DEMOGRAPHIC TRANSITIONS AND ECONOMIC MIRACLES IN EMERGING ASIA

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ABSTRACT

The demographic transition — a change from high to low rates of mortality and fertility — has been more dramatic in East Asia during this century than in any other region or historical period. By introducing demographic variables into an empirical model of economic growth, this essay shows that this transition has contributed substantially to East Asia's so-called economic miracle. The "miracle" occurred in part because East Asia's demographic transition resulted in its working-age population growing at a much faster pace than its dependent population during the period 1965-1990, thereby expanding the per capita productive capacity of East Asian economies. This effect was not inevitable; rather, it occurred because East Asian countries had social, economic, and political institutions and policies that allowed them to realize the growth potential created by the transition. The empirical analyses indicate that population growth has a purely transitional effect on economic growth; this effect operates only when the dependent and working-age populations are growing at different rates. An important implication of these results is that future demographic change will tend to depress growth rates in East Asia, while it will promote more rapid economic growth in Southeast and South Asia.

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The Agenda

This paper has two objectives. The first is to estimate a new empirical model which isolates the impact of demographic variables on economic growth. It rejects common steady state views in favor of transition analysis. The second objective is to use these results to infer how much of the East Asia miracle can be explained by the region's spectacular demographic transition.

The paper begins, therefore, by revisiting the debate on the impact of population growth on economic growth. Pessimists believe that rapid population growth is immiserizing because it will tend to overwhelm any induced response by technological progress and capital accumulation (Ehrlich 1968; Coale and Hoover 1958). Optimists believe that rapid population growth allows economies of scale to be captured and promotes technological and institutional innovation (Boserup 1981; Simon 1981; Kuznets 1967). Recent research defeats both views: population growth has neither a significant positive nor a significant negative impact on economic growth (Bloom and Freeman 1986; Kelley 1988). These studies are typically based on cross-country regressions of income per capita growth on population growth, controlling for a variety of other influences. As Kelley and Schmidt put it recently:

> "Possibly the most influential statistical finding that has shaped the 'population debates' in recent decades is the failure, in more than a dozen studies using cross-country data, to unearth a statistically significant association between the growth rates of population and of per capita output" (1995: p. 543).

The neutralist finding is surprising, but it remains unclear whether the finding arises because population truly has no effect on economic growth or because both the pessimists and the optimists have badly mis-specified the test.

Recent work has decomposed population growth into its fertility and mortality components and examined their independent effects on economic growth (Barlow 1994; Brander and Dowrick 1994; Coale 1986; Bloom and Freeman 1988; Kelley and Schmidt 1995). These studies find that measures of fertility, specifically past birth rates, are negatively and significantly associated with economic growth, whereas the effect of mortality is statistically insignificant. These analyses are the precursors of the work reported in this paper, insofar as they justify this decomposition on the grounds that changes in fertility and mortality can and do have very different implications for the population age distribution. Population growth that is due to longevity improvements among the elderly should have an immediate negative effect on economic growth (more elderly to support). Population growth that is due to a general mortality decline has no effect (the ratio of the economically active to dependents stays the same). Population growth that is due to a rise in fertility should have an immediate negative effect on economic growth (more mouths to feed), and so should population growth due to a fall in infant mortality. Both of these population growth effects, however, will have a delayed positive impact via the economically active population two decades later, long after the aggregate population growth effect has disappeared.

This recent literature, however, has paid little attention to reverse causality. The issue is important because there two other bodies of literature showing the effects of income on fertility and mortality (Schultz 1981; Behrman 1990; Fogel 1994; Barro and Lee 1994). The population growth debate has failed to acknowledge fully the possible endogeneity of fertility and mortality.

This paper contributes to the population debate in four ways. First, like Kelley and Schmidt 1995, the paper uses recent advances in the empirical models of economic growth to isolate the effects of demography. It does this by incorporating demographic variables into an economic growth model similar to the one used by Sachs, Radelet, and Lee (1997). Second, the paper attempts to account for possible reverse causality. It does this by using a two-stage specification where instruments for the growth rate of the population are used to account for possible endogeneity. Third, it introduces demography into the growth equations in a theoretically more appealing way than simply by the ad hoc addition of birth and death rates, specifically by adding the growth rates of the total population and the economically active population. By doing so, the paper allows population to affect economic growth by its overall rate of growth and by its age structure. The distinction matters. Finally, the paper highlights how changes in growth of labor force per capita, changes in the savings rate, and changes in the investment rate are three plausible mechanisms through which a changing age structure may affect the rate of economic growth (Higgins and Williamson 1997; Bloom and Williamson 1997).

The paper's second objective is to use the econometric results to assess the extent to which population dynamics can account for some significant portion of East Asia's economic miracle. East Asia is an excellent context in which to examine this effect for a number of reasons. First, it has experienced a more rapid demographic transition then any other region at any time in history. Second, East Asia has also experienced a higher growth rate over a more prolonged period of time than any other region at any time in history. Third, East Asia is naturally compared with Southeast and South Asia, whose demographic transitions either began later or proceeded more slowly, and whose economic progress has not yet rivaled that of East Asia. Additionally, analysts have badly neglected the potential role of population change on economic performance in the region, a neglect illustrated best by the World Bank's oft-quoted East Asian Miracle. In redressing this imbalance, we compare Asia with the rest of the world, and make comparisons between East, Southeast, and South Asia as well.

The paper's first major finding is that ***population dynamics matter in the determination of economic growth***. But the population growth rate is not the mechanism driving economic performance — upholding the neutralist position. Rather, age distribution is the mechanism by which demographic variables affect economic growth. These age distribution effects seem to be purely transitional -- although a full transition can take more than fifty years -- and operate only when the growth rates of the working-age and dependent populations differ. We also find no evidence of reverse causality.

Induced by an initial decline in infant mortality, the demographic transition triggers an economic transition in which growth performance passes through three phases: it is impeded in the early phase of the demographic transition when the youth dependency cohort swells; it is abetted in the next phase about two decades later when the youth enter the working age cohort; and it may or may not be impeded again some decades later when the elderly cohort swells. That is, it appears that a rising elderly share does not depress the rate of economic growth, although it doesn't elevate it either. Perhaps the reason why this paper is unable to find any evidence that the elderly are the burden they are often assumed to be, is because many work or make it possible for others to work, or because they save more than life cycle models would predict. The econometrics also suggest that Asia behaves no differently than the rest of the world.

The paper's second main finding is that ***population dynamics account for a substantial share of East Asia's economic miracle***. Population dynamics account for somewhere between 1.4 and 1.9 percentage points of East Asian GDP per capita growth per annum from 1965 to 1990, or as much as a third of the observed economic growth over the period. The economic miracle can, of course, be defined differently. Assume that the steady state growth rate in East Asia is about 2.6 percent per annum (which it appears to be: see footnote 5), in which case the "miracle" is everything exceeding that, about 3.5 percent (6.1-2.6=3.5). Under this definition, population dynamics could account for more than half of the miracle. A third or a half certainly isn't everything, but it makes population dynamics the most important growth determinant by far. Within Asia, the evidence also suggests that demographic divergence contributed to economic divergence over the same period. If Southeast and South Asia can utilize their mid-phase demographic "gift" in the same way that East Asia did, demographic convergence within Asia will contribute to economic convergence in the coming decades.

The next section describes the demographic transition in more detail. Special attention is given to the difference between the historical experience of Western Europe and Asia to show that demographic effects have been much more pronounced in the latter case. The paper then describes the model and the recent literature on economic growth upon which it is based. This followed by a section which presents the econometric results, and another which uses the econometrics to identify just how much of the East Asian miracle is explained by demographic dynamics. A penultimate section discusses the likely channels through which population dynamics might affect economic growth — labor supply and accumulation. We conclude with an agenda for future research.

The Demographic Transition

The Demography

The demographic transition describes the change from pre-industrial high fertility and mortality to post-industrial low fertility and mortality. Figure 1 offers a stylized view of the demographic transition. Declines in mortality — especially infant and child mortality — mark the beginning of almost all demographic transitions. After a lag, fertility also begins to decline marking the next stage of a demographic transition. The population growth rate is implicitly shown in the first panel of Figure 1 as the difference between fertility and mortality. The second panel makes the population dynamics explicit: the demographic transition must be accompanied by a cycle in population growth <u>and</u> in the age structure. Changes in the age structure are especially exacerbated since most of the early declines in mortality are enjoyed by infants and children. An example of these cohort effects is offered for East Asia in Figure 2: the closest steep ridge describes the movement of the relative size of the cohort through time, and the second ridge in back of the first describes the echo effect.

These components of the demographic transition might have separate influences on economic growth. The population growth rate could influence economic growth, for the reasons asserted by both the population pessimists and optimists. The demographic transition could also affect economic growth through the age distribution. Coale and Hoover (1958) coined the term dependency rate to predict the impact of big youth cohorts on low savings, low investment and slow educational capital deepening. They were more concerned with the first "burden" phase of the Asian demographic transition in the 1950s and 1960s, so they devoted little attention to the "gift" phase that drives this paper, from the mid-1960s to the present. Of course, the age distribution effect will also operate to first lower, then raise, then lower again the ratio of the economically active to the total population, and thus will have an impact on labor force per capita growth.

It is important to stress that the demographic "gift" in the middle phase of the transition may or may not be realized; it represents a growth potential whose realization depends upon other features of the social, economic, and political environment. Whether it was realized should be revealed by past performance.

Like industrial revolutions, the demographic transition takes many decades to complete, but it has been much faster in postwar Asia than it was in 19th century Europe. Over a century and a half, Europe slowly improved its understanding of basic sanitation, management of solid waste, provision of clean drinking water, and the elements of sound nutrition. It invested in these measures to reduce mortality and chronic malnutrition, and eventually eliminated famines (Fogel 1994b). It cleaned up what Victorian reformers called "killer cities" (Williamson 1990). These factors, together with the advent of antibiotics and vaccines and recognition of the importance of preventive medicine, led to a gradual decline in European mortality. Infant and child mortality led the decline since infants and children, like the elderly, have always been most vulnerable to disease, and since they are far more numerous than the elderly at early development stages, the decline in infant mortality rates matters most. The fertility rate also declined slowly, and the European demographic transition stretched out for more than a hundred years (Coale and Watkins 1986).

The practices, investments, and technologies that had been developed and put into practice in Europe did not exist in Asia until relatively recently: there was a big gap between best health practice prevailing in industrialized Europe and local health practice prevailing in Asia. The scope for the transmission of health technologies was enormous in the 1940s, since it had been pent up by de-globalization, two world wars, a great depression, and wars of liberation. When the postwar transfer of health technology finally took place, it happened in a rush. The process was speeded up even further by investment in health-improving social overhead which was heavily financed by world funding agencies that were non-existent in the 19th century. In short, the possibilities for an Asian catch up with the West in terms of health and demography were enormous in the late 1940s, and they were driven by factors external to Asia itself. In the half century since then, Asia has exploited the catch-up potential with such enthusiasm that it has produced one of the fastest and most dramatic demographic transitions ever.[1]

Asia's demographic transition followed the stylized model by starting with a decline in mortality rates. By the late-1940's, the crude death rate began declining very rapidly everywhere in Asia. The decline proceeded most rapidly in East Asia (Figure 3) and it was accompanied by an increase in life expectancy from 61.2 to 74.6 years from 1960 to 1992. Similar declines occurred in Southeast and South Asia where life expectancy improved from 51.6 to 67.2 and from 46.9 to 60.6, respectively. In the 1950s and 1960s, most of the aggregate mortality decline was being driven by mortality decline in the youngest cohorts (Bloom and Williamson 1997).

There are a number of possible explanations for the rapid decline in Asian child mortality in the middle of this century, which, after all, was the real force driving the age distribution over the first two phases of the demographic transition. One possibility has already been suggested: in the 1940s, Asia escaped from four or five decades of relative isolation, ushering in an era of health technology transfer and the diffusion of new public health programs and techniques. For example, the medical advances that were implemented in postwar Asia had been accumulating on the technological shelf for at least two decades: 1927 discovery of penicillin; 1932 discovery of sulfa drugs; 1943 discovery of bacitracin; 1943 streptomycin isolated and its curative value against tuberculosis demonstrated; 1943 curative effects of chloroquine on malaria demonstrated; 1945 non-military use of penicillin; 1948 introduction of tetracycline. With the advent of these and other drugs, diseases that had once killed hundreds of thousands and even millions became treatable, and at low cost. In addition, DDT became available in 1943. To cite just one example, DDT spraying in the late 1940s reduced the incidence of malaria in Sri Lanka dramatically: the crude death rate declined from 21.5 to 12.6 between 1945 and 1950, with the most sudden drops in the most malarial areas (Livi-Bacci 1992). Figure 4 illustrates the effect by plotting changes in mortality in the most and least malarial zones of Sri Lanka between 1930 and 1960. While there is a

[1] The language being used in this section is similar to that used in the debate over economic catch up and convergence (Abramovitz 1986; Baumol 1986; Barro 1991; Sachs and Warner 1995) because we think exactly the same reasoning applies to the demographic transition in Asia.

gradual decline over the thirty years in the least malarial zone, the decline is dramatic and steep between 1943 and 1949 in the most malarial zone.

Another possibility is that increased agricultural productivity and trade in food both raised nutrition sufficiently to lower infant mortality dramatically over less than a decade, and did so everywhere in Asia. Perhaps, but it seems unlikely given that the magnitude and timing of the mortality decline was so similar everywhere in Asia, regardless of level of development and productivity performance in agriculture.

Resolving the debate between the view which favors an exogenous supply-side-driven fall in infant mortality in the 1940s and 1950s and one which favors an endogenous demand-side-driven fall matters since it will influence the extent to which the demographic transition in East Asia was mostly exogenous. It is an issue that must be resolved in future research.

Like the stylized version, the infant mortality decline in the Asian demographic transition was followed, with a lag, by a decline in fertility. While the timing of the mortality decline was remarkably similar across rich and poor Asia, the lag between the drop in mortality and fertility, as well as the size of the ensuing fertility fall, varied (Feeney and Mason 1997; Bloom and Williamson 1997, Figure 5). Figure 5 plots the decline in the crude birth rate for East, Southeast, and South Asia. The crude birth rate in East Asia does fall much more rapidly than it does in Southeast or South Asia, but the timing is not so different. In most countries, like Singapore, Korea, and Malaysia, fertility began to decline about 15 years after the child mortality drop. In other countries, like Thailand, the delay was longer, closer to 25 years. What is remarkable about the onset of the Asian fertility decline is the very short period over which it occurred and that it was so dramatic everywhere, even where the pace of economic development was slow (Caldwell and Caldwell 1996).

There are, of course, a number of possible explanations for the decline in fertility, and it matters in deciding how much of the decline was endogenously related to the miracle itself, and how much was exogenous and driven by policy. Contraceptive use rates vary across Asia (Bloom and Williamson 1997, Table 5); government intervention accounts for some of this variance, while family demand, responding in part to economic events, accounts for the remainder. The big debate is over which mattered most. Two well-known demographers argue that government intervention mattered a great deal and that the intervention was distinctly Asian (Caldwell and Caldwell 1996). Another even offered an estimate. Examining the decline in the TFR 1965-1975 for 68 developing countries, Boulier (1986) concluded that only 27 percent was due to economic change while 40 percent was due to government-supported family planning and 33 percent to previous fertility decline. The general view seems to be that family planning programs have been central to the decline in Asian fertility, beginning with India in 1951.

The pace and timing of the demographic transition has led to enormously divergent trends in population growth and population age structure across Asia. Figure 6 plots the ratio of the working-age population to the nonworking-age population for the three subregions in Asia. With only two precocious exceptions, Japan and Sri Lanka, Asia's surge to peak youth dependency rates occurred in the 1960s and 1970s, reflected in Figure 6 by the low ratio of working-age population to non-working age population. With the exception of Japan, the elderly dependency rate has been mostly irrelevant to Asia in this century, even to the more economically mature East Asia. It will, of course, become very relevant to these older tigers as they enter the next century, as we shall see.

As Figure 6 demonstrates, the ratio of working-age population to non-working-age population has been rising in Asia since 1975, but this increase has been especially dramatic in East Asia. According to the UN projections, the ratio of working-age population to non-working age population will peak for East Asia in 2010 (ending the second phase of the demographic transition), followed by a decline (the third phase of the demographic transition). This reflects the increase in the elderly dependency rate for East Asia as the bulge in the age distribution works its way through the population.

The Economic Hypothesis

What matters most in identifying the impact of demographic change on economic performance is the changing age distribution. This essay argues that in the early stages of the demographic transition, per capita income growth is diminished by large youth dependency burdens and small working-age adult shares: there are relatively few workers and savers. As the transition proceeds, per capita income growth is promoted by smaller youth dependency burdens and larger working-age adult shares: there are relatively many workers and savers. The early burden of having few workers and savers becomes a potential gift: a disproportionally high group of working-age adults. Later, the economic gift evaporates, as the elderly share rises.

If our story is correct, then much of the slower growth performance prior to 1970 can be attributed to the fact that East Asia was carrying a very heavy youth dependency burden, which, by itself, was pushing growth rates down. Without the youth dependency burden, so the argument goes, East Asia would have had higher growth rates prior to 1970. As East Asia entered a phase in which demography graduated from burden to gift, the youth dependency burden decreased and the proportion of working-age adults increased. The result was an acceleration of the growth rate abetted by demographic forces. This and other transitional forces -- productivity gains from "borrowing" foreign technologies, from shifting labor from low (agriculture) to high productivity sectors, from exploiting globalization potential -- served to push the growth rate far above its pre-1970 level to the "miraculous" rates of the past quarter century. The demographic transition accounts for a decrease in the growth rate associated with high youth dependency burdens and a subsequent rise in the growth rate deriving from the emergence of the demographic gift in place of the burden. Sometime in the near future, however, the demographic gift in East Asia will dissipate (and consequently, economic growth will tend to slow down) as the share of elderly in the population increases. Once the demographic transition is complete, population growth will no longer affect economic growth. Hence, any economic effect due to the changing age distribution is only temporary.

Figure 7 offers a stylized version of the economic hypothesis where the sustainable growth rate is taken to be 2.6 percent per annum. What follows in this paper is a test of the hypothesis and a defense of the magnitudes suggested by Figure 7. The reader should note, however, that the contribution of the demographic transition to the East Asian miracle will also depend on how the miracle is defined. If it is defined as a share of per capita GDP growth between 1960 and 2010 in Figure 7, then it accounts for about a third of the miracle; if it is defined as the surplus over the sustainable rate, then it accounts for almost half; and if it is defined as the increase in growth rates from 1945-1960 to 1960-2010, then it accounts for almost three-quarters. Now, can we defend Figure 7 with evidence?

The Theoretical Framework

The cross country growth equation used in this paper is derived from a standard Ramsey model. Consumers maximize utility over an infinite horizon subject to a budget constraint and the standard No-Ponzi-Game restriction. Competitive firms take wages and the interest rate as given and produce the same good. Workers are identical. If we assume that production per worker (y) takes the form $y=f(k)=Ak^{\alpha}$, then we can derive equation (1), the growth rate at any time. Equation (1) will be familiar to any reader of a current advanced macroeconomic textbook (e.g. Barro and Sala-I-Martin 1995). It is also consistent with the empirical growth literature, especially that which focuses on conditional convergence (Mankiw, Romer, and Weil 1992; Barro 1991; Barro and Lee 1994; Sachs and Warner 1995). In the Ramsey model, the average growth rate (g_y) of output per worker between any time T_1 and T_2 is proportional to the logged ratio of income per worker in the steady state (y^*) and income per worker at time T_1 as follows

$$g_y = \frac{1}{T_2 - T_1}\log\left(\frac{y(T_2)}{y(T_1)}\right) = \alpha\log\left(\frac{y^*}{y(T_1)}\right). \tag{1}$$

We make two additional modifications to this model. The first involves the formulation of steady state output. Following Sachs, Radelet, and Lee(1997), we assume that y^* is formed as

$$y^* = X\beta \tag{2}$$

where X is a matrix with k determinants of the steady state. We also follow Sachs, Radelet, and Lee

(1997) in our selection of the variables to include in X. These variables include log level of schooling in the initial period, life expectancy in the initial period, natural resource abundance, a measure of openness, an index of institution quality, average government savings, and geographical variables indicating the ratio of coastline to land area, whether there is access to major ports, and whether the country is located in the tropics.

The second modification involves changing the model from output per worker (y) to output per capita ($\tilde{y}$). We note that

$$\tilde{y} = \frac{Y}{N} = \frac{Y}{L}\frac{L}{N} = y\frac{L}{N} \tag{3}$$

where N is the total population, L is the number of workers, y is output per worker, and $\tilde{y}$ is output per capita. This expression can easily be converted to growth rates,

$$g_{\tilde{y}} = g_y + g_{workers} - g_{population}. \tag{4}$$

When equations (1) and (2) are substituted into (4) and add a stochastic term, our estimation model emerges:

$$g_{\tilde{y}} = X\Pi_1 + y(T_1)\Pi_2 + g_{workers}\Pi_3 + g_{population}\Pi_4 + \epsilon \tag{5}$$

where theoretically, $\Pi_3 = -\Pi_4 = 1$. For a stable population, the growth rate of the workforce equals the growth rate of the population, and net demographic effects should vanish. If the population is unstable (during a dynamic transition), then demography might matter. Finally, note from (1) that the steady state rate of GDP per capita growth can be derived once this equation is estimated.

Econometric Results

The econometric analysis is based on 78 Asian and non-Asian countries covering the quarter century from 1965 to 1990. A complete data description with sources appears in Table 8.

We start by asking whether the level of population growth affects economic growth, since that's the way the population debate has been couched (wrongly). The results appear in Table 1. Most of the recent research on economic convergence has focused on the sign of the coefficient on logged initial income. If the coefficient is negative, the model predicts conditional convergence: that is, after controlling for the steady-state level of income, poor countries tend to grow faster and approach their steady-state level quicker than rich countries. Consistent with recent research on economic convergence, we find conditional convergence in our sample too. Our focus, however, is on the rate of population growth. In the revised specification in Table 1 (column 1), there is no significant relationship between population growth (GPOP6590) and GDP per capita growth, confirming the neutralist finding. Note, however, how sensitive this result is to the specification. As soon as log life expectancy in 1960 and two variables controlling for economic geography are added, population is shown to have a positive and significant impact on GDP per capita growth (Table 1, column 2), supporting the optimist camp!

Table 1 illustrates the kind of mistakes the profession has made when concluding that demography doesn't matter. The conclusion typically fails to pay any attention to the sources of the population growth, and to the stages of the demographic transition. To repeat, the source of the population growth matters: a child mortality decline and a baby boom both raise the youth-dependent-age population; a mortality decline among the elderly increases the retired dependent age cohort; immigration raises the working-age population (because it self-selects young adults); and improved mortality among the population at large has no impact on age structure at all. Since the productive capacity of an economy is directly linked to the size of its working-age population relative to its total population, it is essential to distinguish between the two components when exploring the impact of demographic change on economic performance.

Table 2 conforms with these notions and with the model derived in the previous section: the growth rate in the economically active population (GEAP6590) joins GPOP6590 in the regression. The growth rate of the working-age population measures the change in the size of the population aged 15 to 64 between 1965 and 1990. Table 2 confirms that the growth of the working-age population has had a powerful positive impact on GDP per capita growth, while growth of the total population has had a powerful negative impact. Consider the results reported in the second column of Table 2. The coefficient on the growth rate of the working-age population is positive, statistically significant, and big: a one percent increase in the growth rate of the working age population is associated with a 1.46 percent increase in the growth rate of GDP per capita. The coefficient on the growth rate of the total population is negative, statistically significant, and almost as big: a one percent decrease in the growth rate of the dependent population is associated with about a one percent increase in the growth rate of GDP per capita.[2] The third and fourth columns of Table 2 show what happens when the impact of the growth rates of the working-age and the entire population are constrained to be equal but of opposite sign. In steady state, when the age distribution is stable, population growth doesn't matter in either of these two specifications. In transition, when the age distribution changes, population growth does matter. The coefficient here is big, positive and significant. Thus, where the growth rate of the economically active exceeds that of the population in our sample, higher GDP per capita growth rates have appeared (ceteris paribus). Equivalently, where the middle of the age distribution (ages 15-64) grows faster than the tails (ages 15 and below and 65 and above), GDP per capita growth is faster. The opposite is true if the growth rate of the total population exceeds that of the economically active. If the dependent population is growing faster than the workforce, our model predicts slower growth.

As we mentioned earlier, previous contributions to the population debate have, typically, failed to

[2] The coefficients of the other variables are similar to those found in Sachs, Radelet, and Lee (1997), and the interested reader may wish to explore them there. Throughout this paper, specification 2 refers to their (1997) model, while specification 1 refers to a revised version which removes initial life expectancy and two economic geography variables.

explore the possibility of reverse causality between population growth and economic growth, this despite a literature which suggests that economic events clearly induce demographic responses. Table 2 used ordinary least squares (OLS), while Table 3 reports the results when instrumental variables (IV) are used to account for possible reverse causality.[3] In column 2 of Table 3, the coefficients on the growth rates of the working-age and the total population are similar to the OLS estimates: a one percentage point increase in the growth rate of the working age population is associated with an increase of 1.37 percentage points in GDP per capita growth, and a one percentage point decrease in the growth rate of the total population is associated with an increase of 0.92 percentage points of GDP per capita growth. The IV estimates in specification 2, with high standard errors, lacks the precision of the OLS estimates, but the remaining three IV specifications give more precision.

One potential problem in the unconstrained IV specification is our identification of endogenous variables. We instrumented for the growth rate of the population not for the growth rate of the economically active population. We feel that the latter is exogenous to the sample since it is determined by fertility and child mortality patterns prior to the period from which we draw our sample. If the assumption is incorrect, then there are two right-hand-side variables that could be endogenous. If this is the case, our IV estimates for the unconstrained model would also be inconsistent. In the constrained model, however, there is only one right-hand-side variable that is endogenous, so the IV estimates are consistent there.

When the coefficients on GEAP and GPOP are constrained to be equal and opposite in sign, the estimated IV coefficients are almost twice as large as their OLS counterparts. All of the constrained estimates are statistically significant at all conventional levels. The similarity of these estimated coefficients across the many alternative specifications and estimation techniques speaks well for the robustness of our result. They also imply that the steady state rate of growth of GDP per capita is about 2.6 percent in East

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[3] Since the instruments we chose are only available for a smaller sample of countries, the OLS estimates corresponding to this sample are also included in the table. The instruments and the countries excluded from the smaller sample can be found in the notes to Table 3.

Asia.[4]

Hausman specification tests (Hausman 1978) were performed to test for consistency of our OLS estimates. The test statistics, reported in each column of Table 3, suggest that in the both the constrained and unconstrained versions of our model we cannot reject the null that the IV and OLS estimates are statistically equivalent. We interpret this result as meaning that there is no endogeneity problem.

Table 4 shows the results when interaction terms and regional controls are included. In the first two columns, the unconstrained versions of our model are re-estimated by including interactions between GEAP and the quality of institutions, on the one hand, and GEAP and openness, on the other. The last two columns explore whether there is any regional effect remaining. There does seem to be some weak evidence that Asia grew faster even after controlling for all of these forces, but no evidence that Asia's growth responded any differently to openness or institutional quality.

Up to this point, we have used the growth rate of the population and that of the economically active population. We have established that the growth of the dependent population slows down economic growth. However, does a growing young, dependent population have the same impact as a growing elderly, dependent population? We now modify the estimation equation by inserting the growth rates of the population under 15 and over 65 in place of the growth rate of the population as a whole. The results serve to sharpen our understanding of how dependent populations contribute to the slow down. Table 5 offers two specifications (only the coefficients on the demographic variables are reported). The coefficient on the population under the age of 15 is negative and significant in both: thus, a one percentage point increase in the growth of the population under age 15 is associated with a decrease in the GDP per capita growth of about 0.4 percentage points (column 2). In contrast, a positive, yet insignificant coefficient emerges for the elderly population. We conjecture that since the elderly continue to make important economic contributions

[4] An unweighted average of steady state GDP per capita growth for China, Hong Kong, Japan, Korea and Taiwan, across all four specifications in Table 2, is 2.6 percent per annum, not so very different from the estimate of actual growth in the region between 1913 and 1973, 2.7 percent per annum (Maddison 1995, p. 24)..

by tending the young, working part-time and perhaps even by still saving, they are a smaller net drag than are the very young who do not work or save at all. Since the elderly are currently a small minority of the total dependent population in Asia (11 percent in 1990), the relationship between the dependent young and GDP per capita growth dominates, accounting for the negative effects that the dependent population as a whole exerts on the growth rate of GDP per capita.

The economic impact of the demographic transition can be summarized this way: economic growth will be less rapid when the growth rate of the working-age population falls short of that of the population as a whole (an event that characterized the first phase of East Asia's postwar demographic transition prior to 1970); economic growth will be more rapid when the growth rate of the working-age population exceeds that of the population as a whole (an event which characterized the second phase of East Asia's postwar demographic transition overlapping the economic miracle over the past quarter century); and economic growth will be less rapid when the growth rate of the working-age population once again falls short of that of the entire population (an aging event which will dominate East Asia over the next quarter century).

Explaining the East Asian Miracle

So far, these results seem to be consistent with the stylized characterization in Figure 7. But they only involve hypothesis testing. What about magnitudes? Did population dynamics explain a significant part of the East Asian miracle?

Between 1965 and 1990, the working age population in East Asia grew 2.4 percent per annum, dramatically faster than the 1.6 percent rate of growth of the entire population, yielding a 0.8 percent differential (Table 6). The working age population also grew faster than the entire population in Southeast Asia, but the differences were almost half of those in East Asia, while in South Asia they were only a quarter of the East Asian figure.

These demographic differences help explain at least some of the disparity in growth performance across Asia between 1965 and 1990. Combining the coefficients from our estimated growth equations in Table 4 and the growth rates of the working age and total population documented in Table 6, we conclude that population dynamics can explain between 1.4 and 1.9 percentage points of GDP per capita growth in East Asia (Table 6), or as much as a third of the miracle (1.9/6.11). If instead the miracle is defined as the difference between current GDP per capita growth -- a transitional rate where population dynamics matter -- and the estimated steady state of 2.6 percent -- when population is also in steady state and has no impact, then population dynamics can explain more than half of the miracle (1.9/[6.11-2.6]). In Southeast Asia, where the fertility decline took place a little later and the infant mortality decline was a little less dramatic, population dynamics still accounts for 0.9 to 1.8 points of economic growth, or, again, as much as half of their (less impressive) miracle (1.8/3.8). In South Asia, the incipient demographic transition accounts for only 0.4 to 1.3 percentage points of economic growth, but still as much as three quarters of a poor growth performance (1.3/1.7). The countries that benefited most from these demographic events were Korea, Singapore, Taiwan, Hong Kong, Thailand, and Malaysia -- all of which are old or new fast-growing tigers. The biggest demographic contribution seems to have been in Singapore, 1.9 to 2.3 percentage points, but Thailand is close behind, 1.5 to 2.3 percentage points. It is no coincidence that these tigers attracted most of Krugman's attention when he asserted that the East Asian miracle was driven mainly by high rates of accumulation and labor force growth (Krugman 1994; Young 1994a, 1994b).

Compared with the rest of the world, East Asia was the largest beneficiary of the population dynamics coming from the demographic transition. Europe received only a small post-baby boom boost of 0.3 to 0.5 percentage points. Even South America's demographic impact, 0.7 to 1.5 percentage points, was smaller than East Asia's, although the demographic contribution was almost identical to that of Asia as a whole.

The future will look quite different. We forecast these results in Table 7 based on the coefficients of our estimated growth model and the UN demographic projections up to the year 2025. In East Asia, the GDP per capita growth attributable to demographic influences is projected to be <u>negative</u> between 1990 and 2025, declining from a positive gain of 1.4 to 1.9 percentage points between 1965 and 1990 to a loss of 0.1 to 0.4 percentage points up to 2025, a projected retardation of about 1.5 percentage points due solely to demographic forces. The demographically-induced retardation is projected to be even bigger in some parts of East Asia. If nothing happens to offset them, demographic events will induce a 2.0 to 2.4 percentage point decline in Hong Kong's GDP per capita growth rate, a 2.5 to 3.0 percentage point decline in Singapore, a 1.9 to 2.2 percentage point decline in Korea, and a 0.9 to 1.1 percentage point decline in Japan. In contrast, South Asia should see a 0.8 to 1.4 percentage point increase in its growth rate as it leaves the "burden" stage of the demographic transition entirely and enters the "gift" stage, the biggest gains being for Pakistan and Bangladesh. Southeast Asia should register a little smaller demographic gift (0.6 to 1.1 percentage points) with a lot of variance across countries in the region: the biggest gainer will be the Philippines while the biggest losers will be Malaysia and Thailand.

Demographic divergence contributed to Asian economic divergence over the past quarter century, South Asia falling behind East Asia. However, the demographic indicators most important to economic performance will converge across Asia up to 2025. If our story survives further scrutiny, then the demographic convergence should contribute to economic convergence over the next thirty years in the region. The East Asian connection between the demographic transition and the economic miracle is now being replayed in Southeast Asia, and it will be replayed again in South Asia in the near future. While demographic divergence has contributed to economic divergence in Asia over the last three to four decades, demographic convergence will contribute to economic convergence over the next three to four decades. Figure 8 offers a stylized characterization of those events.

Possible Channels of Impact

The Impact of Demography on Labor Force Growth

How much of the fast-growth transition in Asia can be explained by the impact of demography on labor inputs? Elsewhere, we offered some answers which we will only summarize here (Bloom and Williamson 1997: Table 6). Our interest, of course, is in labor inputs per person. Labor input per person (working hours per capita, or H/P) growth can be separated into three parts: changing hours worked per worker (H/L); changing labor participation rates among those of working age (L/EAP); and changing shares of the population of working age (EAP/P), the pure demographic effect. Thus, per capita hours worked can be decomposed into H/P = (H/L)(L/EAP)(EAP/P).

How much of fast Asian economic growth can be explained by a rise in labor inputs per capita due to purely demographic forces? Between 1965 and 1975, very little. Between 1975 and 1990, quite a lot. The rising working-age share served to augment labor-input-per-capita growth by about 0.75 percentage points per annum. This implies about 0.4 percentage points of Asia's transitional growth since 1975 explained (or about a tenth of GDP per capita growth).[5] The figures are much bigger for East Asia: labor-input-per-capita growth due to pure demography was more than 1.1 percentage points per annum, equivalent to 0.6 percentage points of economic growth explained. Since the previous section estimated that demographic forces could account for 1.4 to 1.9 percentage points of the East Asian miracle, their impact on labor inputs per capita must account for about 30 to 40 percent of the total demographic effect. The figures for Southeast Asia are more modest, a little more than 0.6 percentage points per annum and thus a little less than 0.4 percentage points of economic growth explained. They are much smaller for South Asia. By itself, the pure demographic effect implies a 0.5 percentage point reduction in GDP per capita growth in South Asia compared with East Asia, thus contributing to economic divergence between the two regions since the early 1970s.[6]

These demographic labor-input-per-capita forces do not, of course, exhaust all influences on labor

[5]Calculated by multiplying labor-input-per-capita growth by the output elasticity with respect to the labor input. The output elasticity is taken to be 0.56, the average for the 1960s and 1970s of Japan, Hong Kong, India, Korea, Singapore, and Taiwan (Chenery, Robinson and Syrquin 1986: Table 2-2).

[6]How much of faster growth in East Asia, compared with the OECD, has been due simply to these demographic labor-input-per-capita forces? The answer is almost 0.5 percentage points, or about four-tenths of the gap between East Asia and the OECD.

supply, nor do they exhaust all demographic transitional influences on the growth rate, but are they likely to persist in the future? It depends on where in Asia we are looking. The fall in the pure demographic effect will be a huge 1.13 percentage points per annum in East Asia, causing a growth retardation there by about 0.6 percentage points. In sharp contrast, it will raise South Asia's GDP per capita growth rate, although not by much. The demographic influence on labor inputs will by itself foster GDP per capita convergence between the poor South and the rich East, favoring growth in the South by 0.7 percentage points.Whether this potential will be realized by South Asia is, of course, another mater entirely.

Will these purely demographic contributions to growth retardation be offset by Asians working harder, and by their more active participation in the labor force? No. Asians will work less hard as their incomes rise, just as workers have done before them in the more industrially mature countries. And fewer prime-age Asians will work since they will be able to afford earlier retirement and longer spells of schooling. In any case, if Asians work just as hard in the future, this will reduce that part of the labor-input-per-capita-growth effect to zero. Asians will have to work harder and harder simply to maintain the effect, and they will not if history is any guide.

The Impact of Demography on Savings

Almost forty years ago, Coale and Hoover (1958) proposed their famous dependency hypothesis. It was based on a simple but powerful intuition: rapid population growth from falling infant and child mortality and rising fertility swells the ranks of dependent young, and that demographic event increases consumption requirements at the expense of savings: eventually, the youth dependency burden evolves into a young adult glut and the resulting savings boom contributes to an economic miracle; finally, the demographic transition is manifested by a big elderly burden, low savings, and a deflation of the miracle. The Coale-Hoover hypothesis suggests that some of the impressive rise in Asian savings rates can be explained by the equally impressive decline in dependency burdens, that some of the difference in savings rates between sluggish South Asia and booming East Asia can be explained by their different dependency burdens, and that as the youth dependency rate falls in South Asia and as the elderly dependency rate rises in East Asia over the next three decades, some of the savings rate gaps between the two regions should tend to vanish.

The Coale-Hoover intuition has evolved into explicit economic models that, now revised, do very well in accounting for savings. Almost all of recent analysis of macro data confirm the Coale-Hoover effects, especially for Asia (Fry and Mason 1982; Mason 1987, 1988; Masson 1990; Webb and Zia 1990; Collins 1991; Williamson 1993; Higgins 1994, 1997; Kang 1994; Kelley and Schmidt 1995, 1996; Harrington 1996; Lee, Mason, and Miller 1997; Taylor and Williamson 1994; Taylor 1995).

The biggest impact has been estimated by Higgins and Williamson (1996, 1997) and we use those results in what follows. Higgins and Williamson estimate the effect of changes in population age distribution on the savings rate as it deviated around the 1950-1992 mean. Thus, East Asia's savings rate was 8.4 percentage points above its 1950-92 average in 1990-92 due to its transition to a much lighter dependency burden. Similarly, East Asia's savings rate in 1970-74 was 5.2 percentage points below its 1950-92 average due to the heavy dependency rate burden at that time. The total demographic swing was an enormous 13.6 percentage points, accounting for <u>all</u> of the total rise in the savings rate in East Asia over these twenty years. The figures for Southeast Asia are similar, but not quite so dramatic. Southeast Asia's savings rate was 7.9 percentage points higher in 1990-92 than its 1950-92 average due to its lighter dependency burden late in the 20th century. And Southeast Asia's savings rate was 3.6 percentage points lower in 1970-74 due to the heavier burden at that time. The total demographic swing was 11.5 percentage points, a smaller figure than for East Asia but still accounting for <u>all</u> of the total rise in the savings rate in Southeast Asia after 1970. The region with the slowest demographic transition has been South Asia, so the far more modest changes in the savings rate there are predictable.

To the extent that domestic savings constrains accumulation, falling dependency rates have played an important role in East Asia's economic miracle since 1970. Indeed, assuming the increase in investment to have been equal to the increase in savings -- an assumption rejected in the next section, and assuming a capital-output ratio of 4, it follows that the demographic impact raised accumulation rates in East Asia by 3.4 percentage points, thus augmenting GDP per capita growth by 1.5 percentage points. Since we have already estimated that demographic forces raised East Asian growth rates by as much as 1.9 percentage points, it looks like about three-quarters of this is due to accumulation responses. The figure is too high, of course, due to that assumption that domestic savings fully constrained investment.

The Impact of Demography on Investment

To the extent that East Asia was able to exploit global capital markets over the past quarter century, domestic saving supply is far less relevant than investment demand in determining accumulation performance. As the children of a baby boom became young adults, did not the increase in new workers imply the need for investment in infrastructure to get them to work, to equip them while at work, and to house them as they moved away from their parents?

When Higgins and Williamson (1996, 1997) test this augmented Coale-Hoover hypothesis on Asia's past, it appears that changing age distributions have the predicted impact. For East Asia, demographic effects have served to raise investment shares by 8.8 percentage points since the late 1960s. Using the same assumptions made in the previous section on savings, this implies a 1 percentage point rise in the rate of GDP per capita growth. In short, demographic forces contributed 0.6 percentage points to the East Asian miracle via labor inputs per capita and 1 percentage point via capital accumulation per capita, roughly consistent with the total demographic impact estimated using macro growth equations, 1.6 versus 1.4 to 1.9 percentage points. Thus, labor force growth responses might account for a third of the positive demographic contribution to the miracle (0.6/1.9), accumulation responses for a half (1/1.9), and other forces for the small remainder.

Directions of Future Research

We can think of four ways to further this line of research. First, there are other theoretical approaches which might be explored. The standard Ramsey model has, after all, been criticized. New ways of thinking about growth could provide other models in which demographic dynamics and economic growth could be jointly assessed. Second, as further advances in the growth literature define more effectively the steady-state, the robustness of these results can be tested and the analysis extended. Third, far more work needs to be done to establish the sources of the demographic transition in Asia after World War II: how much exogenous and how much endogenous? The recent explosion in the empirical growth literature incorporating panel data sets could provide additional analysis as to how economic growth varies with population dynamics. Fourth, economic and demographic historians should join the search for other dramatic episodes of growth and population dynamics, one of which might be the age of mass migration (Taylor and Williamson 1994; Williamson 1997).

In any case, while our results certainly do not prove that population dynamics affects economic growth during transitions, they do appear sufficiently robust to justify far more additional research on the economic-demographic connection. That research should reject steady states and aggregate population growth, and focus instead on transitions, population dynamics and changing age distributions.

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Table 1: OLS Regression of Economic Growth on Population Growth, 1965-90.
Dependent variable: Growth rate of real GDP per capita, 1965-90, in PPP terms
Sample includes 78 countries.

Independent Variables	OLS Estimates	
	(1) Specification 1 Revised	(2) Specification 2 Emerging Asia
GPOP6590	.16 (.20)	.56 (.16)
GDP per Capita as ratio of US log GDP per capita, 1965 (logged)	-1.50 (.25)	-2.30 (.22)
Log Life Expectancy, 1960		5.81 (.98)
Log Years of Secondary Schooling 1965	.82 (.18)	.37 (.15)
Natural Resource Abundance	-4.68 (1.35)	-2.40 (1.17)
Openness	2.23 (.47)	1.88 (.36)
Quality of Institutions	.21 (.10)	.22 (.07)
Access to ports (landlocked)	-.68 (.39)	-.87 (.29)
Average Gov't Savings, 1970-90	.18 (.04)	.15 (.03)
Located in the Tropics		-1.09 (.33)
Ratio of Coastline Distance to Land Area		.29 (.12)
Constant	-2.11 (.92)	-27.38 (4.3)
Adjusted R^2	.69	.83

Standard errors are reported in parentheses below coefficient estimates.

Table 2: Effects of Population Growth on Economic Growth, 1965-90.
Dependent variable: Growth rate of real GDP per capita, 1965-90, in PPP terms
Sample: 78 countries

Independent Variables	OLS Estimates			
	(1) Specification 1	(2) Specification 2	(3) Specification 1 (constrained)	(4) Specification 2 (constrained)
GEAP6590	1.95 (.38)	1.46 (.34)		
GPOP6590	-1.87 (.43)	-1.03 (.40)		
GEAP6590-GPOP6590			1.97 (.38)	1.68 (.35)
GDP per Capita as ratio of US GDP per capita, 1965	-1.36 (.21)	-2.00 (.21)	-1.39 (.21)	-1.97 (.22)
Log Life Expectancy, 1960		3.96 (.97)		2.94 (.97)
Log Years of Secondary Schooling 1965	.50 (.16)	.22 (.14)	.50 (.16)	.28 (.14)
Natural Resource Abundance	-4.86 (1.2)	-2.35 (1.0)	-4.86 (1.1)	-2.57 (1.1)
Openness	2.06 (.40)	1.92 (.32)	2.00 (.38)	1.72 (.33)
Quality of Institutions	.23 (.08)	.20 (.07)	.22 (.08)	.15 (.07)
Access to ports (landlocked)	-.35 (.34)	-.64 (.27)	-.31 (.32)	-.40 (.27)
Average Gov't Savings, 1970-90	.14 (.03)	.12 (.03)	.14 (.03)	.13 (.03)
Located in the Tropics		-1.31 (.30)		-1.20 (.31)
Ratio of Coastline Distance to Land Area		.24 (.11)		.23 (.12)
Constant	-2.46 (.79)	-19.5 (4.3)	-2.28 (.69)	-14.3 (4.1)
Adjusted R^2	.76	.86	.78	.85

Standard errors are reported in parentheses below coefficient estimates.
Column 1: Test of gpop6590=-geap6590: F(1,68)=.22; Prob>F=.64
Column 2: Test of gpop6590=-geap6590: F(1,64)=9.03; Prob>F=.003

Table 3: Instrumental Variables Estimates of the Effects of Population Growth on Economic Growth.
Dependent variable: Growth rate of real GDP per capita, 1965-90, in PPP terms.
Sample size: 70 Countries

Independent Variables		(1) Specification 1	(2) Specification 2	(3) Specification 1 (constrained)	(4) Specification 2 (constrained)
GEAP6590	IV	3.83 (.82)	1.37 (1.71)		
	OLS	1.95 (.40)	1.41 (.37)		
GPOP6590	IV	-4.19 (.96)	-.92 (2.12)		
	OLS	-1.93 (.45)	-.97 (.43)		
GEAP6590-GPOP6590	IV			3.52 (.75)	3.43 (.98)
	OLS			1.95 (.40)	1.60 (.38)
Hausman Specification Test (Chi Square w/ df)		7.13 (10 df)	.00 (13 df)	6.16 (9 df)	4.14 (12 df)

Standard errors are reported in parentheses below coefficient estimates.

[a] Instruments from first stage regression include average growth of population from 1950-60, percentage of the urbanized population in 1965, population policy variables including attitudes toward fertility and population growth and whether a government agency exists to create population policy , and dummy variables for countries where the major religion was Muslim or Judeo-Christian.
The following countries are not included in truncated sample due to missing data: Botswana, Zaire, Niger, Hong Kong, Taiwan, Singapore, Haiti, and Tanzania.

Table 4: Effects of Population Growth on Economic Growth with Alternative Specifications, 1965-90.
Dependent variable: Growth rate of real GDP per capita, 1965-90, in PPP terms
Sample: 78 countries

Independent Variables	OLS Estimates					
	(1) Specification 1	(2) Specification 2	(3) Specification 1	(4) Specification 2	(5) Specification 1	(6) Specification 2
GEAP6590	1.94 (.66)	1.36 (.55)	2.03 (.43)	1.43 (.39)	1.91 (.45)	1.24 (.40)
GPOP6590	-1.87 (.45)	-1.01 (.41)	-1.88 (.43)	-1.02 (.40)	-1.72 (.49)	-.78 (.45)
Interaction Between GEAP & Instit'l Quality	.002 (.07)	.01 (.06)				
Interaction Betwenn GEAP & Openness			-.12 (.31)	-.05 (.25)		
Asia Dummy					.81 (.44)	.60 (.35)
North America Dummy					.36 (.67)	.67 (.55)
South America Dummy					.08 (.49)	.35 (.42)
Europe Dummy					1.00 (.60)	.53 (.50)
Constant	-2.43 (1.35)	-19.3 (4.3)	-2.62 (.89)	-19.6 (4.3)	-2.89 (1.20)	-20.19 (4.4)
Adjusted R^2	.77	.86	.77	.86	.79	.86

Standard errors are reported in parentheses below coefficient estimates.

Table 5: Effects of Population Growth on Economic Growth with Alternative Specifications, 1965-90.
Dependent variable: Growth rate of real GDP per capita, 1965-90, in PPP terms
Sample: 78 countries

Independent Variables	OLS Estimates	
	(1) Specification 1	(2) Specification 2
GEAP6590	.82 (.21)	.81 (.18)
Growth Rate of Population < 15, 1965-90	-.71 (.16)	-.37 (.16)
Growth Rate of Population 65+, 1965-90	.11 (.10)	.08 (.08)
Adjusted R^2	.78	.86

Standard errors are reported in parentheses below coefficient estimates.
Note that only the coefficients on the demographic variables are reported in the table.

Table 6: Contribution of Demographic Change to Past Economic Growth.

Regions	Average Growth Rate of Real GDP per Capita, 1965-90	Average Growth Rate of Population, 1965-90	Average Growth Rate of Economically Active Population, 1965-90	Average Growth Rate of Dependent Population, 1965-90	Estimated Contribution, 1965-90 (Columns correspond to specications in Table 4)			
					(1)	(2)	(3)	(4)
Asia	3.33	2.32	2.76	1.56	1.04	1.64	.86	.73
East Asia	6.11	1.58	2.39	.25	1.71	1.87	1.60	1.37
Southeast Asia	3.80	2.36	2.90	1.66	1.25	1.81	1.07	.91
South Asia	1.71	2.27	2.51	1.95	.66	1.34	.48	.41
Africa	.97	2.64	2.62	2.92	.14	1.10	-.07	-.06
Europe	2.83	.53	.73	.15	.43	.52	.39	.33
South America	.85	2.06	2.50	1.71	1.03	1.54	.87	.74
North America	1.61	1.72	2.13	1.11	.94	1.34	.81	.69
Oceania	1.97	1.57	1.89	1.00	.74	1.14	.62	.53

Table 7: Contribution of Demographic Change to Future Economic Growth.

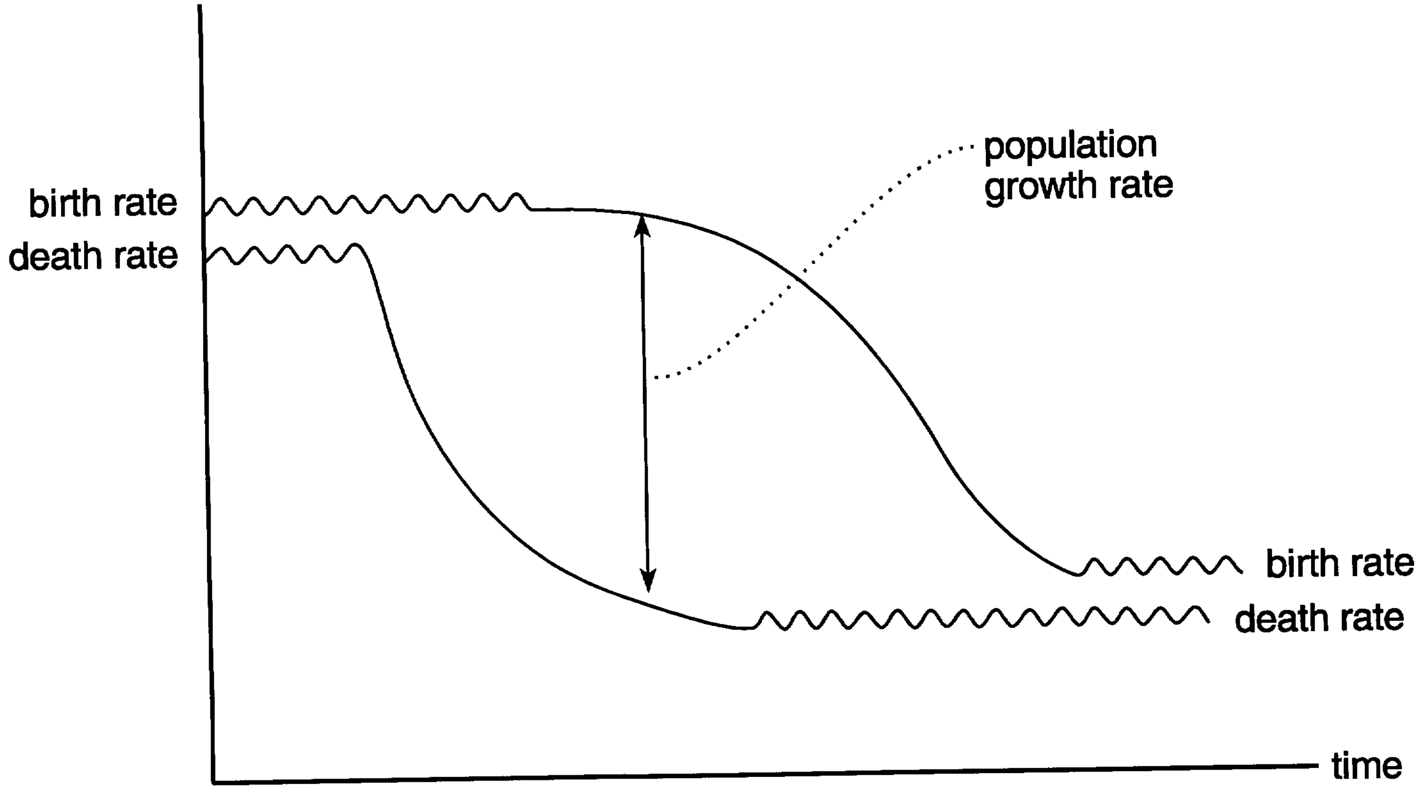
Regions	Projected Growth Rate of Population, 1990-25	Projected Growth Rate of Economically Active Population, 1990-25	Projected Growth Rate of Dependent Population, 1990-25	Estimated Contribution, 1990-25 (Columns correspond to specications in Table 4)			
				(1)	(2)	(3)	(4)
Asia	1.36	1.61	.99	.61	.99	.50	.43
East Asia	.43	.20	.87	-.40	-.14	-.44	-.38
Southeast Asia	1.29	1.66	.63	.83	1.10	.73	.62
South Asia	1.65	2.11	.90	1.02	1.38	.90	.77
Africa	2.40	2.78	1.88	.98	1.63	.73	.68
Europe	.17	-.004	.48	-.32	-.16	-.34	-.29
South America	1.50	1.87	.94	.82	1.15	.71	.60
North America	1.28	1.33	1.21	.21	.645	.11	.10
Oceania	1.08	.93	1.37	-.22	.24	-.31	-.26

Table 8: Variable Definitions and Selected Descriptive Statistics.

Variable Name	Definition (Source)	Mean	Standard Deviation	Min	Max
GPOP6590	Population Growth Rate, 1965-90. Source: World Bank.	1.88	1.00	0.17	3.49
GEAP6590	Growth rate of economically active population 1965-90. Source: World Bank.	2.17	1.03	0.25	3.63
Growth rate of population <15	Source: World Bank	1.11	1.53	-1.43	3.69
Growth rate of population 65+	Source: World Bank	2.62	0.98	0.79	5.73
Growth of the dependent population	Source: World Bank	1.46	1.17	-0.40	3.55
Average birth rate, 1967-87	Source: World Bank	30.89	12.56	13.7	53.9
Average death rate, 1967-87	Source: World Bank	11.68	5.04	5.15	28.85
Average infant death rate	Average infant death rate, 1967-87 Source: World Bank	2.54	2.52	0.12	9.70
Average non-infant death rate	Average non-infant death rate, 1967-87 Source: World Bank	9.03	3.21	3.87	19.55
GDP per Capita as ratio of US GDP per capita	Ratio of GDP per capita in country and US in 1965. Source: World Bank	-1.65	0.91	-3.34	-0.00
Schooling (log)	Average year of secondary school for population 15+ in 1965. Source: Barro&Lee	-0.70	1.15	-4.83	1.26
Life Expectancy (log)	Life expectancy in 1960. Source: World Bank	4.02	0.22	3.47	4.30
Natural Resource Abundance	Share of primary product exports in GDP in 1971. Source: World Bank	0.10	0.09	0.00	0.51
Access to ports	Dummy variable indicating if country is landlocked	0.13	.34	0.0	1.0
Openness	Source: Sachs & Warner	0.45	0.45	0.0	1.0
Between the tropics	Dummy variable indicating if country is between the tropics	0.51	0.48	0.0	1.0
Ratio of coastline to land area	Source: World Bank	0.30	0.96	0.0	7.33
Growth of government savings, 1970-90	Expressed as share of GDP. Source: World Bank	1.44	3.43	-5.24	12.57
Growth of private savings, 1970-90	Expressed as share of GDP. Source: World Bank	15.94	9.57	-19.36	34.70
Quality of institutions	Source: Keefer and Knack index of the quality of governmental institutions.	6.11	2.42	2.27	9.98

Figure 1

Demographic Transition



Population Growth and the Age Structure

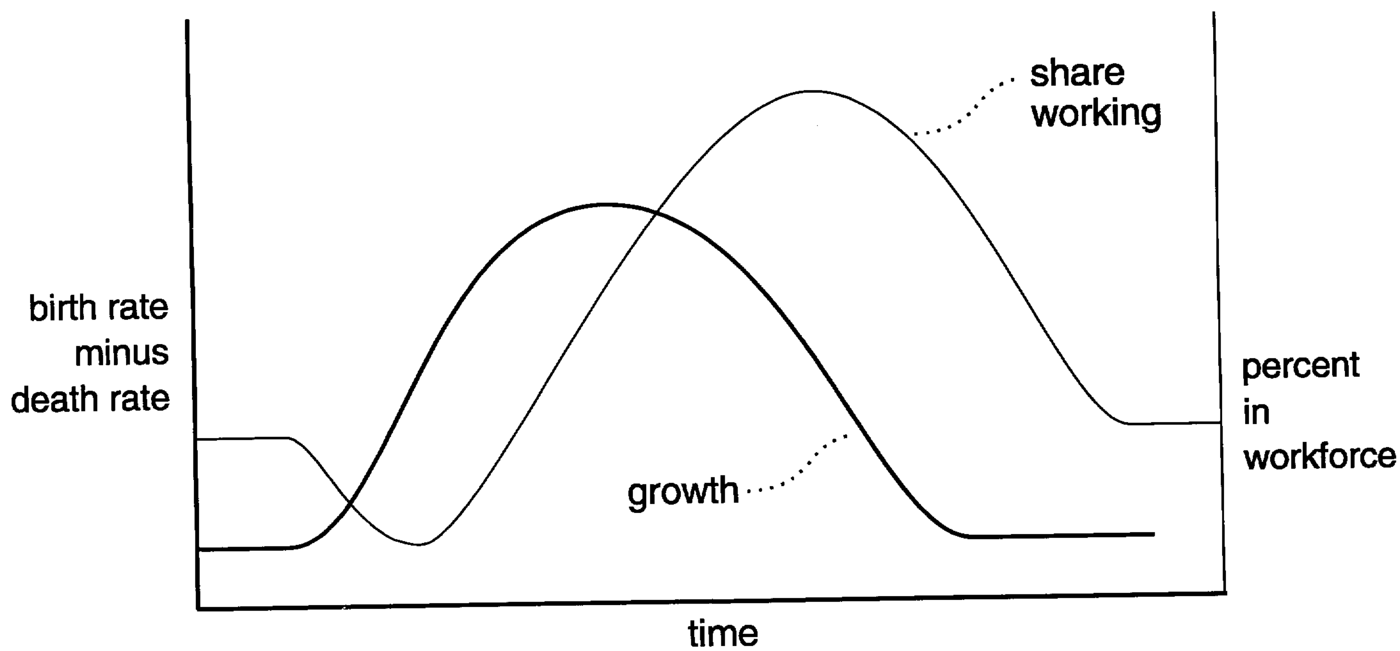
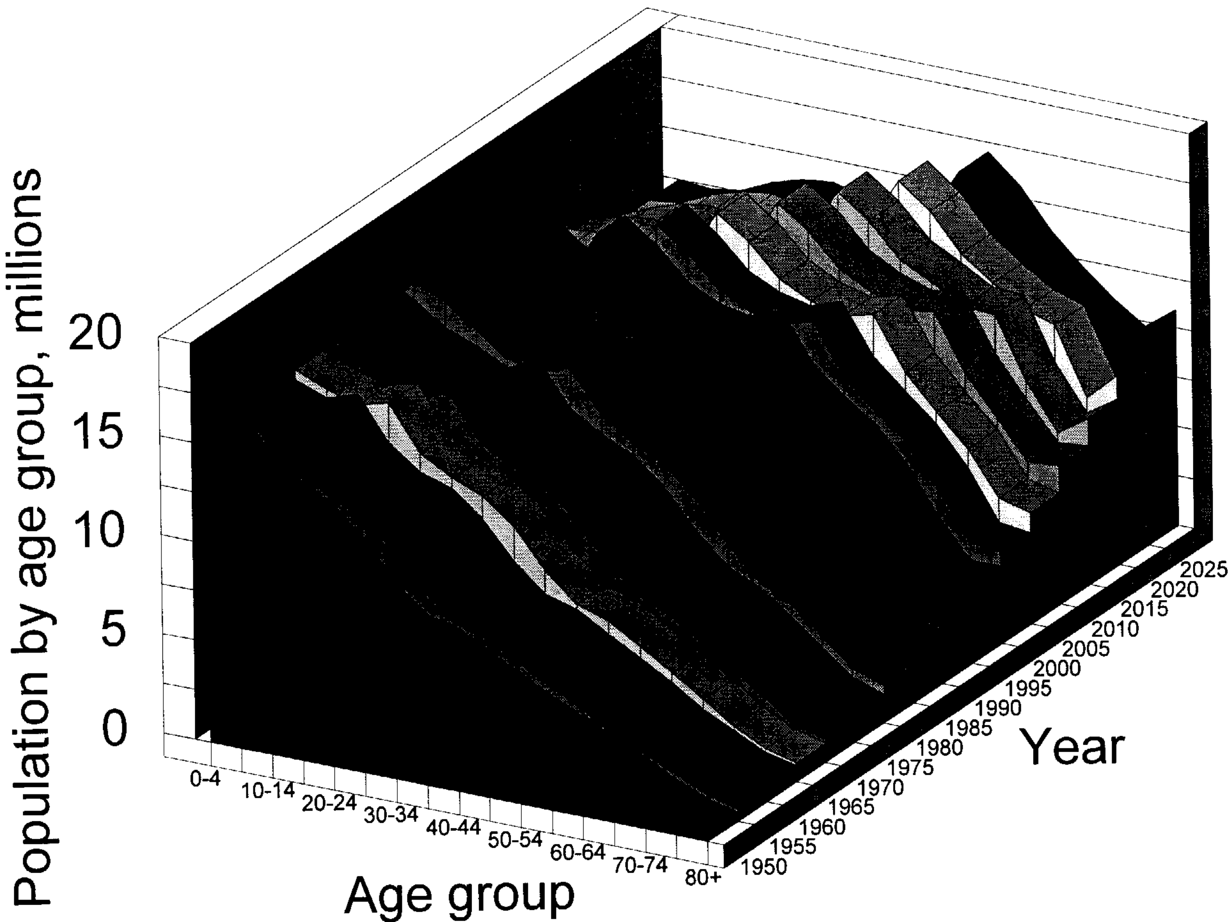


Figure 2. Changing Age Distribution

East Asia without China



Source: The Sex and Age Distributions of Population. The 1992 Revision of the United Nations' Global Population Estimates and Projections

Figure 3. Crude Death Rate by Subregion

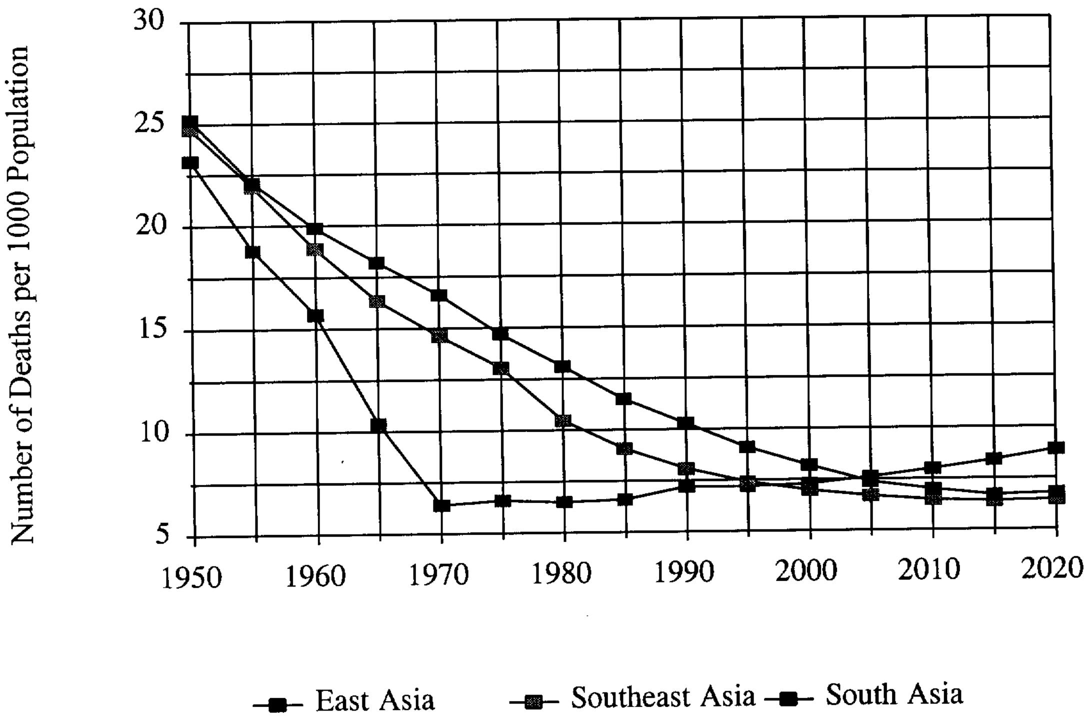
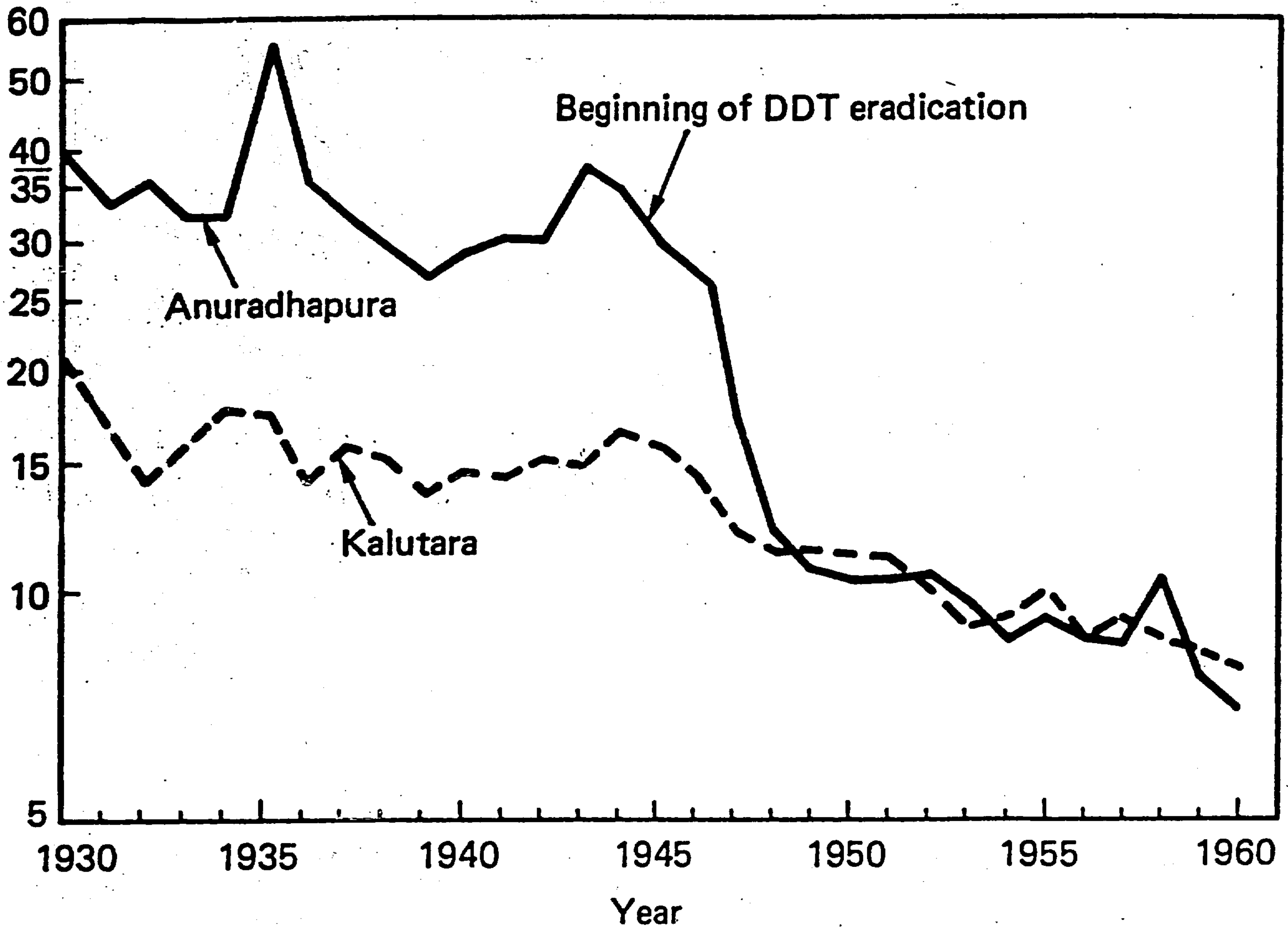


Figure 4. The Effect of DDT Usage on Mortality in Sri Lanka



Source: Livi-Bacci, Massimo (1992). *A Concise History of World Population.* Cambridge, MA: Blackwell, p. 157.

Figure 5. Crude Birth Rate by Subregion

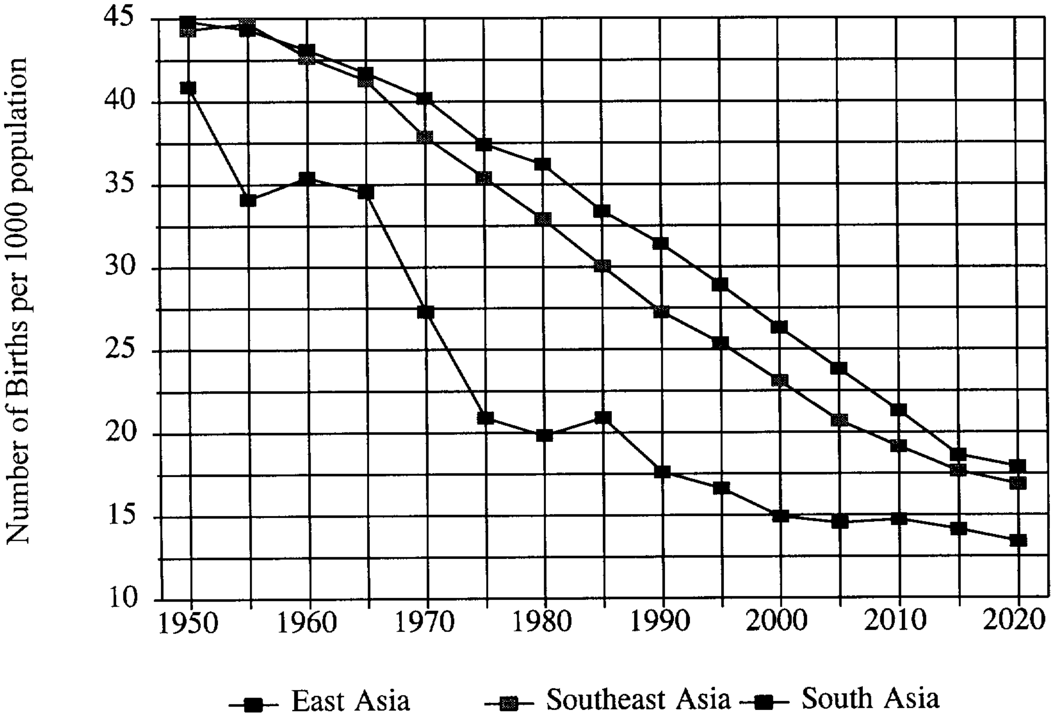


Figure 6. Ratio of Working-age to Non-working-age Population

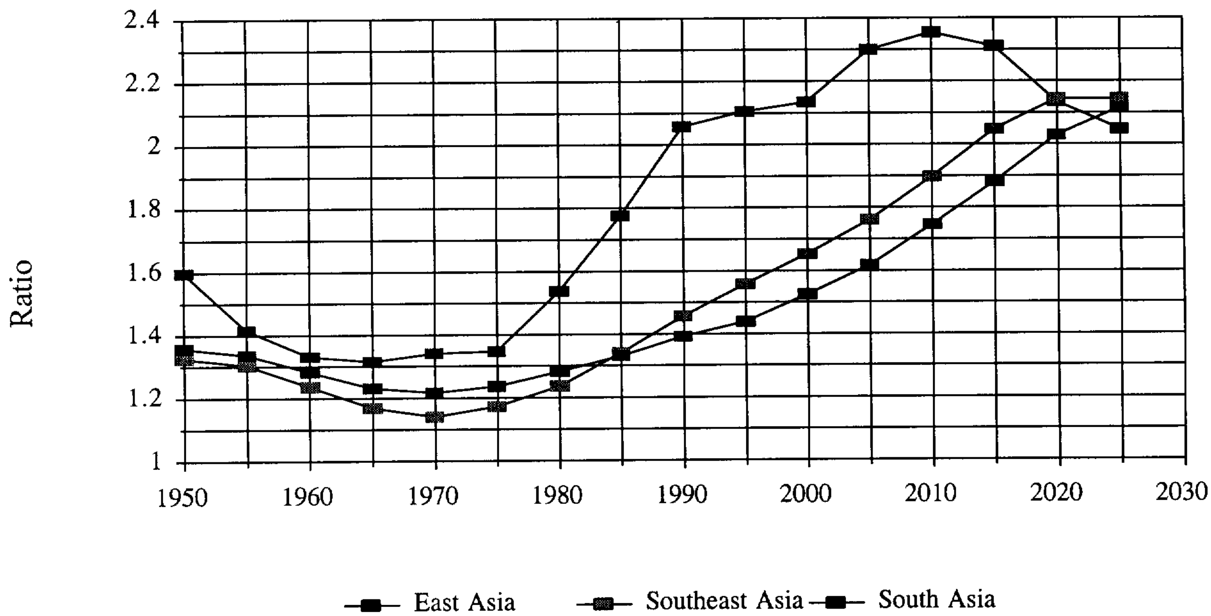


Figure 7

Stylized Model of Economic Growth and the Demographic Transition in East Asia

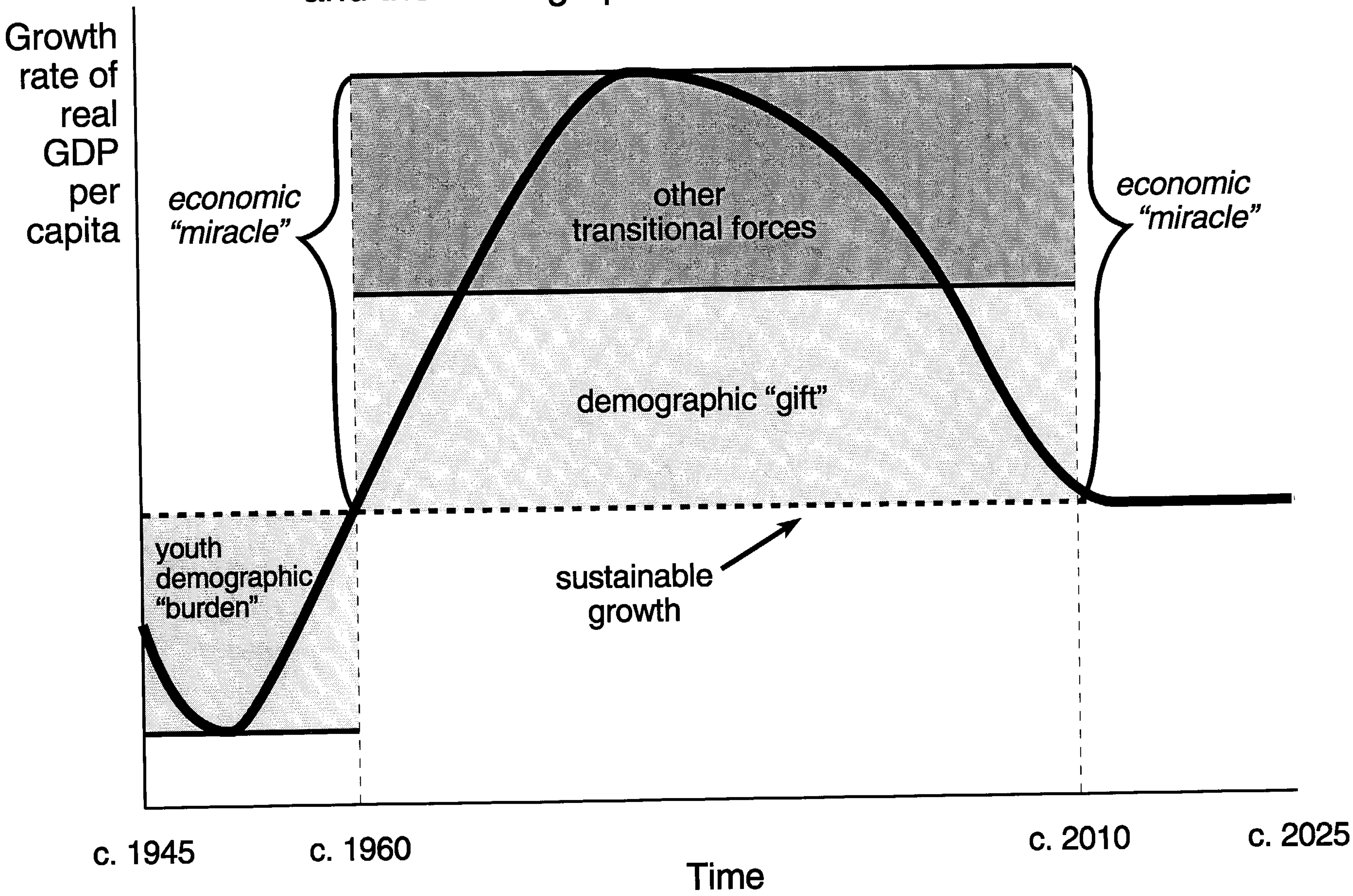


Figure 8

Stylized Model of Economic Growth and the Demographic Transition in Asia