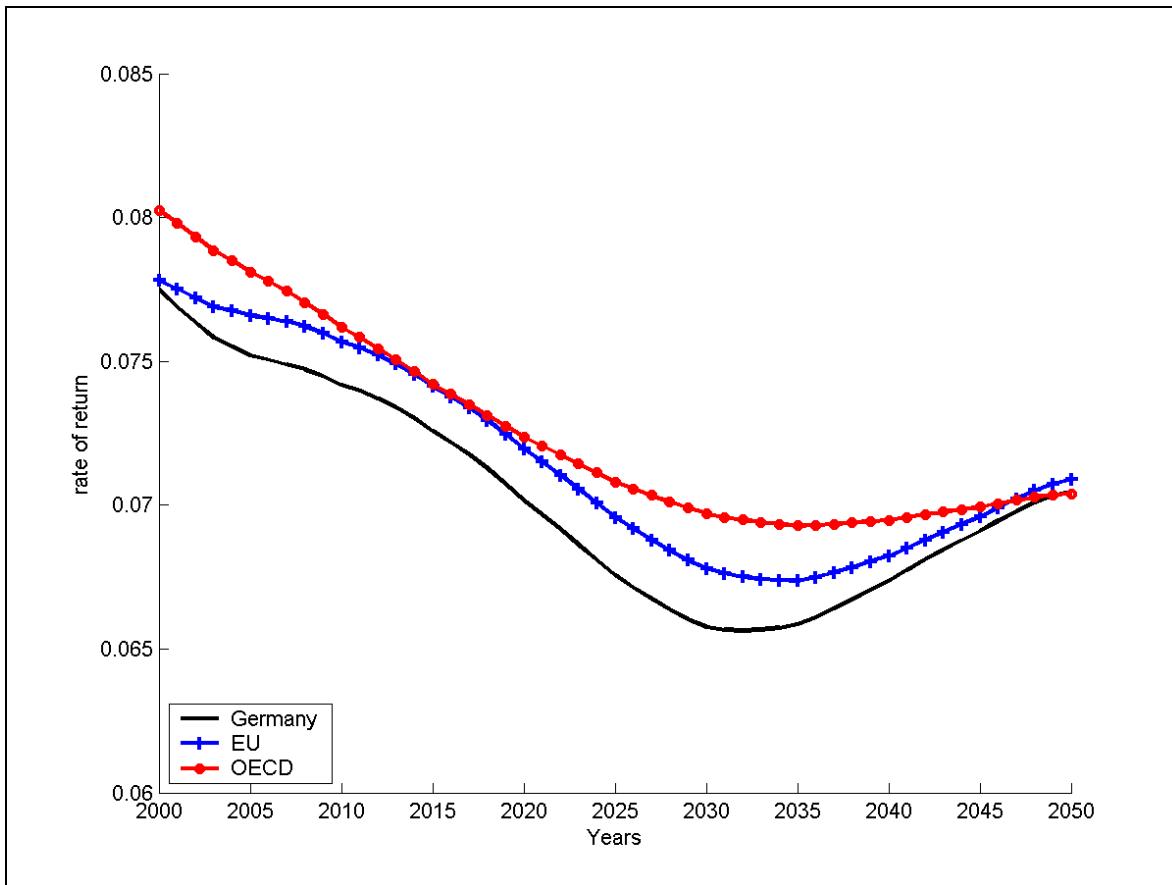
The two figures present the long-term capital returns on total productive capital. This yield includes fixed-interest securities (industrial securities and bonds) as well as shares and direct investments. The basic rate of capital return is calculated in the model and corresponds closely with the empirical values in Börsch-Supan (1999) for the period 1970-1994. The level of return varies slightly, depending on the extent of international diversification in the portfolio. If one looks at productive capital in Germany and the EU, the returns in 2000 - the initial year - are approx. 7.7% but if the other OECD countries and particularly the USA are added, it edges up slightly to approximately 8%.

(a) The purely demographic effect

Figure 9 starts with the scenario in which no pension reform takes place, in other words only the demographic effects are mapped. Overall, the maximum decline as a result of demographics until 2035 will be around 120 basis points and then this will only be in the fallacious situation whereby there will be no capital movements with foreign countries. In this

case, capital returns will fall from 7.7% (2000) to 6.5% (2035). Where diversification is applied, the decline is reduced by 10 to 20 basis points; for diversification within the EU, the demography-related decline in capital return is from 7.7% to 6.7% and, within the OECD as a whole, from around 8% to 7%.

Figure 9: Capital return if the present pay-as-you-go system is continued
(long-term return on productive capital; pension level of the pay-as-you-go system remains at 70%)



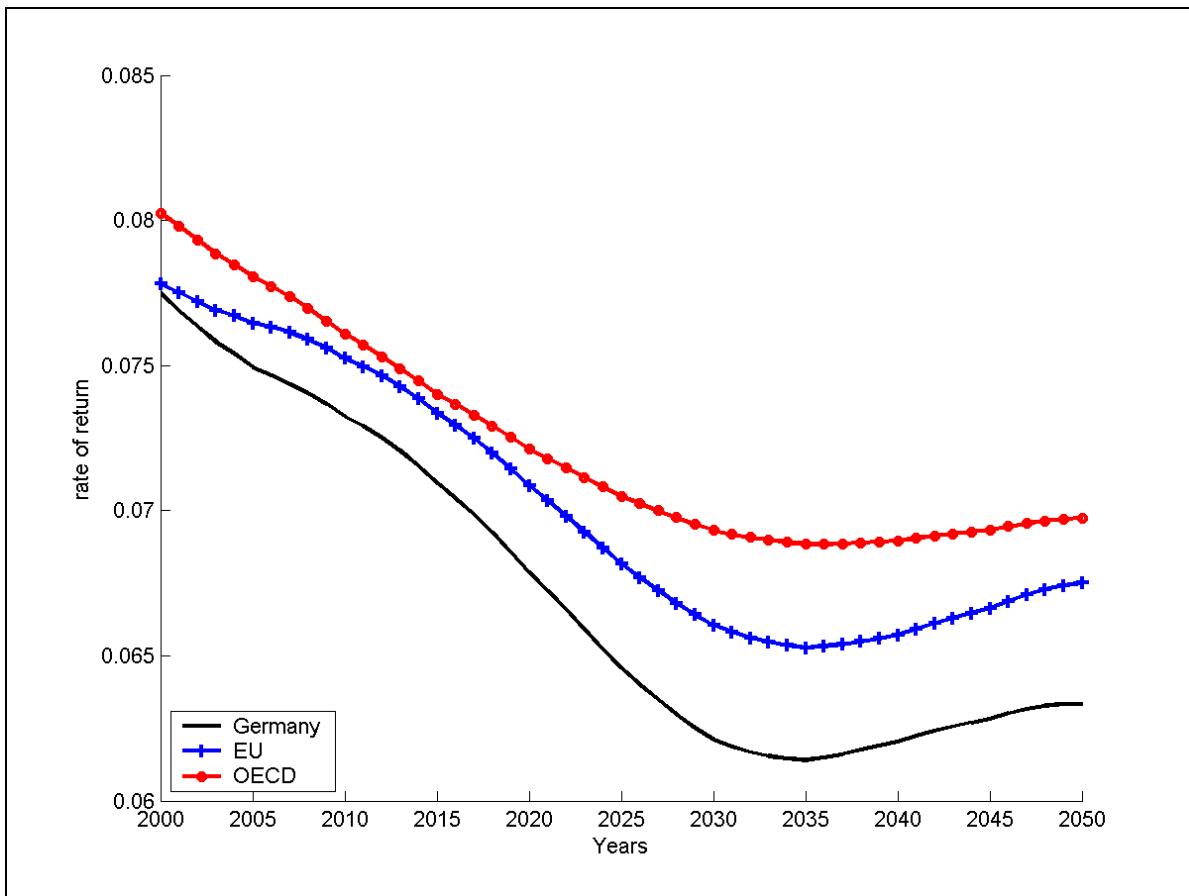
Source: MEA-OLGA model (Börsch-Supan, Ludwig and Winter, 2003). The "Germany" scenario: All German savings are invested in Germany; "EU" scenario: All German savings are invested within the EU; "OECD" scenario: All German savings are invested in OECD countries.

(b) The effect of a drastic pension reform

The comparison with figure 10 shows the additional effect of a pension reform that focuses systematically on stable contributions. It reduces returns on capital because it creates an additional supply of capital. However, this effect is only significant in quantitative terms if international diversification options are excluded. In this case, capital returns fall by a further

40 base points in 2035. Where diversification takes place within the EU, this effect is reduced to approximately 20 basis points and, if the USA - which dominates capital markets in the other OECD countries - is included, the decrease in the rate of returns disappears almost completely as a result of the funded pension reform.

Figure 10: Return on capital in the case of a partially capitalized pension reform (long-term return on productive capital, contribution to the pay-as-you-go system is limited to 20%)



Source: MEA-OLGA model (Börsch-Supan, Ludwig and Winter, 2003). The "Germany" scenario: All German savings are invested in Germany; "EU" scenario: All German savings are invested within the EU; "OECD" scenario: All German savings are invested in OECD countries.

4.4 The fairy tale of "asset meltdown" and the diversification effect of global capital markets

There are two important messages here. Firstly, the fairy tale of "asset meltdown" is not applicable if both supply *and* demand on capital markets are carefully incorporated into the forecast. Secondly, international capital markets play an important role in balancing out the

remaining fluctuations in returns. Expressed in more contentious terms, it can be said that aging requires globalisation in order to cushion its macroeconomic effects. It is not difficult to understand the intuition behind this result and it is completely in line with the view in international trade. Different developments always provide the opportunity to balance these out through trade. In this case, different demographic trends in the OECD countries provide the opportunity and international capital movements the mechanism to allow national differences in population and gainful employment to be balanced out to the benefit of all countries. Even when we were looking at the figures on demography in section 2, we could see that the populations of different countries were definitely not aging uniformly - not across the industrial countries and not even within the European Union.

In many respects, these findings turn the maxim we often hear on its head and that is that globalisation is especially dangerous in times when the population is aging because it threatens our social systems. Increasing non-wage labor costs (here the rise in pay-as-you-go pension contributions in the first pension scheme scenario) in aging economies do indeed make life difficult because in younger economies companies can pay the same net wage yet the gross wages are lower. Conversely, a comparison of Figure 9 with Figure 10 shows that it is precisely because of this that a partial changeover to a funded pension system delivers advantages. It is only by using the international capital market that the demographic risk can be diversified.

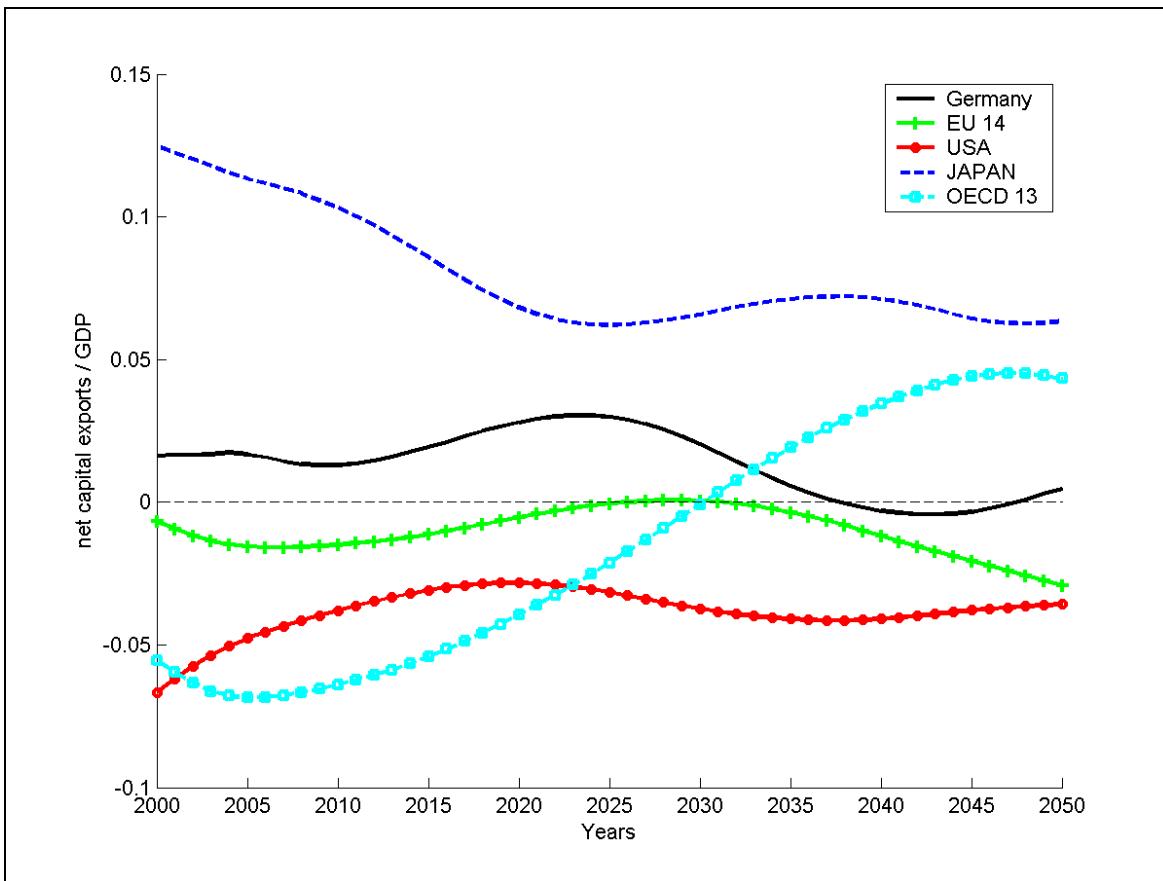
4.5 International capital flows

The cushioning role of the international capital market is based on the capital flows prompted by the aging process. The effects on savings and returns related to demography, which were described in the two previous sections, have a different impact in the various countries. With free mobility of capital, therefore, flows of capital will come from the aging countries with low rates of returns and move into the young economies where returns tend to be high and this causes the returns to balance out.

Figure 11 shows capital exports for five regions in the OECD (Germany, the rest of the EU, the USA, Japan and the rest of the OECD), measured as a percentage of the gross domestic product in each case. The model first reproduces the well-known initial levels of capital flows: Japan as a particularly large exporter of capital and the USA as the largest importer of capital. As is the case for Japan, Germany saves more than it invests in its own country but to nowhere near the same extent.

These very different initial values now have to accommodate the demographic change. Falling support ratios mean lower savings, thus tending to reduce capital exports. This is particularly clear in Japan where capital exports are declining sharply. If Japan had not started with such a high export rate, Japan would become an importer of capital. Because aging in Germany is more pronounced than in the other EU states (see the change, not the level, in Figure 2), the change in the capital export rate is also greater than it is in the other EU states. In the USA and the remaining OECD countries, where the support ratio is initially rising again, they are reducing their capital imports; from 2030 onwards the other OECD countries will even become exporters of capital, primarily in the USA, where the high gross domestic product makes the capital import rate plotted in Figure 11 particularly important.

Figure 11: Capital flows within the OECD



Source: MEA-OLGA model (Börsch-Supan, Ludwig and Winter, 2003).

5. The Development of Returns from Equities, Fixed-interest Securities and Secure Investments

In the previous section we demonstrated that the aging of the population brings about a relatively small yet significant fall in capital returns. There is, however, no reason to expect that this decrease in the rate of return will affect all types of capital investment to the same degree. In reality, it is probable that risk-free investments - such as money market investments - or relatively low-risk investments like government bonds will be more severely affected by the fall in rates of return as a result of aging than risky capital investments - such as equities or corporate bonds. This hypothesis is based on the consideration that older households tend to invest in risk-free capital investments because they do not want to jeopardize the income from capital required for their old age as a result of a sudden negative shock that affects the returns from risky investments. These considerations do not only appear in numerous investment recommendations and products, as summarized in section 5.1 but they also have a theoretical basis, as section 5.2 shows, in the fundamentals of portfolio selection of an individual household, which is important for our simulation model.

As the population grows older, restructuring in the portfolios of many households increases the overall demand for risk-free investments on the financial markets. Where there is a given supply, the increased demand causes the prices of these investments to rise, thus putting pressure on returns. This effect is further reinforced because, in an aging economy, the overall supply of capital and thus also the supply of relatively risk-free securities falls.

A quantitative forecast of these portfolio effects is, however, very difficult because it is almost impossible to estimate how the future portfolio selection pattern of households will develop. Our simulation model, which is described in more detail in section 5.3, should therefore be seen as illustrative. Many may find it surprising, but overall there are only very minor effects. Our model forecasts an increase in the risk premium for shares ("equity premium") by around 70 basis points in the coming 25 years and a corresponding greater decline in returns for investments without an interest and price risk. This and further simulation results are shown in section 5.4.

5.1 Typical strategic investment recommendations

The two strategic recommendations for investments probably given most frequently, according to advice from typical financial service providers, are to rely mainly on equities during the early stages of working life and then to gradually change to safe forms of investment as one grows older. In addition, portfolio recommendations are common for different types of investors. Here it is usual to differentiate between "growth orientated", "balanced" and "conservative" investors. Typically, the proportion of equities is reduced in the sequence listed in favour of higher fixed-interest securities and cash deposits (see table 1).

Table 1: Typical recommendations for “strategic portfolio allocation”

Source and investor type	Shares of portfolio			Ratio between bonds and equities
	Cash	Bonds	Equities	
<i>Fidelity</i>				
Conservative	50	30	20	1.5
Moderate	20	40	40	1.0
Aggressive	5	30	65	0.5
<i>Merrill Lynch</i>				
Conservative	20	35	45	0.8
Moderate	5	40	55	0.7
Aggressive	5	20	75	0.3
<i>Jane Bryant Quinn</i>				
Conservative	50	30	20	1.5
Moderate	10	40	50	0.8
Aggressive	0	0	100	0.0
<i>The New York Times</i>				
Conservative	20	40	40	1.0
Moderate	10	30	60	0.5
Aggressive	0	20	80	0.3

Source: Canner et al. (1997) "An Asset Allocation Puzzle", translated.

However, with this rough categorization it is unclear whether the different investor types are differentiating between their risk aversion, their investment time scale or the extent to which their income from work is at risk and on which expectations for returns the recommendations are based. Superimposed over the above mentioned recommendation on optimum portfolio allocation over the life cycle are classifications on the extent to which an investor will gradually change from being a growth-orientated investor to a conservative investor over the life cycle. For an example of this, see the "MLP matrix" (Heinrich, 2002).

5.2 Theoretically based models of portfolio allocation of an individual household

The optimum portfolio allocation over the lifecycle and the resulting restructuring of assets in an aging society are therefore complex. Tables such as the ones above are by no means adequate to produce a fairly reliable quantitative estimate. Before we come in section 5.3 to present our simulation model for supply and demand of households of different ages on the financial markets, we therefore require a theoretically reliable model of portfolio allocation from the view of an individual household based on the following fundamentals.

The "Capital Asset Pricing Model" (CAPM) developed by Markovitz (1952) is the best known theoretically based model for portfolio allocation. Even today, is it a major component of any academic lecture on finance during university studies and, in spite of its shortcomings, it is still commonly used - unchanged - in practice. Besides the rules of thumb that are often used when providing investment advice, the CAPM is often still the only instrument for portfolio optimization.

The problems of applying the CAPM uncritically are however clearly demonstrated by looking at the assumptions on which it is based but, if these assumptions are not correctly applied, the validity of the results cannot be guaranteed in any way. For instance, Markovitz assumes that the investor is only interested in the expected returns and the standard deviation of these and makes one single portfolio decision - in other words, with no dynamic adjustment. In the balanced view of the model, all investors place their money in the market portfolio which, depending on their risk profile, is mixed with an appropriate proportion of safe investments (cash, funds from the money market) and may even be financed with credit where this is consistent with the investor's attitude to risk. The fact that all investors - irrespective of their risk preference - should invest in the same optimum ratio of risky investments, is a familiar reference in the form of Tobin's "Mutual Fund Theorem" (1958). The assumption stating that both upward and downward swings have a negative effect on the

benefits to the investor and the statistical view of one-off investments are therefore particularly critical.

We therefore apply a dynamic portfolio model. The distinctive features of these models, originally developed by Merton (1969, 1971, 1973) and Samuelson (1969) and which are essentially applied unchanged, are that in a life cycle model the portfolio is selected at the same time as consumption and savings decisions are being made. The savings decision is understood to mean both the amount saved and the investment of existing assets and the net new savings. Because they are integrated in a consumption or savings model, these models - if they are embedded in the overall economic environment - are also termed the "Consumption Capital Asset Pricing Model" (in brief: C-CAPM) (Lucas, 1978; Mehra and Prescott; 1985).

These models nevertheless also make extremely limiting assumptions, which we explain below, so that it is clear to the reader that the quantitative results that then follow can only be considered to be rough estimates. We must however adopt some of these bold assumptions in order to be able to use the simulation model but, in important cases, we can relax the bold assumptions of the C-CAPM model considerably.

(a) Risk preferences of households

A comparatively unproblematic assumption relates to the risk preferences of households. The C-CAPM model assumes that, irrespective of their assets, investors always prefer the same proportion of risky investments. Campbell (2002) explains why this assumption, in spite of many justified doubts that are raised at first sight, is entirely realistic because - in spite of considerable increases in income and assets over the last few decades - households are only very gradually placing an increased proportion of their assets in risky investments. Consequently, we are not making any changes to this characteristic in our model.

(b) Returns that are constant over time

The original C-CAPM model adopts the premise that each individual household estimates that expected future returns (and the distribution of these) are constant over time. This assumption poses a problem, particularly because we specifically want to model changes.

Our model extends the C-CAPM model so that the average returns expected by households changes from age group to age group and can, for instance, adapt to the demographic shift. The households adopt a (deterministic) trend in respect of returns and factor this into their long-term planning.

(c) Income from employment that is safe and known

The C-CAPM model abstains from the fact that employment can be viewed as an additional investment, which brings in earnings that are more or less secure and thus can be viewed within the context of asset risks. The cash value of future income from work can be viewed as an asset and, for this reason, the term "human capital" has become established with economists. This human capital is generally not tradable and so only implicitly represents a capital investment in the usual sense of the term. Apart from the self-employed sector, this is more likely to be a low-risk rather than a risky investment. Consequently, each employee implicitly holds a non-tradable, low-risk investment. For the younger age group, in particular, this investment may exceed the optimum proportion of low-risk investments out of total assets. The household will then invest the largest possible proportion of its free assets in risky investments. Over the life cycle, the significance of non-tradable human capital as part of total assets nevertheless falls because the period of working life that lies ahead becomes shorter and equally savings in money and real-estate assets rise. Thus the optimum proportion of risky assets falls over the life cycle, even if the attitude of the investor to risk does not change. The conventional C-CAPM model ignores this effect.

Campbell and Viceira (2002) describe in detail the differences that apply to optimum portfolio allocation, both with and without consideration to this and similar effects. Their results are complex and depend on many parameters, for instance how sudden changes in income correlate with returns on the equities market. In the event of positive correlation - as is typically the case for self-employed entrepreneurs but also if employees hold shares in their company or profit-sharing plans - the attractiveness of risky investments diminishes. In contrast, investments with negative correlation act as a safeguard against sudden changes in income. As a general rule, it can be ascertained that the assumptions on the level of risk involved in income from employment and its correlation to returns on the capital market only bring about negligible differences in optimum portfolio allocation. In contrast, the principle of taking income from employment into account has far-reaching implications. For modelling on the portfolio decision we have therefore added remuneration from employment to the C-CAPM model. We have therefore decided not to model this income from employment as being risky and endogenous (i.e. the amount can be controlled by the employee, as desired), as Bodie, Merton and Samuelson (1992) have done.

(d) Rationing of credit

A further and final aspect relates to realistic limitations of portfolio allocation. If there were no limitations, the optimum situation would be for young investors to sell no-risk investments

short, i.e. to take out loans for risky investments and ones with correspondingly higher returns. Viewed realistically, short-selling of risk-free investments is only a possibility for a small number of investors. Buying equities on credit may have become increasingly popular during the stock market boom of the late 1990s but, typically, such a course of action is only adopted by very few people. Banks, too, will only permit such transactions if they are backed by considerable wealth or a regular high income. When modelling portfolios, it is usual to limit short-selling of no-risk investments and this convention has indeed been incorporated into our model.

5.3 The MEA-POR TA simulation model for portfolio selection

Taking as a basis this portfolio decision of a single household, we are now developing the "MEA-POR TA" simulation model, which brings together households of different ages and different cohort groups in financial markets in order to map the differential effects of an aging population on returns for risky and risk-free securities.⁹ Because financial markets are becoming ever closer, we are not limiting ourselves to Germany but instead we are modelling development for the whole European Union. The demographic development, the overall underlying economic conditions and the basic values for the portfolio therefore correspond to the average for the 15 EU countries.

We are modelling the trends in returns and volumes for three investment categories:

- Risk-free investments ("cash")
- Low-risk investments ("fixed-interest securities")
- Risky investments ("equities")

By risk-free investments we mean investments not subject to any interest or price risks, in other words cash, i.e. primarily savings deposits and related investment vehicles. We interpret risky investments as all investments in productive capital, as defined in the MEA-OLGA model, i.e. equities, industrial bonds and direct placements in corporations outside the financial sector. In between there are low-risk investments, in particular fixed-interest securities issued by regional and local authorities.

As far as we know, there is no model that analyses the portfolio decision of numerous households and their interaction on the capital market in the course of a demographic shift. One exception is Brooks (2003), who simulates these interactions using a small but

⁹ A detail description of the model and a discussion can be found in Ludwig (2003).

consequently very stylized model that incorporates a rough map of the demography. A problem of such small and stylized models is that they distort the effects of the capital markets and their scope delivers an exaggerated result.

In order to avoid this distortion and to produce the most realistic forecasts possible, we are adopting the same population structure of overlapping generations, as described for the MEA-OLGA model in section 4. From this model we are also adopting the supply side of financial markets - in particular, the securities of issuing companies -, the calculation of overall economic balances on the labor and goods markets, and the market for productive capital. Thus at the outset our simulation model is a suitably realistic description of demographic change and trends within the economy as a whole.

In addition, we model the limitations in household behavior, which has been explained in the previous section. Whereas we have kept very close to reality in respect of demographics, we have simplified savings and portfolio decisions so that we can represent this complex process whilst keeping the outlay within acceptable limits. This means that we simplify households' investment decisions considerably - as is usual in the references mentioned in the previous section - by assuming that the households can only chose between two alternatives - a risk-free ("cash") and a more risky capital investment ("equities"). We cover the third form of investment - low-risk fixed-interest securities - through a weighted average of these two investments, with the weighting determined in such a way that the returns are the historical yield to maturity of fixed-interest securities. For this reason, we assume that the overall economic growth model (essentially identical to the MEA-OLGA model) provides us with the returns of risky investments (equities, etc. in productive capital), the characteristic and level of which we can take as a given in the portfolio model.

The basic structure of portfolio models such as the MEA-PORTA model and the model already mentioned from Brooks (2003) is based on the work of the Nobel Prize winner Lucas (1978). They are characterized by the assumption that the supply of and demand for risk-free securities on the part of the model households actually occurs and that the risk-free interest rate adjusts so that supply and demand on this market balance out. As mentioned in section 3, realistic models must solve what is termed the "Equity premium puzzle", which was first raised as a subject for discussion by Mehra and Prescott (1985). This is the phenomenon that conventional economic models underestimate the risk premium obtained on the market for risky investments. We follow the model of Constantides, Donaldson and Mehra (2002), whose work was described briefly in the previous section, and adopt credit limitations that are the same as those that apply to realistic mapping of actual household behavior. More

precisely, we assume that credit for model households is so strictly rationed that the maximum amount of credit is only a certain proportion of the available period income.

Furthermore, we assume an exogenous supply of risk-free securities. We adapt to this exogenous supply in such a way that the risk premium mapped by the model is within a realistic order of magnitude ("calibration"). The MEA-PORTA model therefore supplies more realistic forecasts of the "equity premium" than older models presented in the academic literature.

We adopt the parameters of the MEA-OLGA model to calibrate the MEA-PORTA model. In addition, we require the initial values for returns of the three forms of investment, their distribution over time and their proportions in the household portfolio. As we have no EU-wide average data on the return from productive capital, for the following analysis we are calibrating the part of the macroeconomic model in a way that the return from the risky investment in the initial year of 2000 is 7.6% and the return from the low-risk investment is 4.1% which reflects the performance of the DAX and REXX indices for stocks and fixed-interest securities in Germany. The proportions of the three investments in the portfolio are taken from Guiso et al. (2003) who have recorded the composition of household portfolios in the major European countries (cf. Table 2). We form the "EU" portfolio approximately by taking the average for the four major EU countries.

Table 2: Proportions of investments in the portfolios of European households

	France	Germany	Italy	UK	"EU"
Cash	32.6	37.6	22.7	21.5	28.6
Bonds	17.2	34.8	32.3	26.5	27.7
Equities	50.4	27.6	45.0	52.0	43.8

Source: Guiso, Haliassos and Jappelli (2003) and own calculations. Indirect investments (pension funds, life insurances, etc.) have been apportioned pro rata to the original investment types. The values refer to the period from 1996 to 1999.

We are finally setting the exogenous supply of risk-free investments in such a way that the portfolio proportions correspond to the last column of Table 2 and the return from a risk-free investment in the initial year of 2000 is set at 3.3%.

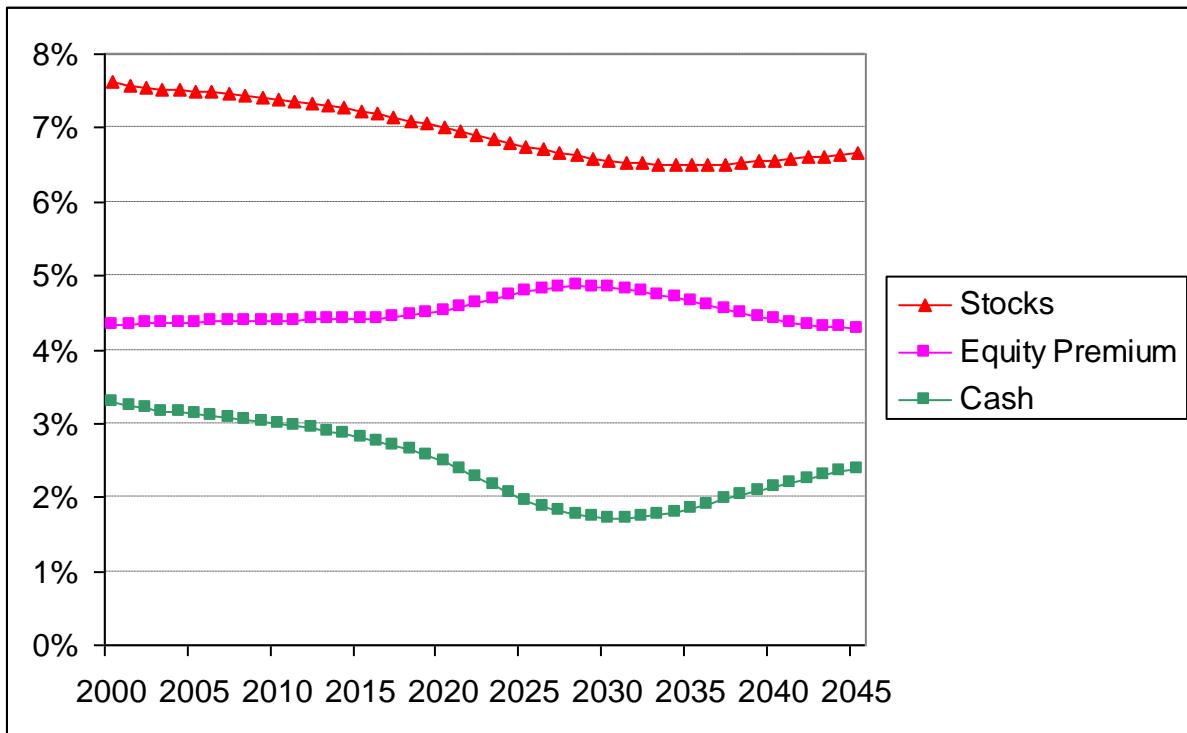
All these calibration assumptions must be seen as estimates and the results presented in the next section are therefore to be understood as indications. It is obviously impossible to

estimate precisely (down to the last tenth of a decimal place) how returns will move over the next 40 years.

5.4 Simulation results of the MEA-PORTA model

We are initially forecasting the development using the assumptions on population and employed persons, which were also the basis for section 4, i.e. the average trend as was presented in Figures 4 and 5. As can be seen in Figure 12, the risk-free return, in other words return on cash investments with no risk relating to price or interest, will fall relatively sharply over the next 25 years from 3.3% to just over 1.8% in 2027. This decline is much more pronounced than the fall in returns from risky investments (equities) from approx. 7.6% to 6.8% by the year 2027. After this year, when the aging of the population in Germany reaches its peak, the return on safe investments will then rise again, whereas the returns from the equity market will essentially move sideways and will only begin to rise again after 2035, the year when the aging of the population in continental Europe reaches its peak. We calculate that, in the period up to 2025, the risk premium that the market will pay for a risky investment - the "equity premium" - will rise by approximately 70 basis points. However, this effect is temporary. It will fall again to the extent that the baby-boom generation will use cash assets invested for old-age provision for consumption purposes.

Figure 12: Returns from cash and equities, and the risk premium in the basic scenario

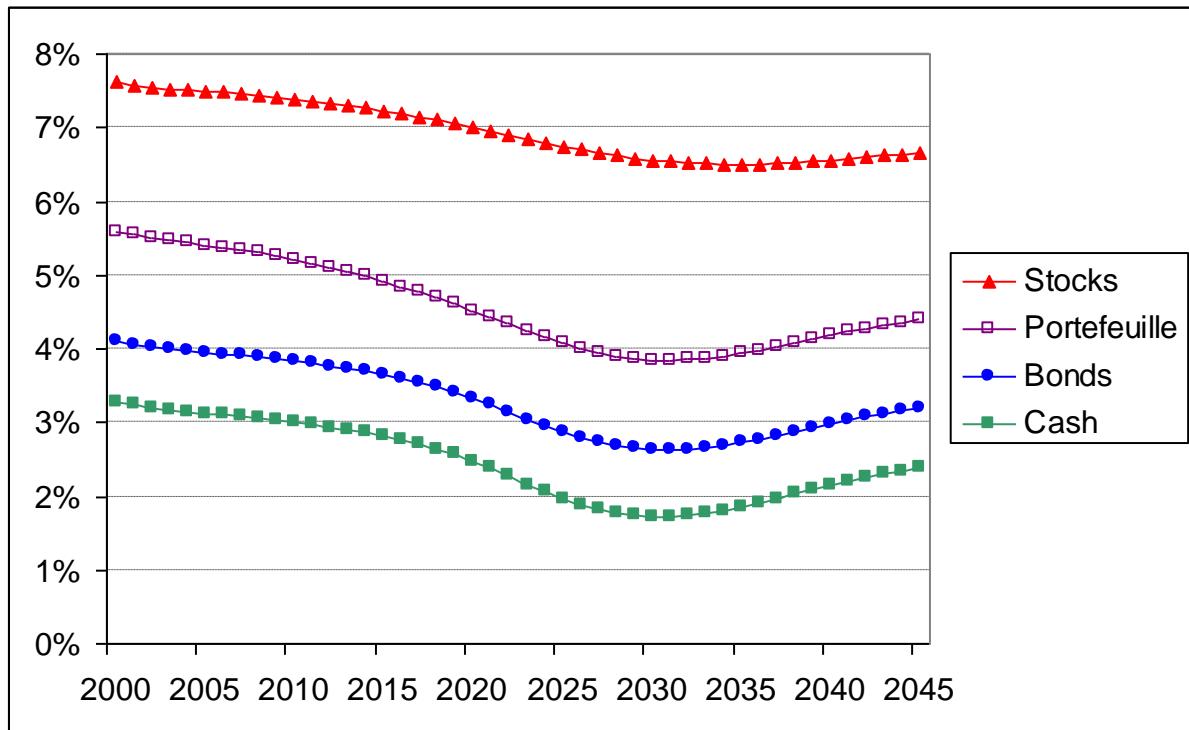


Source: MEA-PORTA model.

Figure 13 adds the movements of yields to maturity of fixed-interest securities, i.e. the low-risk investment which was modelled as a composite capital market instrument of risky and risk-free investment. The return on bonds falls correspondingly slightly less than is the case for pure cash deposits but, with a decline from 4.1% in the initial year to 2.8% in 2027, the drop is much more pronounced than the fall in returns from equities.

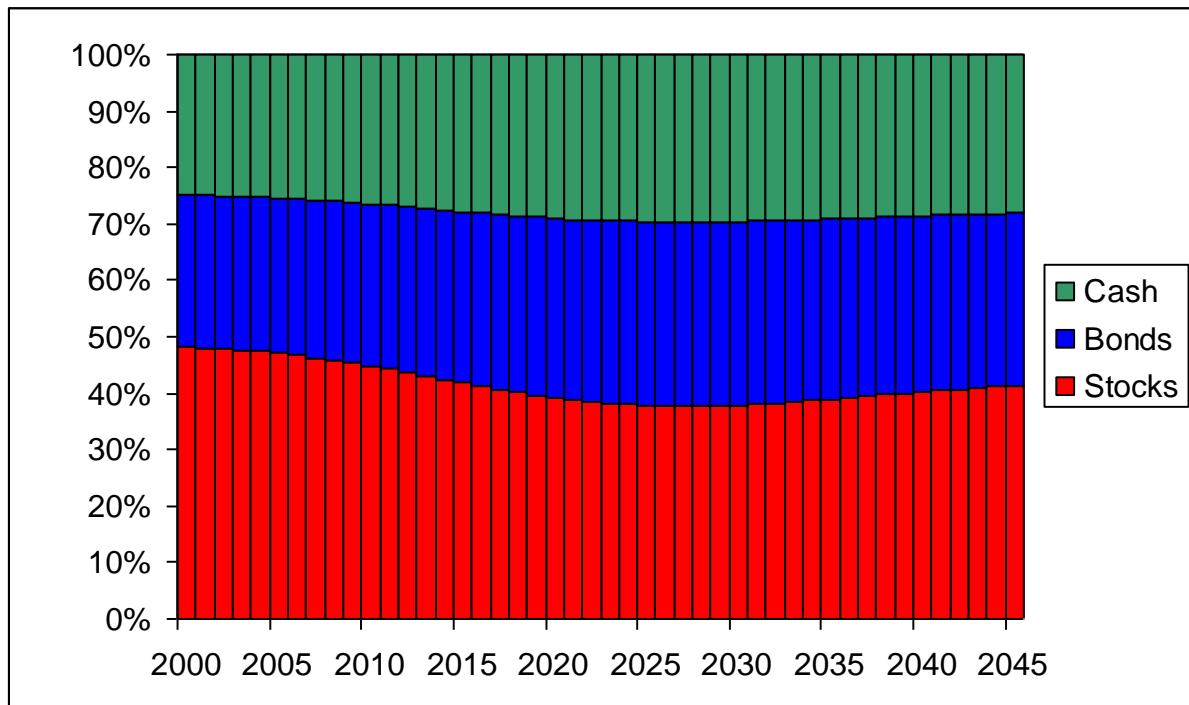
The proportions for the portfolios change surprisingly little, as can be seen in Figure 14. The proportion of relatively safe investments held on average by EU households will increase by around five percentage points between 2000 and 2027 from 25% to 30%, whereas the proportion of shares will fall by around 10 percentage points from approximately 48% to about 38%. After the aging process reaches its peak, the proportion of equities held in the portfolios of EU households will again increase: the change in the structure of portfolios is therefore only a transitional effect of the baby-boom generation.

Figure 13: Returns on an individual investment and the total portfolio



Source: MEA-PORTA model.

Figure 14: The average portfolio in the wake of demographic change

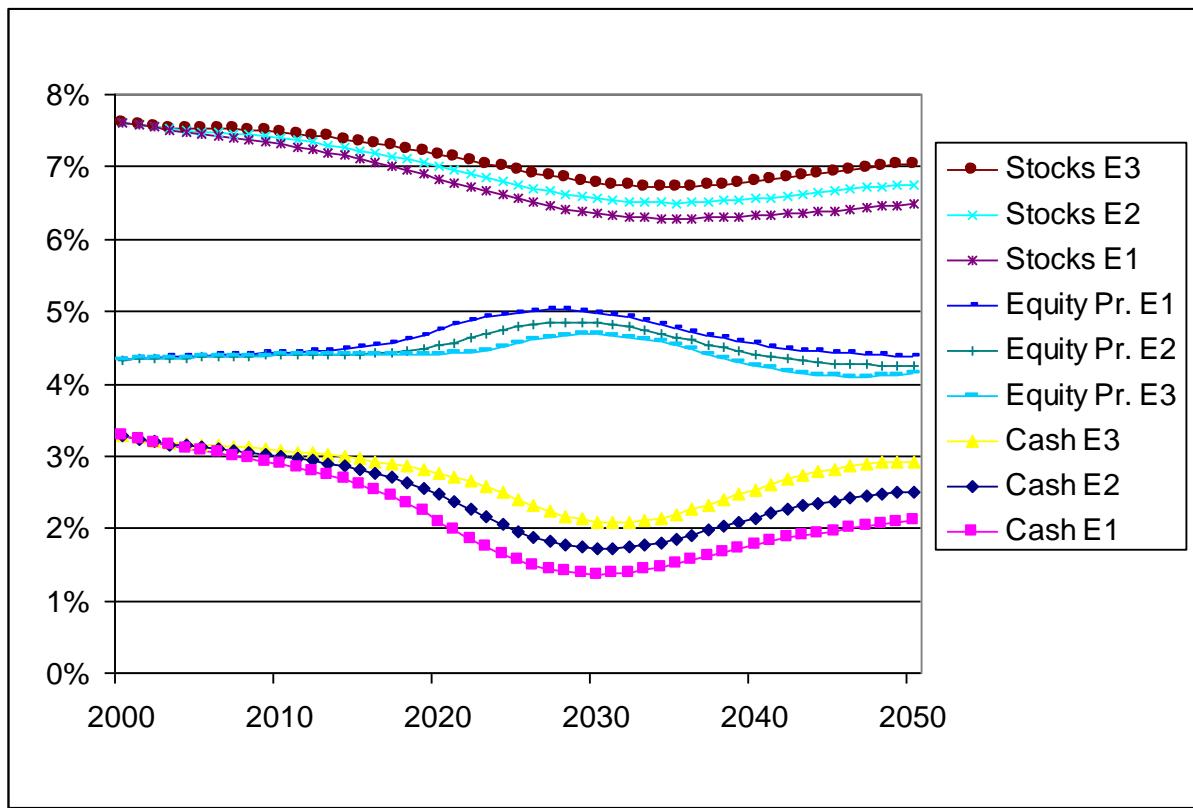


Source: MEA-PORTA model.

How robust are these forecasts? How do they depend on the assumptions for trends in the population and employment? Can a high growth rate for the economy as a whole cushion the fall in returns? In order to answer this question, we compared the basic forecast in Figure 12 with each of the two extreme scenarios, which probably mark the limits of possible movements.

Various scenarios for modelling employment in Germany are presented in Figure 15. These are the most likely scenario ("Scenario E2"), which follows the basic forecast, and also the extreme E1 and E3 scenarios, which have already been presented in section 2 (cf. Figure 5).

Figure 15: How does the forecast trend in returns change if the development of employment is more positive/negative than in the basic scenario?

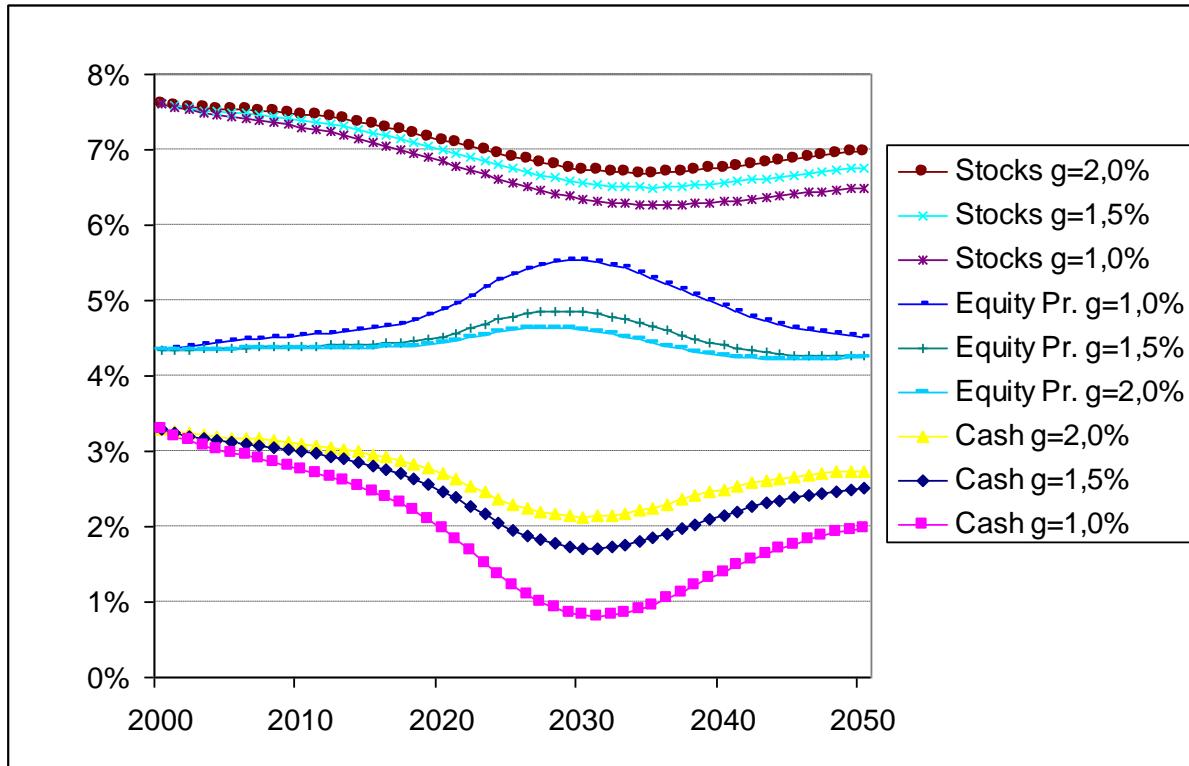


Source: MEA-PORATA model.

In the pessimistic E1 scenario, we assume that current employment rates also apply in the future, whereas the E3 scenario represents a very optimistic trend in which the rate of employment for women almost converges with the rate for men, the retirement age increases from 60 to 65 and the unemployment rate falls to 4%. The substantial aging in the pessimistic E1 scenario causes the risk premium to rise much more steeply. According to our calculation, in such a situation it would rise by around 0.8 percentage points. The impact on equities and

cash will also be greater. Conversely, a very positive development in employment would reduce the fluctuations in returns considerably.

Figure 16: How does the forecast trend in returns change if the growth rate in the economy as a whole is higher/lower than in the basic scenario?



Source: MEA-PORTA model.

The fluctuations are somewhat greater if the growth rates in EU countries vary. In view of the current economic situation, a real growth rate of 1.5% per year looks rather optimistic. For this reason, we varied the growth rate so that we could, in particular, analyse a situation with a low growth rate (1.0% p.a.) but also look at a high growth rate (2.0% p.a.). As Figure 16 shows, a low growth rate produces a result that is similar to greater aging because the high demand by an aging population for risk-free investments at a time of low growth in incomes conflicts with a low supply of such investments. The important result that can be deduced is that a higher growth rate can actually compensate - at least in part - for the impact that aging has on the capital market.

Overall, the rise in the "equity premium" and thus the steep decline in returns from secure cash deposits compared to the comparatively stable returns on equities is a robust result. The key reason for this development is that older households tend to invest in risk-free capital

investments because they do not want to jeopardize the income from capital required for their old age as a result of a sudden negative shock that affects the returns from risky investments. This restructuring of the portfolios of many households increases the demand for risk-free investments. Where there is a given supply, the increased demand causes the prices of these investments to rise, thus putting pressure on returns. This effect is further reinforced because, in an aging economy, the overall supply of capital and thus also the supply of relatively risk-free forms of investment falls.

6. Returns and Assets on the Residential Property Market

For various reasons, a separate section has been devoted to the market for residential property. Firstly, residential property accounts for a major part of privately held assets and accordingly provides an important motive for saving; the movement in the value of owner-occupied homes or properties that are rented out is an extremely important factor in determining the situation of a household with regard to assets and/or income. At the same time and in contrast to other financial investments, property is a halfway house: for owner-occupiers of apartments and houses the home is not just an asset that is "parked" - it is also a consumer good that can be actively enjoyed by living in it. Consequently, it cannot be classed as "productive capital", which was the main emphasis of sections 4 and 5, and for which the substitution effect - machines and computers replace the work of people - was so important in view of the scarcity of labor in an aging society. The substitution effect does not apply to residential property. Ultimately, the residential property market is influenced by the demographic shift both directly and indirectly, because an aging society needs different housing from a young society. This is particularly true if one views it from the perspective that a population that is shrinking in the long term will need fewer homes than a society where the population remains stable or is growing. In contrast to financial assets, involvement in capital markets does not provide any relief for real estate assets in the face of dwindling demand.

Our procedure for assessing the plausibility of an asset meltdown of this kind of capital is fundamentally different from that for the forms of investment discussed previously, as the scope for "dividing" residential property is limited (most households generally only buy one house and it is very unusual to buy a fraction of one or several houses, unless it is in the form of a property fund) and the dual role as both a capital investment and consumer goods transcends the bounds of existing portfolio models. We therefore adopt an empirical approach: We first analyse the pattern of residential property consumption over the life cycle and the trends over the last two decades. We then project a typical residential property consumption curve over the life cycle, taking into account the cohort effects of residential property consumption, which also include the expected trends in income, and project this taking the demographic changes into account.

It is not surprising that our results show that there will not be a boom in the property market over the next few decades. However, at the same time, a dramatic fall in prices due to

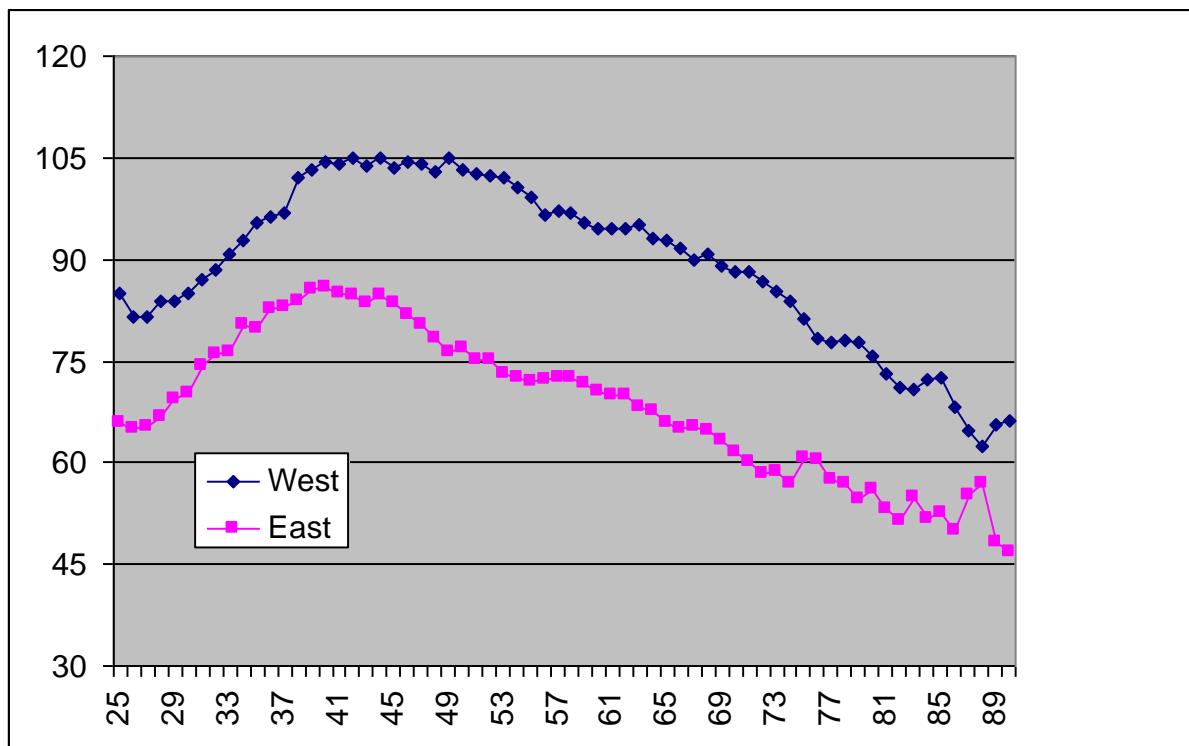
demographic factors as, for instance, predicted by Mankiw and Weil (1989) for the USA, has become unrealistic. We argue this case in section 3. Our less pessimistic estimate is based on the development of residential property consumption over the life cycle, which implies lower household sizes and the clear trend over the last 20 years towards occupying a more space - a pattern that we have observed for all age groups.

Quantitative forecasts for returns depend on the region and sector and therefore cannot be covered by this study. This part of the study provides evidence from Germany which is suggestive for France (probably more dampened) and Italy (probably somewhat stronger) as well. The main insight is that household size lags population size by about 20 years. One reason is that an older society features a smaller household size and thus, *ceteris paribus*, more households. Hence, housing demand will only begin to fall from 2025 onwards even if populations start declining today. Thereafter housing demand will only drop very gradually such that house prices will not fall dramatically over the next 30 years. Mankiw and Weil's (1989) estimate of a housing price drop between 1990 and 2010 to half of their original levels will certainly not materialize.

6.1 Trends in the demand for residential property

Many studies on prospects for the German residential market have analysed the consumption of living space over the life cycle on the basis of cross-sectional data from the German Income and Expenditure Surveys (EVS) or the Socioeconomic Panel (SOEP). The same procedure characterizes the analysis by Mankiw and Weil (1989). Figure 17 shows the average area of residential accommodation consumed per household in Germany. A comparison of age profiles in the east and west show that they are similar - it is only the level that is very different.

Figure 17: Average living area per household according to age, west-east comparison

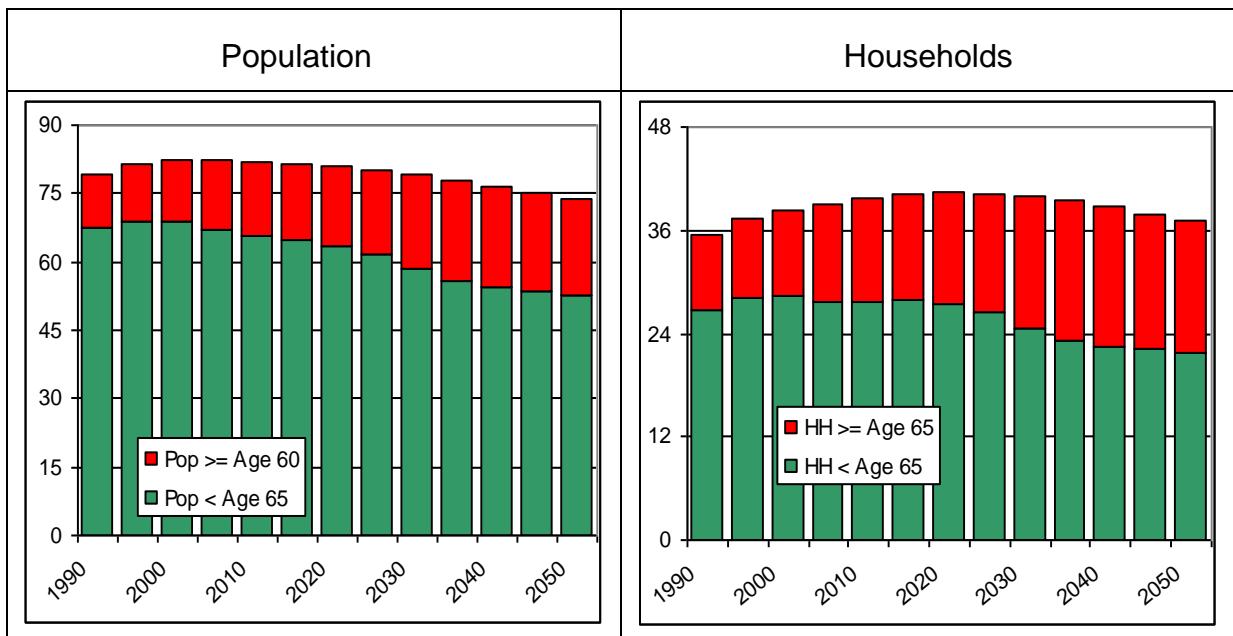


Source: Socioeconomic panel (SOEP), average for the years 1999-2001

One could conclude from Figure 17 that the consumption of living space will fall drastically in view of an aging population, because older households require considerably less living space than younger ones and in the future there will much fewer younger households. However, it would be wrong to draw such a conclusion. This is because the profiles in Figure 20 hide many developments that need to be separated from each other. Firstly, the majority of households that Figure 17 show as being older than 60 years old, were purchased or initially rented at a different time than was the case for the younger households. Part of the supposed age-related trend in the figure is actually a development over time - a "cohort effect", as we have described in detail in section 3.3. In section 6.3 we will therefore separate the age-related and cohort effects before we can start to make a projection with respect to the demographic shift.

Börsch-Supan (1993) explains in detail which demographic mechanisms play a role. Firstly, the falling demand resulting from the declining population must be mentioned - see the left-hand part of Figure 18.

Figure 18: Trends in population and households



Source: *Population projection* in accordance with UN (2000), cf. section 2. *Household projection* according to age of reference persons, own calculations based on age-specific household ratios in the 2001 micro census.

At the same time, the average size of households in an aging society becomes smaller so the number of households falls much more slowly than the population - see the right-hand part of Figure 18. This effect cannot be stressed enough: Whereas according to UN forecasts the population of Germany will fall from approximately 2005 onwards, the number of households will not start to decline until 2020, in other words with a time delay of 15 years. The number of households will not drop below today's figures before 2043 and the figure will be just under 3% lower than today in the year 2050.

The scale effects of the area required for a household also need to be taken into account. In other words, smaller households characteristically have a higher floor area per person. Demand for residential space will therefore fall much less substantially than might be feared on the basis of the population developments.

What is more, rising life expectancy will also 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. Börsch-Supan (1993) quantifies the effect of increasing life expectancy at approx. 20% of new building units¹⁰.

¹⁰ Average of new building units from 1975 to 1990.

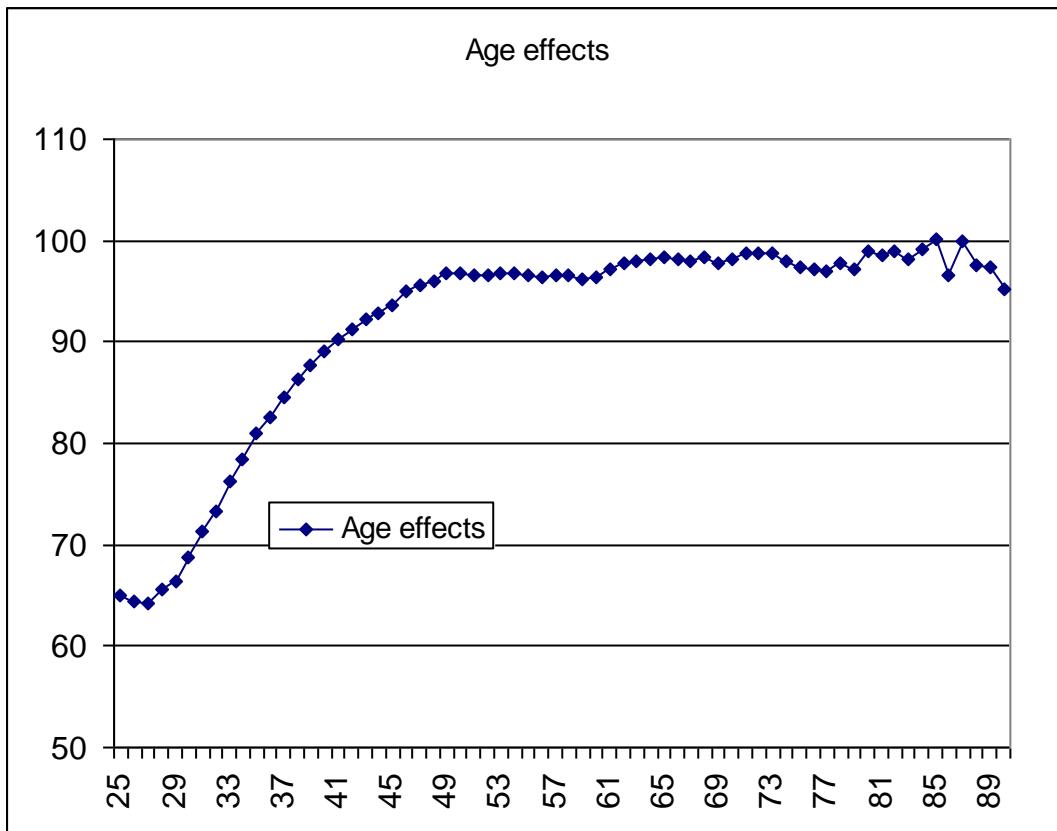
Demographic factors – a changed age structure and shrinking birth cohorts – are accompanied by economic changes. The young birth cohorts entering the housing market are typically more prosperous than the current generation of pensioners. An income and asset effect involving higher housing consumption, despite unchanged household size, has been seen in the past too and is very likely to continue in the future. Even if incomes and assets are likely to grow more slowly in the future than in previous decades, housing demand will increase simply because those from the richer post-war generations make up a larger proportion of the overall population. Finally, a third trend, which can be viewed as a "cohort effect" (see the next section) and may 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.

6.2 Correct age profiles for residential property demand

Below we are quantifying the trends described in the previous section concerning the change that manifests itself in the cohort-specific demand for housing. To do this, in the age profile of Figure 17, which was produced from cross-sectional data, we isolated the age-related effects (how the demand for housing changes when an age group becomes older) and cohort effects (how does the demand for housing change from cohort to cohort). We used the process devised by Deaton and Paxson (1994) to do this.

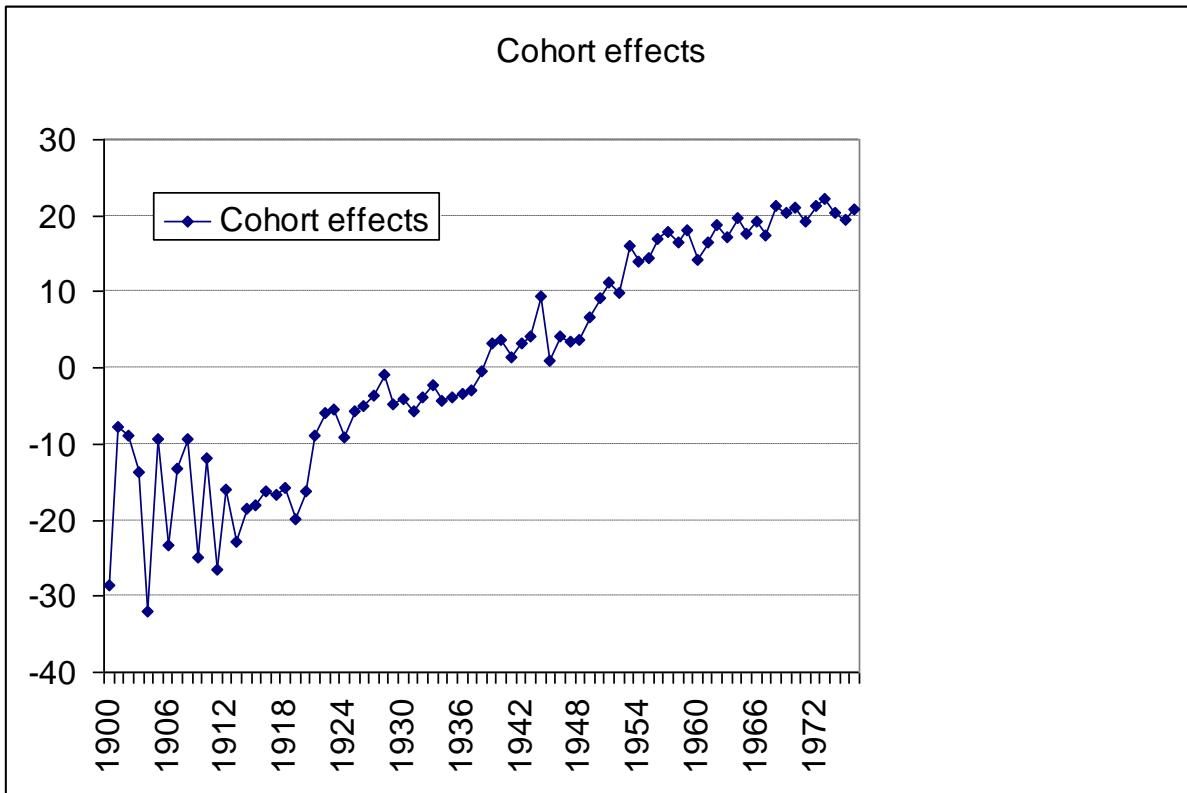
The corrected age profile (see Figure 19) shows an almost constant demand for residential space from the age of approximately 45 onwards, which reflects the fact that only very few people move into a small dwelling in old age. In contrast, the cohort effects (see Figure 20) illustrate how the demand for housing continually increases with each age group.

Figure 19: Corrected age effects in the demand for housing



Source: Own calculations based on SOEP, 1984-2001.

Figure 20: Cohort effects in demand for housing



Source: Own calculations based on SOEP, 1984-2001.

6.3 Three scenarios on the development of housing demand in the first half of the 21st century

In a similar procedure to the one adopted in section 2, we used three scenarios for forecasting housing demand. These range from the very pessimistic to the optimistic and are therefore bound to cover future trends reliably.

In the pessimistic W1 scenario, we assume that the demand for residential accommodation among future generations will only be at the same level as today's youngest generation. The demand for housing is therefore developing in accordance with the age-specific demand for housing and the decline in the population. There will either be absolutely no increases in income or these will not be reflected in the demand for more residential space. At the same time, the demand in the federal states in the eastern part of Germany is maintained at today's level: there is no further convergence with the situation in the former West Germany. We therefore consider this scenario to be unrealistic. We will, however, show that even using these pessimistic assumptions, a dramatic fall in residential property prices in the order of

magnitude predicted by Mankiw and Weil (1989), who - as we know - forecast a 50 percent drop in prices and started off the "asset meltdown" debate, cannot occur.

For the middle W2 scenario we assumed that the demand for housing of future eastern German birth cohorts will converge with the western German level by 2050. However, at the same time we assumed that the demand for housing was saturated at the 1990 level in the western part of Germany. The future cohort-related growth in demand is therefore purely derived from the need for the lower demand that currently exists in the east to catch up with the level in the west. When it comes to the future development of assets in the residential property sector, our middle scenario definitely errs on the side of caution.

The optimistic W3 scenario projects the growth in the years prior to German Reunification. Equally, we also assume that east German demand will latch onto this growth trend. We consider this third scenario to be the "best case".

In this context, our expectations are between scenarios W2 and W3. We are expecting both further convergence in the living standards between the west and the east and thus a convergence in demand for housing. At the same time, however, it must be expected that the historical growth rates will slow down, in the same way as the growth rates of per capita income have already weakened over the last few decades.

6.4 Trends in the demand for housing in the face of demographic change

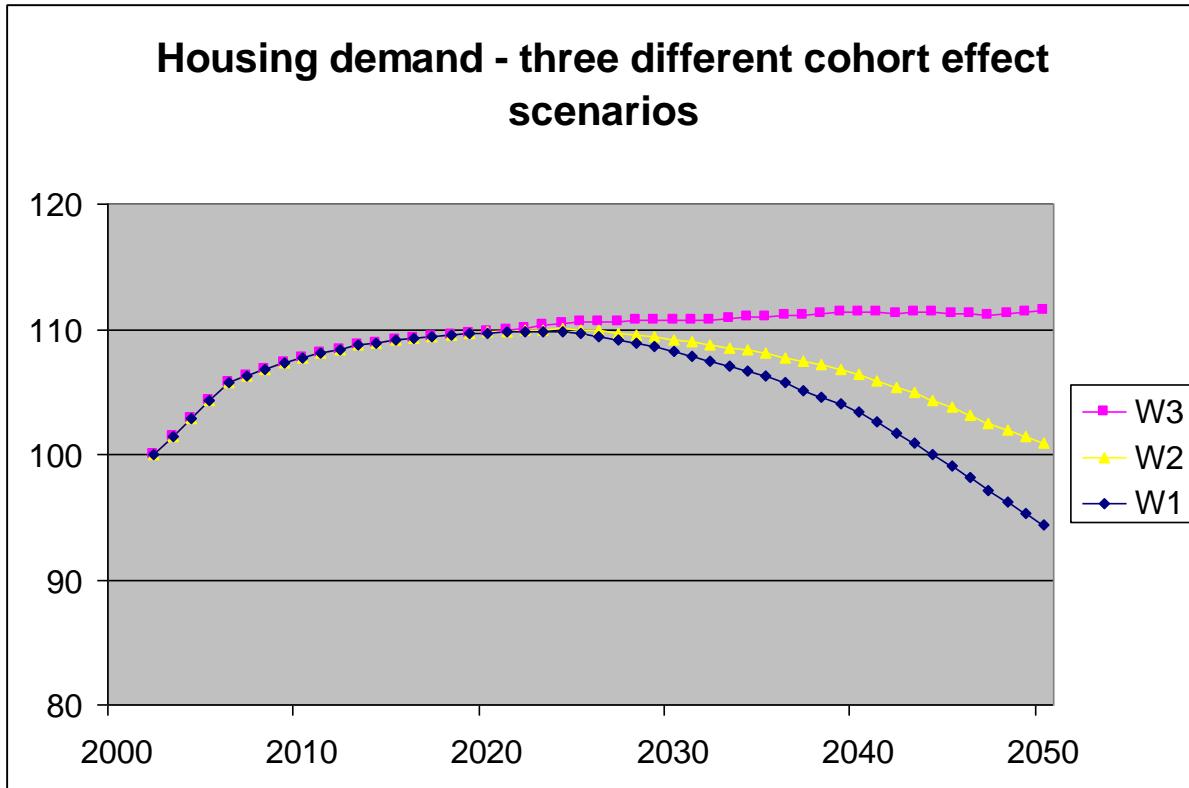
By their definition the three scenarios exhibit a largely uniform trend until 2025 - see Figure 21. Until 2025 demand for residential space will increase by around 10% in comparison to 2002. This gives an annual mean rate of growth of approximately 0.45%, although the rate of increase will begin to slow down even before 2010.

The forecasts begin to diverge sharply from 2025 onwards, because this is when the different assumptions on the future development of the cohort effects begin to have an impact. Whereas for the W1 scenario in which we assumed no further increase in demand for future birth cohorts, we calculated that by 2050 there would be a downturn in the demand for residential accommodation of approximately 15% as compared to 2025, for the W3 scenario we are forecasting a further, albeit minimal, increase in demand for housing in the second quarter of our century.

Both forecasts are extreme - the one because it assumes no further growth for the next 50 years and is even ruling out any effects as a result of eastern Germany catching up and the

other because it assumes unbridled growth in demand for housing, even though growth in income over recent years has already slowed down. From today's perspective, the actual trends will probably lie between scenarios W2 and W3. Hence, whereas the demand for residential space between 2025 and 2050 will fall slightly between 2025 and 2050 for demographic reasons, a sharp fall to below today's level is rather unlikely. If one assumes that demand between 2025 and 2050 will fall by 5%, the decline each year will be around 0.2%.

Figure 21: Development of demand for housing, indexed (2002=100)



Source: Own calculations on the basis of SOEP, 1984-2001, and the UN's population forecast (2000).

The development of demand for housing forecast in Figure 21 therefore implies a much more stable development of property values on average than would be associated with an "asset meltdown" situation. In view of the declining population, substantial increases in value after 2025 cannot be expected but in no way will values fall 47% by 2020, as feared by Mankiw and Weil.

7. Summary and Outlook

According to our results, a catastrophic "asset meltdown" is extremely unlikely. The key reason behind this is that aging societies need more productive capital to take the place of labor, which is scarce, so the demand for capital is increasing. A further explanation, which - in comparison - is of secondary importance, is the internationalization of capital markets, which allows finance to be provided for those production facilities abroad in "younger" countries (notably the United States, to some extent also the United Kingdom and France) from which, in future, consumer goods will be imported to the "older" countries (the most prominent being Germany, Italy and Japan). Internationalization of capital markets almost completely prevents a decline in capital returns prompted by pension reform.

The spectre of an "asset meltdown" is ultimately based on incorrect order of magnitudes and time dimensions. In fact, the aging process occurs slowly and can be predicted and the establishment of the next generation is superimposed over the departure of the baby-boom generation. So it is ultimately no surprise that changes in households' portfolios are small on average and there will be no great distortions between safe and risky investments.

The majority of these arguments do not apply to the residential property market. Aging of the population is less of a threat than the fact that population numbers are declining. However, there will be a time lag of 15 to 20 years before the number of households starts to fall, which means that the figure will increase until around 2025, although the population is already in decline. Factors relating to income and assets will also play a role so a dramatic slump in demand for housing and with it a drastic fall in the value of residential property is not expected before 2040.

In spite of this, economic policymakers still cannot afford to relax. Even if capital markets are not threatened by an "asset meltdown", the development of employment looks much less rosy. The effect of the demographic change is that the number of gainfully employed persons will fall sharply from 2010 onwards, whereas the number of consumers will largely remain constant until around 2040. This will put pressure on production capability and thus also on the overall growth of our economy: labor - at least in the highly skilled sector - will become increasingly scarce because it is not possible to compensate for this decline in employment per head of population by intensifying the capital deployed. For this, the change is too rapid and too extensive. Labor productivity will in fact need to increase in order to compensate for the effects of the shift in the age structure on domestic production. Owing to the effects of

population aging in particular, education and training will assume an increasingly important role.

The greatest threat will naturally be to the pay-as-you-go social insurance systems. The amply discussed age-related rise in the burden of contributions and tax resulting from pension, health and long-term care insurance schemes and other benefits financed by tax for older citizens have dramatic impacts on the future employment market. The ever widening gap between gross and disposable earnings - the burden of taxation and the non-wage labor costs - threatens to reduce the work available to the younger generation at the very time when we need it the most.

This study also shows that the capital market plays a particularly important role in an aging society. The logic of this is obvious because labor is becoming scarce. There are however two further reasons. Firstly, capital investments are the only way of distributing resources over time and between the generations. More specifically, in the case of the demographic shift, capital investments are the vehicle that allow part of the earning power of baby-boomers to be used to finance their own pension instead of allowing the entire pension to be financed by those of the next generation, who will be completely overwhelmed because of their greatly reduced numbers. We therefore need the capital market so that the earning power of the younger generation is not overwhelmed by the excessive demands of the older generation.

The second reason lies in the international mobility of capital. As we know, mobility of the factor labor is not particularly good and we old countries cannot expect that younger countries will help to finance their pay-as-you-go systems, nor is it likely that a surge of migrants will pay their pension contributions. Capital, in contrast, can move around the global economy and bring in earnings from countries abroad where labor is more plentiful than it is here. For "old countries" such as Germany, Italy and Japan in particular, an open and globalised world can be of assistance during the aging process. Rich in consumers, poor in labor, these countries must have an intrinsic interest in boosting their imports. Free trading relations are therefore a substitute for inward migration. However, capital is required to extend production abroad. Not only that, it will also certainly be in the old countries' interest to retain a certain degree of control over companies which will be producing our consumer goods in the future by means of the mechanism offered by their foreign direct investments.

This exchange is not a one-way process. It offers scope for improvement that allows both benefits for the aging countries, which are relatively short of labor, as well as for the economies with younger populations that are relatively short of capital. The advantages for the old countries lie in a restored balance between employment and the demand for goods.

The younger countries obtain both capital and sales markets. The demographically younger countries will thus be able to grow faster than they would do without direct investments from and exports to the old countries.

We can therefore safely put the asset meltdown scare to rest, and proceed to exploit the multifaceted advantages that global capital markets can offer for our aging world.

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