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Abstract

As the public pay-as-you-go pension systems of the aging industrialized countries are likely to become seriously strained under the growing dependency burden, the question arises whether a society should rely on private savings to finance old-age consumption. This is an empirical question about the magnitude and the flexibility of saving rates. This paper argues that saving rates must increase in an unprecedented fashion in order to compensate for the dependency effect.

The paper takes the German case as an example. It analyses saving behavior in Germany using three waves of the Income and Expenditure Survey. It separates age and cohort effects; computes the demographically induced change in the aggregate saving rate; and compares the magnitude of these excess savings with the increasing burden of the pension system. Finally, a macroeconomic simulation model is used to explore possible paths of the cohort effects in saving rates.

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by Axel Börsch-Supan

1. Introduction

1.1 Motivation and Outline

The expected change in the age structure in the European and virtually all industrialized countries is dramatic and will lead to a substantially higher proportion of older people. As a consequnce, the public pay-as-you-go pension systems are likely to become seriously strained under the growing burden of dependency. If the public system is endangered, the question arises whether more reliance on private provision will help. While arguments pro and contra funding pension systems have been discussed widely, a more concrete question is whether the projected gap between current-level contributions and current-level benefits could realistically filled by an increase in private savings. This is an empirical question about the magnitude and the flexibility of saving rates.

The paper takes the German case as an example. Although virtually all industrialized countries are aging, speed and extent of the aging processes differ rather markedly across the industrialized countries, and even within the European Union. Germany will experience the most pronounced aging process among the EU countries, much more than the United Kingdom and the United States. Within the next 40 years, the proportion of elderly persons in Germany will increase to more than a quarter of the population. Even more accentuated, the proportion of households headed by persons aged 60 and above is projected to increase in Germany from 21 percent in 1980 to 37 percent in 2030. The dependency ratio will about double, hence, twice as many elderly aged 65 and above have to be supported by the same number of persons aged 15 to 64.

The implications for a pay-as-you-go pension system have been modelled in many instances. One can keep the accostumed benefit level constant and compute the sky-rocketing contribution rates necessary to keep the system solvant. Similarly, one can compute the declining benefit level while the contribution rate remains fixed at the current level. As a third (and equivalent) exercise, one can compute the deficit which would emerge when the rising pension burden at the current replacement rate is financed by debt rather than rising contributions. I will call this deficit the pension gap. It is computed in the following subsection under a set of assumptions on demographic and labor supply changes.

Can this gap be filled by private savings? To answer this question, Section 2 is devoted to an analysis of saving behavior in Germany. In subsection 2.1, I employ three waves of the German Income and Expenditure Survey, 1978, 1983, and 1988, in order to separate age and cohort effects in saving. In a second step, I apply the estimated saving rates on a population forecast in order to compute the demographically induced change in the aggregate saving rate. Finally, I compare the magnitude of the emerging „excess savings“ (as compared to a constant saving rate) with the pension gap.

The data exhibit cohort effects, although they are rather hard to measure precisely in three waves. How could they evolve over time? To answer this question, Section 3 uses a macroeconomic simulation model to explore possible paths of cohort effects in saving rates. The first subsection is devoted to a closed-economy situation and predicts strongly declining saving rates. Subsection 3.2 shows that this decline can be offset in an open economy under very realistic circumstances. Section 4 summarizes and puts the results in perspective.

1.2 The Pension Gap

The mechanism of a pay-as-you-go pension systems is well known. At constant benefit levels -- in terms of replacement rates -- the contribution rate to the public pension system grows in proportion to the ratio of pensioners to workers:

$$c = p \cdot r \cdot (1\text{-}s).$$

where c denotes the social security contribution rate, p the ratio of pensioners to workers, and r the average replacement rate, i.e., the average pension devided by the average labor income. The state subsidy rate s reflects a pecularity of the German system which is financed from two sources. The main proportion of the budget, $1\text{-}s$, is paid from contributions to the pension system. The remaining fraction s is a state subsidy which is financed by general taxes not linked to the social security contribution rate. The German pension reform of 1992 freezes this rate at about 19.2 percent through the year 2010.

The ratio of pensioners to workers, p, depends on assumptions on demographic and employment changes. I use a simulation model described elsewhere that rests on the following assumptions that depart in several instances from the official population projections by the German Census and the German Bureau of Labor Statistics (IAB):

- **Fertility**: Fertility will experience a slight upturn once the awareness of population aging becomes more widespread and in reaction to changes in social security policy. This is a crude attempt to „endogenize" fertility in response to population aging. It is unlikely that fertility will rebound to full replacement values. Departing from the OECD (1988) estimate, I assume a more gradual increase, starting from the current net replacemente rate of 1.39 and reaching the OECD rate of 1.60 only in the year 2050.
- **Mortality**: I assume that German life expectancy will trace the development of other countries that already experience a higher life expectancy such as Sweden, Switzerland, or Japan. Specifically, I assume that the German life expectancy will reach the current Japanese life expectancy in the year 2010; that it keeps increasing at the same speed until 2030; and that the progress in life expectancy will only then start to slow down. Accordingly, life expectancy at birth in Germany is projected to be 78.1 years in 2000, 78.9 in 2010, 81.0 in 2030, and 83.2 in 2050.
- **Immigration**: In response to the changes in the German asylum policy immigration will be lower than the IAB forecast but substantially higher than the Census prediction. I assume that in the long run immigration will be 80 percent of the IAB figures, i.e., about 115,000 immigrants in 2000 and about 100,000 after 2010.
- **Female Labor Force Participation:** I first employ the projections of the Research Institute of the German Employers Association (IW, Institut der Deutschen Wirtschaft, Köln), namely an

increase in female labor force participation from 34.7 percent in 1990 to 38.2 percent in 2000. I assume a continuation of this increase to 39.3 percent until 2010, remaining at this level thereafter.

- **Retirement Age:** In another crude attempt to „endogenize" responses to population aging, I assume an increase in the average retirement age by one year until 2010 and by two years from 2030 on. Pensioners in the simulation model are defined as all persons as all persons who become non-workers past the peak of labor force participation at about the age of 48. This includes persons making use of the various early retirement schemes in Germany as well as persons claiming disability insurance.

- **Sensitivity**: I may finally note that different assumptions about fertility and mortality change the projections from now through the year 2030 only marginally because both the generation of future retirees and the generation of future workers are already in place. Different demographic projections begin to diverge significantly only after the year 2030. However, different assumptions about the labor force, in particular immigration, do produce significant changes from the scenario depicted above.

Fixing the average net replacement rate at the current 72 percent, the resulting contribution rates are displayed in Figure 1. They reach 34 percent at the peak of population, departing from 18.7 percent in 1990.

FIGURE 1: Pension Contribution Rate (Replacement Rate Fixed)

Turning the pay-as-you-go balanced-budget equation around, we now compute the average replacement rate if the contribution rate would be pegged at the current rate of 19.1 percent. The resulkting replacement rate would fall from the generous 72 percent currently to about 40 percent in the year 2030. This is shown in Figure 2.

FIGURE 2: Pension Replacement Rate (Contribution Rate Fixed)

As opposed to many other countries, Germany cannot finance the public pension system by debt without changing the law. Otherwise, the pay-as-you-go mechanism is strictly enforced. If one would anyway keep both replacement rate and contribution rate at current levels, the emerging debt is rather large. It is depicted in Figure 3 and peaks at almost 140 billion DM in the year 2035. As a fraction of total public pension expenditures, the emerging deficit is 11.8 percent in the year 2000, 23.1 percent ten years later, and about 45 percent in 2035.

FIGURE 3: Pension Gap

To put this number in perspective, the flow of private saving in Germany was 225 billion DM in 1990, resulting in an aggregate private saving rate of 14.8 percent of disposable income. Hence, the pension gap in 2035 corresponds to about 9 percent of 1990 disposable income. Current usage of funds held constant, financing this gap through increased saving then would demand an increase in the aggregate private saving rate from 14.8 percent to 23.9 percent!

Departing from this crude back-on-the-envelope calculation, the sequel of the paper is now mainly devoted to two questions. First, will the shift in the age distribution „automatically" create more savings because cohorts in their prime saving ages will become more numerous? Second, what do we know about changing usages of funds: Since an aging population has less need for capital in production, is it possible to divert these funds to finance the pension gap, holding saving rates approximately constant? The first question is subject of Section 2, and Section 3 will attempt an answer to the second question.

2. Age and Cohort Effects in Saving Rates

2.1 Micro Data on Saving Rates

Measuring household saving in Germany is not an easy task because there is little available data. I employ two micro data sets -- the German Income and Expenditure Survey and the Socio-Economic Panel -- and aggregate data provided by the Deutsche Bundesbank.

The German Income and Expenditure Surveys ("Einkommens- und Verbrauchsstichproben," EVS) are collected every five years by the German Bureau of the Census. Their design roughly corresponds to the U.S. Consumer Expenditure Survey. The surveys include a very detailed account of income by source, consumption by type, and savings flows and asset stocks by portfolio category. Extensive descriptive analyses have been carried out by members of the German Bureau of the Census (Euler, various years). The 1978, 1983 and 1988 surveys are available in public use form, although at high costs and under tight confidentiality restrictions. These public use files have been analyzed with respect to household savings by Börsch-Supan and Stahl (1991), Velling (1991), Lang (1993), and Börsch-Supan (1992,95).

The Income and Expenditure Surveys are representative cross-sections of all West German households with annual gross incomes below DM 300,000. They include some 45,000 households in each wave. These large sample sizes provide for sufficiently large cell sizes in each age category, even for old ages. The EVS therefore allow for a separate analysis of consumption and savings patterns among the very old.

The data exclude the very wealthy households and the institutionalized population. The former represent about two percent of households who have annual gross incomes in excess of DM 300,000 (Euler, 1985). For this reason, the data cannot be expected to add up to national accounting figures, in particular not the wealth data. Due to the rather skewed wealth distribution, omission of the upper two percent tail of the income distribution results in a substantial underestimation of total household wealth in Germany. For the same reason, the saving rate aggregated from the EVS is lower than the aggregate household saving rate reported by the Bundesbank. EVS savings yields a net private saving rate of 12.0 percent while the "official" Bundesbank figure is 13.6 percent.[1]

Omission of the institutionalized is only serious among the very old. Although less than one percent of all persons aged 50 and over in Germany are institutionalized, this percentage increases rapidly with age and is estimated to be about 9.3 percent of all persons aged 80 and more. Elderly in institutions are more likely to have few assets and no savings.

The EVS are stratified quota samples on a voluntary basis. The German Bureau of the Census establishes a target number of households for each stratum defined by household size, income and employment status. To meet these targets, a large number of households is contacted by various mechanisms; e.g., former participants of previous respondents to the EVS or other surveys are asked

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[1] This divergence is due to two differences in the base: The EVS omit the upper 2 percent of the income distribution while the Bundesbank also includes non-profit organizations.

by mail whether they would volunteer for another survey. The ratio of final acceptances to target size is published and was in excess of 120 percent in 1983. However, this ratio varied between 20 and 150 percent across strata. Moreover, response rates with respect to initial inquiries are not available and are only vaguely alluded to as rather small. Acceptance rates are lowest in the strata of low income households, one-person households, and blue collar workers and self-employed.

I use the flow data -- income and savings -- which are measured rather precisely because they are aggregated from weekly diaries and carefully cross-checked against yearly records such as salary slips. Most types of income add precisely to the national accounting totals with the qualification that the data cover only the first 98 percent of the income distribution. Net savings are computed as the sum of purchases of assets minus sales of assets. Changes in financial assets reported in the EVS are deposits to and withdrawals from the various kinds of savings accounts; purchases and sales of stocks and bonds; deposits to and withdrawals from dedicated savings accounts at building societies ("Bausparkassen") which are an important savings component in Germany (see Börsch-Supan and Stahl, 1991b); and contributions to life insurances and private pension plans minus payments received. New loans are subtracted and repayments are added to net savings. Not reported are changes in cash and checking accounts. Changes in real assets reported in the EVS are purchases and sales of real estate and business partnerships. Not reliably reported are changes in durables (other than real estate). Unrealized capital gains remain unreported. To arrive at saving rates, household saving is divided by disposable household income, consisting of labor, asset, and transfer income minus taxes and social security contributions.

Households in the three EVS cross sections 1978, 1983, and 1988 are not necessarily the same and cannot be matched. It is therefore impossible to construct a true panel of individuals although this would be most desirable for the separation of age and cohort profiles. By aggregating into age categories, however, I will construct a panel of synthetic cohorts and compare a representative household headed, say, by a 60 year old person in 1978 with a household of the same age category five years later. The large sample sizes are of considerable help for the synthetic cohort approach because aggregation units can be defined sufficiently narrow to assure homogeneity without loss of statistical precision.

Figure 4 depicts the age-specific saving rates by survey year. These age profiles are rather similar across the three survey years, with 1988 significantly lower in the older ages. Saving rates increase quickly until about age 37, remain fairly constant until retirement, decline during the first ten years after retirement but then feature a strong increase to a new maximum in very old age. In the 1983 wave, the oldest age category has the highest saving rate over the life course.

FIGURE 4: Cross Sectional Age-Saving Profiles

The renewed increase of saving rates in old age is a rather stable phenomenon in these data, see Börsch-Supan (1995a). Median saving rates, mean and median annual net financial savings in absolute terms depict similar life cycle patterns. In addition, the proportions of household with positive respectively negative net financial savings echo these life cycle patterns. The proportion of households with positive savings is large (about 60 percent) and increasing with old age, while the proportion of households who deplete their assets becomes smaller with old age rather than larger as a naive version of the life cycle hypothesis would imply.

On should, however, keep the sample selectivity issues of the Einkommens- und Verbrauchsstichproben in mind. While including the very wealthy probably strengthens the conclusion about increasing saving rates in old age -- the very wealthy are the least likely to decumulate their assets --, the omission of the institutionalized may bias this profile upwards because the sample omits those who are most likely to deplete their assets. It appears unlikely, however, that accounting for this selectivity problem would reverse the age-savings profiles in old age because the share of the institutionalized among persons aged 80 and above is only 9.3 percent. Even if all of these households would deplete their assets completely, their inclusion in the survey could not offset the 16.2 percent decrease in the number of those households who have negative savings.

More important is a correction of cohort effects. As visible in Figure 4, 1988 saving rates are substantially lower for older ages than in 1978 and 1883. Part of the increase may thus be cohort rather than age related. Figure 5 shows that this is only partially the case.

FIGURE 5: Age-Specific Saving Rates by Birth Cohort

This figure depicts the same data as figure 4, but connects data points of equal birth cohorts rather than those of equal survey year. It therefore depicts true age effects, correcting for potential pecularities of each birth cohort. Conventional life cycle effects are visible for the younger households, who experience a strong increase in their saving rates, and among the households entering retirement, who decrease their savings. However, in contrast to the naive version of the life cycle hypothesis, the two oldest birth cohorts, born in the five year intervals around 1916 and 1911, increase their saving rates.

A descriptive regression of saving rates on fifth-order polynomials in age and birth cohort separates age and cohort effects. The following table shows the regression results. The age profile is estimated rather precisely, while the cohort effects are difficult to measure when only three waves are at disposal.

Dependent Variable: Age-Specific Saving Rates 1978, 1883 and 1988

Independent Variable	Estimated Coefficient	Standard Error	t-Statistic
const	-136.941	38.471	-3.56
age	15.525	4.483	3.46
age2**	-0.599	0.197	-3.04
age3**	0.011	4.128*E-3	2.82
age4**	-1.134*E-4	4.122*E-5	-2.75
age5**	4.390*E-7	1.581*E-7	2.78
cohort	-0.350	0.136	-2.56
coh2**	-7.729*E-4	1.617*E-2	-0.05
coh3**	2.104*E-4	7.545*E-4	0.28
coh4**	-3.123*E-6	1.402*E-5	-0.22
coh5**	1.401*E-8	8.988*E-8	0.16

Number of Observations	42
R-squared	0.90153
Corrected R-squared	0.86977
Durbin-Watson Statistic	2.41911
Mean of Dependent Variable	12.01905

Plotting the age polynomial for a given cohort yields a very early peak in the saving rate at about age 37 together with a rebound after age 75, see Figure 6.

FIGURE 6: Pure Age Effect in Saving Rates

The corresponding cohort effect is depicted in Figure 7. It features a strong decline from the early birth cohorts to the cohort born around year 1940. Thereafter, cohort-specific saving ratyes increase slightly.

FIGURE 7: Pure Cohort Effect in Saving Rates

I refrain from interpreting this pattern since it is based on too few variation over time. Similarely, the predicted pure age pattern in Figure 6 may suffer from the small time variation in the data.

2.2 Demographically-Induced Changes in the Aggregate Saving Rate

A change in the age distribution of the population implies a change in the aggregate saving rate through several mechanism. First, as seen in the previous subsection, saving rates vary with age. Less households in the low saving age categories and more households in the high saving age categories result in higher saving on an aggregate level. As can be seen from the age saving profile, this effect is ambigouos: Population aging reduces the relative proportion of households below age 37, but it also increases the number of households in the „saving trough“ after retirement. The increase in saving rates after age 75 is of little relevance because even after accounting for mortality changes, the number of households of very old age is relatively small.

There are two additional effects. First, a change in the age distribution also reduces average disposable household income because more households will live on retirement income which is about three-quarter of average labor income at current replacement rates. Second, average household size changes since household size is age-specific with a strong decline in size as households age.

Household sizes are much higher in younger years because of marriage and children. In Germany, there is no appreciable reduction in the household rate at very old age because the percenatge of children taking in their aging parents is rather low.

Figure 8 presents a shift-share analysis of the aggregate saving rate, simulating the effect of shifts through age-specific saving rates, age-specific disposable household incomes, and age-specific household rates.

FIGURE 8: Projected Aggregate Household Saving Rates

The projected changes are very small relative to the historical fluctuation in the aggregate household saving rate. Based on the 1983 cross sectional age-saving profile (Figure 4), the saving rate will increase very slightly. Based on the age-saving profile generated by the regression on age and cohort terms (Figure 6), the aggregate household saving rate is going to fall from 14.8 percent in 1990 to 13.5 percent in 2030. Historically, the saving rate fluctuated during the last twenty years between 13.0 in 1985 and 16.2 in 1975.

The gain in savings based on the 1983 cross sectional age-saving profile is about 3.6 billion DM in 2025, a very small proportion of the pension gap at that time (Figure 3). Based on the regression profile, 13 billion DM in saving volume are lost vis-à-vis 1990. In summary, little if at all new savings are generated by the age shift in the population.

This result is in contrast to projections for the United States.[2] These projections predict an increase in savings of about 240 billion $ p.a. for the next ten years. This is about two-third of the predicted pension gap, still less but a sizable proportion.

The difference to the U.S. is mainly due to the difference in age-saving profiles between both countries. In the U.S., households between age 50 and 60 are characterized by an increase, rather than a decrease of saving rates as is the case in Germany.[3] After age 60, U.S. households exhibit a rather sharp decline in savings. The difference in the location of the „hump“ in life cycle savings is

[2] McKinsey Global Institute (1994).

[3] Attanasio (1995).

likely related to the later retirement age in the U.S. It is noteable that the saving profiles in both countries feature a similar increase at very old ages.

Having seen that age effects are unlikely to increase future saving in Germany, we now turn to cohort effects.

3. Macroeconomic Projections of Cohort Effects

The shift-share analysis in the preceding section rested on the assumption of constant age specific saving rates. This is equivalent to a complete absence of cohort effects. In times of population aging, however, capital becomes relatively more abundant while labor becomes relatively scarce. From a macroeconomic point of view, a society which maximizes consumption should decrease savings to accomodate a growth path that requires less capital to equip the shrinking labor force. The mechanism is the falling return on capital. This section provides estimates on the magnitude of this effect, based on a simple growth model. It is a matter of taste whether one calls this macro economic effects of population aging on saving behavior a cohort or a year effect. As a matter of facts, this is undistinguishable.

The empirical evidence on the question, whether age-specific saving rates vary indeed with the rate of return on capital, is highly controversial.[4] One may not be too irritated by the inconclusive time series evidence as none of the concepts is easy to measure, and fluctuations in savings and the rate of return have very different frequencies. However, it puts one in the uncomfortable position of not being able to relate the results of the growth model in this section directly with observed historical episodes.

In order to obtain an idea how an optimal saving rate will develop in the face of population aging, I employ the well-known Cass-Ramsey-Solow optimal growth model in a version popularized by Cutler, Poterba, Sheiner and Summers (1990) in an application to the aging problem in the United States. An major feature of this model is an aggregate savings rate that responds to the relative scarcity of labor and capital, hence demographic changes. An important consideration, particular in the case of Germany, is the sensitivity with respect to the openness of an economy. I therefore extend this model by allowing for an international determination of the rate of return on capital and

[4] See for instance Boskin (1978), Bosworth (1982), Bosworth, Burtless, and Sabelhouse (1991).

thus saving in a world that has many countries competing for the most efficient use of capital. The model is presented in full detail in Börsch-Supan (1995b).

The growth path is determined by two mechanisms. In each country, the saving rate is adjusted to maximize the present discounted utility from current and future consumption. Labor supply is exogenously given, for Germany by the demographic and employment forecast that was already used in Section 2. The second mechanism is free capital mobility. Capital flows will occur as long as the rate of return differs across countries. At each point of time, the equilibrium capital flows are therefore determined by a common interest rate.

I assume that a common world production technology in terms of efficiency units of labor. In other words, after accounting for differential labor productivity, it does not matter in which country machines are located. This assumption is less strong than it may appear at first sight because we can account for productivity differences by rescaling the efficiency units of labor. Per worker world output at time t, $y(t)$, is produced from $k(t)$ units of capital per worker using a worldwide neoclassical technology $y(t) = f(k(t))$ that fulfills the Inada conditions. Per worker output $y(t)$ and capital intensity $k(t)$ are measured in a efficiency units, e.g., $k(t) = K(t)/(e^{gt} L(t))$, that reflect technical progress at a rate denoted by g as well as differences in labor productivity across countries. At the world level, wage rate $w(t)$ and interest rate $r(t)$ are determined by the familiar marginal productivity conditions. The world capital stock is the sum of the assets owned by each country, denoted by $a_i(t)$ on a per worker basis.

The growth model is characterized by two equations of motion for each country. The first equation of motion is each country's asset accumulation equation or budget constraint:

$$(1) \qquad da_i(t)/dt = w(t) + r(t)\cdot a_i(t) - c_i(t)/\alpha_i(t) - [n_i(t)+d+g]\cdot a_i(t).$$

Net additions to each country’s assets, $da_i(t)/dt$, are financed from the difference between gross national income on the one hand, and the sum of consumption and replacement investment on the other hand. Gross national income in country i is the sum of wages and interest income obtained from the assets owned by this country. Consumption, $c_i(t)$, is converted from a per capita to a per worker basis by the ratio of workers to consumers, the support ratio, $\alpha_i(t)$. Finally, replacement investment consists of depreciation at a fixed rate d, and the endowment of new and more efficient labor with capital at a rate $n_i(t)+g$.

Maximizing consumption of country i subject to this country's budget constraint yields the familiar Euler equation for the path of per capita consumption:[5]

$$(2) \qquad \frac{dc_i(t)/dt}{c_i(t)} = s \cdot (r(t) - (r + d + g/s)) .$$

The main mechanism in this second equation of motion is the tradeoff between consuming now and consuming later. This tradeoff is governed by the difference between the rate of return from capital, $r(t)$, and the gross rate of time preference, $r + d + g/s$, which consists of the net rate of time prefernce, r, the rate of depreciation, d, and a correction term due top the measurement in efficiency units, g/s. If the time preference rate is high relative to the interest rate, consumers prefer consumption right now, leading to an initially high and then decreasing consumption. In turn, consumption increases relative to the previous year if the market interest rate exceeds the gross rate of time preference. The factor of proportionality between the difference in interest and time preference rates and the relative change in consumption is the intertemporal elasticity of substitution, s. The larger s, the more sensitive is current consumption to changes in the rate of return from capital relative to the time preference rate.

Asymmetries between countries emerge when the exogenous variables -- the support ratios $a_i(t)$ and the employment growth rates $n_i(t)$ in each country -- begin to differ. Starting from an equal position, flows of capital from country i to country j make $a_i(t)$ larger and $a_j(t)$ smaller than $k(t)$, the average capital endowment of a worker in the world (in efficiency units):

$$(3) \qquad f_i(t) = [a_i(t) - k(t)] / k(t) .$$

The Ramsey model is a very crude model of a macroeconomy. It traces only long-run trends and those under very restrictive assumptions. It abstracts from many feedbacks, and it describes a highly aggregate level of the economy. The intertemporal utility maximization in equation presumes perfect foresight. Impatience is built in by allowing for a discount rate $r > 0$, but there is no uncertainty or disagreement about the path of demographic changes, and social preferences stay constant during a period of considerable social changes. Some of the missing feedbacks are cushioned by the assumptions underlying the demographic and employment scenario described in Section 2. We already mentioned the exogeneity of labor supply. Other feedbacks are more elusive.

[5] Underlying is a constant-elasticity felicity function weighted by the size of population.

The rate of technical progress may change with population aging (see Cutler et al., 1990), and fertility may change in the face of an aging society (see Becker and Barro, 1988). There is little empirical guidance to model these feedbacks.

Population aging has very different impacts on the evolution of savings depending on whether the country is a closed or an open economy. While the assumption of a closed economy is one extreme, particularly for a EU country such as Germany, the assumption of free capital flows across the world is the other extreme. We will inspect each case in turn, hoping to bracket the interim case.

3.1 Closed Country Simulations

For a single country, the growth model departs from the Ramsey model only in its time-varying paths of the exogenous variables $a(t)$ and $n(t)$, support ratio and labor force growth. In order to achieve realistic orders of magnitudes, I fit the growth model to actual national accounting data for Germany from 1978 through 1989, the year before unification.[6] Estimates of a CES production function yield a share of capital in total income of 40.99 percent, a ratio of capital to output of 2.70, and an essentially unitary elasticity of substitution in production, in combination with a rate of technical progress of 1.40 percent p.a., and a depreciation rate of 5.28 percent p.a.. Assuming a steady state in 1989, the gross rate of time preference is computed using the steady state equation for capital. This results in $r + g/s = 0.099$. The most problematic parameter in the model is the elasticity s because it cannot be obtained easily from national accounting data. I calibrate the model by a grid search over σ, fitting the predicted path of consumption to actual consumption data 1965-1989. This results in an elasticity of intertemporal substitution in consumption $s = 0.6749$, and implies a net discount rate $r = 7.8$ percent. This large discount rate indicates a high degree of impatience and is in line with the estimated low intertemporal elasticity of substitution in consumption. The model is rather insensitive to variations in the two elasticities and reasonable variations in the parameters of the CES production technology. The most crucial parameter is the gross discount rate because it governs one of the Euler equation (2). Reducing the discount rate leads to a smoother path of consumption as impatience decreases, making intertemporal substitution more important.[7]

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[6] The data is provided by the DIW, Berlin.

[7] A higher degree of intertemporal substitution does not appear to be warranted by the empirical evidence. One may wonder, however, whether such an assumption would change the following results in their substance. This is not the case. Assuming a substantially lower net discount rate of 3 percent reduces the gain from free capital flows from and to the NICs, for example, by only little more than 25 percent.

Figure 9 depicts how aggregate saving would react to population aging if we abstract from trade and foreign direct investment in countries with different changes in their population structures. Savings of course equal investment in this closed economy. Because capital becomes partially obsolete when the labor force shrinks, savings and investment go dramatically down.

Figure 9: Aggregate Saving Rate under Autarchy

Figure 9 also depicts the sensitivity to labor force assumptions. Without any substantive refreshment through immigration (e.g., as assumed by the German Bureau of the Census), disinvestment becomes actually larger than depreciation, resulting in a negative savings ratio, i.e., in an actual decrease in the capital stock. However, this is not a likely scenario. With some immigration (e.g., as estimated by the German Bureau of Labor Statistics, IAB), saving and investment rates remain positive although at a substantially lower level than today.

If some of the capital becomes obsolete, this should also be reflected in the interest rate. Figure 10 depicts the rate of return to capital which is invested domestically or in countries with similar population aging. The estimates are not very sensitive to reasonable variations in labor force assumptions. They agree on a substantial decrease in the rate of return, about 21 percent.

Figure 10: Rate of Return under Autarchy

3.2 Open Economy Scenarios

Since Germany has the one of the most pronounced aging processes among all countries, the decline in the aggregate saving rate projected in the preceding section is likely to be an overestimate. It is rather obvious that by exporting capital to less rapidly aging countries and producing there will at least partially offset the reduction in the rate of return and, according to the logic of the neoclassical growth model, thus also in saving. The issue is not completely trivial in a system of many countries, some of them aging faster than others, some of them not aging at all. There will be competition across the aging countries for profitable foreign direct investment in countries that age slower or not at all. A more realistic model must represent the interaction among many countrys with different population, capital and production structures. Investment will compete across countrys, with interactions among the industrialized countrys, crowding out some of the foreign direct investments „projected“ so far. As crowding out occurs, it is important to observe the absolute sizes of the countries involved.

To this end, I feed the above growth model of with data from all OECD countries together with the South-East Asian countries, arranged in 13 regions. I disaggregate the European Union into the major single countries (Germany, France, Italy, and the United Kingdom), define a region of the small countries of the European core (Austria, Belgium, Luxembourg, the Netherlands, and Switzerland), Scandinavia (Denmark, Finland, Iceland, Norway, and Sweden), the Southern European Periphery (Greece, Portugal, Spain), and add the quickly growing countries of Turkey and Ireland as a ninth region. Together with the United States, Canada, Australia (combined with New Zealand), and the newly industrialized countries (NICs) in South East Asia (consisting of Hong Kong, Indonesia, South Korea, Malaysia, the Philippines, Singapore, and Taiwan), we arrive at a world now divided into 13 regions. This covers all OECD countries (as of 1988) plus the NICs. Although these countries make up only one third the world's population, they account for almost 85 percent of the world's output and consumption. Still missing in this picture are the emerging Eastern European economies.

The inclusion of Turkey at the European periphery is particularly significant. Turkey has an extremely different demographic outlook than the European core countries. According to the OECD (1988) projections, Turkey will face virtually no population aging, even after the year 2030, when the South East Asian countries are projected to age quickly. Since Turkey is also relatively big, reaching Japan in about the year 2030, she can absorb a lot of capital in form of foreign direct investment.[8]

In order to describe the German demographic and employment evolution, I again use the demographic and employment scenario lined out in Section 2, now based on the migration numbers projected by the German Bureau of the Census. American support ratios and labor force growth are taken from Cutler et al. (1990) who employ projections from the U.S. Social Security Administration. Projections for the other European countries and Japan are less detailed and were taken from Summers and Heston (1990) and the OECD (1988). Data for the newly industrialized countries is much harder to obtain. I start with the 1990 support ratios published by the OECD Labor Force Statistics for each of the NICs, and then take Taiwan's projected changes in the support ratio and her labor force growth, published by the World Bank, as representative for the entire NICs region.

Figure 11 shows, how different the relative evolution of the ratio of workers to consumers will be in 5 of the 13 selected regions. While Germany faces a steady and dramatic decline in the support ratio, Turkey will experience no population aging at all, and the Southern European Periphery only to a very modest extent. In the United States and in the South East Asian countries there is still employment growth. Population aging begins to turn the support ratio around after the year 2005. The development is astoundingly parallel. One should note, however that the level of the support ratio is substantially higher in the South-East Asian countries than in the United States.

Figure 11: Support Ratios in Selected Regions

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[8] The odd combination of Ireland with Turkey results from the very similar demographic patterns in both countries.

It is instructive to start the presentation with the results of the emerging capital flows, the relative ownership of capital as defined in Equation 3 and displayed in the table below.

Capital Ownership in a Disaggregate Open Economy Simulation

Year	D	F	I	UK	USA	Ja-pan	Ca-nada	Bene lux, A,CH	Scan dina via	E,P GR	Tur-key	AUS NZ	NICs
2000	14,8	1,62	8,89	1,67	2,66	8,05	4,27	6,65	0,62	-1,53	-11,8	-1,17	-7,29
2005	18,8	2,12	11,3	1,33	2,77	11,9	5,98	9,89	3,06	-3,81	-20,2	-2,47	-7,63
2010	21,5	3,11	11,7	1,45	3,59	13,5	8,94	13,5	6,40	-6,97	-27,8	-3,45	-7,37
2015	25,2	4,93	11,1	2,27	5,09	11,9	12,6	17,9	9,25	-10,3	-33,4	-3,94	-7,07
2020	29,8	6,33	10,8	2,82	5,84	8,85	15,2	21,6	10,77	-13,2	-37,8	-4,74	-5,82
2025	34,7	6,41	11,4	2,64	5,34	5,95	15,7	23,7	11,09	-15,1	-41,6	-6,29	-3,46
2030	40,2	6,28	12,8	2,64	4,89	3,79	16,0	25,4	11,41	-16,4	-45,0	-7,70	-1,45
2035	46,1	7,16	14,8	3,75	5,45	2,44	17,7	28,4	12,64	-17,3	-48,1	-8,09	-1,14
2040	52,2	8,84	17,6	5,59	6,51	2,70	19,9	32,3	14,59	-17,3	-50,8	-8,11	-2,29

Note: Net capital flows are measured as the relative difference in each countries per capita assets to the world average per capita assets, see Equation 3.

Germany and the smaller European core countries, to a lesser extent Italy, Scandinavia, and Canada export relatively much capital to the Southern European Periphery, with the bulk going to Turkey. These countries export capital during the entire period from 1990 through 2040. Japan exports a lot of capital until the year 2020, much less thereafter, when the aging process slows down. The table illustrates two points. First, crowding out of foreign direct investment is not really a big issue as long as the number of regions in need of capital -- relatively speaking -- is as large as it is. The inclusion of Turkey is particularly significant in this respect. Second, capital exports from the EU countries are very different across these countries, of course reflecting the different demographic changes to come. Most pronounced is the difference between Germany and the UK.

Figure 12 displays the effect of shifting capital profitably in still growing economies on saving. Since saving does not have to equal domestic investment, the aging country's saving is considerably higher in an open economy scenario than in the autarchy case, although domestic investment remains low. The difference in net saving is almost two percent around 2020.

Figure 12: Saving and Investment in the Open Economy

Savings remain higher than in the autarchy case because the world interest rate does not decline as fast as in the domestic interest rate in a closed, aging economy. The reason for a more stable world interest rate is of course that capital can be used more profitably in a world economy that is still growing or at least less shrinking than for instance the German population. Nevertheless, even in an open economy and with a substantial share of capital invested elsewhere, saving will still decline to a dramatic extent.

I should not finish this section without a word of caution: The simulations in this section are illustrative parables rather than projections, aiming at rough orders of magnitudes. The simulation results are rather robust against variations in the technology, but the capital flows depend very sensitively on the demographic inputs and the relative sizes of the regions included. They of course very much depend on the absorption of capital in the receiving countries, in particular economic and political stability necessary to warrant high rates of return. In turn, the dampening of the decline in saving would become even stronger when we would include the potential of currently under-capitalized regions not listed in the 13 regions above, in particular the immense capital requirements of the emerging Eastern European economies.

4. Conclusions

As the public pay-as-you-go pension systems of the aging industrialized countries are likely to become seriously strained under the growing dependency burden, the question arises whether a society should rely on private savings to finance old-age consumption. This is an empirical question about the magnitude and the flexibility of saving rates. The paper takes the German case as an example. A simple computation of the pension gap shows that saving rates must increase in an unprecedented fashion in order to compensate for the dependency effect. However, the analysis of German age and cohort patterns shows that this is unlikely. First, the life cycle structure structure of German saving rates will not generate a lot of „excess“ savings. If one believes the (weak) evidence generated by the separation of age and cohort effects, the opposite is the case. Second, if cohort effects are governed by the rationale underlying a neoclassical growth model, i.e., if an aggregate saving rate emerges that maximizes the long-run welfare of a country, then saving will strongly decline, only somewhat moderated in the case of heavy investment in less aging countries.

The paper illustrates a well-known theoretical point. In an economy with a shrinking labor force, funding a pension system cannot work as an escape route from a rising burden of dependency. Faltering rates of return prohibit this mechanism. Section 3 of the paper shows that under moderately realistic assumptions, foreign direct investment helps -- it actually helps considerably in terms of consumption possibilities -- but the magnitude of the problem is too large to be offset. Because all industrialized countries are aging, a full offset would require a very large emerging market for investment.

References:

Attanasio, O., 1995, Household Saving in the U.S., in: Poterba, J. (ed.), *International Comparisons of Household Savings*, University of Chicago Press, forthcoming.

Becker, G.S., and R.J. Barro, 1988, A Reformulation of the Economic Theory of Fertility, *Quarterly Journal of Economics 103*.

Blanchard, O. and S. Fischer, 1989, *Lectures on Macroeconomics*, Cambridge, Mass.

Boskin, M.J., 1978, Taxation, Saving, and the Rate of Interest, *Journal of Political Economy 86*, S3-27.

Bosworth, B., 1982, Capital Formation and Public Policy, *Brookings Papers on Economic Activity 2:1992*, 273-317.

Bosworth, B., G. Burtless, and J. Sabelhaus, 1991, The Decline in Saving: Evidence from Household Surveys, *Brookings Papers on Economic Activity 1:1991*, 183-256.

Börsch-Supan, A., 1992, Saving and Consumption Patterns of the Elderly: The German Case, *Journal of Population Economics*, 189-303.

Börsch-Supan, A., 1995a, Regional Development, Capital Flows, and Trade Policies in an Aging Europe, in: B. Gahlen, H. Hesse, H.J. Ramser, *Neue Entwicklungen in der Regionalökonomik*, J.C.B. Mohr (Paul Siebeck) Tübingen, forthcoming.

Börsch-Supan, A., 1995a, The Consequences of Population Aging on Pensions and Saving, in: L. Bovenberg and C. van Ewijk, *Lecture Notes on Pensions and Saving*, Oxford University Press, forthcoming.

Börsch-Supan, A., 1995b, Household Savings in Germany, in: Poterba, J. (ed.), *International Comparisons of Household Savings*, University of Chicago Press, forthcoming.

Börsch-Supan, A., and K. Stahl, 1991, Life Cycle Savings and Consumption Constraints, *Journal of Population Economics*, 233-255.

Bös, D. and R.K. von Weizsäcker, 1989, Economic Consequences of an Aging Population, *European Economic Review*, pp. 345-354.

Cutler, D.M., J.M. Poterba, L.M. Sheiner and L.H. Summers, 1990, An Aging Society: Opportunity or Challenge?, *Brookings Papers on Economic Activity.*

Deardorff, A.V., 1985, Trade and Capital Mobility in a World of Diverging Populations, in: D.G. Johnson and R.D. Lee. *Population Growth and Economic Development: Issues and Evidence.* The University of Wisconsin Press.

Euler, Manfred, 1982, Einkommens- und Verbrauchsstichprobe 1983, *Wirtschaft und Statistik 6*.

Euler, Manfred, 1985, Geldvermögen privater Haushalte 1983, *Wirtschaft und Statistik 5*.

Euler, Manfred, 1987, Einkommens- und Verbrauchsstichprobe 1988, *Wirtschaft und Statistik 8*, 664-669.

Euler, Manfred, 1990, Geldvermögen und Schulden privater Haushalte Ende 1988, *Wirtschaft und Statistik 11*, 798-808.

Hagemann, R.G., and G. Nicoletti, 1989, Population Ageing: Economic Effects and Some Policy Implications for Financing Public Pensions, *OECD Economic Studies No. 12*.

Hurd, Michael D., 1989, Issues and Results from Research on the Elderly: Economic Status, Retirement, and Savings, *Journal of Economic Literature*.

Jensen, S.E.H., and S.B. Nielsen, 1992, Aging, Intergenerational Distribution, and Public Pension Systems, Working Paper, Copenhagen Business School.

Lang, Oliver, 1993, Die Qualität der Vermögensdaten in der Einkommens- und Verbrauchsstichprobe 1983: Ein Abgleich mit aggregierten Statistiken, mimeo, Zentrum für Europäische Wirtschaftsforschung, Mannheim.

OECD, 1988, *Ageing Populations: The Social Policy Implications*, Paris.

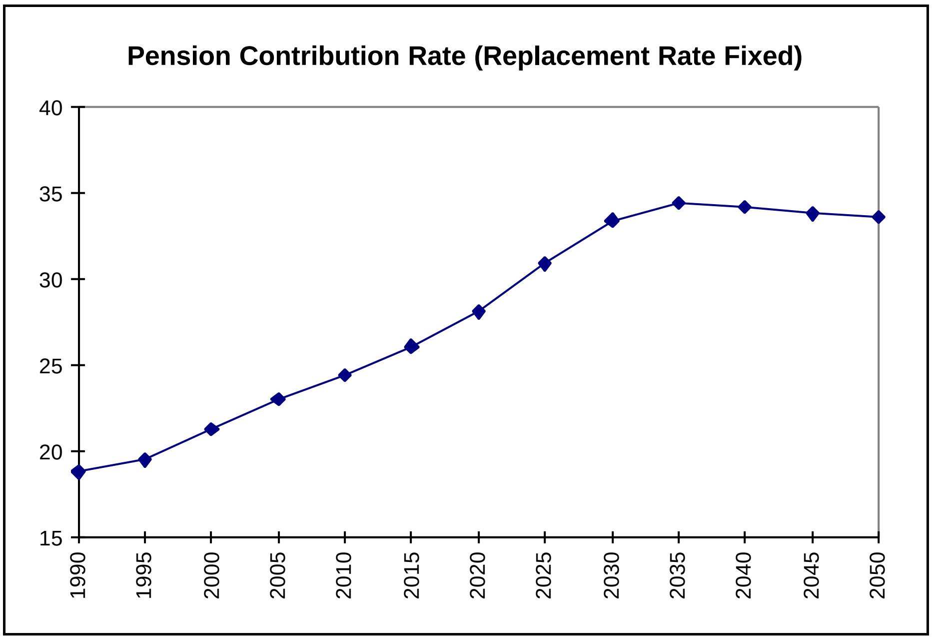
Sommer, B., 1992, Entwicklung der Bevölkerung bis 2030: Ergebnis der siebten koordinierten Bevölkerungsvorausberechnung, *Wirtschaft und Statistik 4*.

Summers, R., and A. Heston, 1990, The Penn World Tables (Mark 5): An Expanded Set of International Comparisons, *Quarterly Journal of Economics*.

Thon, M., 1992, Neue Modellrechnungen zur Entwicklung des Erwerbspersonenpotentials im bisherigen Bundesgebiet bis 2010 mit Ausblick bis 2030, *Mitteilungen aus der Arbeits- und Berufsforschung*.

Velling, Johannes, 1991, Der Beitrag der Lebenszyklushypothese zur Erklärung des Sparverhaltens im Alter, Unpublished Diplomthesis, Mannheim.

Figure 1:



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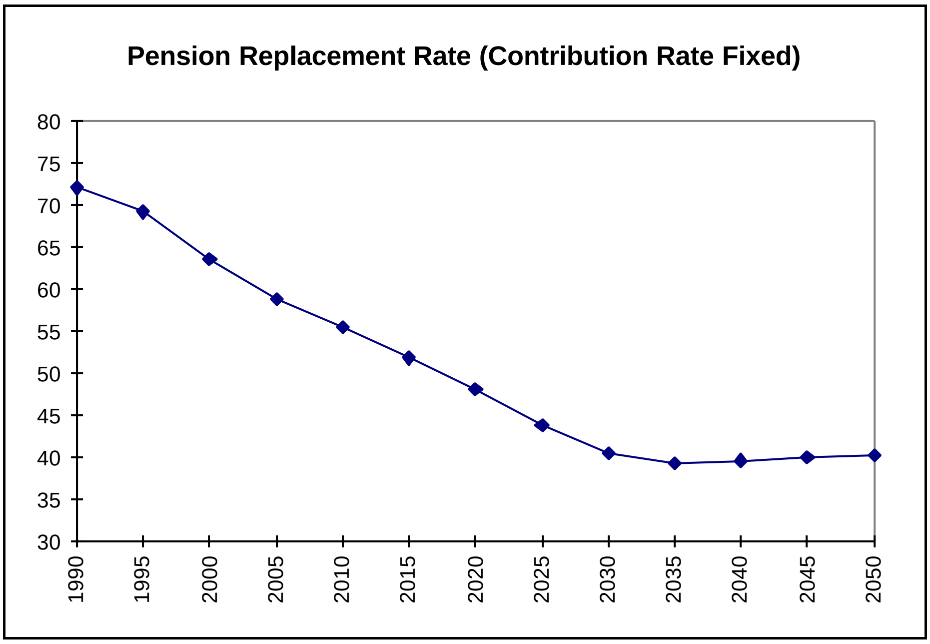

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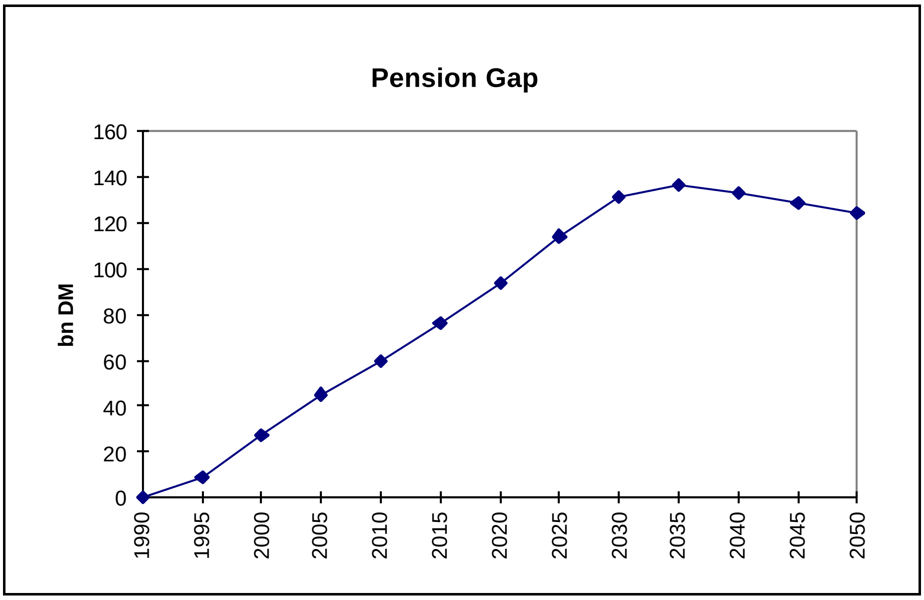
Pension Gap
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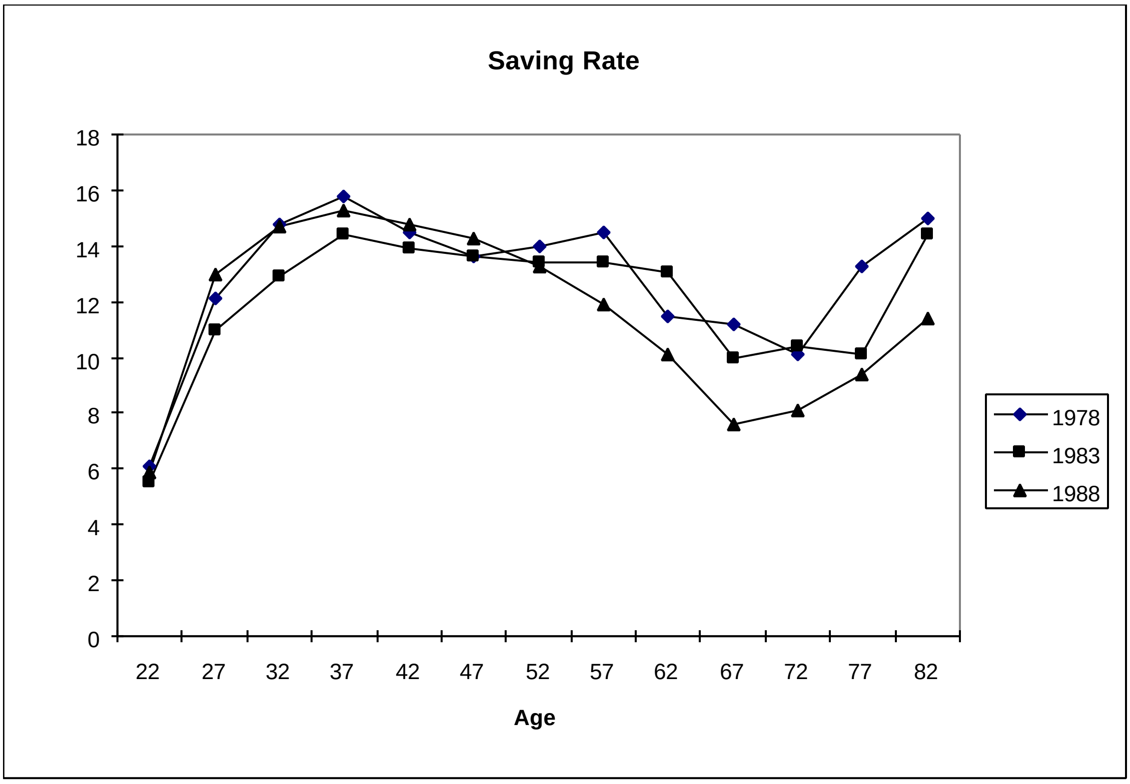
Figue 4:



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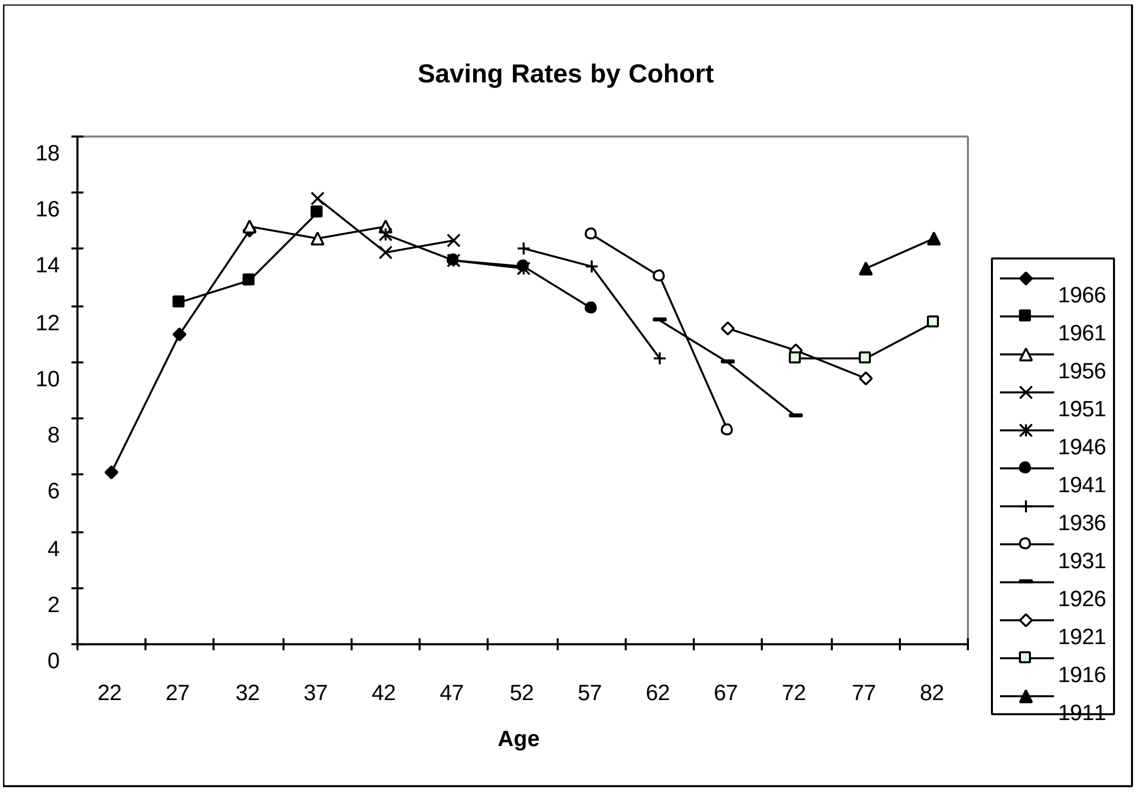

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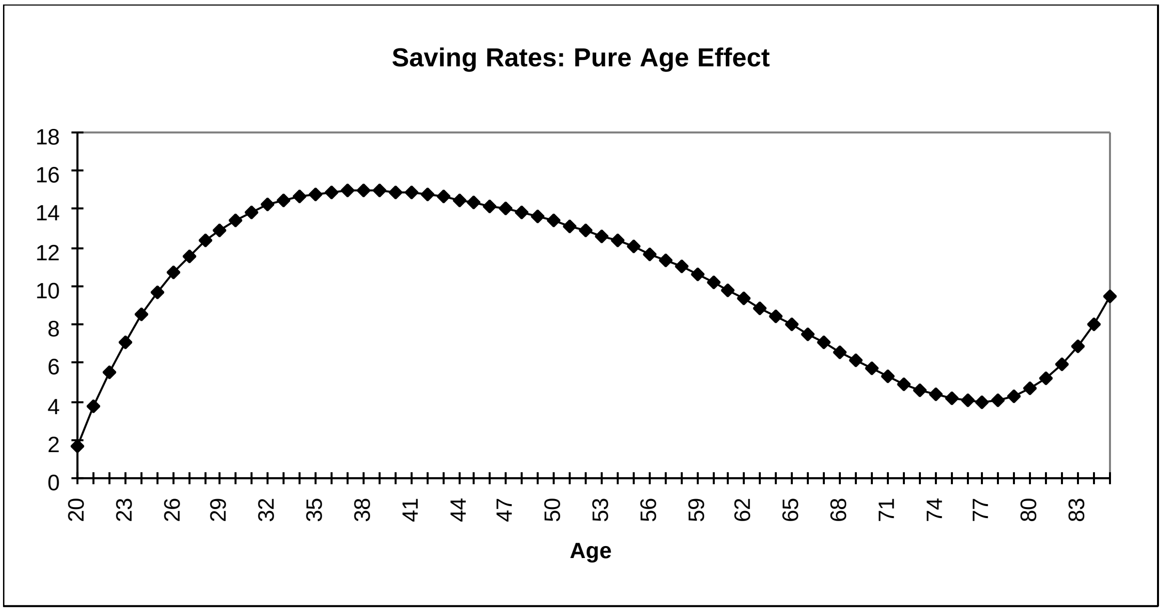

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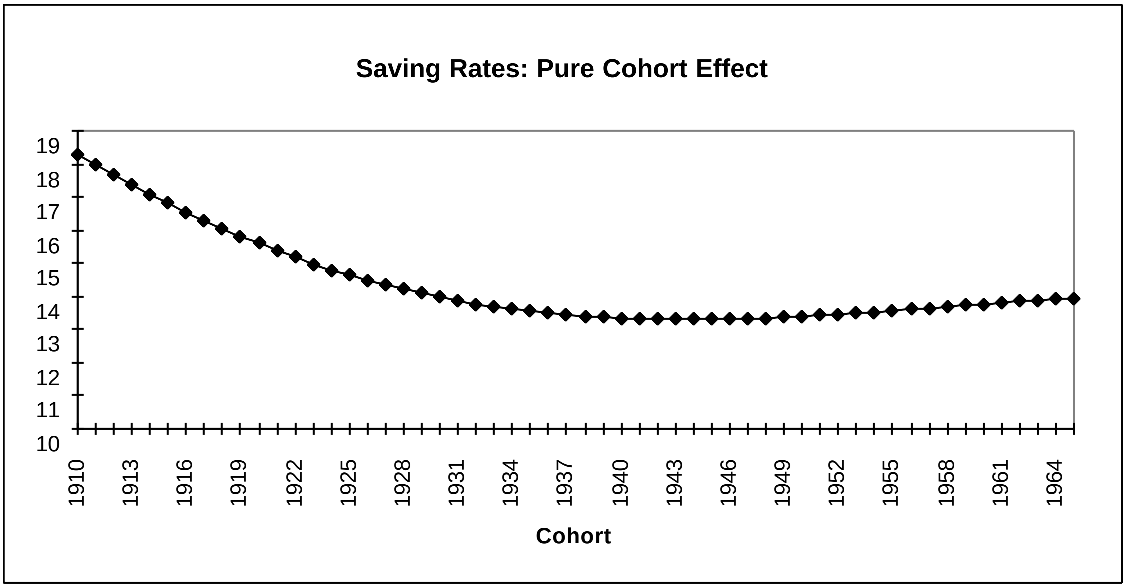

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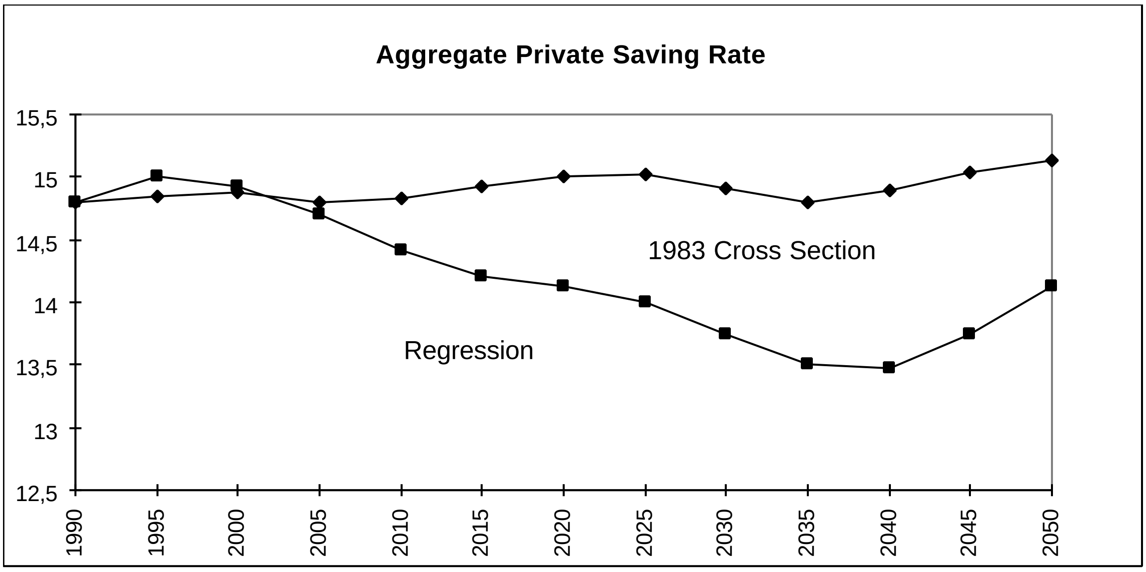
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1983 Cross Section
Regression

Figure 9: Saving Rates under Autarchy

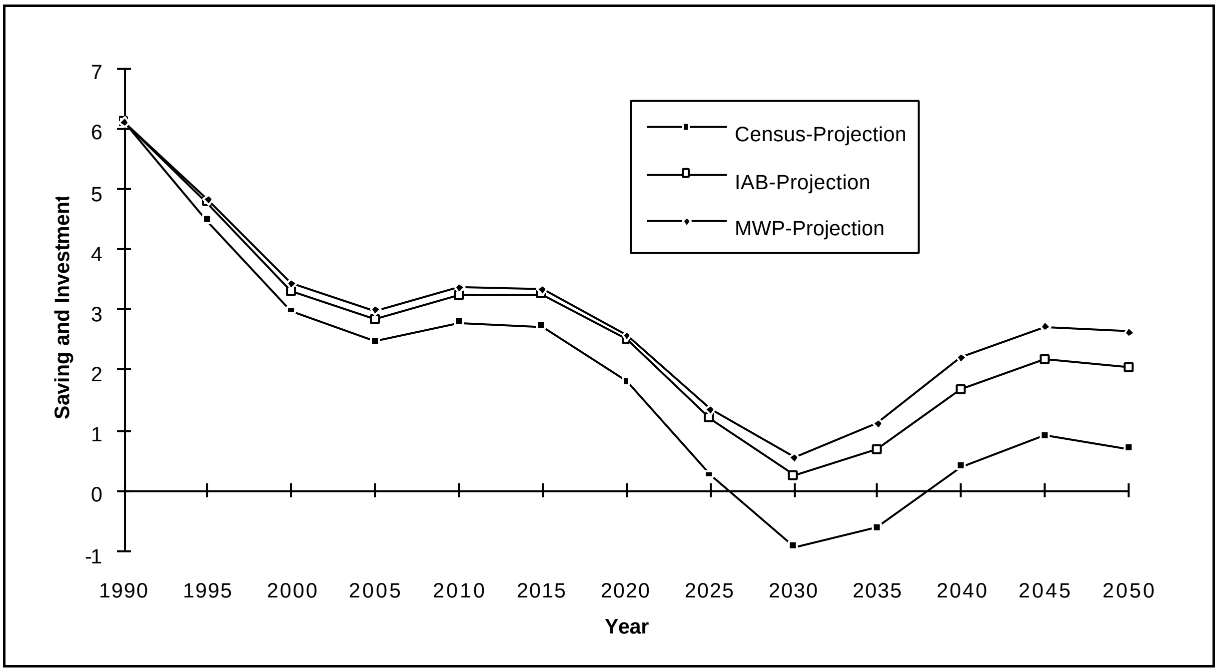

Figure 10: Rate of Return under Autarchy

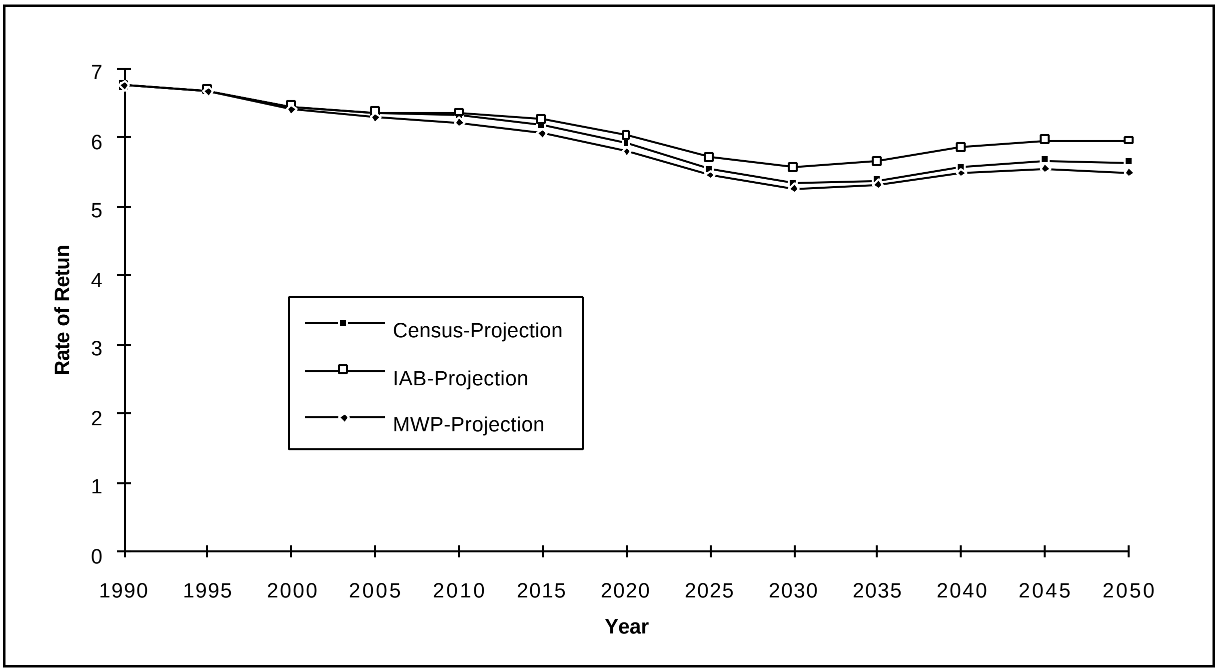

Figure 11: Support Ratios for Selected Regions

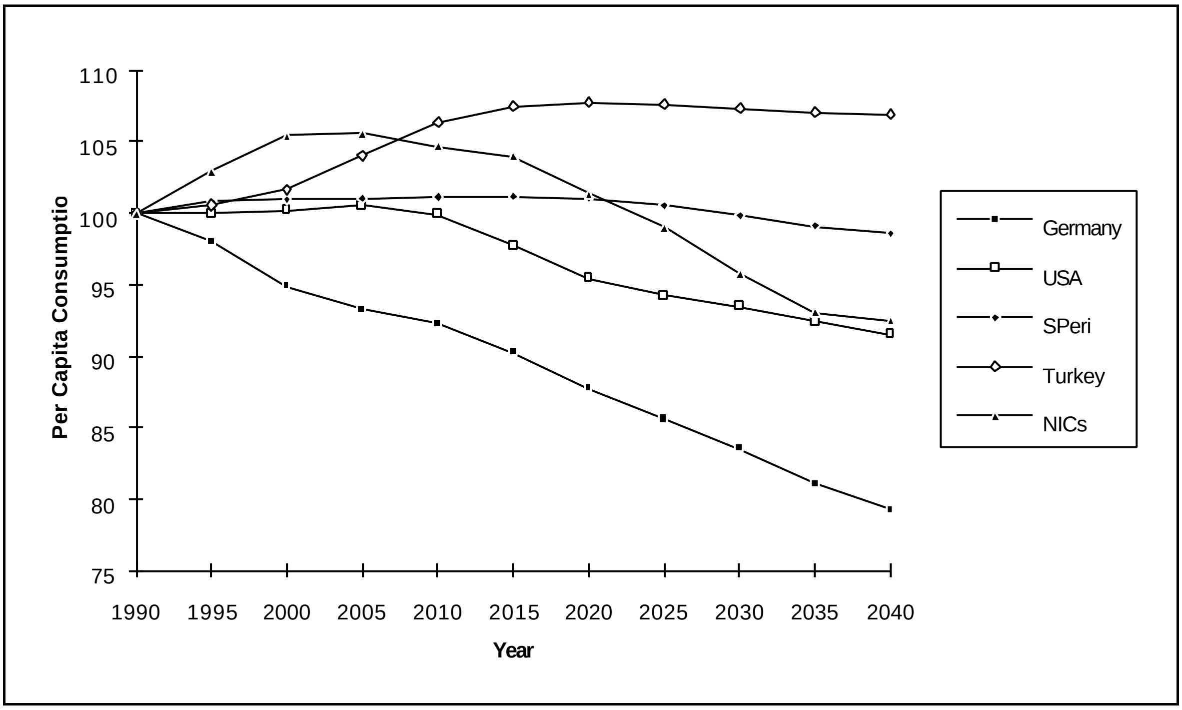

Figure 12: Savings and Investment in the Open Economy