Swedish post-war economic development

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The role of age structure

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September 4, 2000

Abstract

There are strong life cycle patterns in practically all kinds of human behavior as well as in the resources and capabilities of individuals. Variations in the age structure of the population therefore affect all aspects of the aggregate economy, not only saving as is generally recognized. Swedish post-war development exhibit patterns of age structure effects on saving, growth, investment, current account, budget balance and inflation that are consistent with the dynamics of these variables in historic cycles, only these effects apply to much longer periods. The deviations of actual time series from the model predictions are consistent with the institutional detail of economic policy and its fluctuating directions over the post-war period. The poor performance of the Swedish economy during the period 1975-1995 can partly be explained by inappropriate policies working against the underlying age structure changes. The rapid expansion of non-working elders in the population in the 1980s was simultaneous with the depletion of the more experienced part of the older work force. This would according to our estimates put strong downward pressure on the budget balance and the current account. Swedish economic policy aimed at current account balance, mainly by a series of devaluations in the early 1980s did succeed in improving the current account. The cost of this was a serious overheating of the economy in the end of the 1980s since fundamental behavior and resources in the population did not back this policy. The attempts to nevertheless fix the exchange rate at an unrealistically high level (the price of a dollar in 1992 was close to half of today’s rate) led into a serious crisis and depression in the beginning of the 1990s. Our conclusion is that it is a serious mistake for macroeconomic modeling to ignore the general equilibrium effects of changing age distributions.
1. Introduction and background

The macroeconomic effect of cohort-size variation in the population is a matter that has been increasingly recognized in recent literature. Empirical evidence is accumulating that the size of age groups in the population has pervasive effects throughout the economy. The variables that have been shown to correlate with age structure range from GDP growth\(^1\), saving\(^2\), investment\(^3\), consumption of durable goods\(^4\) to inflation\(^5\), financial asset prices\(^6\), interest rates\(^7\) and unemployment\(^8\). In view of life cycle theories of saving, human capital accumulation and the huge literature on overlapping-generations (OLG) models\(^9\) it is not unexpected to find such effects although the magnitude is often surprisingly large. Most of the empirical literature treats these demographic effects as an isolated influence on a particular variable, and it is more seldom recognized that cohort-sizes will have a decisive impact on the whole macroeconomic equilibrium.

The great variety of different age effects must necessarily interact in the equilibration of the economy. That should affect the evolution of the business cycle\(^10\) as well as longer quasi cycles—the Juglar, Kuznets and Kondratieff cycles. The new evidence that growth is highly affected by age structure also settles the old battle between population pessimists and population optimists. Whether it is good or bad for the economy when the population grows depends on which part it is that grows. When the active population grows it is generally good news, when the dependent population grows it is bad news.

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2 Leff (1969) is an early empirical study that has been followed by a host of studies too numerous to list here. Some important studies are Fry & Mason (1982) and Mason (1987) who showed that controlling for growth rates stabilized the relation. Recent studies by for example Kelley & Schmidt (1996) and Horioka (1991) have used modern time series techniques confirming robust relations between the dependency rates and savings.
3 Separate age effects on investment are much less investigated. Higgins & Williamson (1997), Higgins (1998) and Lindh & Malmberg (1999b) study these and the implied effects on the current account. The latter effect is also the theme in Herbertsson & Zoega (1999).
4 Fair & Dominguez (1991) who also study the relation to labor participation, money demand etc.
8 Shimer (1998) finds that the main parts of the variation in U.S: unemployment rates is due to shifts in age structure.
10 Alvin Hansen (1939) in his presidential address to the American Economic Association even defined it as the most urgent task for economists to improve upon our understanding of the interaction between demographics and economics in order to understand the business cycle.
Our starting point takes the different age effects on the economy as granted. Given this we form an overall picture of the connections between reduced-form estimates of age structure effects on saving, growth, investment, the current account and inflation in the Swedish post-war economy. Cohort-size variations emanating from baby booms and baby busts in the past are responsible for most of the medium-run trends in these macroeconomic variables. This systematic, more or less cyclical pattern resemble the reference cycle patterns that economic historians like Schön (2000) have found to be a stable dynamic feature in Sweden over the last 200 years. This means that much of both the long-run variation and the medium-run variation in macroeconomic trends, i.e. the so-called “long waves” in economic development, are explained in a statistical sense by age structure variations which to a large extent are predetermined from fertility variations several decades ago. It may also explain some of the instability in business cycle patterns, i.e. why we sometimes observe stagflation: recessions where inflation accelerates and at other times we observe recessions associated with deflation or at least retarded inflation.

It is well worth emphasizing that our results does not mean that demographics determine the evolution of the economy as an exogenous factor. In the very long run demographics are, of course, endogenously determined within the economic system. But demographics define a largely predetermined variation in economic fundamentals that must be taken into account in order to explain economic development. This line of thought has a long and distinguished history in economics. Our theoretical understanding of how all these different age effects interact in detail is, however, still in its infancy. Although OLG models are capable of describing such mechanisms, the behavior of realistic OLG models with unstable population age distributions becomes very complex and to identify structural parameters empirically seems beyond reach at present.

Our approach offers a shortcut that works well with Swedish data over more than half a century. It provides a coherent explanation of puzzling phenomena such as the productivity slowdown in the 1970’s and the stagflation associated with it as well as other more or less cyclical changes in the Swedish economy. Although many details need to be filled in the age share approach offers even at the current stage a better prospect for making medium-term forecasts than existing macroeconomic models (Lindh 1999b). This is due to the simple fact that age structure can be projected for several years ahead with much less uncertainty than other explanatory variables.

In the next section the Swedish data are described and put into context. The estimation methods are discussed in Section 3 where we also present the results. In Section 4 the interpretation

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11 See Perlman (1975) for an historical overview of this literature stretching from well before the works of Malthus and Smith through economists like Wicksell, Keynes and Myrdal up to the population debates of the 1970s.
of the patterns found are related to Swedish economic development in the post-war period. Section 5 summarizes and discusses the implications.

2. Swedish Post-War Empirics

This section presents the background and evolution of the Swedish age distribution and shortly discuss post-war macroeconomic development in Sweden.

Swedish demographic history

In the beginning of the 20th century Sweden had an age distribution typical for a developing country with very large child cohorts and each older cohort smaller and smaller. It was the kind of age distribution that arises early in the demographic transition and takes the form of a broad-based triangle in the traditional sex-age diagrams. Sweden was a pioneer in population statistics. By law the priests of the state church were required in 1686 to register deaths, births, marriages and migration in the population of each parish. Since there was no religious freedom in Sweden at that time the registers came to cover the whole Swedish population. In 1749 the parish priests were required to send an annual report to the central authorities. These were summarized in statistical tables. Although not completely reliable Swedish population statistics have been and still are of the highest international standard.

In Figure 1 these data from 1749-1999 illustrate the Swedish demographic transition from a high mortality-high fertility state to a low mortality-low fertility state. We see how mortality started to fall in the beginning of the 19th century or even earlier although the mortality rates at that time are so volatile that it can be hard to distinguish the downward trend. The same holds for birth rates although the downward trend in birth rates starts considerably later around the middle of the 19th century. The gap between death rates and birth rates that opened up remains fairly constant up to the beginning of the 20th century. During the latter half of the 19th century the two rates decrease in parallel. It is only when the fall in birth rates accelerates during the first two decades of the 20th century and the death rates start to level out that the two rates close the gap again. Indeed, for the first time since 1809 and the Napoleonic wars we could in 1999 observe death rates that are higher than the birth rates.

The result was a fairly high rate of population growth in Sweden during the 19th century, mainly in the young part of the population since the decline in mortality was concentrated

\[^{12}\text{Cohort fertility rates dropped drastically for women born around the turn of the century from an average of around 4 children per woman to around 2 at which level it still stands for the women born in the 1950s for which we have a complete observation of the fertile period.}\]
to infant mortality. Compared to the rate of population growth in developing countries today this growth rate was very moderate, hardly reaching one percent annual population growth on average. It would have been considerably higher were it not for the very substantial emigration starting in the 1870s and continuing at a receding rate up to around 1930. From 1850-1930 there was a net migration out of the country of more than one million people, most of it taking place between 1870 and 1910 and very concentrated to age groups below 30 years of age moving to North America. To appreciate the enormous size of this migration we should note that the population of Sweden in 1870 was slightly less than 4 million and slightly less than 5.5 million in 1910. Immigration during this period was almost exclusively re-migrating Swedes. There were of course minor variations in this trend and especially regional variation in the timing of the demographic transition and migration flows, see Malmberg & Sommestad (2000).

After World War II the migration tide turned and in the post-war period Sweden has experienced net migration into the country. Up to the mid 1970s it was mainly labor migration but after that refugees came to dominate the immigration. Today around 10 percent of a population slightly below 9 million have been born abroad.

One important feature of Figure 1 that should be noted is that volatility decreases to practically nothing in the death rates as health care services are built up and the modern welfare state takes form. The volatility in birth rates remains high although the frequency of the variation drifts from high annual variation to more cyclical, decadal variation. Most other industrialized countries have experienced a more continuous downward trend in fertility.

The result of this is seen in the post-war development of age group shares in Figure 2. The baby boom in the 1940s raised children’s (0-14) share during the 1950s, then swells the ranks of young adults (15-29) in the 1960s. Then the mature adults share (30-49) starts to rise after a historic minimum in the 1970s as the cohorts from the 1940s grow older. Finally we see the forties’ generation increasing the share of middle aged (50-64) from a minimum in 1990, coinciding with the peak of the most recent baby boom starting in the second half of the 1980s. The numbers of young and old retirees rise in parallel up to the mid 1980s when the baby bust from the 1930s enter retirement and the share of young retirees (65-74) starts to diminish until it becomes smaller than the steadily rising share of old retirees (75+).

**Swedish post-war development**

In Figure 3 it is clear to the naked eye that the first quarter century after the war was an economically much more prosperous period than the latter part of the period. In the first panel the CPI inflation rate shows a rising trend up to the early 80s. In the second panel the real GDP
growth rate shows a corresponding downward trend. The third panel shows how gross investment rates and national saving rates first rise and then fall with the difference between savings and investment constituting the current account. Finally in the fourth panel the sound public finances up to the mid 1970s is reflected in the financial saving of the consolidated government sector.

The Swedish economy had a fairly regular development in the first quarter century after World War II. With the exception of the Korea War inflation in 1951 that partly continued into 1952 annual inflation rates were moderate (median inflation 1946-1969 was around 3 percent) and the real annual GDP growth rates were on average 4.4 percent 1946-1969. The more recent part of the post-war period the Swedish economy has performed considerably worse. Median inflation 1970-85 was 8.4 percent and in 1970-98 it was close to 7 percent notwithstanding that the 1990s inflation has turned downwards and 1998 even was a deflation year. The mean growth rate 1970-98 is a mere 1.9 percent.

The current account was more or less balanced up to 1970 when saving and investment rates rose in unison to a peak around 26 percent in the mid 1960s. As inflation started to rise the government implemented a credit squeeze that caused a surplus in the beginning of the 1970s which, however, turned into a deficit as growth rates receded and inflation surged in the aftermath of the Bretton-Woods collapse and oil price hikes in 1973. Saving and investment rates followed a downward trend after that, saving rates decreasing a little faster than investment rates.

It was only in the mid 1980s that balance was achieved again after several decisions to devaluate the krona, the latest and largest devaluation took place in 1982 and cut the exchange rate by 25 percent. Soon, however, the economy started to overheat and finally collapsed in November 1992 as the Central Bank in vain tried to defend an unrealistically high exchange rate. A tax reform in 1991 had reduced the value of interest rate tax deductions to half for a large part of the population and gave rise to a real estate crisis with house prices going down on average by around 25 percent. This in turn boosted loan-to-value ratios and made the financial markets shake. The state had to intervene in order to avoid a bank crisis. Saving and investment rates reached their lowest level since the war around 15 percent and unemployment skyrocketed from around 2 percent to over 10 percent. Savings recovered fastest—mainly by reductions of the government deficits—and in the last years of the 1990s the economy has run a large surplus on the current account.

Up to around 1980 changes in the budget deficit lagged changes in the national saving rate by one or two years. After this we see, however, that the changes in the budget deficit become contemporary with national savings and the variation increases vastly. In fact it is hard to avoid the
impression that it is the budget deficit that drives the changes in national savings during this latter period.

3. **Age effects on the economy**

The age distribution of the population is by no means stable but changes radically as cohorts of different sizes are aging and move through the age structure. This should reflect in the macroeconomic development of the economy since economic behavior and resources of individuals vary in a fairly regular way over the life cycle. Macroeconomic effects arise in two ways. First we have a direct, pure summation effect. For instance an increase in the number of young adults with a high migration propensity translates directly into a higher number of migrations ceteris paribus. However, market adjustments and interaction with other behavioral changes as the age structure changes means that the observed outcome of a shift in the age distribution also will have indirect macroeconomic effects that may either reinforce or dampen and even reverse the direct effect. It is for example conceivable that an increase of young adults in the population also increases political instability and in some countries shift demand towards imported goods, thus depressing the economy and migration. On the other hand it is also conceivable that the increased housing demand associated with increasing numbers of young adults on the contrary stimulates the economy and further increases the number of migrations through urbanization and structural adjustment. The exact balance will in general depend in complex ways on economic policy, institutions and other factors.

The analysis of *simple* direct age effects is different from the analysis of *compounded* indirect age effects. The former can be calculated from invariant age-specific behavior at the micro level given, of course, that such invariants can be found. The latter are harder to analyze since they involve macroeconomic equilibrium shifts. However, by using simple regression analysis of macroeconomic variables’ dependence on age structure we can estimate the total effects of age structure changes and—to the extent that these correlations remain stable—use them to predict macroeconomic responses to foreseeable changes in the age distribution.

**Estimation methods**

We estimate single-equation parameters by regressing the dependent variables on population age shares. Although these parameters cannot be structurally interpreted we get estimates of the total impact on the economy. One of the difficulties with regression analysis in this context is that age shares in the population change relatively slowly so to achieve sufficient
variation we need fairly long time series to get reliable results. But once we have such data, the correlation between age structure and macroeconomic variables exhibits a high degree of stability.

Regression models with age variables differ in the way the age effects are specified. The basic problem is that not all one-year or even five-year age groups can be included in the regression since multicollinearity would prevent identification of individual coefficients. Often, age effects are, therefore, represented by a single aggregate measure—for example population mean age, old age dependency rate, youth dependency rate or total dependency rate (old age plus youth dependency rate). A weakness with this approach is that only a small part of the total age structure variation that might be relevant is used in the estimation of age effects. In particular, some important variations in economic behavior and economic resources that occur during the course of an agent’s normal working life are ignored.

Another approach, pioneered by Fair and Dominguez (1991), is to use a polynomial restriction. The age profile of the demographic effects is then restricted to a low-order polynomial. This is also the approach of Higgins (1998). But data may well reject the polynomial restriction. Especially the rather abrupt change in behavior that takes place at retirement is hard to fit in with this restriction.

A third way—which we use—is to include population shares for a set of aggregated age groups that capture the most important phases of an individual’s economic life cycle. In comparison to the single-measure approach this age share approach allows a fuller representation of the age structure. It also offers a more direct and flexible way of estimating age effects than the polynomial approach. Although we prefer this approach it should be noted that it is a compromise that may be sensitive to collinearity and the exact delimitations. We have found a subdivision into six age groups useful\(^\text{13}\): children 0-14 years old, young adults 15-29 years old, mature adults 30-49 years old, middle aged 50-64, young retirees 65-74 and old retirees above 75 years of age. This general division can be motivated on theoretical grounds. Children, first, do not take economic decisions themselves and are dependent on other adults. Young adults often live single or are still living with parents. In OECD countries they are also to a high extent still in education and have quite distinct consumption habits.\(^\text{14}\) Mature adults are raising families, buying homes and starting in earnest to accumulate wealth. The middle-aged people are generally past their family years, have high incomes and are more immediately concerned with their retirement prospects. Young retirees

\(^{13}\) The best choices for the set of aggregated age groups may be somewhat different for different variables, but to make comparisons easier we have used the same set for all variables.
are no longer working although still rather active and healthy and have started to dissave, at least in terms of their pension claims. The oldest have considerably more health problems, much higher mortality and are more concerned with bequests.

To use the population shares as regressors in an equation with intercept we would have to drop one group due to perfect collinearity. Here we have chosen to nevertheless use all groups and instead drop the intercept. It is easier to directly see the whole life cycle pattern in the coefficients that way. The reader should note that the interpretation of the coefficient signs is somewhat ambiguous since the linear combination of age group shares cannot be separately identified from any constant that should have been present. One therefore has to keep in mind that a negative coefficient must be interpreted relative to the other coefficients. That would, however, hold even if an intercept were included.\textsuperscript{15}

In the growth regression literature it is common to use variables in the form of averages over 5 years or 10 years. This is often motivated as a way to reduce the amount of business cycle noise. In a time series for the post-war period this is non-feasible so we use annual data. But we also would like to point out that the effects that arise through the comparatively slow movement of the age distribution are persistent. There is a serious risk for time aggregation bias and it is by no means clear that using five-year averages really eliminates business cycle noise.

In this paper our focus is, however, not on the econometric specification of the age models. We, therefore, only present simple OLS estimates where age group shares are used as regressors. Thus we run a risk of omitted variable bias and for forecasting purposes more reliable models need to take regime shifts and dynamic behavior in the short run into account. However, the form of the patterns we present below are fairly robust even if the magnitudes of coefficients may vary a bit. We refer to our previous work for more extensive sensitivity analyses and specification tests.

The data we use are mostly National Accounts data from Statistics Sweden, which we have extended a few years back by using historical statistics from a diversity of sources. The current account series is obtained from the Central Bank of Sweden. National saving rates are computed by subtracting the current account from the gross investment series. Details on data and sources can be found in the appendix. Demographic data are also from Statistics Sweden. The source data refer to

\textsuperscript{14}The implicit assumption we make when using broad age shares is that the mean effect from the group remains stationary over time. For young adults this could be questionable since participation rates in the labor force has dropped rapidly during the post-war period, due to increased secondary and higher education enrollment.

\textsuperscript{15}The only way to resolve this ambiguity is by adding a restriction, for example that age coefficients should sum to zero, but this is rather ad hoc. It imp lies that a uniform age distribution is the benchmark case with no effect. Since a uniform age distribution is virtually impossible to achieve this is a rather strange choice.
the population at 31 December in the current year, so we have lagged these data to ensure that the independent variables really are predetermined relative to the dependent variables.

The results are collected into Table 1 below. The absolute $t$-statistics in parentheses indicate that not all coefficients are significantly different from zero but the patterns are in most cases well determined. Note that the coefficients for age groups in the current account case only are reported for completeness since that information already is contained in the savings and investment regressions and we can get the current account coefficients by subtraction of the investment coefficients from the savings coefficients. Below we will discuss each regression separately starting with saving.

Table 1. Regression coefficients, Swedish macroeconomic variables 1946-1998. Absolute values of $t$-statistics are reported in parentheses below the coefficients. For government financial saving our data cover 1950-98.

<table>
<thead>
<tr>
<th>Dep variable</th>
<th>Saving rate</th>
<th>Investment rate</th>
<th>Current acc/GDP</th>
<th>Gov. fin. saving/GDP</th>
<th>GDP growth rate</th>
<th>Inflation rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Share 0-14</td>
<td>-1.10</td>
<td>-1.55</td>
<td>0.45</td>
<td>-1.56</td>
<td>-1.17</td>
<td>0.67</td>
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<td></td>
<td>(2.17)</td>
<td>(3.67)</td>
<td>(1.26)</td>
<td>(1.78)</td>
<td>(2.58)</td>
<td>(1.04)</td>
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<tr>
<td>Share 15-29</td>
<td>-0.08</td>
<td>-0.05</td>
<td>-0.03</td>
<td>0.71</td>
<td>0.37</td>
<td>-0.14</td>
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<td></td>
<td>(0.31)</td>
<td>(0.22)</td>
<td>(0.18)</td>
<td>(1.29)</td>
<td>(1.69)</td>
<td>(0.44)</td>
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<tr>
<td>Share 30-49</td>
<td>0.53</td>
<td>0.82</td>
<td>-0.29</td>
<td>0.38</td>
<td>0.64</td>
<td>-0.37</td>
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<td></td>
<td>(1.96)</td>
<td>(3.62)</td>
<td>(1.51)</td>
<td>(0.80)</td>
<td>(2.60)</td>
<td>(1.06)</td>
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<tr>
<td>Share 50-64</td>
<td>2.30</td>
<td>1.99</td>
<td>0.32</td>
<td>1.61</td>
<td>0.97</td>
<td>-1.30</td>
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<tr>
<td></td>
<td>(5.09)</td>
<td>(5.26)</td>
<td>(0.99)</td>
<td>(2.05)</td>
<td>(2.38)</td>
<td>(2.23)</td>
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<tr>
<td>Share 65-74</td>
<td>-0.11</td>
<td>1.58</td>
<td>-1.68</td>
<td>-1.33</td>
<td>-1.14</td>
<td>4.42</td>
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<tr>
<td></td>
<td>(0.18)</td>
<td>(3.19)</td>
<td>(4.03)</td>
<td>(1.23)</td>
<td>(2.14)</td>
<td>(5.79)</td>
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<tr>
<td>Share 75+</td>
<td>-1.39</td>
<td>-2.80</td>
<td>1.41</td>
<td>-1.57</td>
<td>-0.87</td>
<td>-2.01</td>
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<tr>
<td></td>
<td>(2.45)</td>
<td>(5.91)</td>
<td>(3.53)</td>
<td>(1.64)</td>
<td>(1.71)</td>
<td>(2.76)</td>
</tr>
<tr>
<td>Adj $R^2$</td>
<td>0.60</td>
<td>0.69</td>
<td>0.28</td>
<td>0.38</td>
<td>0.42</td>
<td>0.46</td>
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</table>

Age effects on saving

The productive capacity of humans vary more strongly over age than their consumption needs leading to the life cycle hypothesis of consumption smoothing over the life cycle through saving in the most productive phase of the life cycle and borrowing and depletion of wealth in the less productive phases, (Modigliani & Brumberg, 1954). Theory thus predicts that
young and old age are periods of deficit while the latter period of working life is a period of surplus allowing for saving.\textsuperscript{16}

In Figure 4 smoothed curves connecting the estimated age coefficients show the age patterns in Swedish data. The hump-shaped saving pattern expected from the life cycle hypothesis does emerge. The population shares of children and retirees have a strong negative effect. The strongest positive effect comes from the group between 50-64 years old, but mature adults with families, i.e. the 30-49 years old also have positive effects on saving. However, this cannot constitute any direct evidence for the life cycle hypothesis. One obvious reason is that the national saving rate does not only comprise household savings. Retained profits as well as public budget balances are large and important components in national savings. Thus it is likely that only part of the explanation is due to life cycle saving by the households. Both revenue and expenses for the public sector are strongly affected by the age distribution as seen in the age coefficients for financial savings of the consolidated government sector. Investment behavior in firms will also be affected by the supply of labor at different ages and their often age-specific education.

Age effects on investment

In a study based on data for 100 countries Higgins (1998) shows that age effects on investment rates are different from those on the saving rates. Malmberg & Lindh (1999b) show that this holds also for the OECD countries, although the differences found in the OECD sample are not the same as in the world sample. The implication is by definition that there are age effects also on the current account since national saving rates are measured as investment less the current account. The Swedish age pattern in Figure 4 is similar to the general OECD pattern. The greatest difference to the savings pattern is found for the group 65-74 years old. This group has a neutral or negative effect on saving but a clearly positive effect on investment. Also note that mature adults have a stronger positive effect on investment than on saving.

When investment is decomposed it turns out that age effects are clearly different for different types of investment. As would be expected young adults have a strong positive effect on residential investment. This holds in Swedish data as well as in the OECD (Lindh & Malmberg 1999c). It is a natural consequence of the fact that household formation for the young is strongly—

\textsuperscript{16}Macroeconomists in general have, however, been rather skeptical to the importance of demographic factors for saving, e.g. Muellbauer (1994) and Bosworth et al. (1991). The main reason for this skepticism seems to be that household data show a fairly large degree of variability in age-specific saving rates leaving little room for simple direct effects to explain the large variation in national saving rates. Bosworth et al. (1991) show that age-specific saving rates in each age group follow the changes in the aggregate saving rates. Consequently it seems that the correlation between cohort
and in Sweden almost exclusively—concentrated to the age interval 15-29. Household formation in turn is a decisive factor in aggregate housing demand.

Business investment on the other hand has a much stronger association to the size of the cohorts between 50-64. One possible explanation for that is Griliches (1969) capital-skill complementarity hypothesis with strong empirical support, see e.g. Goldin & Katz (1998). Since skill to a large extent is experience an older labor force induces more investment. Another explanation may be derived from the supply side of capital. From household studies it is known that a shift in the portfolio composition takes place around 50 when the share of real wealth—mainly real estate—decreases as financial wealth becomes more dominant in the portfolio choice (Ekman 1996 and Andersson 2000b documents this for Sweden and Skinner 1989 for the U.S.) This increased supply of capital makes it easier for firms to finance investment through equity emissions. The higher wealth in the middle aged group is also known to be related to the fact that self-employment is considerably higher in these age groups than among the younger (Evans & Leighton 1989).

The current account

Our estimates implicate the age group 65-74 as the main troublemaker for the current account, see Figure 4. This group has a large positive effect on investment but not on saving. When this group becomes relatively large it therefore creates deficits in the current account. When the group 75 and above grows the current account improves, since investment (mainly housing investment) is negatively affected. Saving is less negatively affected as seen in Table 1. This may be due to the fact that in this group of the elderly health care services that are non-tradable become much more important thus strengthening the home bias in trade. The same basic pattern is found in OECD data (Lindh & Malmberg 1999b).

These results suggest that not even deficits in the current account with duration over decades need to be seen as a sign of economic and political decay. Just like individuals, families and households go through periods of surplus and deficits over the life cycle, the evolution of a varying age distribution causes similar variation for the economy of a country. At the individual and sizes and aggregate savings only to a small extent can be explained by the simple direct age effect from life cycle saving. Lindh & Malmberg (1999b) and Malmberg & Lindh (2000) discuss these issues in more detail.

\footnote{There is empirically a home equity bias that is connected to the Feldstein-Horioka puzzle. Obstfeld and Rogoff (2000) point out that a theoretical possibility to explain different types of home bias in international macroeconomics is to introduce transport costs. However, as they note this is equivalent to a home bias in preferences. When the population ages a shift in demand from tradeable goods to non-tradeable services takes place. This shift is liable to change not only the trade patterns but also the real exchange rates. Age structure effects on real exchange rates have been found by Andersson & Österholm (2000) on Swedish data.}
household level consumption is smoothed by temporal redistribution and there seems little cause for concern if countries should use international capital markets to achieve a similar temporal redistribution of resources by borrowing from abroad when need arises.

Age effects on the budget deficit

The pattern of age effects on the financial saving of the consolidated public sector, shows the expected pattern. Middle-aged high income earners pay more taxes than other groups and carry relatively small expenses for the public sector, hence there is a surplus when their population share is high. Children and retirees spell high public expenses but little revenue, hence there is a tendency towards deficit when their shares rise. In Figure 5 it is also very clear that most of the variation in the national saving rate around the age predicted curve actually is due to the deviations in the public sector saving in the latter half of the period from the age predicted public saving. The fact that the variation in public saving tends to become contemporary with the savings variation rather than lagging it strongly suggests that public saving drives the cycles in this period away from the age structure contingent equilibrium.

Age effects on growth

The growth pattern in Figure 4 is similar to that on investment and saving, at least in part probably due to the fact that some effects are mediated via the investment mechanism. But the form of the pattern still remain similar even if investment is controlled for and in fact looks much the same if GDP growth is replaced by TFP growth in manufacturing (Malmberg 1994). The general tendency is that growth increases with a high share of the population in working ages while higher dependency rates lead to lower growth. This pattern has been confirmed in numerous other studies, see footnote 1.

The correlation in Swedish data is therefore not surprising, but the strength of the correlation should be noted. Around half of the variation in post-war growth is explained in a statistical sense by the changes in the age distribution. It is mainly the changes in the growth trend that are picked up by the age variables. Most of the productivity slowdown taking place in the 1970s is for instance explained by the large cohorts from the 1910s retiring at the same time that the sparse cohorts from the 1930s dominated the mature adult part of the working age distribution.

Several theoretical explanations can be put forward to explain the correlation pattern, for example the increase in experience associated with an older work force, or the increase in the
supply of capital making investment relatively cheap. Other hypotheses are possible, like better work discipline and stability in the labor force when the density of older people is high. It is well known that the rate of self-employed is much higher in the older part of the work force, indicating that the supply of entrepreneurial skills should be higher. Government finances are in much better shape with an older work force, which pay more taxes and entail less expense for social security systems and education. Thus any negative allocative effects from taxation should be less with an older active population.

But there may be several other indirect mechanisms as well. Lindh & Malmberg (1999a) find that inclusion of controls for trade and inflation changes the age effects. This indicates that some of the growth effects may be associated with current account effects, changes in the composition of imports and exports and the inflation pressure in the economy. Indirect compounded effects may be especially important as explanation for the negative effects from the old population. Their demand is to an increasing extent directed towards services rather than goods. In particular the relative demand for health care services increases with the old population. Productivity growth in the service sector is in general much slower than in the goods sector (Baumol’s disease). In Swedish data this is so by definition in the National Accounts since the output from the public sector—which in Sweden comprises most health care and education services—is measured under the assumption of zero productivity growth.

Age effects on inflation

Many macroeconomic issues concern the short-run trade-off between inflation and unemployment. Inflation is strongly correlated with age structure. This is not unexpected theoretically since aggregate demand and supply effects from changes in the ratio of net savers to net borrowers should have such effects, see Lindh & Malmberg (1998).

In both Swedish and OECD data the young retirees appear as the group mainly responsible for increased inflationary pressures while the age group 30-49 years old is the main deflationary group, see Figure 4. Age effects on inflation is more or less a mirror image of the age effects on the current account. A deficit in the current account arises when domestic saving is insufficient to finance domestic investment. Total domestic demand (consumption and investment) is therefore necessarily greater than total domestic supply. Domestic prices therefore tend to rise. In a fixed exchange rate regime domestic inflation then spills directly into a current account deficit as foreign goods become relatively cheaper and substitute for domestic goods. At floating exchange 18

In Appendix 9 to the Swedish Long Term Survey 1999/2000 (LU 2000) the strong concentration of public expenses
rates this substitution is partly offset by a depreciation of the currency but this has the same effect on the current account since export income becomes less worth and imports more expensive.

Summary

There is plenty of empirical evidence that the age distribution of the population co-varies with a large number of macroeconomic variables both in terms of quantities and in terms of prices. Our results confirm this for a variety of central macroeconomic variables in Swedish post-war time series. Moreover, the different patterns are congruent with each other in the sense that for example the growth effects of the middle aged would be expected to reinforce the saving and investment effects as well as improve the budget deficit and dampen inflation.

The estimated age effects are likely to be the result from equilibrium interactions between several different mechanisms. However uncomfortable, we are led to the conclusion that simple partial models of the type represented by the life cycle hypothesis for saving are insufficient explanations for the age group correlation with macroeconomic development that we can observe.

A number of indirect mechanisms are probably interacting to generate this development and must be taken into consideration. For example, age structure will affect saving not only through direct household saving mechanisms but also through effects on inflation and growth rates. In some cases this will reinforce the life cycle pattern but in other cases it may dampen the simple direct effects. Also other variables depend on age structure like asset prices, mobility on labor markets, relative wages and housing markets and so forth and interact through more or less inert adjustment mechanisms with the above-mentioned variables.

In the next section we will discuss what our results mean for the interpretation of Sweden’s post-war economy and the general theoretical structure this will fit in with.

4. The importance of age structure for Swedish economic development

In Figure 5 is shown how much of the variation in saving, investment, growth, current account, government financial saving and inflation during the period 1960-1998 that is explained by our simple age regression models. Two observations from these graphs immediately stand out. One is that the age models pick up most of the medium-run variation in these macro variables. The second observation is that in the short run there are quite substantial deviations between actual outcomes and age predicted development.

to dependent age groups is documented.
Looking for example at the slowdown of growth that takes place during the 1970s variations in the Swedish fertility rate in the beginning of the century play a central role. The inflow of young adults into working age started to decrease at the same time that the outflow of middle aged into retirement was increasing. This had one positive effect in that it opened up the labor market for women whose participation rates increased at a high rate during the 1970s. In most other respects it was, however, a rather disadvantageous age structure that pushed inflation upwards and the current account and growth downwards. The following deterioration of government financial saving led into a budgetary crisis as public expenses expanded heavily and the economy was hit by further oil price hikes.

The Swedish age structure then remained rather disadvantageous up to the middle of the 1990s when a turning point is reached. At the turn of the century demographic conditions for growth are again as good as they were during the 1960s. The age influence on inflation is also strong. Around 1980 age structure has its peak inflationary pressure which turns into a deflationary pressure during the 1990s.

National savings has been affected by a long-run negative trend created by the age structure from the 1960s and onwards. In the middle of the 1990s this trend turns around. Investment shows a similar trend with the important difference that changes in the demographically induced investment trend lags the changes in demographically induced saving. This lag implies that demography from the beginning of the 1970s up to the beginning of the 1990s has a negative effect on the current account. When the age effect on saving turns to a positive trend a few years into the 1990s the effect on investment is still negative and generates a positive current account effect.

Behind these long-run shifts in the macroeconomy we discern the demographic shifts in the age distribution mainly in the age groups 0-14, 50-64, 65-74, and 75+. These age groups have strong effects on saving, investment, growth and inflation. Children have negative effects on saving, investment and growth. Middle aged have positive effects on the same variables while young retirees have negative saving and growth effects but a strong positive effect on inflation. The old retirees affect growth and investment negatively. A decline in the share of middle aged and the rise in the share of retirees up to recently therefore explain the decline of saving and growth in Sweden from the 1970s. During the period 1977-1985 when the share of children decreases the decline in growth and saving is dampened. The stagflation that hits Sweden during the 1970s and 1980s is strongly dependent on the age group 65-74 which increases strongly up to the 1990s when the increase is dampened and even turns to a decrease for the first time since World War I.
The downward trend in national savings in Sweden is strongly associated with the public budget balance. The disastrous budgetary situation in the beginning of the 1990s was not wholly the result of a temporary depression although that reinforced it. At that point the high saving groups between 50-64 were at a historic minimum coinciding with a maximum in the share of the population above 65. During the first years of the 1990s the children share was also increasing putting further downward pressure on the saving rate and the budget deficit.

During the 1990s the demographic pressure on the government budget has lightened up considerably. The fertility decrease has turned the trend for the children share. The share 65-74 has decreased by more than one percentage point and the share of middle aged increased by more than three percentage points. Together these changes in the age distribution imply an upward pressure on the saving rate.

But it is not only on the savings front that Sweden’s macroeconomic situation has improved in the 1990s. The turn in the inflation trend is also an important part of the recovery. The fast fall in the inflation rate was contingent on the relative decline in aggregate demand.

During 1985-93 the demographic growth conditions became worse mainly by the growth in the group of children and the continuing downward trend in the middle aged group. That resulted in a record low level of real resources for growth at the same time that a high level of dependants demanded more resources than ever before.19

In Figure 5 we have also marked the 1999 outcomes for the variables. These did not form part of the estimation sample. The point forecasts of the age model are not too bad, especially when compared to forecasts from authorities and banks in the beginning of 1999. But both inflation rates and government financial saving is substantially higher in 1999 than predicted by the age model. This is not too surprising since both variables have been targeted by economic policy. The Central Bank has an official target to keep inflation at 2 percent within a band of +/- 1 percent. This has actually been missed from below since 1996. The government aims at repaying government debt at a rather high rate so it is consistent that financial savings of the government sector should exceed the age predicted amount.

Other factors

From Figure 5 it is obvious that actual outcomes follow the age predicted development much more closely before 1980 than afterwards. There are clearly other factors at work in this period. The strong deviations we see from the age predicted development are by and
large consistent with the changes and shifts in the economic policy and the international economy occurring during the period. The overheated Swedish economy in the late 80s, a result of too expansive fiscal and monetary policy is clearly discernible in Figure 5.

Oil crises 1973 and 1979, devaluation of the currency 1979 and 1982 and the failed attempt to defend an unrealistically high exchange rate in 1992 all result in obvious deviations from the age predicted development. This is as it should be. An age model should not be able to predict that kind of events. But with hindsight it is also clear that the devaluation policies pursued in the end of the 1970s and the beginning of 1982 were actually working against the economic fundamentals. In this situation when dependency rates were rising temporarily a more stable policy choice might have been to accept moderate deficits in the current account which would likely have avoided the overheated economy in the end of the 1980s. This was to a large extent generated from the high profitability in export industries and the housing sector. The former because of the favorable terms of trade created by the devaluations and the latter because the resulting inflation caused by raised import prices and excessive nominal wage growth decreased user costs for housing. This artificially created a booming housing market that was further fueled by governmental interest subsidies to homeowners and deregulation of the credit markets. Mortgages were given for real estate purchases with loan-to-value ratios that sometimes could exceed 100 percent as mortgage underwriters relied on rapidly increasing prices to cover their risks.

Population fundamentals and cycles

Our statistical models indicate that most of the “long waves” in Swedish post-war development are fairly well explained statistically by variations in the age structure without resorting to nebulous concepts like Kondratieff, Kuznets or Juglar cycles, the post-industrial society, the new economy or anything like that. We do not, of course, deny that there have been important institutional, political and technological innovations that accompany this development. On the contrary these innovations tend to cluster around the transitions between three clearly discernible phases in the Swedish post-war development.

First, there is a growth phase following World War II with moderate inflation, external balance and sound public finances where rates of saving and investment rise and the economy seems to be in a positive feed-back loop. Demographically this phase is characterized by a steady aging of the working age groups that towards the end of the period starts to reverse as the baby boom of the 1940’s enter working age. Somewhere between 1965 and 1970 the economy

19 Not least should we note that there are time costs incurred by parents that constitute very substantial parts of GDP
enters a new phase of considerably lower growth, higher inflation and deteriorating external and internal balance and declining investment and saving rates. This continues up to the beginning of the 1990s when a new turning point is reached.

Although these phases can be discerned already in the somewhat noisy time series of actual outcomes they are much more obvious in the age predicted curves. Judging from our age models it is possible to point to episodes where political innovations have turned the economy away from the trends predicted by age structure but nevertheless the economy seems to return fairly quickly to the age predicted trends.

How can we explain this theoretically? The coefficients we estimate are consistent with several different and plausible mechanisms. However, there is little hope to identify which the mechanisms are from aggregate data. A complete macroeconomic model of the age related mechanisms we are investigating would require a great deal of specialized assumptions in order to be at all tractable. Testing such a model against data we would be at a loss when it comes to separating the importance of our specialized assumptions from the age structure hypotheses. It is, however, helpful nevertheless to clarify some issues by using the well-known neoclassical growth model of Solow (1956) and Swan (1956).

Let output \( Y = AK^\alpha L^{1-\alpha} \) be determined by a standard constant-returns-to-scale Cobb-Douglas technology, where \( A \) is a technology factor, \( K \) is the capital stock and \( L \) is the supply of efficient labor units, and \( \alpha \) is the capital share of output. The standard capital accumulation equation in a closed economy is

\[ K = sY - \delta K \]

where \( s \) is the national saving rate and \( \delta \) is the rate of capital depreciation. Obviously life cycle saving implies that \( s \) increases with the proportion of middle aged in the economy.

But this is not the only way age structure affects growth. The efficient labor supply depends directly on the number of persons in working ages, migration and participation rates, but in a closed economy we should disregard migration. Participation rates depend among other things on how much time that is devoted to childcare, on health status, etc. In Sweden hours worked decrease during family years then increase to a peak around 50 and then decreases again. Since participation rates are low among young adults the peak around 50 cause most of the demographic variation in average hours worked. But in efficient labor should also be included the quality of labor, as measured by education and experience. The latter is, of course, highest in the middle age group. The general trend is that younger people are more educated, but in Sweden it has also been shown that

(Klevmarken & Stafford 1999)
the average level of education is higher in the large cohorts from the 1940s than in the preceding and succeeding cohorts (Ohlsson 1986). The explanation is that the forties generation met a tougher labor market and also caused a rapid expansion of higher education.

A more speculative route for influence of the age structure could also be via \( A \) if we for instance hypothesize that the rate of technological change itself is dependent on the inflow of newly educated young people into the labor force. There is not much evidence for such a mechanism, however. The inflow of post-war baby boomers into the labor force took place in the 1960s and—in particular for the more educated of them—in the 1970s when productivity growth in the Western industrialized countries weakened considerably. If there is such an effect the delay must be quite long before we see it in productivity growth.

Usually growth models are formulated in terms of \( f(k) \), output per effective labor unit \( k=K/L \) and we then get the equation of motion

\[
k = sf(k) - (\delta + n)k,
\]

where \( n \) is the growth in labor. In the standard setup a constant rate of population growth, a stable population and constant rate of depreciation is presumed. The steady state capital intensity then under the Cobb-Douglas assumption becomes

\[
k^* = \left( \frac{sA}{\delta + n} \right)^{\frac{1}{1-\alpha}}.
\]

Given this theoretical framework variations in the saving rate and the effective labor supply will cause the steady-state parameters of this model to oscillate in a manner, which is broadly predictable by changes in the age structure. A population with a growing share of middle-aged people will have a higher saving rate increasing the steady-state value of capital intensity. An increasing rate of growth in efficient labor supply will cause a movement in the other direction. Since the steady-state value of output per labor unit is

\[
y^* = A\left( \frac{sA}{\delta + n} \right)^{\frac{u}{1-\alpha}},
\]

the effect of for instance an increase in middle-aged is not a priori given. However, on the transition path to steady-state the following relation holds approximately

\[
g = \lambda \left( \ln y^* - \ln y \right),
\]

where \( g \) is the growth rate of output per efficient labor unit and \( \lambda \) is the rate of convergence. This can be rewritten in terms of output growth \( G \) as

\[
G = n + \lambda \left( \ln y^* - \ln y \right).
\]
For empirically valid parameter values the net impact on output growth of an increase in efficient labor supply growth would be clearly positive.\textsuperscript{20}

The result of a higher share of middle-aged is then what we see in Swedish data, viz. growth rates are higher when the share of middle-aged is increasing and lower when it is decreasing. More children and more retirees will cause the opposite change. Note in Figure 5 that growth rates in the end of the 1940s, 1960s and the 1980s are negatively affected by the baby booms but it is the longer swing in the 50-64 share that is the more decisive influence. The transition path of the neoclassical model will respond to these exogenous changes in roughly the way we observe in the Swedish data for investment and saving and the corresponding growth rate.

In a growth model of the Cass-Koopmans type with endogenously determined saving the age structure influence must be modeled through aggregation of the individually chosen consumption paths and the impact this has on interest rates, or through age variation in intertemporal elasticities of substitution and rates of depreciation.\textsuperscript{21} In the simplest endogenous growth model—the AK model (Rebelo 1991)—with capital externalities generating constant returns in capital it is immediately obvious that age structure change would generate a shift in the growth path through the savings mechanism.

To explain the other three variables a more complex model incorporating money, a global economy and the government sector would be needed. We just sketch this without formal detail. A younger adult population will tend to decrease revenue and increase demand for durable consumption goods. Increases in the number of young retirees increase public expenses and decrease revenue at the same time. This results in deteriorating internal balance. Lower productivity growth and increased demand for consumer durables and thus consumption credit interacts to generate inflationary impulses and worsens terms of trade with the result that the current account deteriorates.

Theoretical OLG models are capable of generating similar patterns. Specifically for the Swedish experience Blomquist and Wijkander (1994) explores the implication of a shock like the Swedish Baby Boom in the 1940s for the economy in a simulation of a 3-generation OLG model for a closed economy. That OLG models with a varying age structure can lead to practically any results is, we believe, well known among economists, and—somewhat perversely—it has led to a wide-spread blind eye for the macroeconomic age effects under the pretext of tractability. The

\textsuperscript{20} The same would hold for output per worker if the increase was caused by increased efficiency in the existing labor force rather than an increase in the number of workers.
complexity has precluded clear-cut theoretical results and efforts have instead been invested in analyzing simpler partial models like the life-cycle theory for saving assuming that the age distribution only affects saving, but have no effects on productivity or affects human capital accumulation (see Murphy et al. 1988 and Macunovich 1998 for some evidence to the contrary).

Of course, in the very long run the inclusion of a mechanism that feeds back into fertility might well imply that the age structure also approaches a stable configuration, which reproduces the age shares as constants. However, the point is that this is a far cry from being the case today and moreover we cannot predict what form of stable age structure that might arise from a convergence.

The Swedish “age cycle”

In Figure 6 the age effects on macroeconomic variables have been collected into two graphs. The effects of a baby boom traversing the age distribution forms a well-known pattern which have been characteristic for both longer and shorter cycles in Sweden ever since the 19th century22. A bulge in the age distribution created by a baby boom thus first gives a negative effect on growth, saving and investment while there is a slightly positive effect on the current account and inflation. When the effect of these unaccounted investments in future labor peters out as they enter the young adult stage the economy gets a boost, at first mainly through a positive effect on residential investment. As the baby boomers mature and settle down the positive trend becomes stronger and when they reach middle age with the resulting boost to savings the current account gets a positive impulse again. But at retirement the cycle has reached its apex. Investment lags the downward growth and savings trend with the consequence that the current account rapidly deteriorates and inflation is boosted. When the bulge finally reach the high mortality age groups investment drops rapidly and the current account improves again as inflation subsides. Such a cycle thus have a period of 80-90 years from trough to trough.

The actually observed development is, however, the result of interaction between several such baby booms and busts in Sweden. This creates cyclical variation of this pattern also at higher frequencies, see further below. An initial growth impulse boosts investment and income starting off an accelerator mechanism further boosting growth and saving and investment. As the peak is reached investment lags behind but becomes depressed as productivity growth and saving

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21 Yaari (1965) shows how finite life will have drastic effects on the individual consumption choice in the absence of perfect annuity markets by adding mortality risk to the depreciation of future consumption. There are also arguments implying that evolutionary pressures should cause higher discount rates among young people (Rogers 1994).

22 We are very grateful to Lennart Schön for bringing this to our attention and recommend Schön (2000) for a comprehensive discussion. This is in Swedish but a brief account in English is available in Schön (1991).
rates decreases and inflation takes off. In classic business cycle descriptions the trough is associated with deflation. In the 1990s in Sweden this classic pattern was followed but not in the 1970s where we instead got a stagflation. The crisis in the 1970s coincided with rising shares of young retirees, when the middle-aged people, who had driven the rapid growth expansion in the 1960s, became older. The child share was still high due to a baby boom during the 1960s and the deflationary adults share was low. The result was a strong and persistent demographic inflation impulse. In the 1990s the preceding growth impulse was much weaker since the cohorts born in the 1930s were much smaller and it was mainly mature adults born in the 1940s that drove the weak growth trend. Young retirees were diminishing their share in the population and the children share was still fairly low in spite of the baby boom that peaked in 1990. But it is this baby boom that breaks the weak growth trend and interacts with the weak middle-aged cohorts so the inflation impulse as the cycle turns becomes very short and the classic deflationary pattern is restored.

A demographic interpretation of Swedish post-war economic history is not all that different from conventional accounts in regard to the mechanisms and is not really a competing explanation but rather a complementary view that deepens our understanding by pointing to underlying fundamental trends. The conventional explanation of the overheating of the economy in the end of the 1980s is attributed to lax fiscal and monetary policies due to the influence from too strong unions and a too big public sector. The age based explanation indicates that the problems were more a result of policies working against underlying demographic pressures. These policies in turn were surely dependent at least to some extent to strong pressure groups and inabilities among politicians to attain policy credibility. But an appreciation of the demographic situation would have made it possible to design policies working with instead of against the fundamentals in the Swedish economy, to surf the waves rather than plunging headfirst into them.

Imbalances in wage formation, which have constituted standard explanations for the devaluation policies as necessary to solve cost crises undoubtedly contributed to overheating in the 1980s but policy focused on exchange rate policies and deregulation as a solution. The underlying pressure from the age distribution on the current account made this a rather poor policy response even if it initially seemed successful.

Likewise it was not really a policy failure that the Swedish government had trouble balancing the budget at a point in time when our population had the largest share above 65 in the world. A growing baby boom contributed further to expenses while the number of high-income taxpayers in middle age were approaching a minimum. Public budget balances were boosted as the economy overheated, but this was not backed by productivity growth, but rather relied on an
investment expansion that was to a large part driven by speculation. The problem was partly recognized at the time but popular debate was very much focused on the need for the government to restore credibility for its monetary policies and as inflation started to surge upwards the government reverted to a fixed exchange rate regime. Budgetary balance was at the time not seen as a major problem. On the contrary parental insurance were built out in a way that contributed to boost the baby boom and worsen problems.  

Theoretical considerations

The cycle traced out by a fertility shock has a period of some 80-90 years before it peters out. This economic cycle is comparable to the Kondratieff cycle according to common estimates. Within this 70-90 year cycle some shorter cycles are often defined, the exact length often varies, but in Sweden economic development is often characterized as a number of technologically driven structural cycles around 40 years. These periods are characterized by major industrial innovations, often referred to as General Purpose Technologies. These periods in turn can be subdivided into an innovative phase of domestically oriented restructuring and another phase of export-oriented maturity. In Sweden the domestically oriented periods are characterized by decreasing labor shares of output, credit expansions, current account problems and inflationary pressure. The export-oriented phase show increasing labor shares, deflationary tendencies and current account surpluses. Economic historians point out the 1850s, the 1890s, the 1930s and the decade around 1970 as approximate turning points for this structural cycle. Thus we are now in the export-oriented maturity phase, which would be expected to end around 2010. The predictions of the age models agree quite well with this scenario. The retirement of the forties generation is expected to slow down growth, increase inflation and worsen the current account around this time, see Malmberg & Lindh (2000).

The interplay of baby booms sometimes attenuates the economic effects and sometimes reinforces them. The mechanism for such interaction can be easily illustrated by using truly cyclical trigonometric functions. Multiplying together several sine functions with the same amplitude and period but with a phase translation, we obtain a pattern like that in Figure 7. Although the age distribution is not quite cyclical it is indeed not difficult to imagine how interaction can create shorter cycles with the same general timing.

Now, the suspicious and intelligent reader, of course, realizes that any time series can be approximated by using Fourier series of trigonometric functions, so the time series for age

23 The reform made it very advantageous to bear two children in quick succession, for details see Hoem (1990)
groups work in a similar fashion. That is, of course, true. Are then these regressions spurious? Are we only picking up the intrinsic cyclical pattern by using quasi-cyclical series?

We find this a very remote possibility. The chance is very small that we by pure fluke get economically sensible age patterns for the six macro series here that are stable and consistent with results obtained previously in the literature, both in other countries and in cross-country panels. That we, moreover, also would be able to tie deviations from the model to actual economic policy shifts and international shocks makes us convinced that the correlation we find is indeed causal although it is likely to be indirect compounded effects working through several economic mechanisms. We cannot quantify this conviction through a formal statistical test. However, from a theoretical perspective the effects are entirely plausible and we have elsewhere subjected the results to a number of stringent econometric tests, like varying the age group set, controlling for a great number of other variables, checking to what extent outliers may drive the results, checking for functional form, unobserved variables and heterogeneity, etc.

Moreover, models for growth and inflation very similar to those reported here, with addition only of dummies for some indisputable outliers like the Korea inflation and lagged dependent variables to account for autocorrelation in the residuals perform very well in simulated forecasting experiments in the 1990s for Sweden (Lindh 1999b). If predictive performance is the main criterion by which to judge the relevance of models then age models must indeed be taken seriously. At this point we, therefore, leave it to others to disprove our conjecture that cohort-size variations drive most of the medium-term cyclicality in Swedish time series.

5. Conclusions

In this paper we have illustrated on Swedish post-war time series how changes in the age distribution affect macroeconomic variables like GDP growth, inflation rates, saving, investment, the current account and the budget deficit. The results are congruent with standard macroeconomic theory and indicate that much of the medium- and long-run trend movements have been caused by the recurring variations in the age distribution that are ultimately reflections of past baby booms and baby busts.

If cohort size has this impact on aggregate macroeconomic variables then consistent variation in the age distribution will explain not only long cyclical movements but also variation on shorter frequencies will be correlated with the age distribution of the population. Even business

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24 There is a major literature around this concept, see Helpman (1998)
25 A growth model for the United States built after the same principles also succeed in predicting the long boom in the U.S. economy from real-time data (Lindh and Malmberg 2000b).
cycle variation may to some extent be explained by the interaction of effects generated by the age
distribution. It follows that any attempt to understand business cycles as well as longer cycles under
an explicit or implicit assumption of a stable population will either fail or alternatively will be
seriously misleading.

In no way can the results be taken to imply that economic policy is impotent. Rather,
the obvious interpretation of our results is that policies working against the age pressure on for
example the current account in the economy are quite powerful at least for some years and can
cause considerable damage by increasing medium-term volatility.

That the complexity of interacting optimizing agents at different ages pose a
formidable obstacle to any clear-cut analytical conclusions is freely admitted. Thus there are good
reasons to try and simplify the analysis. However, if we want to explain the macroeconomics of real
economies and offer policy advice to real politicians the strategy to ignore age distribution
complications may be quite inferior to a strategy aimed at exploring whatever regularity there is to
be found in real data and exploit this as a stylized fact to simplify the macroeconomic models. The
strategy may lead to a loss of the ability to derive welfare implications and normative conclusions.
However, we gain in empirical relevance and the ability to actually predict where the economy is
going.

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Appendix: Data

This appendix describes sources and definitions of the data. GDP at factor costs in current prices 1860-1980 and a deflator are from Krantz (1997) were used to link to the GDP at market price from Statistics Sweden. Thus the years 1946-1949 are slightly different from the series 1950-1999. For the period 1941-1950 the sum of sector GDPs were used since the aggregate for that period is not accurate according to the author. These series were spliced to the latest update from Statistics Sweden by ratio linking in 1950. Real GDP is the deflated series. Due to changes in the National Account system the last years 1994-1999 refer to GDP at market prices according to the new ENS definition which is at a level about three percent higher than previous estimates, and have been ratio-linked to previous data. There was also a more minor change in definition in 1980, which also has been ratio-linked.

The consumer price index is spliced in 1980 by ratio linking using the latest update of annual CPI from Statistics Sweden and historical cost-of-living indices from Statistics Sweden that go back well beyond 1860. The basic age structure data are five-year cohort population numbers on annual basis. The series 1911 up to 1967 has been compiled from official statistics by Bo Malmberg. 1968 to 1998 are from the latest updates of Statistics Sweden. Projections 1999-2030 are an updated version of the 1997 forecasts of Statistics Sweden. Note that all these population data refer to 31 December in the current year, but in the estimations they have been lagged one year.

For the period 1950-1998 the latest update from the Central Bank of Sweden was obtained. The missing years 1946-1949 were filled in by data from Ohlsson (1969) table B:1 column 6 without linking. The overlap to the Central Bank data have somewhat larger differences but they are diminishing as we go back in time, so it seemed reasonable not to use any ratio link in 1950 either. Ohlsson (1969) compiles earlier data sources on the balance of payments up to 1966. in order to arrive at a measure more suited to compute savings from. The lacuna 1946-49 was closed by domestic investment in Krantz & Nilsson (1975). The latest updates from Statistics Sweden (April 1999) were then ratio-linked in 1950 to this series. Note that due to definitional changes these data are spliced by ratio-linking in 1980, too.

The national saving rate was then obtained by adding the current account to gross investment. Strictly speaking we should have added in net factor income, too, but that is very small numbers. All ratios were computed by using current value estimates. This means that the investment rate is not the real investment rate in terms of goods, but a value estimate consistent with the saving
rate and current account, since there is no obviously correct way to deflate these values. Growth rates and inflation have been computed by the logarithmic difference of the level variables.

The series of financial saving of the consolidated public sector was graciously put at our disposal by Lennart Berg who has linked data from Statistics Sweden 1950-1998. It includes the balances of local as well as central government at all levels and the social insurance sector.
Figure 1. Swedish birth and death rates 1749-1999. Source Statistics Sweden.

- 1773: Famine
- Napoleonic wars
- Start of the emigration
- 1918: Spanish flu
- 1945: Peak of the 1940s baby boom

Graph showing birth and death rates per 1000 inhabitants from 1749 to 1999.
Figure 2. Age shares in the post-war period

Percent shares of children and young adults

Percent shares of mature adults and middle aged

Percent shares of young and old retirees
Figure 3. Sweden, 1946-1998

- **Inflation rate, CPI**
  - 1945: 0%
  - 1955: 5%
  - 1965: 0%
  - 1975: 5%
  - 1985: 10%
  - 1995: 15%

- **GDP growth rate**
  - 1945: 0%
  - 1955: 5%
  - 1965: 10%
  - 1975: 5%
  - 1985: 0%
  - 1995: -5%

- **Saving, investment and current account**
  - National saving rate
  - Investment rate

- **Government financial saving**
  - 1945: 0%
  - 1955: 5%
  - 1965: 0%
  - 1975: -5%
  - 1985: -10%
  - 1995: -15%
Figure 4. Smoothed estimated age effects

- National saving rate
- Growth
- Investment
- Inflation
- Current account
- Budget deficit
Figure 5. Estimated age models and actual data, 1946-1998

- National saving rate
- GDP growth rate
- Investment rate
- Inflation rate, CPI
- Current account
- Government financial saving
Figure 6. Age cycle patterns

- Investment
- Saving
- Current account

- Growth
- Inflation
- Budget deficit
Figure 7. Curve generated by multiplying three phase delayed sine curves