Institute for FUTURES STUDIES

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Arbetsrapport/Institutet för Framtidsstudier; 2004:7
ISSN 1652-120X
ISBN 91-89655-56-7

Demographically based global income forecasts up to the year 2050*

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September 28, 2004

Abstract

Demographic projections of age structure provide the best information available on long-term future human resources and demand. In current data fairly robust correlations between age structure and GDP and GDP growth have been discovered. In this paper we use these two facts and study the forecasting properties of demographically based models. Extending the forecasts to 2050 suggests that due to fertility decreases poor countries of today will start to catch up with developed economies in which the growth process will stagnate due to the growth of the elderly population. That remains the case whether or not indications of positive longevity effects are taken into account.

Keywords: demographic projections, global income, long-term forecasts

*We are grateful for constructive comments from participants in "Symposium on Global Income Growth in the 21st Century" in Honolulu, Hawaii, January 9-10, 2003, and "Demographic Change and Global Income Growth in the 21st Century", in Krusenberg, Uppsala, January 7-9, 2004.

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1 Introduction

The question of how demographic change interacts with economic development has been discussed in the social sciences since before the 18th century and onwards. The mercantilist view was that a large population stimulates economic growth. In the 19th century Malthus' arguments had persuaded most economists that population growth, due to decreasing returns, leads to lower per capita income. During the 20th century, opinions were more mixed. Neo-malthusians still argued that population growth is harmful. Keynesians, on the other hand, could see population growth as a stimulus to investment demand and, thus, to income growth (Perlman 1975). A third neutralist view, gaining influence during the 1970s and 1980s, was that population growth rates are not an influential factor behind variations in per capita income growth.

During the last ten years, however, a certain convergence of views has emerged. The new consensus is that population age structure, and not population size, is what matters for the level of per capita income. In addition, more and more stress has been put on the fact that low mortality should not be seen only as an outcome of economic development. Increasing life expectancy also plays an important role in triggering economic growth.

At least three arguments underscore the importance of age structure for per capita income. One is the savings argument. In countries with high child-dependency rates, savings rates will be low and this may lead to low productivity. This argument was first put forward by Coale and Hoover (1958). Subsequent research has largely corroborated their argument.[1] Second, a high dependency rate implies a low worker per capita ratio and this should lead to a lower per capita income in a direct way by a pure accounting effect. Using human capital theory, Anne Krueger (1968) elaborated this argument. Janowitz (1973) and others have demonstrated the empirical relevance of Krueger's argument.[2] Third, as demonstrated by Lindh and Malmberg (1999) age structure within the working-age population is also of importance.

The argument for a life-expectancy effect on economic development has equally strong support. First, increasing life-expectancy is likely to increase savings by increasing the risk for survival into old age dependency. Second, higher life expectancy increases the expected return of education.[3]

[1] For a few examples see Leff 1969; Mason 1987; Mason 1988; Kelley and Schmidt 1996.

[2] Bloom and Freeman (1986), Brander and Dowrick (1994), Malmberg (1994), Bloom and Williamson (1997), Bloom and Sachs (1998), Bloom et al. (2000).

[3] De la Croix and Licandro (1999), Kalemli-Özcan et al. (2000), Zhang et al. (2001), Boucekkine et al. (2002), Kalemli-Özcan (2002), Boucekkine et al. (2003), Kalemli-Özcan

These arguments have important implications for long-term per capita income forecasting. Historically, such forecasts have been based primarily on assumptions about the rate of technological change. However, if—as suggested in this literature—there exists a stable statistical relation between on one hand, per capita income and, on the other hand, age structure and life expectancy, then it should be possible to use conventional population projections to forecast future trends in income growth.

An important question is the interpretation of such per capita income forecasts. Here, different views are possible. One interpretation is that the income forecast only clarifies that population projections contain implicit forecasts of future economic development. If increasing life expectancy historically has been associated with increasing per capita income, then a population projection that assumes rising life expectancy implicitly assumes a rising per capita income. The second possibility is that we believe that the assumptions made in the population forecasts are based on trends in fertility and mortality independent of income growth. In this case, the demographically based income forecasts become statements about the probable future trends in per capita income caused by such demographic trends. A third option following from a causal interpretation is to treat such income forecasts as policy models. Changes in fertility and mortality can often be influenced by explicit policies. The HIV/AIDS epidemic, for example, might be successfully contained by investing resources into health care and prevention. In this case, demographically based income forecasts are tools for evaluating the economic impact of population policies. Irrespective for which purpose demographically based income forecasts are used, however, we need knowledge about the stability of the forecasting model. The purpose of this paper is, therefore, primarily to explore whether demographically based models can deliver such stability and thus provide a valuable forecasting tool.

In the next section we first discuss some obvious problems, and explain our estimation strategy. In Section 3 we review our specification search and present out-of-sample tests. In Section 4 we discuss two alternative forecasts, one simple homogeneous approach and one allowing for heterogeneity in effects contingent on the current level of life expectancy. In Section 5 finally we conclude that our forecasts imply shifts in future economic power from currently developed economies to economies where fertility is now on its way down.

(2003), Zhang, Zhang et al. (2003).

2 Forecasting problems in focus

There are a number of problems to deal with in the basic specification of a robust regression equation of GDP on demographic variables. First, it must be noted that demographic projections, of course, are uncertain. To a first-order approximation this is a question of the assumptions made on fertility, migration and mortality in the demographic projections. Probabilistic demographic forecasts could be plugged into the model to deal with this issue in an explicit way (see e.g. Prskawetz et al. 2005 in this issue). Here we abstract from that problem, however.

In focus for this paper is the problem of model heterogeneity both across countries and over time. This is a common worry when working with cross-country panels (Ul Haque et al. 1999). Is it legitimate to assume a homogeneous model for such a variety of countries, different in size, location, history, institutions and natural resources? In some sense, every country is a unique economic system related to its neighbours by a multitude of different relations. There are countries like Singapore, which cannot really be modelled as a closed independent national economy. There are vast differences between a country like Sweden and a country like Zaïre which would seem to invalidate any comparison. In the extreme one might even consider individual models for every country. That would, however, not be an efficient use of the available information, not to mention that there are a substantial number of countries where our information is scant or of questionable quality.

Using a panel estimation approach confers substantial advantages. Not only do our number of observations increase substantially, but it also allows us to control for unobservables that are constant over the estimation period as well as common time-specific effects. The price to be paid for this is that we need to assume that a more or less general model applies to all countries in the sample. It is, however, neither inconceivable nor impossible to account for some country differences within the model.

Structural breaks in the data are in a sense the corresponding problem of heterogeneity in the model across time. Some events liable to cause structural breaks or model shifts may be worldwide influences like oil crises, that we can control for by time-specific effects, some of more regional importance as the opening of free markets within the EU are harder, some only affecting specific countries like the genocide in Rwanda may be controlled for by dummies. Others like the breakdown of the Bretton-Woods system are likely to have much more long-lasting regime changing effects, and still others may have important spin-off effects on neighbouring countries.

There are also some difficulties at the global scale that we wish to draw attention to. We start from the assumption that our cross-country observations are drawn from a data generating process that is at least partly common to all countries, viz. the demographic transition and the concurrent industrialization and aging of the population. However, our observations are drawn only from a limited period of this transition for each country. Some countries are just in the beginning of this process while others are entering a second transition into an ageing society. While the observations from more developed countries provide information to forecast (to some extent at least) the evolution of the less developed countries, our sample contains little information regarding the ageing society and how it will adapt to a rising dependency burden.

Finally, a standard problem of time series analysis should be mentioned. Regression of non-stationary series on each other can cause spurious regression. However, recent work demonstrates that this problem is substantially ameliorated in a panel context by the cross-section information (Phillips and Moon 1999). Österholm 2005 in this issue also demonstrates that GDP and age structure are likely to be cointegrated in an OECD sample. Moreover, our out-of-sample tests below indirectly probe also this issue, since a spurious regression cannot generate reasonable out-of-sample forecasts.

There is always a trade-off of drawbacks and advantages in different approaches to forecasting. Our target is to devise a forecasting model that only relies on variables which can be independently projected. First of all, this makes structural modelling less interesting since in the end we will have to rely on a reduced model anyhow. Second, degrees of freedom are limited in spite of using annual data on a world panel and overfitting can easily become a problem. This is so primarily because we are attempting to estimate low frequency long-run correlations, and thus in practice need very long period data. Moreover, adding to the problem, the demographic variables are rather collinear, limiting the number of variables for which regression coefficients can be identified. Third, since we are not interested in tracing all the ups and downs of GDP per capita in detail or finding a model that fits all countries, we have to accept that some country observations will deviate considerably from model predictions.

3 Specification of model

We start with a model for a panel regression in levels of the logarithm of per capita GDP, y, on the logarithms of age shares, a, and a trend function $h(t)$,

t being the time period:

$$y_{it} = h(t) + \sum_{k=0-14}^{65+} \beta_k a_{kit} + \eta_i + \varepsilon_{it} \qquad k = 0-14, 15-29, 30-49, 50-64, 65+ \tag{1}$$

Thus we assume for starters that GDP per capita can be described by a Cobb-Douglas index of age shares and an exponential trend function intended to capture technological change. This is essentially a standard production function specification although we use population shares as substitutes for production factor intensities. We allow for country-specific intercepts through η_i. The logarithmic form ameliorates problems with heteroskedasticity and also makes it possible to include the whole distribution of age shares in the fixed effect estimation.[4]

Based on previous work (Lindh and Malmberg, 1999) an aggregation of age groups to children 0-14, young adults 15-29, mature adults 30-49, middle aged 50-64, and old age 65+ is known to work well in growth equations for the OECD without running into collinearity problems. This corresponds roughly to the age intervals in which humans are first dependent on parents, second finding their place in adult life and forming a family, third raising their family, fourth preparing for retirement and fifth retiring. The limits for these functional groups are, of course, not exact. They vary both with time and culture, as well as the institutions that transmit and govern the economic effects of each age group. Nor do we expect effects to be uniform within the limits. This specification is thus a pragmatic approximation for estimating growth effects from the continuous age distribution. The age distribution in turn proxies for the actual functional changes over the life cycle which are the real causes for the income effects.

We use a sample of 111 countries with GDP data in the Penn data base (Heston et al. 2002) at least 1961-1996 and in some cases for the full period 1950-1998. Demographic variables are from UN World Population Prospects (2000). More details are in the appendices.

Plotting the log of GDP per capita for all the time series in Figure 1 it becomes apparent that although most of the individual country series are trended, a common linear trend is not obviously present, nor any convergence. Most of the series also seem far too smooth to be generated by a common stochastic trend (with asymptotically infinite variance). The smoothness also indicates a high degree of autocorrelation and persistence in the series.

[4] Since the exact linear dependence of the full set of age group shares is broken.

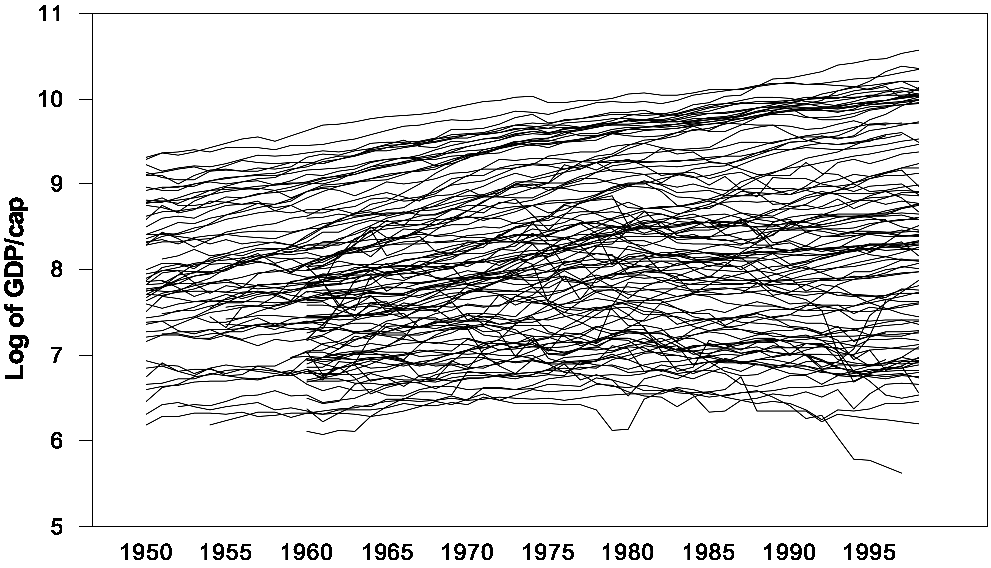

Figure 1: All 111 log GDP per capita time series plotted in one graph. Source: Penn World Tables 6.1. To interpret the scale note that 6 correponds approximately to $400 1996 USD and 10 to $22 000.

3.1 Specification tests

In this sub-section we review some variations of the basic specification of the homogeneous model. First, in Table 1 we present a pooled model in column 1. Results reported in the table are for the unbalanced sample with standard errors adjusted for that. Using just a linear trend significant non-linear trends appeared in the residuals. The quadratic trend got rid of these anomalies. In spite of the quadratic trend the residual tests indicate that we still have some unaccounted time-specific effects as well as strong country-specific effects. The next two columns compare a fixed and random effects specification of country-specific effects. The serial correlation of errors is highly significant indicating that omitted variables bias may be present, so in the last two columns of the table we compare specifications with country-specific effects including lagged dependent variables. The long-run factors implied are large, however, and the precision of age coefficients compromised. The efficiency gain from using random effects seems to be very small or non-existent and we conclude that the simpler and more robust fixed effects estimator is preferable.[5]

The age coefficients do show the hump-shape over the life cycle—at least when we control for country-specific effects—that we would expect making us confident that we are on the right track. The quadratic trend (with maxima around 1980) is, however disturbing, since projecting such a strong downward trend forward indicates negative GDP per capita for several countries in 2050.

Although the Ljung-Box Q-test is not fully appropriate in this context it gives some indication of the strength of the auto-correlation in the residuals which is monotonously tapering off, indicating that an AR(1) model for the residuals might be an alternative to the lag model. However, scrutinizing the individual country residuals it becomes very obvious that the autocorrelation is far from similar over countries and thus fitting a common autoregressive errors model will be misleading. On the other hand country-specific AR models are likely to be overfitting the data.

The first lag coefficient is close to unity suggesting that the hypothesis of a unit root in GDP/capita cannot be dismissed directly. As noted above we do not consider the risk of spurious regression to be very high. To have a further check we nevertheless estimated an ECM model (not reported) which could not reject that GDP and the age variables are cointegrated. Testing the stationarity of the residuals we, furthermore, found no evidence of non-stationary behavior apart from autocorrelation. The experiment reassured us

[5] We do not rely on a formal Hausman test because both in the omitted variables case and when using lags the fixed effect model cannot be guaranteed to yield consistent estimates, which is necessary for the validity of this test.

Dep var	*OLS*	*Country effects*		*Including lags*	
log(GDP/cap)		Fixed	Random	Fixed	Random
Constant	**10.40**		**5.941**		**0.388**
	(0.96)		(0.34)		(0.10)
$\log a_{0-14}$	**-1.399**	**-1.691**	**-1.684**	**-0.057**	-0.021
	(0.24)	(0.08)	(0.08)	(0.03)	(0.02)
$\log a_{15-29}$	**0.952**	**-0.202**	**-0.199**	0.004	0.015
	(0.21)	(0.06)	(0.06)	(0.02)	(0.02)
$\log a_{30-49}$	**1.102**	**0.153**	**0.158**	**0.045**	**0.045**
	(0.22)	(0.07)	(0.07)	(0.02)	(0.02)
$\log a_{50-64}$	**-1.110**	**0.146**	**0.159**	0.019	0.022
	(0.20)	(0.05)	(0.05)	(0.01)	(0.01)
$\log a_{65+}$	**1.205**	**-0.077**	-0.057	-0.0086	0.009
	(0.11)	(0.04)	(0.04)	(0.01)	(0.01)
Trend $T*10$	**0.39**	**0.47**	**0.47**	**0.024**	**0.014**
	(0.06)	(0.01)	(0.01)	(0.004)	(0.004)
$T^2 * 1000$	**-0.72**	**-0.66**	**-0.66**	**-0.04**	**-0.03**
	(0.10)	(0.02)	(0.02)	(0.01)	(0.01)
max trend eff in year	1976	1984	1984	1979	1974
y_{t-1}				**1.057**	**1.069**
				(0.01)	(0.01)
y_{t-2}				**-0.105**	**-0.098**
				(0.01)	(0.01)
long run factor				20.9	34.3
$\bar{R}^2$	0.672	0.959	0.960	0.997	0.997
F time effects	**2.27**	**2.55**	**2.55**	**3.92**	**3.91**
F country eff	**185.1**	–	–	–	–
Ljung-Box $Q(6)$	**23202**	**13955**	**13979**	7.57	9.25

Table 1: Bold face indicates that the estimates or residual tests are significantly different from zero on the 5 percent level. In parentheses Newey-West robust standard errors allowing for three lags are reported for the pooled model. Standard errors in parentheses for the panel models are adjusted for the unbalanced panel.

that the statistical problems of spurious regression with random coefficients, diverging t-ratios and so on, are indeed highly unlikely.

The residuals of the models in Table 1 exhibit rather strong non-normality, mainly due to high kurtosis in the distribution of the errors of the models allowing for country-specific intercepts. The question then is whether it is meaningful to pursue a common homogeneous model or turn to an attempt to model some of the country heterogeneity.

Including time-specific effects instead of trends stabilizes the age coefficient estimates somewhat (not reported here). The fat error distribution tails may raise a suspicion of structural breaks that may distort both deterministic and stochastic trend estimates. Recursive coefficient estimates revealed that the coefficients remain unstable until we start to include data from the 1990s, perhaps strengthening that suspicion. On the other hand the low frequency variation in the variables suggests that it may be unreasonable to expect stable estimates from too short time series dimensions.

3.2 Life expectancy and heterogeneity

Summing up what we learned from the specification search the quadratic trend cannot be used for forecasting so we need to find some other way to account for this trend in the data. Time-specific effects is one obvious remedy. Moreover, we need to devise some practical way of accounting for heterogeneity without getting stuck with parameter estimates that are hard to project forward.

The relationship between income and demographic variables is likely to shift over time and stage of development since life cycles and institutions are adapting to new conditions. There are numerous reasons why we should expect the coefficients of age shares to vary over time and countries, for one important example consider length of education. This variable in turn is dependent on expected returns which are partly determined by life expectancy. Therefore, interacting the age shares with life expectancy at birth, e_0, could correct for some of the heterogeneity across countries that depends on stage of development. Partly this may also capture something of the trend of technological change (or more correctly the Solow residual measuring our ignorance of this factor). If so, this allows us to skip the undesirable quadratic trend in the specification and substitute life expectancy at birth, a country- and time-dependent variable, for this mechanical variable and also expect to catch some of the country heterogeneity in coefficients by interaction terms. Thus we specify a purely demographic model that allows for some systematic country heterogeneity.

$$y_{it} = \alpha \log e_{0it} + \sum_{k=0-14}^{65+} (\beta_k + \gamma_k \log e_{0it}) a_{kit} + \eta_i + \nu_t + \varepsilon_{it} \tag{2}$$

In theory this allows for changing age share coefficients contingent on how far the demographic transition has progressed. We have also added ν_t to account for time-specific effects. A potential problem is that life expectancy is highly correlated with age structure, especially the size of older groups, and more seriously with the interaction terms themselves. However, checking the correlation matrix it turns out that log life expectancy is more strongly correlated (about 0.8) with log GDP per capita than with any of the age share variables. Although there are some elements in the correlation matrix above 0.9, these mainly involve children and the above 50 age groups, which all have rather trend-like movements. This might lead to some distortions of the coefficients for these groups, but as is clear from below, the models are rather stable in spite of this, given that the time series dimension is long enough.

3.3 Parameter estimates of heterogeneous model

To simplify later out-of-sample tests and forecasts, we only use data up to 1996 from this point on. Table 2 presents the results obtained by estimating the model in eq. 2, in the first column without the interaction terms. The second and third column report the interaction regression, direct age effects in the second column, and coefficients for the interaction with $\log e_0$ in the third column.

The estimates show that life expectancy is positively correlated with per capita income. The estimates of interaction effects also indicate that the basic hypothesis is valid; life expectancy modifies the correlation with demographic structure by shifting life phases. Of course, these estimates also imply that a substantial impact of life expectancy is through the interaction with the age share variables.

In Figure 2 we visualize this shifting pattern of age elasticities on income that are implied by the heterogeneous model (without outlier corrections). The effect of young and mature adults decreases with life expectancy while the negative effects of dependents tend to decrease also. This shifts the hump of the life cycle pattern upwards and makes it flatter and less pronounced as life expectancy rise. This might indicate that increasing length of education in low mortality populations reduces positive effects from young adults while increasing them for middle aged and even perhaps for the elderly. The latter

Dependent var. log(GDP/cap)	*Simple model* without interaction $\gamma_k = 0$	*Heterogeneous model, interaction* $\log e_0$ with interaction $\alpha,\ \beta_k$	γ_k	incl. outlier corr. $\alpha,\ \beta_k$	γ_k
$\log e_0$	**0.312**	**5.412**		**14.593**	
	(0.07)	(2.38)		(2.13)	
$\log a_{0-14}$	**-1.850**	-5.45	1.062	**-11.001**	**2.429**
	(0.09)	(3.01)	(0.69)	(2.67)	(0.61)
$\log a_{15-29}$	**-0.249**	3.704	-0.872	0.677	-0.122
	(0.07)	(2.25)	(0.52)	(1.98)	(0.46)
$\log a_{30-49}$	0.013	**3.800**	**-0.831**	**-3.759**	**0.937**
	(0.07)	(1.79)	(0.42)	(1.59)	(0.37)
$\log a_{50-64}$	**0.135**	0.251	0.017	-0.891	0.289
	(0.05)	(1.02)	(0.24)	(0.91)	(0.22)
$\log a_{65+}$	**-0.078**	**-7.597**	**1.873**	**-11.151**	**2.761**
	(0.04)	(0.65)	(0.16)	(0.61)	(0.15)
$\bar{R}^2$	0.961	0.964		0.973	
Skewness	**-0.110**	**-0.097**		-0.017	
p-value	0.002	0.007		0.630	
Kurtosis	**0.777**	**0.938**		**0.219**	
p-value	0.000	0.000		0.002	
Jarque-Bera	**127.8**	**179.8**		**9.637**	
p-value	0.000	0.000		0.008	

Table 2: Elasticity estimates of demographic structure and life expectancy on log per capita GDP. Heterogeneous interaction model in eq. (2) with fixed time and country effects. Bold face indicates that the estimates or tests are significantly different from zero on the 5 percent level. Standard errors in parentheses for the panel models are adjusted for the unbalanced panel.

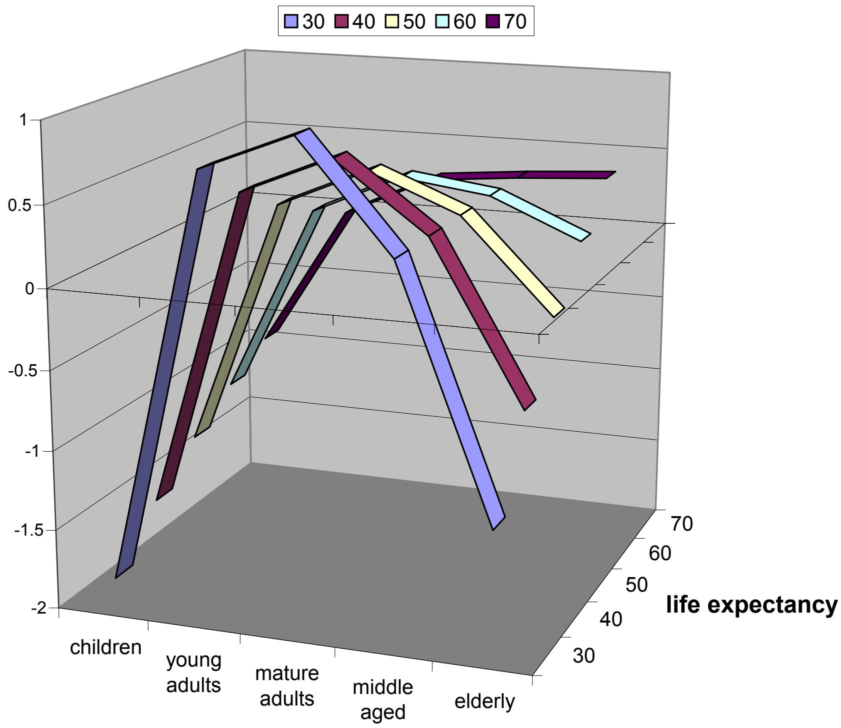

Figure 2: The pattern of shifting age elasticities from the heterogeneous model without outlier corrections in Table 2.

conclusion is highly uncertain due to the collinearity issue between children and elderly although it is an intriguing possibility that we actually catch a trend in that direction.

The attempt to control for country-specific periods, e.g. associated with civil wars and other extreme events, as well as some country-specific trends did not entirely succeed in getting the residuals normally distributed, see columns 4 and 5 and the Jarque-Bera tests for normally distributed residuals. We also report tests for significant skewness and kurtosis to show that kurtosis is the main cause for the failure of the normality tests. The general age pattern is similar in the outlier-corrected version, with the exception that 30-49 years old tend to have negative effects (although still positive relative to dependents). It is, however, hard to assess whether this has to do with the tinkering of the model or is a real phenomenon, and since it does not substantially affect forecasts, we leave it as a puzzle for future research.

One way to summarize these findings is to note that at low and medium levels of life expectancy the age effects on per capita income are dominated by the balance between children and young adults.[6] Child-rich populations tend to be poor whereas countries with declining child dependency and an expanding young adult population enjoy rising per capita income. At higher levels of life expectancy it is instead a high share of middle age adults (30-49 and 50-64 years old) that ensure good economic prospects. Although the age patterns clearly shift with life expectancy it should be noted that the direct elasticities in the model without interactions are, if we take account of different intercepts rather close to an average of the patterns observed contingent on life expectancy.

3.4 Out-of-sample tests

In Table 3 we compare the out-of-sample errors of the simple homogeneous age model in the first column of Table 2 and the interaction model without outliers (in the next two columns of Table 2) with two simple test models. We take cross-section means of forecast errors using data recursively 1980 up to 1996 and average over the observations available for x step forward forecasts. An add-in factor has been used in the forecasts in order to have the same value in the last sample year as in the forecast. A rationalisation of this common procedure is available in e.g. Hendry and Clements (1998). To check whether the results are driven only by high autocorrelation in time series we estimated a pure lag model with three lags included and one naive

[6] It might be worth mentioning that examining a scatter plot of life expectancy against GDP per capita, it is evident that the correlation between the two variables becomes substantially stronger and more positive only when life expectancy climbs above 50 years.

steps ahead	# obs	**me**	**mae**	**me**	**mae**
		Simple model		*Pure lag model*	
1	17	-0.004	0.040	0.020	0.055
2	17	-0.008	0.064	0.037	0.084
3	16	-0.012	0.083	0.054	0.113
4	15	-0.014	0.100	0.072	0.141
5	14	-0.017	0.113	0.087	0.165
6	13	-0.020	0.127	0.104	0.189
7	12	-0.023	0.140	0.119	0.212
8	11	-0.025	0.154	0.136	0.236
9	10	-0.029	0.166	0.151	0.259
10	9	-0.032	0.179	0.166	0.282
		Interaction model		*Naive model*	
1	17	-0.006	0.040	0.008	0.042
2	17	-0.011	0.065	0.015	0.069
3	16	-0.017	0.084	0.023	0.092
4	15	-0.021	0.101	0.031	0.112
5	14	-0.026	0.116	0.039	0.129
6	13	-0.030	0.130	0.047	0.146
7	12	-0.035	0.144	0.055	0.164
8	11	-0.039	0.159	0.063	0.182
9	10	-0.044	0.172	0.071	0.198
10	9	-0.049	0.186	0.078	0.214

Table 3: Dynamic forecast over the horizon 1980-1996 using two demographic models from Table 2 and a lag model and a naive (random walk) model for comparison. Negative mean errors (me) indicate over-shooting, positive under-shooting. Mean absolute errors (mae) are also reported. The models have been re-estimated and forecasts for different steps cumulated. The means have been taken over the sample countries and then over the number of observations available of different steps ahead forecasts.

random walk model with forecast $\hat{y}_{i,t+k} = y_{it}$.We tested (but do not report) the model with outlier corrections since this does not improve on the other two models.

Both the demographic models forecast better than the comparison models. And we should keep in mind that, as noted above, the coefficient estimates do not become stable until we use data up to the 1990s. Starting with data only up to 1980 thus puts these models at a disadvantage. To test reasonably long forecast horizons out-of-sample we have, however, no choice but to use these estimates in spite of the instability. The non-demographic models have a tendency towards a positive mean error $y_{it} - \hat{y}_{it}$ while the demographic models tend to have negative mean errors indicating a tendency to overshoot actual outcomes in this period, 1980-1996. It bears emphasizing that in this context of very long-run forecasts of income trends the mean error is actually more relevant than the mean absolute errors since the latter measures the variation around the trend. In a sense, we estimate and forecast potential GDP rather than actual GDP (see Lindh 2004 for a demonstration of this). Thus we do not really want to penalize business cycle deviations but rather trade off them as in the mean error measure. That is, of course, even more the case with the root mean square error that penalizes large deviations, as in cases of war outbreaks, even more.[7]

Some experiments with including lags in the homogeneous demographic model showed that the overshooting tendency could be reversed and even better mean errors achieved over this period. However, the models including lags estimate age share coefficients very imprecisely. This leads to some strange forecasting behavior on the even longer horizons we are aiming for. Hence, including lags for forecasts on 10 year horizons would be recommended but not for very long-term forecasts.

The conclusion is that although heterogeneity in the age effects seems to be clearly present, the difficulties in getting reliable estimates of twice the number of parameters for highly collinear variables are dominating our out-of-sample tests. However, forecasts for the next century may still be more plausible if taking account of this heterogeneity. One important reason being, as noted above, that we really do not know how ageing societies will adapt, for example by longer work lives. The heterogeneous model as seen in Figure 2 actually seems to catch such a tendency. In the next section we therefore proceed to compare the long-term forecasts up to 2050 from the homogeneous age model with those of the interaction model.

[7] Anyway the root mean square error may not be very reliable for judging accuracy as Armstrong and Collopy (1992) argue, especially in a situation where we do not want to give outliers caused by wars or other extreme events undue weights.

3.5 Forecasts up to 2050

Below the 1997-2050 forecasts per capita income in different countries are discussed. These forecasts are all based on the medium variant of World Population Prospects: The 2000 Revision. The fertility assumptions applied by the Population Division in the medium variant are reproduced in appendix A. According to the Population Division mortality in the medium version is projected on the basis of the models of change of life expectancy produced by the United Nations. In countries highly affected by the HIV/AIDS epidemic, estimates of the impact of the disease are made explicitly through assumptions about the future course of the epidemic, that is, by projecting the yearly incidence of HIV infection. The parameter values used in the forecasts are those that are presented in Table 2.

Besides the difficulties in presenting 111 separate country forecasts it is also important to recall that the forecasts are based on average models that cannot be expected to fit all countries equally well. In Table 4 we present some summary statistics comparing actually observed growth rates up to 1998 with the projected growth rates up to 2050 for the two models: the simple homogeneous model and the heterogeneous model with life expectancy interaction. To further emphasize that the models predict stagnation for a number of countries in terms of decreasing mean growth rates and convergence for some others in terms of increasing mean growth rates we have subdivided the sample along these lines. From this table it is clear that, as expected, the interaction model is the more optimistic one predicting overall higher growth rates and less stagnating countries. The differences are, however, surprisingly small and only ten countries shift groups and only from stagnating to converging countries. The countries in the samples are reported in the Appendix.Table 5 where it is also noted whether forecasts are implying increasing or decreasing growth It is clear that the division of countries here is overall consistent with the generalization that currently developed countries will stagnate and currently less developed countries will converge to the growth economies.

The general pattern that developed countries will tend to stagnate while developing countries will tend to take off on a growth path holds also if we attempt to include lags in the forecast model. The exceptions are mainly in Sub-Saharan Africa and due to the AIDS epidemic, but even there we predict a take-off eventually.

In Figure 3 we see the implications of the forecasts in terms of changes in the cross-country rank distribution of GDP per capita. The simple model implies a more equal distribution in 2050 than the interaction model. The generally more optimistic forecasts from the interaction model are even more

		Obs	Mean	Std Error	Minimum	Maximum
All 111 countries: growth statistics						
Observed	20th century	4849	0.017	0.061	-0.487	0.438
Simple model	21st century	5994	0.018	0.014	-0.032	0.096
Interaction	21st century	5994	0.023	0.014	-0.076	0.108
Simple model: emerging 62 countries						
Observed	20th century	2628	0.006	0.068	-0.487	0.438
Simple model	21st century	3348	0.021	0.012	-0.016	0.059
Simple model: stagnating 49 countries						
Observed	20th century	2221	0.030	0.050	-0.301	0.335
Simple model	21st century	2646	0.015	0.017	-0.032	0.096
Interaction model: emerging 72 countries						
Observed	20th century	3076	0.009	0.067	-0.487	0.438
Interaction	21st century	3888	0.025	0.013	-0.039	0.108
Interaction model: stagnating 39 countries						
Observed	20th century	1773	0.032	0.047	-0.301	0.335
Interaction	21st century	2106	0.020	0.014	-0.076	0.068

Table 4: Descriptive statistics for growth rates, old and projected, in different samples, where emerging denote that the projected growth rates are higher than the old and stagnating vice versa.

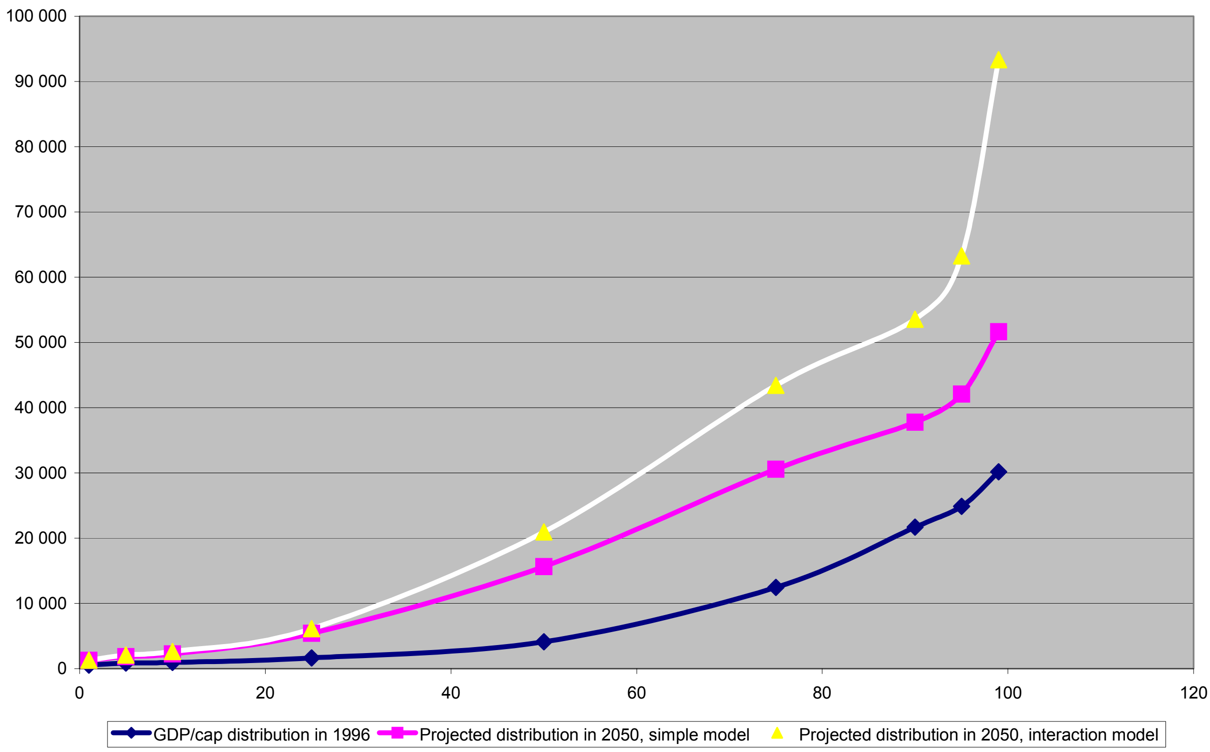

Figure 3: The rank distribution of income in 1996 US dollars in 2050 compared to 1996 for the simple model and the interaction model.

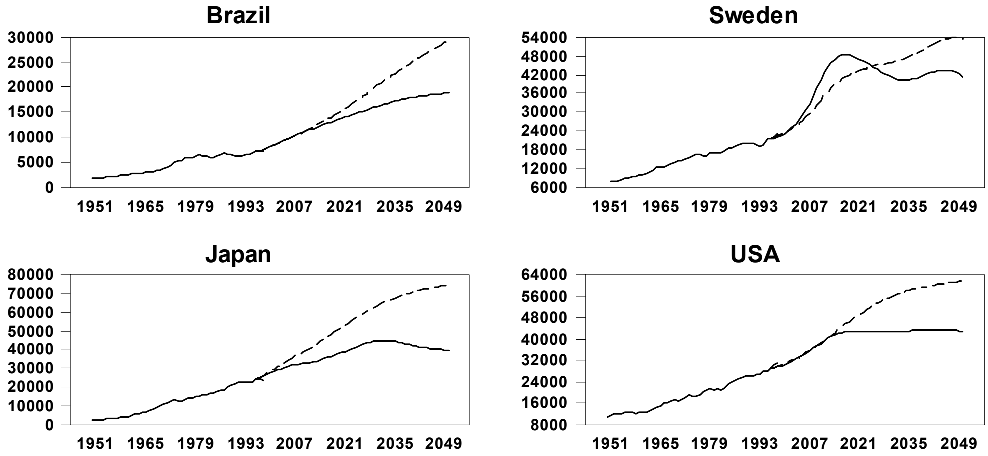

Figure 4: Predicted GPD per capita in 1996 US dollars compared with actual postwar development. Dashed lines are forecasts from the interaction model, whole lines actual data and forecasts from the simple model.

optimistic for the higher percentiles, which are, of course still the countries that are highly developed economically today. Recomputing growth rates per capita in terms of world GDP growth the simple model imply an average 2.1 percent annual growth 1997-2050 while the interaction model implies 2.8 percent annual growth.

In Figure 4 some typical examples of GDP forecasts for developed countries are shown and compared to the largest Latin American economy. The simple model loads ageing negatively while the interaction model predicts continued but stagnating growth. In Sweden due to its recent baby boom around 1990 the simple model predicts very fast growth over the next two decades while the US stagnates earlier and Japan already has stagnated. The interaction model which loads increased longevity positively has a much more positive path but still stagnating in the long run. Note that the scales are different for different countries.

In Figure 5 some examples of less developed economies are shown. In India and China the difference between the two forecasts have a similar pattern as for the US although at lower levels and the simple model stagnates later in China and later still in India. For Senegal as for most of Sub-Saharan Africa there is practically no difference between the forecasts from the two models. South Africa on the other hand shows the typical pattern for HIV stricken countries where the interaction model shows a less favorable path due to the

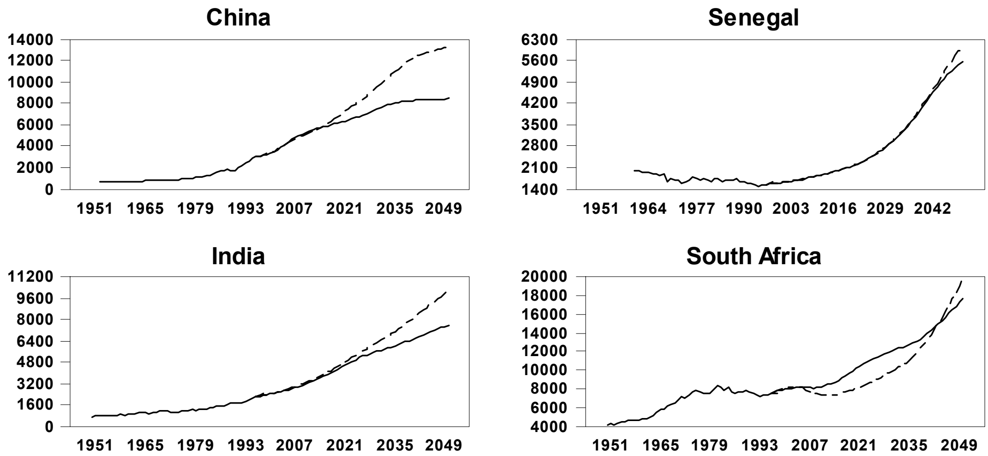

Figure 5: Predicted GPD per capita in 1996 US dollars compared with actual postwar development. Dashed lines are forecasts from the interaction model, whole lines actual data and forecasts from the simple model.

AIDS impact on longevity, but as the UN predicts that the epidemic comes under control growth becomes very fast.

These few examples of the country forecasts must suffice to give a general impression of the tendencies implied by the forecasts.

4 Conclusions

Using demographic projections we evaluate forecasting models for GDP per capita based on demographic information. The out-of-sample experiments are satisfactory but cannot give us more than a clue to the long-term reliability, since we have too few observations to be able to evaluate 50 years ahead However, the pattern of growth rates generated are by and large reasonable and lies well inside the numbers observed over the 20th century. Still, the out-of-sample tests indicate that there may be a certain over-shooting tendency in the forecasts.

When we allow for heterogeneity by interaction with life expectancy that generates a shifting age pattern forecasts in general becomes more optimistic and especially for the developed part of the world. The picture emerging from both a homogeneous age structure model and a heterogenous interaction model is, however, similar in its general trends. The currently aging developed countries will experience a stagnating or even negative growth trend in GDP. Most developing countries will, however, experience accelerating growth and converge to although not reach the income levels of the developed world. The main exceptions to this are to be found in sub-Saharan Africa where the impact of AIDS on the age distribution postpone any growth take-off. However, even in these countries the UN assumptions that the AIDS epidemic will be brought to an end results in increasing growth rates towards the end of the period.

Thus we expect that demographic change and the demographic gift following from decreased fertility rates will substantially decrease the share of people living in extreme poverty in the world. The negative aging effects on developed countries do not imply any catastrophic decrease of living standards although there may be some stagnation and even decrease. The futures scenario that appears from this forecasting exercise is thus a rather bright one, where economic prosperity increases and fewer people will live in extreme poverty.

The reliability and validity of our forecasts, of course, must be subjected to further tests and studies. There are, however, at least three circumstances pointing in the direction that the method compares favorably to any alternatives. First, demographic structure is the most fundamental determinant of human resources that we can easily measure. Second, this structure can be reliably (in a relative sense) projected for a long period of time thanks to the inertia inherent in demographic momentum. Third, although our point forecasts for individual countries in 2050 are highly uncertain, the statistical patterns generated seem reasonable enough with world growth rates between 2 and 3 percent annually.

There are still, of course, a number of unsolved problems to investigate closer. One of the more interesting directions to go is an integration with stochastic demographic projections in order to achieve better estimates of the uncertainty of these forecasts.

References

Armstrong, J. S. and Collopy, F.: 1992, Error measures for generalizing about forecasting methods: Empirical comparisons, *International Journal of Forecasting* **8**, 69–80.

Bloom, D. E., Canning, D. and Graham, B.: 2003, Longevity and life-cycle savings, *Scandinavian Journal of Economics* **105**(3), 319–338.

Bloom, D. E., Canning, D. and Malaney, P. N.: 2000, Population dynamics and economic growth in Asia, *Population Development Review* **26**, Supplement.

Bloom, D. E. and Freeman, R. B.: 1986, The effects of rapid population growth on labor supply and employment in developing countries, *Population and Development Review* **12**(3), 381–414.

Bloom, D. E. and Sachs, J. D.: 1998, Geography, demography, and economic growth in Africa, *Brookings Papers on Economic Activity* (1998:2), 207–273.

Bloom, D. E. and Williamson, J. G.: 1998, Demographic transitions and economic miracles in emerging Asia, *World Bank Economic Review* **12**(3), 419–455.

Boucekkine, R., de la Croix, D. and Licandro, O.: 2002, Vintage human capital, demographic trends, and endogenous growth, *Journal of Economic Theory* **104**(2), 340–375.

Boucekkine, R., de la Croix, D. and Licandro, O.: 2003, Early mortality declines at the dawn of modern growth, *Scandinavian Journal of Economics* **105**(3), 401–418.

Brander, J. A. and Dowrick, S.: 1994, The role of fertility and population in economic growth - empirical results from aggregate cross-national data, *Journal of Population Economics* **7**(1), 1–25.

Coale, A. and Hoover, E.: 1958, *Population Growth and Economic Development in Low-Income Countries*, Princeton University Press, Princeton.

de la Croix, D. and Licandro, O.: 1999, Life expectancy and endogenous growth, *Economics Letters* **65**(2), 255–263.

Hendry, D. F. and Clements, M. P.: 1998, *Forecasting Economic Time Series*, Cambridge University Press, Cambridge.

Heston, A., Summers, R. and Aten, B.: 2002, Penn World Table version 6.1, *Technical report*, Center for International Comparisons at the University of Pennsylvania (CICUP).

Janowitz, B. S.: 1973, The effects of demographic factors on age composition and the implications for per capita income, *Demography* **10**(4), 507–515.

Kalemli-Özcan, S.: 2002, Does the mortality decline promote economic growth?, *Journal of Economic Growth* **7**(4), 411–439.

Kalemli-Özcan, S.: 2003, A stochastic model of mortality, fertility, and human capital investment, *Journal of Development Economics* **70**(1), 103–118.

Kalemli-Özcan, S., Ryder, H. E. and Weil, D. N.: 2000, Mortality decline, human capital investment, and economic growth, *Journal of Development Economics* **62**(1), 1–23.

Kelley, A. C. and Schmidt, R. M.: 1996, Saving, dependency and development, *Journal of Population Economics* **9**(4), 365–386.

Krueger, A. O.: 1968, Factor endowments and per capita income differences among countries, *Economic Journal* **78**(311), 641–659.

Leff, N. H.: 1969, Dependency rates and saving rates, *American Economic Review* **59**, 886–896.

Lindh, T.: 2004, Medium-term forecasts of potential GDP and inflation using age structure information, *Journal of Forecasting* **23**, 19–49.

Lindh, T. and Malmberg, B.: 1999, Age structure effects and growth in the OECD, 1950-90, *Journal of Population Economics* **12**(3), 431–449.

Malmberg, B.: 1994, Age structure effects on economic growth: Swedish evidence, *Scandinavian Economic History Review* **42**(3), 279–295.

Mason, A.: 1987, National saving rates and population growth: A new model and new evidence, *in* D. G. Johnson and R. D. Lee (eds), *Population Growth and Economic Development: Issues and Evidence*, The University of Wisconsin Press, Madison, Wisconsin, chapter 13.

Mason, A.: 1988, Saving, economic growth, and demographic change, *Population and Development Review* **14**(1), 113–144.

Perlman, M.: 1975, Some economic growth problems and the part population policy plays, *Quarterly Journal of Economics* **89**(2), 247–256.

Phillips, P. C. and Moon, H. R.: 1999, Linear regression limit theory for nonstationary panel data, *Econometrica* **67**(5), 1057–1111.

Ul Haque, N., Pesaran, M. H. and Sharma, S.: 1999, Neglected heterogeneity and dynamics in cross-country savings regressions, *in* J. Krishnakumar and E. Ronchetti (eds), *Panel Data Econometrics: Future Directions, Papers in Honour of Professor Balestra*, North Holland, Amsterdam.

United Nations Population Division: 2000, *World Population Prospects: The 2000 Revision*, UN Department of Economic and Social Affairs.

Zhang, J., Zhang, J. and Lee, R.: 2001, Mortality decline and long-run economic growth, *Journal of Public Economics* **80**(3), 485–507.

Zhang, J., Zhang, J. and Lee, R.: 2003, Rising longevity, education, savings, and growth, *Journal of Development Economics* **70**(1), 83–101.

A Fertility assumptions

The medium variant of World Population Prospects: The 2000 Revision

Fertility assumptions are described in terms of the following groups of countries:

1. High-fertility countries: Countries that until 2000 have had no fertility reduction or only an incipient decline;

2. Medium-fertility countries: Countries where fertility has been declining but whose level is still above replacement level (2.1 children per woman);

3. Low-fertility countries: Those countries with fertility at or below replacement level (2.1 children per woman) plus a few with levels very close to replacement levels that are expected to fall below replacement level in the near future.

Medium-fertility assumptions:

1. Fertility in high-fertility countries is generally assumed to decline at an average pace of nearly one child per decade starting in 2005 or later. Consequently, some of these countries do not reach replacement level by 2050.

2. Fertility in medium-fertility countries is assumed to reach replacement level before 2050.

3. Fertility in low-fertility countries is generally assumed to remain below replacement level during most of the projection period, reaching by 2045-2050 the fertility of the cohort of women born in the early 1960s or, if that information is lacking, reaching 1.7 children per woman if current fertility is below 1.5 children per woman or 1.9 children per woman if current fertility is equal to or higher than 1.5 children per woman.

B Data

Our economic data are taken from Alan Heston, Robert Summers and Bettina Aten, Penn World Table Version 6.1, Center for International Comparisons at the University of Pennsylvania (CICUP), October 2002. The data were downloaded that same year We first used the 111 countries which had coherent data for at least the period 1961-1996 using the variable RGDPCH (the chain indexed PPP-adjusted real GDP estimate) which is available for many countries since 1950. The RGDPCH series for Haiti only stretched back to 1967 but the Laspeyres indexed RGDPL was available 1960-1965 so we interpolated for 1966 and linked using the ratio RGDPL and RGDPCH after 1967.We deleted countries with shorter time series both because we wanted to maintain a reasonably balanced panel and because we know from time series estimation that too short time series are unreliable when estimating the correlations to age structure. The resulting list of 111 countries are in Table 5. We only report regressions on that sample in order to enhance comparability. In the table we report the period for which we have data, and also whether the country belonged to the converging sample with higher growth rates in the projections: two asterisks if that is the case in both models, one asterisk if it is only in the interaction model.

Country	Period
Africa	
Algeria**	60-98
Angola**	60-96
Benin**	59-98
Botswana**	60-98
Burkina Faso**	59-98
Burundi**	60-98
Cameroon**	60-98
Cape Verde*	60-98
Centr. Afr. Rep.**	60-98
Chad**	60-98
Comoros**	60-98
Congo**	60-98
Congo, Zaïre**	50-97
Cote d'Ivoire**	60-98
Egypt**	50-98
Equatorial Guinea**	60-96
Ethiopia**	50-98
Gabon	60-98
Gambia**	60-98
Ghana**	55-98
Guinea**	59-98
Guinea-Bissau**	60-98
Kenya**	50-98
Lesotho	60-98
Madagascar**	60-98
Malawi**	54-98
Mali**	60-98
Mauritania**	60-98
Mauritius*	50-98
Morocco**	50-98
Mozambique**	60-98
Namibia**	60-98
Niger**	60-98
Nigeria**	50-98
Rwanda**	60-98
Senegal**	60-98
Sierra Leone**	61-96
South Africa**	50-98
Tanzania**	60-98
Togo**	60-98
Tunisia*	61-98
Uganda**	50-98
Zambia**	55-98
Zimbabwe**	54-98
Europe	
Austria	50-98
Belgium	50-98
Cyprus	50-96
Denmark	50-98
Finland	50-98
France	50-98
Greece	51-98
Iceland	50-98
Ireland	50-98
Italy	50-98
Luxembourg	50-98
Netherlands	50-98
Norway	50-98
Portugal	50-97
Romania	60-98
Spain	50-98
Sweden	51-98
Switzerland	50-98
United Kingdom	50-98
Asia & Oceania	
Australia	50-98
Bangladesh**	59-98
China	52-98
Fiji**	60-96
Hong Kong	60-98
India*	50-98
Indonesia	60-98
Iran**	55-98
Israel	50-98
Japan	50-98
Jordan**	54-98
Korea, Republic of	53-98
Malaysia	54-98
Nepal**	60-98
New Zealand*	50-97
Pakistan**	50-98
Papua New Guinea**	60-98
Philippines**	50-98
Singapore	60-98
Sri Lanka*	50-98
Syria*	60-98
Thailand	50-98
Turkey	50-98
America	
Argentina**	50-98
Barbados	60-96
Bolivia**	50-98
Brazil	50-98
Canada	50-98
Chile	51-98
Colombia**	50-98
Costa Rica**	50-98
Dominican Republic	51-98
Ecuador**	51-98
El Salvador**	50-98
Guatemala**	50-98
Guyana**	50-98
Haiti**	60-98
Honduras**	50-98
Jamaica**	53-98
Mexico**	50-98
Nicaragua**	50-98
Panama*	50-98
Paraguay**	51-98
Peru**	50-98
Trinidad & Tobago*	50-98
USA	50-98
Uruguay*	50-98
Venezuela**	50-98

Table 5: The final sample comprise these 111 countries, 44 in Africa, 19 in Europe, 23 in Asia & Oceania and 25 in America with the observation periods we have in our data. Two stars mark countries that both the simple demographic and the interaction model predict will grow faster over the forecast period than they did over the observation period. One star marks countries that will grow faster only according to the interaction model.

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ISSN 1652-120X
ISBN 91-89655-56-7