Population Research and Policy Review **18:** 261–277, 1999.

Age structure and economic policy: The case of saving and growth

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Abstract. The age structure of the population affects aggregate saving, which affects growth through investment. Growth in turn is influenced by other age structure effects and feeds back into aggregate saving by well known life cycle mechanisms. Some of these feedbacks are generally ignored in empirical work. Especially the age structure effect on macroeconomic variables is a commonly overlooked, yet easily accessible factor useful for prediction, policy evaluation and design. The connection between age structure, savings and growth in the OECD from 1950 to 1990 illustrates how policy analysis that ignores the macroeconomic effects and feedbacks from age structure changes is liable to lead to faulty and potentially costly conclusions about policy issues.

Keywords: Demography, Europe, Growth, Panel study, Saving

Introduction

The age distribution of the population is a useful tool for understanding the economy, not a deplorable imperfection to control for. Panel regressions using age structure, growth and saving in the OECD countries 1950–1990 show the patterns expected from life cycle and human capital models. Although this result probably reflects aggregation properties rather than individual behavior, it may nevertheless be useful for forecasting macroeconomic performance.

The efficacy and relevance of economic policy depend on the quantitative effects of changes in policy parameters. By necessity inferences have to be made from the historical experience of actual economies. The predicted effects are, therefore, contingent on institutional facts, technological and cultural background, demographic structure etc. It is clearly impossible to allow for the potential changes in every such background variable. The age structure can, however, be fairly accurately projected several years into the future. Individual economic behavior changes profoundly over the life cycle. Consequently, variations in the age composition of the population change aggregate economic behavior.

The design of pension systems, health care, education and so forth, is unavoidably concerned with the age distribution of the population. However, the economic feedback effects are all too often ignored. Age effects on saving, growth, inflation, housing, etc., feed back into prices, interest rates, taxes, and so on. The total impact goes far beyond the partial direct effects. Partial effects will sometimes reinforce each other and sometimes cancel out. A reliable policy evaluation, therefore, must estimate total rather than partial effects and distinguish changes in individual behavior from aggregation effects.

This point is illustrated here by the relation between saving and growth. The life cycle theory of saving is very well known. Yet there is still controversy among economists regarding the importance of demographic variables for empirical saving behavior. Growth research has in general neglected age structure altogether. Still, the bi-directional causation between saving and growth constitutes an important feedback loop in the economy, a feedback that the two branches of research mutually have tended to ignore.

The empirical results in this paper show that direct age structure effects can explain only a small fraction of the variation in saving. However, age effects on growth will reinforce the positive saving effects from the middle age groups. The effects are also cumulative so that increases in saving in one period will increase saving in the next period.

Age structure affects many other macroeconomic variables. The results here, therefore, cannot identify any specific mechanism. They could arise from a host of different mechanisms with rather different policy implications and, therefore, they serve as a stimulus to further research rather than a basis for immediate policy proposals.

In the next section the relation of saving and growth to age structure in current economic research is briefly discussed. Then the empirical results are presented and discussed. The last section concludes and summarizes the argument for giving age structure a more prominent place in economic policy discussions.

Age structures, saving and growth

Demographic variables in empirical studies of saving and consumption are often viewed with considerable skepticism.[1] Macroeconomic regressions, especially cross-country studies, generally find a relation, albeit not very strong, while microeconomic studies tend to imply a much weaker and more ambiguous impact of demographics on saving.

There is little consensus about the interpretation of these findings. Disagreement often seems to have focused on the saving behavior of the elderly, who in micro data turn out not to be spending savings as predicted by simple life cycle theory. Macro regressions, however, yield negative coefficients on the elderly. Pension claims are not accounted for in micro data, hence mismeasurement of personal wealth can be part of an explanation, see Miles (1997). Weil (1994) attempts to reconcile the micro-macro discrepancy by intergenerational dependencies; expectations of bequests may make the younger generations less prone to save.

However, in one important study Bosworth et al. (1991) compare household data before and after falls in the aggregate saving rates in the United States, Canada and Japan. They found that saving rates were falling in all age groups and that the pure demographic effect was negligible. This rejects direct life cycle effects as the main explanation of these decreases in saving rates.

Bosworth et al. go even further and conclude: 'We thus reject the prediction that the private saving rate will necessarily increase in the near future as the large baby-boom cohort enters middle age' (1991: 223). They find evidence that sharply higher home prices may have contributed to the drop in saving rates, but tentatively they attribute the drop primarily to sluggish income growth.

In fact, the US private saving rate did decrease in the beginning of the 1990s but has now risen again. Based on the empirical results below, I suggest that this increase in saving is indeed an age structure effect that works through a delayed feedback from age effects on growth.

It is empirically well established that saving increases with growth, theoretically explained by the increase in saving of young cohorts as they see their permanent income grow, see Deaton (1995) for a discussion. A steady increase in aggregate income growth as baby boomers reach middle age is expected from standard human capital theory.[2] Human capital is accumulated over life. Young adults in industrialized countries devote the main part of their time to education, thus forsaking income. To realize the full productivity gains of education requires seasoning by experience and the accumulation of activity-specific human capital, so it is only as a mature adult a person's human capital is fully operational. A contributing factor is, of course, the resources spent on reproduction by the prime age cohorts.

There has been remarkably little work on the implications of the simultaneity of income and saving when age structure changes. There are some simulation studies though, e.g. Blomquist & Wijkander (1994) and Miles (1997) using highly stylized assumptions. A growth enhancing effect of baby boomers reaching middle age will feed back into increased saving, in turn boosting growth further. Even modest increases in saving by direct age structure effects will be further magnified by this feedback loop and reinforced for middle aged groups by the productivity effect.

There are empirical evidence of pervasive macro effects from the age distribution on labor supply and demand, asset demands, even the demand for money, inflation, housing, migration and so forth.[3] For example, although hotly debated, a study by Mankiw & Weil (1989) explains the rising house prices in the USA around 1980 by the household formation of the baby boomers.

The combined effects of baby boomers entering middle age are thus very likely to create circumstances that with some delay will boost the saving rate, even if the direct effect on saving is small. For economic policy and forecasting it is, of course, this total effect that is of interest rather than the partial effect.

Empirical evidence for the OECD, 1950–1990

OECD variations in the age structure are by no means small. The population shares of children under the age of 15 have decreased rapidly in the last 25 years. During the early post-war period more than 20 percent of the population were children in all OECD countries and almost half of the countries at times had more than 30 percent children. In 1990 only seven OECD countries had more than 20 percent and no country had more than 30 percent.

At the other end of the age spectrum, the OECD has gone through an ageing process. In most of the countries the share of people aged 75 years or more in the adult population has more than doubled. But there has been a temporary pause in the ageing process. The mean share of the 65–74 age group in the adult population actually fell in the early 1980's and had not returned by 1990 to the peak level reached in the 1970s. This temporary recess is a reflection of the reduced birth rates in many developed countries during the 1910–1939 period.

The data

Economic data for 23 OECD countries[4] for the 1950–1990 period are taken from the Penn World Table, Version 5.5, see Summers & Heston (1991). These data are averaged over 5-year periods, except for initial GDP which refers to the beginning year of the period. Age group data are point data (at the end of the initial year in each 5-year period) taken from United Nations (1990). All in all there are 184 observations with 8 periods per country.

Figure 1 presents a scatterplot of saving rates and preceding growth rates. Since one period is lost by using preceding period growth there are 161 observations in the plot. A bivariate regression confirms a statistically significant relation where a 1 percentage point increase in the growth rate of the preceding period increases the national saving rate by 0.7 percentage points. Using current period growth there is no significant relation at all.

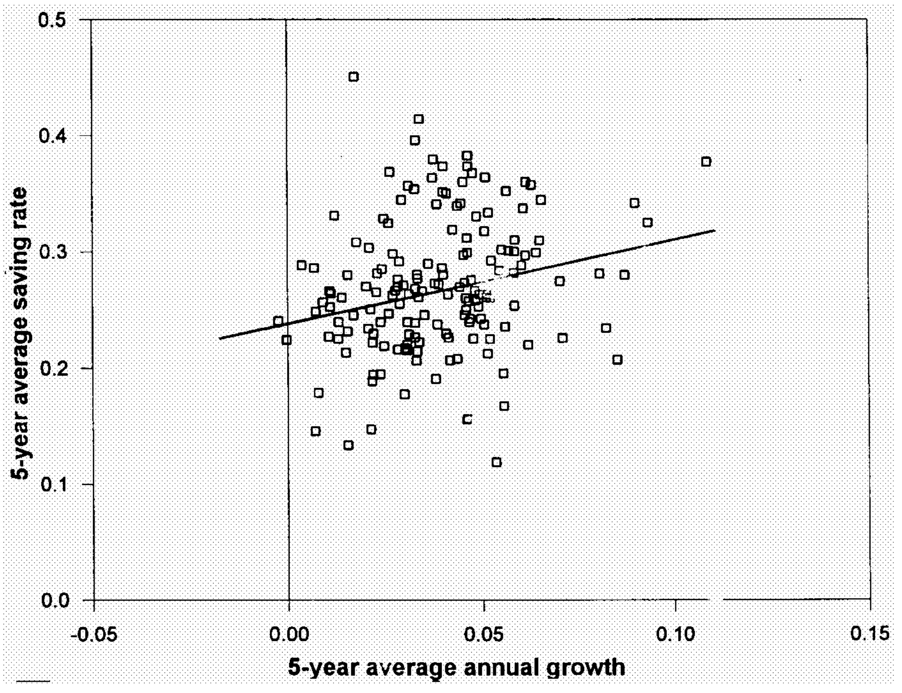

Figure 1. Preceding GDP growth versus saving rate.

Regressing investment on saving confirms a close correlation between these variables, the coefficient on saving being 0.77 with a t-value of 25. This is in line with the well-known Feldstein & Horioka (1980) results. The OECD data, thus, conform to stylized facts in the literature.

Age and saving

Life cycle consumption smoothing implies that young cohorts (15–29) should borrow, prime (30–49) and middle aged (50–64) save and amortize, while the elderly (65+) spend savings. The indicated age brackets operationalize an age structure corresponding to these groups.

Using all age group shares of the population, there would be perfect collinearity in the regressions forcing me to either drop the intercept or some age group. The theory really pertains to household decisions. That motivates dropping the group of children.

In Table 1 the base regression on pooled data, using only age groups as regressors, has a pattern that is consistent with the life cycle story. There are indications of autocorrelation that can be removed by including lagged saving. This improves the fit dramatically and strongly increases the joint

Table 1. Regression of 5-year average national saving rates on initial age shares for 23 OECD countries 1950–1990

Dependent variable Gross national saving rate	Base regression	Lag included	Controls included	Time and country dummies included
Constant	0.001	−0.004	0.001	−0.047
	(0.01)	(0.10)	(0.04)	(0.53)
Age group share 15–29	0.241	0.017	−0.011	0.171
	(0.78)	(0.19)	(0.13)	(1.27)
Age group share 30–49	0.605	0.235	0.179	0.337
	(1.91)	(2.25)	(1.88)	(2.12)
Age group share 50–64	0.584	0.193	0.190	0.167
	(1.34)	(1.60)	(1.76)	(1.22)
Age group share 65 and above	−0.325	−0.389	−0.159	−0.176
	(1.05)	(3.52)	(1.39)	(0.77)
Lagged saving rate		0.836	0.760	0.637
		(22.6)	(23.6)	(9.59)
Preceding growth rate			0.613	0.564
			(6.41)	(5.23)
Government consumption share			−0.071	−0.130
			(1.03)	(0.95)
Trade balance			0.272	0.262
			(3.78)	(3.30)
F(22) country effects	22.6	2.0	1.9	–
(p-value)	(0.00)	(0.01)	(0.01)	
F(7) time effects	10.7	4.3	4.7	–
(p-value)	(0.00)	(0.00)	(0.00)	
Usable observations	184	161	161	161
Adj. R^2	0.04	0.84	0.87	0.91
$\chi^2(4)$ joint age	4.87	17.4	12.1	5.9
(p-value)	(0.30)	(0.00)	(0.02)	(0.20)

Least squares estimates with heteroskedastic and autocorrelation consistent errors. Absolute t-values in parenthesis below coefficient estimate. Wald test p-values for the joint significance of the age shares. F-tests on residuals for country- and time-specific intercepts.

significance of the age variables in spite of the decrease in degrees of freedom and decreased magnitude of the coefficients. Adding preceding growth, the share of government consumption and the trade balance as controls change very little in the third column although both the growth and the trade balance coefficients are significant. In the last column, country- and time-specific fixed effects are controlled for by dummies.

Due to the lagged savings variable, this specification is well known to be biased, see Nickell (1981). This bias shows up in the decrease of the coefficient on the lag. The age pattern does not change very much in spite of the dynamic bias. Joint significance on conventional levels is lost though. This is not unexpected, since there is substantial correlation between time dummies and age variables.

By themselves, the age variables explain little of the variation in saving. But neither do the other variables. In fact, the fit depends mostly on lagged saving.

Age and growth

In Table 2 the rate of growth in each period is regressed on the initial age group distribution.[5] In this set of regressions the age structure explains a lot more of the total variation. Including controls does not increase the explanatory power of the model but accounting for country- and time-specific effects do. With respect to growth the age variables retain joint significance for all combinations, including time dummies.

The pattern is somewhat different from the saving regressions. Here it is predominantly the age group 50–64 years old that has a positive effect on growth while retirees have a negative effect and other age groups have insignificant effects. The strong positive effect of the middle aged on income growth thus would be consistent with the prediction that middle aged baby boomers will raise the aggregate saving rate, even if skeptics are entirely right about the insignificance of direct age structure effects. Taken literally the estimates imply that as baby boomers reach 50 years of age we get a growth effect that will feed back into an increase in the saving rate in the following five-year period.

Saving, growth and age

The relation between investment and growth is probably simultaneous through the relation to saving and lagged saving, and also by other mechanisms. Thus, simultaneity bias might affect the estimates in the control regressions both in the saving and the growth equation. Therefore, both equations were estimated as a system.

The simultaneous equation estimates in Table 3 are generally similar to those in the separate regressions, only with a little better precision in the estimates. It also becomes clearer that the hump pattern is different in the two relations. The fertile, family-raising prime age group have the main positive influence on saving while they tend to have a negative effect on growth. The middle-aged group, 50–64 years old, exercises the main positive influence on

Table 2. Regression of 5-year average GDP growth rates on logarithms of initial age shares for 23 OECD countries 1950–1990

Dependent variable GDP growth rate	Base regression	Controls included	Time and country dummies included
Constant	−0.047	−0.081	0.721
	(1.20)	(1.05)	(6.12)
Log of age share 15–29	−0.003	−0.007	0.011
	(0.22)	(0.49)	(0.80)
Log of age share 30–49	−0.020	−0.023	0.040
	(1.28)	(1.42)	(1.74)
Log of age share 50–64	0.049	0.046	0.055
	(4.05)	(3.81)	(3.98)
Log of age share 65 above	−0.064	−0.066	−0.030
	(8.88)	(7.29)	(1.81)
Log of investment rate		0.005	0.012
		(0.85)	(1.43)
Log (0.05+ growth of pop)		−0.007	0.036
		(0.47)	(2.47)
Log of initial GDP		0.4×10^{-3}	−0.065
		(0.61)	(7.26)
F(22)-stat. country effects	2.1	1.9	–
(p-value)	(0.01)	(0.01)	
F(7)-stat. time effects	4.1	4.0	–
(p-value)	(0.00)	(0.00)	
Usable observations	184	184	184
Adj R^2	0.35	0.35	0.64
χ^2(4)-stat. joint age	98.4	55.7	17.5
(p-value)	(0.00)	(0.00)	(0.00)

Least squares estimates with heteroskedastic and autocorrelation consistent errors. Absolute t-values in parenthesis below coefficient estimates. Wald test p-values for the joint significance of the age shares. F-tests for time- and country specific intercepts in the residuals.

growth, while retirees have a negative influence. Time and country effects are controlled for by a more parsimonious set of dummies chosen on the basis of the single equation regression, see the notes in Table 3 for details. The age variables retain joint significance on the conventional 5 percent level.

Taken at face value the regressions indicate that the age effects do not explain much of the saving variation in the same period. However, the persistency in saving patterns is high since the preceding period's saving is the

Table 3. Non-linear system least squares estimates

Dependent variable	Gross national saving rate		Dependent variable	Real GDP growth	
	Pooled	Time & country		Pooled	Time & country
Constant	−0.021	−0.021	Constant	−0.144	−0.090
	(0.54)	(0.64)		(1.62)	(1.09)
15–29	−0.002	0.096	Log 15–29	−0.020	0.006
	(0.03)	(1.33)		(1.29)	(0.38)
30–49	0.213	0.194	Log 30–49	−0.035	−0.046
	(2.27)	(2.59)		(1.90)	(2.66)
50–64	0.169	0.114	Log 50–64	0.048	0.012
	(1.53)	(1.30)		(3.62)	(0.74)
65 above	−0.150	−0.154	Log 65 above	−0.075	−0.040
	(1.44)	(1.81)		(7.23)	(3.31)
Lagged saving	0.770	0.760	Log investment	0.008	0.021
	(25.3)	(24.1)		(1.20)	(3.21)
Preceding growth	0.688	0.526	Log(0.05 + popg)	−0.011	−0.016
	(7.22)	(6.31)		(0.67)	(1.04)
Trade balance	0.267	0.060	Log initial GDP	0.5×10^{-3}	−0.001
	(3.58)	(1.08)		(0.59)	(0.99)
F(22) country	1.9	0.7		1.9	1.4
	(0.02)	(0.82)		(0.01)	(0.15)
F(6) time	4.9	1.1		3.7	0.8
	(0.00)	(0.35)		(0.00)	(0.60)
Usable obs	161	161		161	161
Adj R^2	0.88	0.91		0.40	0.50
$\chi^2(4)$ joint age	12.5	10.6		53.0	32.4
	(0.01)	(0.03)		(0.00)	(0.00)

Heteroskedastic and autocorrelation consistent errors. Absolute t-values in parenthesis below coefficient estimates. Wald test p-values for the joint significance of the age shares. Time dummies are negative for 1975–1980 in the savings equation, negative for 1970–1985 and positive for 1960–1965 in the growth equation. Country dummies are negative for Greece and Portugal, positive for Norway and Switzerland in the savings equation, negative for Denmark, Finland, Iceland, Ireland, Luxembourg, Norway and New Zealand in the growth equations.

major determinant of the current period. There is, thus, a cumulative effect from the age distribution in previous periods. Since the distribution is changing rather slowly, this accumulation of age effects will explain a large part of long-term variation. Furthermore, the age effects on growth explain substantial parts of the growth variation that generates a positive effect on saving in the next period. We would, therefore, expect baby boomers entering middle age brackets to boost both growth and saving with a one-period delay of the growth effect and the full effects distributed over several periods.

Discussion of results

The regressions here do not thoroughly explore all the econometric problems that may arise. But, especially the growth correlation with age groups is very robust. The pattern is shifted somewhat by time dummies, but some part of the time effects are in fact due to general trends in the age structure of all OECD countries.

There are some other econometric difficulties in estimating age structure models. The age distribution is comparatively slow-moving and thus difficult to discriminate from other potential secular trends in the data. Different age groups are correlated both within and between countries leading to some multicollinearity problems. Averaging over periods may also give rise to time aggregation problems, although the averaging ameliorates the problem with business cycle noise in annual data.

The data quality is, however, comparatively superior to most economic variables. The predictability of future age structure changes is excellent in comparison to most economic variables; consider for example variables like the capital stock or the interest rate.

For predictive purposes the reduced form above might serve well, especially since the demographic variables can be independently forecasted. Even if it can be argued that there is feedback from the economy to the age distribution, it works primarily through fertility and migration, both of which mainly affect the young cohorts. As a whole the age structure can be fairly well predicted for several years ahead.

In Figures 2 and 3 the simultaneous saving and growth model with fixed effects is compared country by country with actual data. The figures also contain the forecasts for the 1990–1995 period based on demographically projected age group shares. The national saving rate is predicted to increase for all countries, except Finland, Greece, Iceland, and Portugal. The predicted increase for several countries is rather small, however, e.g. for the USA.

The growth rate, on the other hand, is predicted to decrease for every country except Ireland. Since the Penn World Table has not been updated beyond 1992, we can make no direct comparison with identically defined data. To get some idea about the accuracy of prediction, actual data from the OECD National Accounts are presented in Table 4. The numbers are changes (in percent) of average saving rates and growth between the period 1985–1990 and 1990–1995. The unconditional prediction and the prediction conditional on the actual 1985–1990 data are presented and compared to the actual OECD

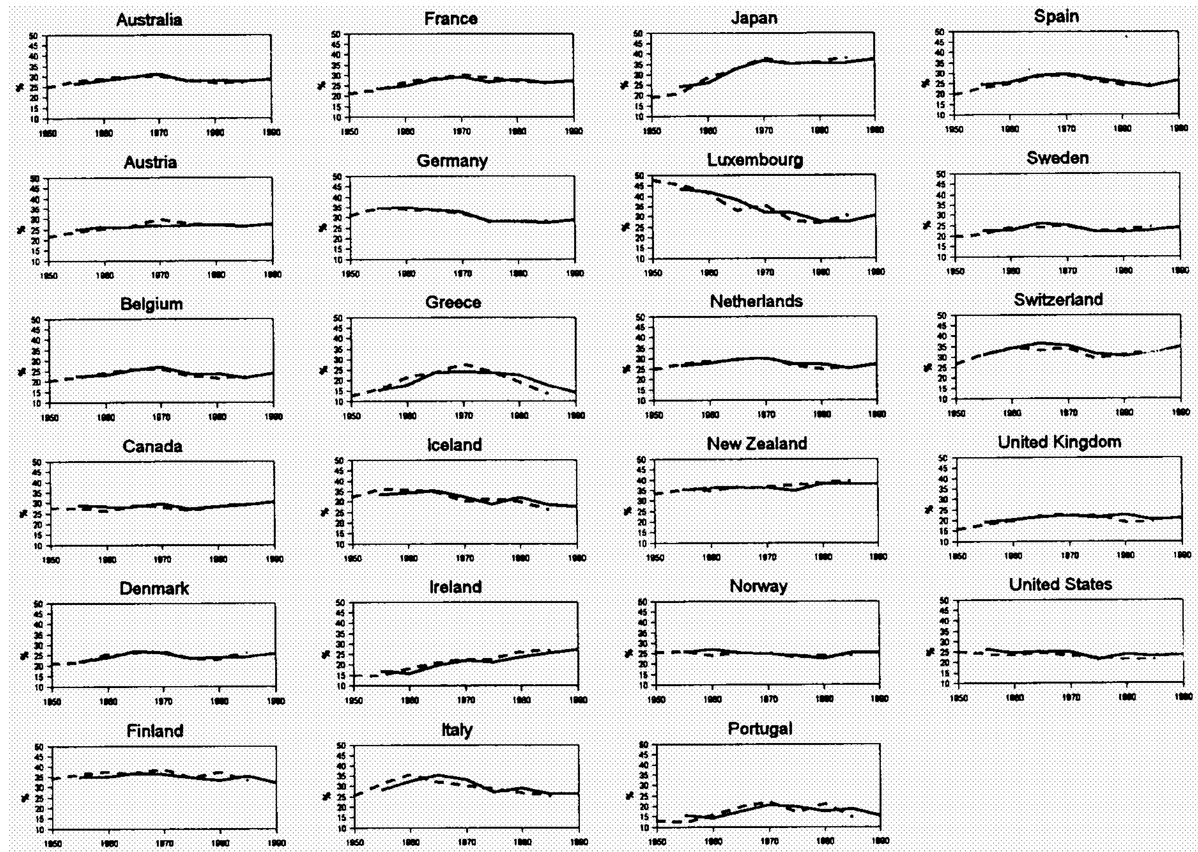

Figure 2. Saving model with forecast. Dashed line is the actual saving rate. Initial year of period on horizontal axis.

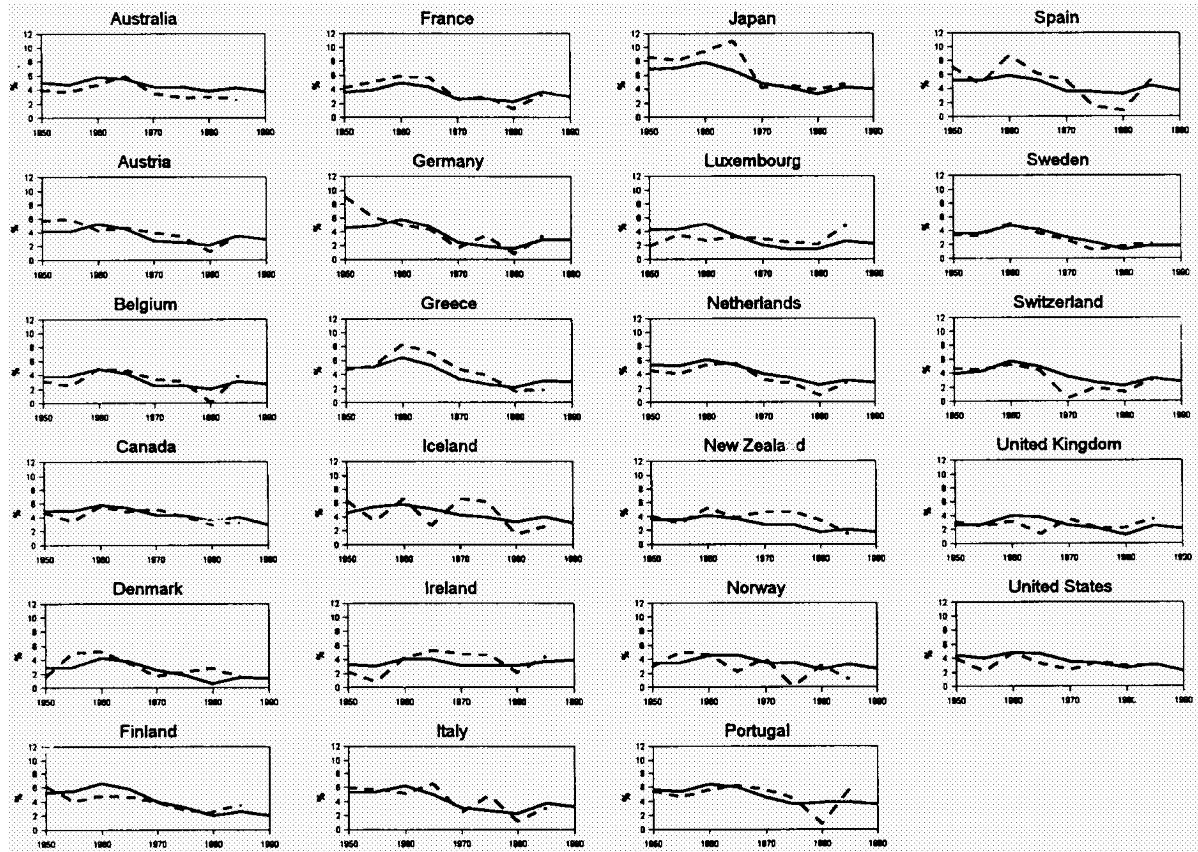

Figure 3. Growth model with forecast. Dashed line is the actual growth rate. Initial year of period on horizontal axis.

Table 4. Predicted and actual changes in the average saving rate and the growth rate of GDP over the periods 1985–1990 and 1990–1995, respectively

	Change percentage					
	Gross national saving rate			Real GDP growth		
Country	Pred.	Cond. pred.	Actual	Pred.	Cond. pred.	Actual
Australia	1.1	1.3	−3.2	−0.6	1.1*	0.4
Austria	1.1*	0.4*	1.7	−0.5*	−0.4*	−0.9
Belgium	2.2*	1.2*	3.4	−0.4*	−1.2*	−1.8
Canada	1.5	1.1	−4.3	−1.1*	−0.3*	−1.3
Denmark	1.8*	−0.5	1.2	−0.2	−0.2	0.6
Finland	−3.0*	−1.0*	−5.8	−0.6*	−1.6*	−4.1
France	0.8	0.6	−0.3	−0.6*	−0.2*	−1.9
Germany (FRG)	1.3*	−0.1	1.9	−0.1	−0.6	n.a.
Greece	−3.4	0.7*	0.1	−0.2*	1.1	−0.3
Iceland	−1.0	1.3*	0.1	−1.0*	0.4	−2.3
Ireland	1.7*	−0.0	3.4	0.2*	−0.5	1.0
Italy	0.2	1.1*	−2.2	−0.5*	0.1	−1.8
Japan	1.3*	−1.0	0.8	−0.2*	−0.7*	−3.2
Luxembourg	3.1	−0.2*	−3.7	−0.4*	−2.7*	−0.9
Netherlands	1.8*	1.2*	0.8	−0.3*	−0.0*	−1.0
New Zealand	0.1	−1.5*	−1.5	−0.4	0.3*	2.4
Norway	0.3	1.3	−1.6	−0.6	1.5*	1.8
Portugal	−3.1*	0.6	−1.1	−0.3*	−2.1*	−0.3
Spain	2.8	1.4	−1.5	−0.8*	−1.6*	−0.3
Sweden	1.2	−0.7*	−3.9	−0.0*	−0.5*	−1.9
Switzerland	3.0	1.5	−0.8	−0.5*	−0.2*	−2.8
United Kingdom	0.7	1.4	−2.8	−0.4*	−1.4*	−2.1
USA	0.5	1.8	−1.0	−0.9*	−0.8*	−0.4

Both the unconditional prediction and the prediction conditional on actual data for 1985–1990 are tabulated for the 5-year mean of the saving rate and the real GDP growth rate. Predictions are calculated from the non-linear system least squares estimates with fixed effects.
* Marks predictions with the same sign as the actual value.

data. Saving rates are calculated on data measured in current prices, while the growth rate is computed from fixed price measures. This may differ considerably from data measured in purchasing power parities measured against a US base as done in the Penn World Table.

The message from Table 4, keeping the caveat above in mind, is that growth predictions generally tend to get the direction of change right, while the predictions for the saving rate tend to overstate it. A conjecture is that the dynamic bias by underestimating the impact of the lagged saving rate is at least in part the reason for this. Note that the predictions are forecasts 5 years ahead of mean saving rates and growth. At this horizon ordinary macroeconomic models as well as pure time series models are totally unreliable.

As an explanatory model to determine effects of policy changes, the model is deficient. Neither the life cycle mechanism for the effects of age groups on saving, nor the human capital mechanism that motivated the growth equation, are unique explanations for the results. Many other mechanisms involving asset prices, inflation etc., are possible, and in view of micro evidence, perhaps even more likely.

For example, real wealth, often in the form of housing with a net debt, dominates in prime age cohorts, while in the middle-aged cohorts debt is amortized and real wealth assets are increasingly transferred into financial assets with a considerably higher liquidity. The relative prices of financial and real assets tend to vary with the proportions of the relevant age groups. Bakshi & Chen (1994) show that asset prices correlate quite well with the average age in the US population back to the beginning of the century.

A correctly specified aggregate saving model would have to take asset prices into account. This provides another age group mechanism consistent with the conjecture by Bosworth et al. (1991) that sharply rising house prices may have depressed saving in the 1980s. One could go even further and assert that the whole relative price structure of the economy is sensitive to the age group distribution since the different needs and means in different phases of life will shift demand for the whole range of goods and services with the age composition of the population.

Summary and conclusions

The age distribution of the population has pervasive effects on the economy. This has been illustrated here in the case of saving and growth in the OECD. The results indicate that age effects on saving do not primarily arise through a direct life cycle mechanism but that changes are cumulative, and reinforced with a delay by growth mechanisms.

To determine likely effects of policy changes, age structure must be taken into account unless good intentions are to be stymied like they were in the 1980s:

> Second, the largest part of the decline [in the private saving rate] occurred, ironically, after the government made an increase in saving a major objective of economic policy and redesigned the tax system to in-

crease effective after-tax rates of return and promote saving. (Bosworth et al. 1991: 183)

A consideration of the US age structure effects at the end of the 1970s might well have indicated that the combined baby boom effects were more likely to increase consumption than saving as taxes were lowered, thus fueling inflation. Baby boomers in prime age had relatively low incomes, low growth prospects to judge from immediate history and experienced sharply increasing housing costs. A policy to increase saving in that situation might have done better by giving incentives for firms to reinvest profits than by relying on household incentives. Today such saving incentives on the other hand may well lead to overshooting by creating too much saving. The long-lasting boom on American and European stock markets may be an indication of that.

Age effects cannot be reduced to partial and isolated effects. We need to consider the repercussions economy-wide in order to avoid costly mistakes. Due to the interaction between different mechanisms, which sometimes can be dampening and sometimes reinforcing, this may be actually hard to do. In view of the welfare losses that can arise if policy measures are miscalculated, research on this ought to have a high priority.

Of immediate value to policy makers is the robustness of the correlation between age structure and growth that has been demonstrated here. This robustness points to a simple and theoretically appealing way to improve medium-term growth forecasts by using demographic projections as forecasting variables. The model here may be insufficiently elaborated for that purpose, but the growth part of the model shows some promise.

Acknowledgements

Research funding from the Bank of Sweden Tercentenary Foundation is gratefully acknowledged. I am indebted to Bo Malmberg, for demographic information and useful comments, and to Daniel Ogden for professional help with the language.

Notes

1. See for example Deaton (1992), Bosworth (1993) or Muellbauer (1994). Other researchers are more positive, e.g., Leff (1969), Fry & Mason (1982), Mason (1987), Horioka (1991), Kelley & Schmidt (1996), Higgins & Williamson (1997) and Higgins (1998).
2. Empirical evidence for such a relation between age structure and growth can be found in, e.g., Malmberg (1994), Lindh & Malmberg (1999), McMillan & Baesel (1990), Lenehan (1996), Williamson (1997), Andersson (1998), and Bloom & Williamson (1997).

3. Evidence can be found in Fair & Dominguez (1991), Brander & Dowrick (1994), Kenny (1991), McMillan & Baesel (1988, 1990), Poterba (1991), Lindh & Malmberg (1998), just to mention a few articles.
4. Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany (FRG), Greece, Iceland, Ireland, Italy, Japan, Luxembourg, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom, and the United States.
5. The specification in terms of logarithms can be derived from a transitional growth Solow model, see e.g., Mankiw et al. (1992).

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