Why Has China's Economy Taken Off Faster than India's?

June 2006

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Abstract

We investigate the determinants of the modest economic takeoff in India and the rapid economic takeoff in China after 1980. We first conduct a simple shift-share analysis of increases in output per worker in the two countries. This analysis highlights the importance of non-agricultural productivity growth to the growth of output per worker in both countries.

We also fit a model of the growth of income per capita to cross-country panel data for 1960-2000. The model predicts the "takeoffs" in growth in per capita income in China and India after 1980 reasonably well, based on changes in domestic factors in each country. The model finds the major sources of increased economic growth to have been, in order of importance, improved health and longevity, increased openness to international trade, and an elevated labor force per capita due to falling fertility rates and dependency ratios.

The income growth model measures the instrumental value of improved health as an input into production. Looking at full income, including the welfare benefits of gains in health as well as consumption, we find that improvements in health in India mean that full income has risen about 50% more since 1980 than is suggested by economic growth figures. Almost all the welfare gains in China since 1980 have been due to rising consumption with little improvement in population health.

1. Introduction

Comparing China and India is a decades-old activity. The world's two population superpowers have long fascinated the West, but until fairly recently they were small players on the international economic scene. The emergence of China as a major economic power was followed by a slower, but still important, economic transformation in India. Both countries, by virtue of their sheer size, have the potential to be dominant forces in the international economy.

Before 1980, economic growth in both China and India, as measured by the growth rate of income per capita (in purchasing power parity terms), was relatively slow. After 1980, growth in both countries accelerated, dramatically in China and more modestly in India (see figure 1). China rapidly overtook India, and now has substantially higher income per capita.

This paper analyzes and compares the acceleration of economic growth in India and China. There are three possible approaches to this task. The first is a simple shift share analysis, which can be used to decompose the growth of income per worker into a portion attributable to the reallocation of labor from low to high productivity sectors and a portion attributable to the growth in labor productivity within sectors. The second approach is to calibrate a production function, along the lines of Young (1994, 1995), and to apply the growth rate of factor inputs in each country to estimates of the marginal productivity of each factor (based on microeconomic data) to find their contribution to overall economic growth.

A third approach is to estimate the impact of different variables that may affect growth in a panel of countries and apply the results to India and China to see the amount of economic growth for which these variables account. The advantage of this approach over the first two is that it enables us to include in the analysis some variables that may matter enormously for economic growth, but whose effects are difficult to calibrate using microeconomic data. These variables include measures of institutional quality and openness to international trade.

The ability of models such as ours to explain takeoffs in economic growth is by no means assured. Easterly, Kremer, Pritchett, and Summers (1993) emphasize that national rates of growth of income per capita are essentially uncorrelated across successive five-year periods. They point out that it is difficult to explain these essentially random fluctuations using the fairly slow-moving variables used to explain cross-country variations in economic growth. Our explanation emphasizes demographic changes, especially in age structure. Such changes can occur relatively quickly and have the potential to explain takeoffs into rapid economic growth. The two demographic factors we emphasize are rapid increases in life expectancy and declines in fertility. These have occurred in both India and China, though in each case the magnitude of the effects has been greater in China.

An increase in life expectancy, which can be thought of as a proxy for population health, has a number of potential economic effects. To the extent that health affects labor quality and productivity, one would expect improved health in China, and therefore the rising standard of labor inputs, to have an effect on GDP per worker. Fogel (1994) emphasizes the role played by better health and nutrition in the Industrial Revolution, and Fogel (2004) argues that these same changes led to a substantial improvement in productivity in China. Bloom, Canning, and Sevilla (2004) estimate the effect of health as a form of human capital in a cross-country study of growth rates.[2] In addition to this effect of health on worker productivity, an increase in health and prospective longevity can also be a driving force for increased savings for retirement (Bloom, Canning, and Graham (2003); Bloom, Canning, Mansfield, and Moore (2006)), higher rates of foreign direct investment (Alsan, Bloom, and Canning (2006)), and higher rates of domestic investment, savings, and educational enrollment (Lorentzen, McMillan, and Wacziarg (2005)).

Rapid declines in fertility have also taken place in both countries, though more precipitously in China. Initially, declines in mortality in India and China, which included large declines in infant and child mortality, led to large cohorts of young people. A subsequent decline in fertility produced a "bulge" generation. In general, when large generations reach working age, a country experiences a demographically induced economic boost, provided this demographic cohort is productively employed. Bloom and Williamson (1998), Bloom, Canning, and Malaney

[2] See also Bhargava et al. (2001).

(2000), and Mason (2001) have investigated the role of this "demographic dividend" in the successful East Asian "Tiger" economies. Cai (2004) does so for China, and Bloom and Canning (2003) likewise examine the recent economic boom in Ireland.

East Asia's macroeconomic performance is tracked very closely by its demographic transition and the resulting changes in age structure. Estimates indicate that the "demographic dividend" accounts for as much as one-third of its "economic miracle" (Bloom and Williamson (1998), Bloom, Canning, and Malaney (2000)). By contrast, the absence of demographic change also accounts for a large portion of Africa's economic debacle (Bloom, Canning, and Sevilla (2003); Bloom and Sachs (1998)). These results of these analyses of demographics have reduced the need to argue that there are factors exceptional to East Asia or Africa. Once age structure dynamics are introduced into the economic growth model, these regions appear to more closely obey common principles of economic growth (Bloom, Canning, and Malaney (2000)).

In 1975, the ratio of working-age (15-64) to non-working-age (0-14 and 65+) people in both China and India was around 1.3. This means that the number of working-age people was only modestly larger than the number of people who, by virtue of their age, were most likely dependents. In the 1970s, China launched the "later, longer, fewer" campaign (later marriage and age at first birth, longer inter-birth intervals, and fewer births (i.e., 2 in the cities and 3 in the countryside)). This evolved into the adoption in 1980 of the one-child policy, which encouraged and very often required couples to have only one child (though the policy was less rigorous in rural areas and among ethnic minorities). The campaign and policy propelled the sharp decline in fertility that began in the 1970s. This decline triggered a subsequent sharp rise in the ratio of working-age to non-working-age people, which is headed toward an expected peak of 2.5 in 2010. India's demographics are changing similarly but more slowly, with an expected peak ratio of 2.1 in 2035, a level that China reached in 1995. In India, the greater portion of this potential demographic dividend lies ahead. China, by contrast, now anticipates a very rapidly rising elderly population in the not-too-distant future, with over 400 million Chinese -- 30% of the population -- projected to be age 60 and over by 2050.

It is clear, both theoretically and empirically, that there is nothing automatic about the link from demographic change to economic growth (Bloom, Canning, and Sevilla (2003), Bloom and Canning (2003)). Age distribution changes create supply-side potential for economic growth. Whether or not this potential is captured depends on the policy environment, as reflected by the quality of governmental institutions, labor legislation, macroeconomic management, openness to trade, and education policy, among other factors. Latin America seems to have stumbled in this realm. Between 1965 and 1990, its demographics resembled those of East Asia, but its economic performance conformed more closely to that of Sub-Saharan Africa (especially during the latter part of this period). Poor macroeconomic management and weak governance seem to have prevented much of Latin America from exploiting, at least during its early phases, the window of opportunity created by its demographics. The practices of China and India appear to have fallen between extremes; their ability to quickly absorb an increase in labor force is better than that in parts of Africa or Latin America, however it is not as good as that of Ireland during its recent demographically-induced economic boom.

There are additional possible explanations of China and India's remarkable economic growth. Both countries embarked on economic reform characterized by deregulation and liberalization, which opened up their economies to international trade and attracted foreign investment. China reformed earlier and much more aggressively than India, beginning in the 1980s. Only in 1991, in response to fiscal and balance-of-payments crises, did India launch widespread economic policy reforms. The main consequences of economic reform and increased openness, such as the growth of private enterprises, the large inflow of foreign direct investment (FDI), and the increased volume of foreign trade, appear to have contributed significantly to economic growth. The relationships among economic reform, the opening-up of trade, and economic growth have been discussed in relation to China by Demurger et al. (2002), Shen and Geng (2001), Chen and Feng (2000), Cai and Du (1998), and for India by Chopra et al. (1995) and Sachs et al. (1999). We try to capture these effects in our empirical analysis with a measure of institutional quality and a measure of openness to trade.

India and China have also made improvements in education. Cai and Du (1998), Wang and Yao (2001), and Chopra et. al. (1995) examine the contribution of human capital, proxied by education level, to economic growth. We include a measure of education in our analysis.

Labor reallocation from agriculture to other sectors has been singled out for attention as a source of economic growth in China and India. These two countries, as well as many others,[3] had surplus labor in agriculture with a large differential in labor productivity between agriculture and industry. As a consequence, the inter-sectoral shift of labor (away from agriculture) increased overall productivity and therefore aggregate output. The effect in China of labor reallocation has been investigated by Sachs and Woo (1994), Woo (1997), and Cai and Wang (1999). To capture this effect, we include a measure of sectoral change in our empirical work.

Lucas (1993) emphasizes productivity growth as a source of economic "miracles." We put more emphasis on demographic factors that increase labor supply per capita, and improvements in the health and productivity of labor. However, our variables for trade, institutional quality, and sectoral reallocation can all be thought of to some extent as proxies for productivity growth effects rather than the quantity or quality of inputs.

Our emphasis on economic growth means that we treat health as an input whose value is purely instrumental. A broader notion of "full income" would measure health as well as consumption. We follow the methodology used in Becker, Philipson, and Soares (2005) to monetize the value of gains in life expectancy and compare these gains to those from rising consumption levels. Continued health improvements in India mean that full income has been rising faster than consumption. This is not the case in China, where population health has been stagnating since 1980. As a result, the deficit in India's development progress -- relative to that of China -- is smaller when measured in full-income terms than when measured in terms of economic growth.

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[3] Bloom and Freeman (1986).

2. Sources of Economic Growth

Most empirical models of economic growth focus on the growth of income per capita, which is a convenient summary indicator of the standard of living. However, economic theories are typically more relevant to the level of output per worker. In addition, growth models often do not consider the sectoral composition of the economy. We therefore begin by considering the possible role that changes in the number of workers per capita and in sectoral composition play in explaining economic growth in India and China.

We start with an accounting identity that links income per capita (Y/N) to income per worker (Y/L)

$$\frac{Y}{N} = \frac{Y}{L}\frac{L}{WA}\frac{WA}{N}$$

In this identity, WA represents the population of working age. The identity merely states that the level of income per capita equals the level of income per worker times the labor participation rate (L/WA) times the ratio of working age to total population (WA/N). Defining

$$y = \log\frac{Y}{N}, z = \log\frac{Y}{L}, \rho = \log\frac{L}{WA}, w = \log\frac{WA}{N}$$

and totally differentiating the identity, we have that the growth rate of income per capita equals the growth of income per worker plus the growth of labor participation plus the growth of the ratio of working-age to total population. That is:

$$\dot{y} = \dot{z} + \dot{\rho} + \dot{w}$$

Table 1 performs this decomposition of growth in India and China for the period 1980 to 2000 with the period 1970 to 1980 given for comparison. The figures suggest that faster growth in output per worker accounts for most of the speed up in growth in China and India, with modest contributions from rising participation rates and increases in the working-age share of the total population.

Growth in income per worker can result from increases in worker productivity in each sector, or from the reallocation of workers from low-productivity to high-productivity sectors. Table 2 reports the shares of employment in agriculture, industry, and services, and Table 3 reports labor productivity in each sector for China and India since 1970.[4] Both China and India have seen a movement of workers out of agriculture and into industry and services, although this effect has been more pronounced in China, contributing to its higher growth rate. Table 3 shows that agricultural productivity is about a quarter of the level of worker productivity found in industry and services. The most striking feature shown in Table 3 is the rapid growth of output per worker in industry in China since 1980.

We can decompose the effect of changing sectoral shares on economic growth more formally by writing

$$z = z_a\beta_a + z_i\beta_i + z_s\beta_s \quad ,$$

according to which GDP per worker is a weighted average of the output per worker in the agriculture, industry, and service sectors, given by z_a, z_i, and, z_s, with the weights being the respective shares of each sector in total employment, given by $\beta_a, \beta_i, and\, \beta_s$.

Totally differentiating and dividing by z, we can write

$$\frac{dz}{z} = \left(\frac{z_a}{z}\beta_a\right)\left(\frac{dz_a}{z_a} + \frac{d\beta_a}{\beta_a}\right) + \left(\frac{z_i}{z}\beta_i\right)\left(\frac{dz_i}{z_i} + \frac{d\beta_i}{\beta_i}\right) + \left(\frac{z_s}{z}\beta_s\right)\left(\frac{dz_s}{z_s} + \frac{d\beta_s}{\beta_s}\right)$$

so that the growth in output per worker depends on (1) the growth of worker productivity in each sector and (2) the growth of each sector's share of total employment. We can separate out these

[4] The data used to construct the shift share analyses are drawn from the following sources: (1) World Development Indicators Database of the World Bank; (2) China Statistical Yearbook (Various Years); and (3) National Sample Employment-Unemployment Surveys (for India), Various Years (Data obtained by Communication with S. Sakthivel and Anup Karan).

two effects. Growth in output per worker due to sectoral productivity growth is

$$\left.\frac{dz}{z}\right|_{productivity} = \left(\frac{Y_a}{Y}\right)\left(\frac{dz_a}{z_a}\right) + \left(\frac{Y_i}{Y}\right)\left(\frac{dz_i}{z_i}\right) + \left(\frac{Y_s}{Y}\right)\left(\frac{dz_s}{z}\right)$$

where each sector's productivity growth rate is weighted by the share of that sector in total GDP (e.g. Y_a / Y is the share of agricultural output in total output). The increase in output per worker due to changes in sectoral composition is given by

$$\left.\frac{dz}{z}\right|_{sectoral} = \left(\frac{z_i}{z} - \frac{z_a}{z}\right)d\beta_i + \left(\frac{z_s}{z} - \frac{z_a}{z}\right)d\beta_s$$

where we have used the fact that $d\beta_a = -d\beta_i - d\beta_s$ due to the adding up constraint that the share of the three sectors must sum to one. Table 4 gives the results of this decomposition. The effect of growth in sectoral productivity is calculated by weighting each sector according to its share in GDP at the beginning of the period. The effect of changing sectoral employment shares is weighted using productivity levels at the beginning of the period. Using beginning-of-period weights, rather than continuously updating the weights as they change over time, means that our decomposition is an approximation and not an identity.[5]

Our calculations suggest that over the period 1980 to 2000, most of the growth of GDP per capita in China and India was due to increased productivity within sectors (5.3 of the 8.1 percentage points in China, and 3.0 of the 3.6 percentage points in India). The results in Tables 1 and 4 also imply that increases in labor force participation, a rising share of working-age people in the total population, and a movement out of agriculture into industry and services account for 2.6 percentage points of growth in China (roughly one third of the observed growth rate), and a paltry 0.3 percentage points of growth in India.

This analysis is mechanical and the interpretation, which attributes the results to separate productivity and labor force effects, assumes that changing sectoral employment shares do not change productivity per worker (that is, we assume the marginal product of workers equals the

[5] In practice we find that our decomposition is a close approximation.

average product). This is unlikely to be true. We also need to explain the growth in worker productivity itself.

We let z_0 be the initial level of income per worker and write the growth rate of income per worker $\dot{z}$ as

$$\dot{z} = \lambda(z^* - z_0)$$

where z* is the steady-state level of income per worker and λ is the speed of convergence (see Barro and Sala-I-Martin (1995) for a discussion of growth models of this type). The steady-state level of income per worker depends on many factors (such as the capital stock and education levels per worker, and total factor productivity levels) that may affect labor productivity.

We now incorporate this into our model of growth in income per capita.

Since $y_0 = z_0 + \rho_0 + w_0$

$$\dot{y} = \lambda(z^* + \rho_0 + w_0 - y_0) + \dot{\rho} + \dot{w}$$

In practice, we include only the effect of the ratio of working-age to total population in our empirical work and not the effect of the participation rate. Bloom and Canning (2003) investigate the effect of labor force participation on economic growth and find the estimated effect to be negative, in contrast to the unit positive accounting effect predicted by our growth equation. This appears to be attributable to the poor quality of the participation rate data as an indicator of labor supply. In rural areas, the household is often the production unit as well as the consumption unit and it is customary to count all adults as workers. This means that measured participation rates fall dramatically during the process of urbanization because those who work at household tasks in urban areas (usually women) are not part of the official labor force. This measured fall in labor force participation does not reflect an actual fall in labor inputs and is not associated with a decline in output. We therefore exclude the labor participation rate from the empirical growth equation.

We include the effect of sectoral change in our model, simplifying by taking just two sectors, agriculture and non-agriculture (i.e., an amalgam of industry and services). The effect of sectoral change depends on the size of the flow and the differential productivity between the two sectors. We assume that the rate of sectoral change is an increasing function of the productivity differences between sectors (on which there is only scattered reporting in our data). We therefore proxy the size of the productivity gap by the size of the flow between sectors. Our sectoral change variable is then

$$s = \Delta ag \frac{\Delta ag}{ag}$$

where Δag is the change in the share of workers in agriculture and $\Delta ag / ag$ is the percentage change in the share (i.e., our proxy for the productivity gap between sectors).[6] We can think of this sectoral change effect as part of the catch-up towards steady state in which the (quality-adjusted) labor productivity in each sector will be equal. Taking the rest of the steady-state level of income per worker to be determined by a set of variables X yields

$$\dot{y} = \lambda(\beta X^* + w_0 - y_0) + \gamma s + \dot{w}$$

This final equation is similar in form to the normal regressions run in growth theory. It relates growth in output per capita to a range of variables, X, that influence the steady-state level of output per worker and the initial level of income per capita, y_0. However, several other terms appear. The log of the initial ratio of working-age to total population affects the steady-state level of income per capita, while the growth rate of the ratio of workers to total population affects the growth of income per capita directly. As a result of the identity used to derive this regression, the coefficients on these two terms are fixed; they represent what will happen if the extra labor

[6] This approach does not impose the condition that productivity is lower in agriculture. Higher productivity in agriculture and a flow of workers into agriculture would also promote economic growth.

supply per capita due to these age structure effects is fully employed and leads to no diminution in the level of inputs per worker given by X. Rather than impose coefficients on these demographic variables we prefer to estimate all the parameters of the above equation, allowing for the possibility that some of the enlarged labor force may not be gainfully employed, and that labor force growth may dilute inputs per worker. We also include our variable, s, which captures the effect of sectoral change on economic growth.

3. Data

We construct a panel of countries observed every five years from 1960 to 2000. Data on GDP per capita and the ratio of investment to GDP are obtained from Penn World Table Version 6.1 (updated by Heston, Summers, and Aten in 2002).[7] Figure 1 shows how real income per capita has grown in China and India between the early 1950s and 2000. Both countries experienced a take-off in growth beginning around 1980, with the rise in income being much more marked in China than in India. Income per capita in China was six times higher in 2000 than in 1955, while in India it was 3.2 times higher. Both cases show the remarkable effects compound growth can have on the standard of living.

The data on working-age population (aged 15 to 64), total population, and life expectancy used in our regressions come from World Bank (2005). Figures 2, 3, and 4 show data for India and China on mortality, fertility, and age structure.

Figure 2 shows the increasing life expectancy in India and China. Although there have been remarkable gains in both countries, the most striking effect is the rapid improvement in population health in China between 1950 and 1975, which resulted largely from the government's focus on disease prevention and public health. Figure 3 shows the total fertility rate in China and India. Both had total fertility rates of around 6 children per woman in the 1950s, and the fertility rate has fallen dramatically since then. Again, the rate declined first in China,

[7] We rely on the Penn World Tables for data on PPP-adjusted GDP per capita because these data are more complete than the corresponding World Bank data.

from over 6 children per woman to around 2.5 children per woman between 1965 and 1980.[8]

Figure 4 shows the effect of the gains in life expectancy and declines in fertility on the ratio of the working-age to the non-working-age populations. The rapid demographic transition in China resulted in a sharp rise in the ratio of workers to dependents, from under 1.5 in 1975 to around 2.5 today. However, this shift is temporary and the ratio is projected to decline rapidly as the population ages. The growth in the ratio of workers to dependents in China will be of shorter duration and greater amplitude than that in India.

Education is measured by the average total years of schooling of the population aged 15 and over, taken from Barro and Lee (2000). Because the Barro and Lee (2000) data are missing for China before 1975, we construct these data based on Lee (2001), which has data for average schooling that span 1949 to 2000. The years of schooling in Lee (2001) are somewhat higher than those in Barro and Lee (2000) and we deflate the Lee (2001) data prior to 1975 by a fixed ratio so as to make the figures for 1975 agree.

Data on the share of labor in agriculture are from Food and Agriculture Organization (2005). In addition to these variables, we include geographic and institutional factors that may affect productivity. Data on the percentage of land area in the tropics come from Gallup, Sachs, and Mellinger (1999). Knack and Keefer (1995) give five indicators measuring institutional quality, corruption, rule of law, bureaucratic quality, expropriation risk, and repudiation of contracts by government. We use an updated version of this data set that contains data from 1982 through 1997. These variables are very slow moving, and we take the value in 1982 as fixed back to 1960. Experimentation with different measures (including using an average of the five indicators) led to the finding that bureaucratic quality seemed to be the most important in our growth regressions. The bureaucratic quality index, measured on a scale of 1 to 6, rose from 3 to 4 in India in the mid-1980s and has remained steady since, while in China it rose from 2.9 to 3 in the mid-1980s and to 3.7 in the mid-1990s (though it receded after 1995). Although we rely on

[8] The famine of 1958-61 and then the political and social instability/turmoil of the Cultural Revolution (1966-76) probably contributed significantly to this reduction, which was not a result of economic growth or of the one-child policy.

bureaucratic quality, we consider this a proxy for the general institutional environment.

One clear force in the economic success of China and India has been reforms that have promoted trade. One measure of trade policy is the Sachs and Warner (1995) measure of openness, a dichotomous variable with 1 for open and 0 for not open. Wacziarg and Welch (2003) updated this measure to an annual series. Using this measure is problematic for the analysis of China and India because both countries have openness measures of zero throughout the period we analyze. This standard indicator is too crude to measure the marked changes in trade policy in these two countries.

We therefore construct our own measure of openness. The ratio of imports and exports to GDP is often used as a measure of a country's openness. However, rich economies tend to participate more in international trade while countries with large populations are more self-supporting and require less international trade. We run a regression of log trade ("imports and exports divided by GDP" from Penn World Table 6.1) on log population and log GDP per capita using data for 1960 to 2000 (without time or country fixed effects).

$$\begin{array}{lllll} \log(\text{trade}) = & 5.869\ - & 0.200 \log \text{population} & + & 0.160 \log \text{GDP per capita} \\ & (0.170) & (0.008) & & (0.014) \end{array}$$

R^2= 0.417, N=1108, standard errors in parentheses.

We take the residual from this regression as a proxy for trade and openness policy. This new variable varies significantly over time for China and India, as shown in Figure 5 (each increase in the trade variable by 0.7 indicates a doubling of trade from its expected value given the regression above).

4. Regression Results

We explain growth in per capita GDP in each five-year period for a panel of countries over the period 1960-2000 (although the first wave is consumed in the 2SLS estimates by the construction of instruments). The results are reported in Table 5. We first run a regression with all the independent variables being beginning-of-period values. The results of this ordinary least squares regression, reported in column 1, indicate that economies that have higher than expected levels of trade, a high investment rate, a high level of bureaucratic quality, high life expectancy, a high ratio of working-age to total population, and that are not located in the tropics and are initially poorer, tend to have higher rates of economic growth. The only surprising result in column 1 is that our schooling variable lacks significance; indeed, its estimate is of the wrong sign, given our strong prior from microeconomic studies that schooling adds to worker productivity and wages. We experimented with a range of different schooling variables but found none that were robustly significant in our regressions. This lack of significance of schooling in growth regressions is quite common and may be due to measurement error in the schooling variables, as discussed by Krueger and Lindahl (2001).

In column 2 we add the growth rate of the working-age share of the total population and our sectoral change variable. The coefficients on the other variables do not appear to change very much from those in column 1, and we find that both new regressors are highly significant. As expected, sectoral change has a positive effect on growth, as does the growth of working age over total population. However, these new variables are measured over the period in which the growth occurs, raising the possibility that growth may affect these variables. In order to control for the potential endogeneity of these two variables, we repeat the regression using instruments. For the growth in the share of the population that is working age we use as instruments the lagged growth rates of total and working-age population and the beginning-of-period fertility rate. For the sectoral change variable we use as instruments the lagged sectoral change variable, the initial share of the workforce in agriculture, and the lagged growth rate of the agriculture share.

The result of using these instruments is shown in column 3. As before, rapid sectoral change seems to promote economic growth. However, the growth of the working-age share of the population is no longer significant once instrumented, though the initial ratio of working-age to total population still affects economic growth. A higher working-age population share appears to represent a supply-side opportunity for a potential output boom. Whether this potential becomes reality depends on how the extra workers are employed. In column 4 of Table 5 we report estimates of the parameters of a regression model that is specified to include an interaction effect between the growth rate of the working-age population share and beginning-of-period bureaucratic quality. This tests whether the effect of an increasing working-age share depends on the institutional environment of the economy. This interactive term involves a contemporaneous growth rate and is instrumented with its lagged value.

We find that the interaction term has a significant and positive coefficient, while the coefficient on the growth of the working-age population share is negative, though not statistically significant. This indicates that the better the bureaucratic quality, the more a country will gain from growth of working-age share. A country with poor bureaucratic quality (a value of zero) will have no immediate gain from an increase in the share of working-age people in the population. In India and China, whose bureaucratic quality varies between 2.9 and 4 over the period, the estimated overall effect of growth in the working-age share (combining its direct effect with the interactive effect) is always positive. It is close to a one-for-one effect on the rate of economic growth near the end of the period, when bureaucratic quality is highest. In all countries the ratio of workers to total population has an effect on economic growth, indicating that the interaction with bureaucratic quality only influences the short-run response.[9]

Specification 4 in Table 5 could be used to generate fitted values for economic growth to compare with the actual growth experiences of India and China. However, doing this produces fitted values that do not track the actual outcomes at all well. We tried a number of approaches to determine why the fitted values were so poor. Adding dummy variables for India and China did not improve the fit and the dummies were statistically insignificant, which indicated that the

[9] For each column in Tables 5 and 6, we test and are unable to reject the hypothesis that the coefficient on the growth of the working age population share is unity. We also test, and do reject, the hypothesis that the coefficient on the log share of the working age population is equal and opposite in sign to the coefficient on the log of initial GDP per capita.

problem is not in fitting the average level of growth for these two countries. We ran the regressions where the period dummies (each five-year growth period has a dummy in the regressions in Table 5) applied to all countries but India and China, thereby treating these countries as if they were immune from worldwide growth shocks. The fitted values from this regression specification (column 1 of Table 6, and also column 2) track the actual growth experiences of India and China better than the specification that treats India and China as being sensitive to global growth shocks.

The fitted values from these regressions seem plausible, but the negative coefficient on years of schooling, though not statistically significant, is puzzling. Although we are not primarily interested in education, the likely failure to estimate this coefficient accurately may bias estimates of other coefficients in the regressions. In addition, for decompositions, our negative schooling coefficient implies that the rising levels of education in India and China will have small negative effects on economic growth, which seems unreasonable. We address this issue by constraining the schooling coefficient based on independent literature-based estimates of its magnitude. We let β_s be the coefficient on years of schooling in the growth regression. Assuming that each year of schooling raises wages and income per capita by 10% in the steady state (which is roughly the average effect of schooling on wages found in a review of studies in many countries by Psacharopoulos and Patrinos (2004)), we have

$$\beta_s = -0.1\beta_y$$

where β_y is the coefficient on log initial income per capita in the growth equation. This equation implies that a one-year increase in schooling, coupled with a 10% rise in income per capita, leaves the growth rate unchanged. Estimating the regression while imposing this constraint on the coefficient on schooling gives the results found in column 3 of Table 6. The results are quite similar to those found in the preceding regressions, though the coefficient on life expectancy does fall slightly. This may be due to a causal link from higher prospective longevity and increased return to education at higher schooling levels and may point to a need for a structural model of growth in which the growth of factor inputs is itself modeled.

5. Explaining the Takeoff in Economic Growth in India and China.

We now use the regression results shown in column 3 of Table 6 to see how well the model fits the experiences of India and China. These fitted values assume that the trajectories for India and China depend on their country-specific values for the different factors posited to determine economic growth, using the worldwide regression weights (except for the period effects). Figure 6 shows the actual and fitted values for economic growth (in GDP per capita) in China from 1960 to 2000. Each observation gives the average annual growth rate over the previous 5 years (for example, the figure for 2000 is the average annual growth rate between 1995 and 2000). The fitted growth rates track the actual rates quite well. The fitted curve shows a steady rise in predicted economic growth between 1960-5 and 1985-90, from around 2½ % a year to around 5½ % a year, with a leveling off thereafter. The fitted values do not capture the volatility in economic growth in China, but they do capture the "takeoff"; however, it appears that they underestimate its pace somewhat.

Figure 7 shows a similar graph for India. Note the difference in scale in the axis measuring economic growth; the "takeoff" in India has been much more modest. The fitted values predict growth being just under 2% a year in the 1960s and early 1970s and then rising steadily to over 3½ % a year by 1995-2000. The fitted values for India also fit the actual behavior quite well, though they do not match the observed volatility in the actual growth rate and they also underestimate the pace of the takeoff.

In principle we can compare the fitted values with the actual growth outcomes in any country for which we have data. In most cases we have examined the fitted and actual values are in reasonably close conformance. For example, the period since 1960 has seen a rapid decline in the growth rate in Japan. As shown by Figure 8, the fitted values of our model capture this decline quite well. Nevertheless, the fitted values are not precise. The R-squared of our regression is low and the 95% confidence interval for our fitted values is $\pm$ 5.3 percentage points, a very wide range, which indicates that there will likely be large deviations from the expected values.

We now address the issue of why the predicted growth rates in India and China rose so much over the period. We take the change in the predicted growth rate between the period 1960 to 1965 and the period 1995 to 2000 and decompose the sources of this change. The results are shown in Table 7. Predicted growth in China rose by 2.7 percentage points over the period, while predicted growth in India rose by 1.9 percentage points. In both cases the major source of this rise in predicted growth rates is the large rise in life expectancy.[10]

The second principal source of the increase in the growth rate has been the increased openness of both economies as measured by our trade variable. The next major contributing factor has been the rise in the level and growth rate of the working-age share of the population. One issue we encountered concerns the attribution of the change in growth to a rise in the value of the interaction term between bureaucratic quality and growth in the working-age share. We address this by calculating the effect of changes in each variable separately, while holding the level of the other at its 1995 value. The rise in bureaucratic quality is estimated to have a small positive effect on growth rates.

Sectoral change in the form of industrialization appears to have had surprisingly little effect on the change in economic growth in either country. Although there has been a movement out of agriculture and into industry, the pace of this movement has been relatively modest in India and China when compared to the pace in Japan or South Korea during their growth spurts. Similarly, the investment rate seems to have had little effect in either country. Investment rates

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[10] The World Bank data used for the regressions indicate a more rapid rise in life expectancy in China over the period than is seen in U.N. data, because the World Bank data for Chinese life expectancy in 1960 are much lower. There are other notable differences between the two sources regarding health in China. Most prominent among them is what appears to be an error in the World Bank (2005) data, which report a total fertility rate of 3.4 for China in 1960 (versus 5.7 in United Nations 2004). By contrast, the two sources are in reasonably close agreement about the total fertility rate in China beginning in 1965 (World Bank records 6.4; UN records 6.1), although there is a momentary difference in 1970 (this time with the World Bank giving the *higher* figure of 5.8, compared with 4.9 from the UN).

for both countries are almost exactly the same in 1960 and 1995 (which in our model affects growth in the periods from 1960 to 1965 and from 1995 to 2000) making this an improbable source of change in growth rates.

The one negative factor mitigating China and India's rates of economic growth has been the effect of rising income levels. The model has the self-limiting property that anything that causes economic growth in one period tends to raise the initial income in the following period, leading to a moderation of future growth rates. The rapid increases in income levels between 1960 and 1995, particularly in China, are estimated to have had a large dampening effect on the growth rate. An extreme version of this is seen in Figure 8, where growth in Japan slowed dramatically over the period due mainly to the end of a phase of rapid industrialization and demographic change, and the effect of rising income levels.

6. The Value of Health Gains

Our analysis of economic growth treats health as an input into the production process that raises income levels. This instrumentalist approach does not include the direct welfare gains that come from improved health. The large gains in life expectancy shown in Figure 2 suggest a large direct benefit of lengthening life spans to people in India and China. How important has the gain in health been for welfare? Becker, Philipson, and Soares (2005) argue that the welfare gains from improved health in developing countries have been large, and in some cases have outstripped the gains from rising incomes. We apply their methodology to an analysis of India and China.

Consider a country in which both income and health improve over time. We can measure the value of health gains over the period by the amount of extra income that would be required to produce the same welfare level at the end of the period if health were to be held constant at its initial level. Becker, Philipson, and Soares (2005) make a number of simplifying assumptions related to income and consumption over the life cycle; they also assume that utility in each period depends on consumption if alive and is zero if dead. A key issue in this formulation is the value of life, and this is addressed by calibrating the parameters of the utility function from value of life studies. Lifetime welfare is the sum of the flow of utility in each period where future utility is discounted at 3% per year due to time preference and is weighted by the probability of surviving to that age. The discounting implies that increasing survival probabilities at young ages tends to be more valuable than increasing survival probabilities at older ages.

When health improves, survival probabilities rise and welfare goes up. We can ask what additional increase in annual income, holding health constant, would have given the same level of welfare at the end of the period as the observed rise in income and health.

We use the Becker, Philipson, and Soares (2005) methodology and their calibrated parameter values to ascribe monetary values to the health improvements in India and China over the last forty years. To do this, we need life tables that show the probability of survival to each age at the beginning and at the end of the period. For China these survival probabilities are calculated from the mortality tables given in Banister and Hill (2004); for India, we use abridged life tables from the Registrar General of India.

The results of our calculations are shown in Table 8. Most of the gains in life expectancy in China came in the 1950s and 1960s and we unfortunately do not have life tables before 1973. The period since 1973, and particularly after 1980, has shown rapid economic growth. However, health improvements over this period have been modest. We calculate that although real income per capita rose by $2540 in China between 1980 and 2000, the value of the gain in health over the same period was only $202 (that is, an extra income of $202 per annum would give the same welfare increase in 2000 as the gain in health between 1980 and 2000).

On the other hand, there have been remarkable continuous health improvements in India over the period 1965 to 2000. The results of Table 8 suggest that over this period the value of the health gains in India, at $1224, rivaled the value of the income gains of $1553. The final column in Table 8 gives the increase in full income, adding the value of the health gains to the usual income gains. This is the increase in annual monetary income that would have given the same increase in welfare as observed, if health had not improved over the period.

India lags China in terms of both income per capita and life expectancy. Over the period 1980 to 2000, income in China increased by about twice as much as it did in India. However, the relative stagnation of health in China since 1980 and the rapid improvements in life expectancy in India mean that the increase in full income, valuing health as well as consumption, has been more similar in the two countries. Thus, the takeoffs in social welfare are less divergent between China and India than are their corresponding takeoffs in income growth.

7. Conclusion

A model explaining economic growth in a panel of countries over the period 1960 to 2000 tracks some key features of the economic growth spurts in India and China since 1980. The reasons behind the growth spurts in the model are primarily a rise in life expectancy, a rise in trade or openness of the economy, and an increasing share of working-age members of the total population.

Our estimates yield two curious findings. First, we find evidence that China and India seem to have been relatively immune to worldwide growth shocks that affected other countries; purely domestic factors explain their growth rates much better. Second, we fail to find a positive effect of education on economic growth. Because this failure is likely to be due to measurement error in our education variable, we impose a calibrated coefficient on education to contain the diffusion of bias among other coefficients.

In both China and India, rising income levels are slowing down the economy; as income levels converge to their steady states it becomes increasingly difficult to maintain a high rate of growth. On the basis of our model, we predict slower economic growth in China after 2010, based on projections of modest further increases in life expectancy and a rising dependency rate as population aging sets in. By contrast, we expect to see somewhat higher growth rates in India over the next 30 years as the effect of the fertility decline and the “bulge” population cohort create a rise in the working-age share of the total population. Predictions based on these demographic changes seem reasonably secure. There appears to be further scope for a rise in growth though improvements in institutions and policies, but these are more uncertain.

Full-income accounting suggests that the picture of stagnation until 1980 followed by takeoff in development may be misleading. India has seen steady improvements in health from before 1980 and China saw rapid health gains from 1950 to 1970. The full income approach suggests that welfare was rising even before 1980 and also that, particularly in China, 1980 marks a shift in the composition in full income growth from health improvements to rising consumption levels, rather than a simple takeoff following a period of stagnation.

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Table 1
Sources of Growth in India and China
Annual Average Growth Rate (Percent)

Variable	India		China	
	1970-80	1980-2000	1970-80	1980-2000
Growth Rate of Real GDP Per Capita	1.4	3.6	3.2	8.1
Decomposition of Growth Rate of GDP Per Capita:				
Growth Rate of Real GDP Per Worker	1.2	3.9	3.0	6.7
Growth of Participation Rate	-0.1	-0.7	-0.4	0.7
Growth Rate of Ratio of Population 15-64 to Total Population	0.3	0.3	0.7	0.6

Table 2
Share of Employment by Sector

Variable	India			China		
	1970	1980	2000	1970	1980	2000
Share in Total Employment (%)						
Agriculture	74	70	60	81	69	50
Industry	11	13	16	10	18	23
Services	15	17	23	9	13	27

Table 3
Output per Worker by Sector (1995 US$)

Variable	India			China		
	1970	1980	2000	1970	1980	2000
Average GDP per worker	453	500	1072	296	396	1454
By Sector:						
Agriculture	264	287	429	188	219	478
Industry	924	893	1806	738	801	3405
Services	1042	1062	2216	760	760	1630

Table 4
Productivity Growth: Shift-Share Analysis

	India		China	
	1970-80	1980-2000	1970-80	1980-2000
Growth Rate of Real GDP Per Worker (%), Annual Average	1.2	3.9	3.0	6.7
Decomposition:				
Due to growth of productivity within sector (with base year sector shares)	0.4	3.0	1.0	5.3
Due to change in sector shares (with base year productivity)	0.7	0.7	2.3	1.3

Table 5
Estimates of the Determination of the Growth Rate of Income Per Capita

	1	2	3	4
	OLS	OLS	2SLS	2SLS
Constant	9.935**	12.74**	13.97**	13.21**
	(2.503)	(2.54)	(2.80)	(2.84)
Log initial GDP per capita	-1.734**	-1.689**	-1.958**	-1.900**
	(0.307)	(0.308)	(0.364)	(0.363)
Ratio of investment to GDP	0.054**	0.045**	0.035*	0.029
	(0.016)	(0.016)	(0.018)	(0.018)
Trade Residual	0.932**	0.718**	0.817**	0.777**
	(0.254)	(0.249)	(0.281)	(0.282)
Average years of schooling	-0.138	-0.047	-0.023	-0.025
	(0.074)	(0.078)	(0.092)	(0.096)
Bureaucratic Quality	0.211**	0.206**	0.252**	0.053
	(0.103)	(0.103)	(0.112)	(0.155)
Tropical Area	-0.995**	-0.925**	-1.006**	-0.983**
	(0.335)	(0.322)	(0.338)	(0.345)
Sectoral Change		0.290**	0.421**	0.452**
		(0.074)	(0.121)	(0.130)
Life expectancy	0.125**	0.078**	0.092**	0.106**
	(0.021)	(0.022)	(0.027)	(0.030)
Log share of working-age population	4.820**	6.605**	6.727**	6.325**
	(1.935)	(1.961)	(2.145)	(2.214)
Growth of share of working-age population		0.869**	0.563	-1.866
		(0.270)	(0.400)	(1.444)
Growth of share of working age population				0.694**
times Governance				(0.342)
Time dummies	Yes	Yes	Yes	Yes
N	661	647	571	571
R squared	0.271	0.608	0.282	0.258

Based on observations from five-year panel of countries, over the period 1960-2000. Time dummies included but not reported. Heteroskedasticity-consistent standard errors are reported in parentheses. Sectoral Change, growth of share of working-age population, and the growth of share of working age population times governance interactive term instrumented in the 2SLS regressions.

** = p < .01

* = p < .05

Table 6
Estimates of the Determination of the Growth Rate of Income Per Capita

	1 2SLS	2 2SLS	3 2SLS
Constant	14.26**	13.13**	13.28**
	(2.88)	(2.93)	(2.96)
Log initial GDP per capita	-1.931**	-1.832**	-1.714**
	(0.402)	(0.401)	(0.409)
Ratio of investment to GDP	0.034*	0.027	0.024
	(0.018)	(0.018)	(0.018)
Trade Residual	0.822**	0.804**	0.808**
	(0.279)	(0.282)	(0.284)
Average years of schooling	-0.018	-0.019	0.171
	(0.092)	(0.096)	[calibrated]
Bureaucratic Quality	0.247**	0.036	-0.012
	(0.112)	(0.156)	(0.150)
Tropical Area	-0.983**	-0.922**	-0.830**
	(0.346)	(0.353)	(0.360)
Sectoral Change	0.418**	0.468**	0.543**
	(0.119)	(0.131)	(0.117)
Life expectancy	0.093**	0.108**	0.073**
	(0.027)	(0.030)	(0.028)
Log share of working-age population	6.575**	5.789**	4.868**
	(2.195)	(2.287)	(2.373)
Growth of share of working-age population	0.538	-2.149	-2.180
	(0.376)	(1.449)	(1.455)
Growth of share of working age population times Governance		0.735** (0.344)	0.763** (0.342)
Time dummies for countries other than China and India	Yes	Yes	Yes
N	571	571	571
R squared	0.287	0.258	0.247

Based on five-year panel of growth rates, over the period 1960-2000. Time dummies for countries other than China and India included but not reported. Heteroskedasticity-consistent standard errors are reported in parentheses. Sectoral Change, growth of share of working-age population, and the growth of share of working age population times governance interactive term instrumented in the 2SLS regressions.

** = p < .01; * = p < .05

Table 7
Sources of the Increase in Predicted Growth Rates in India and China

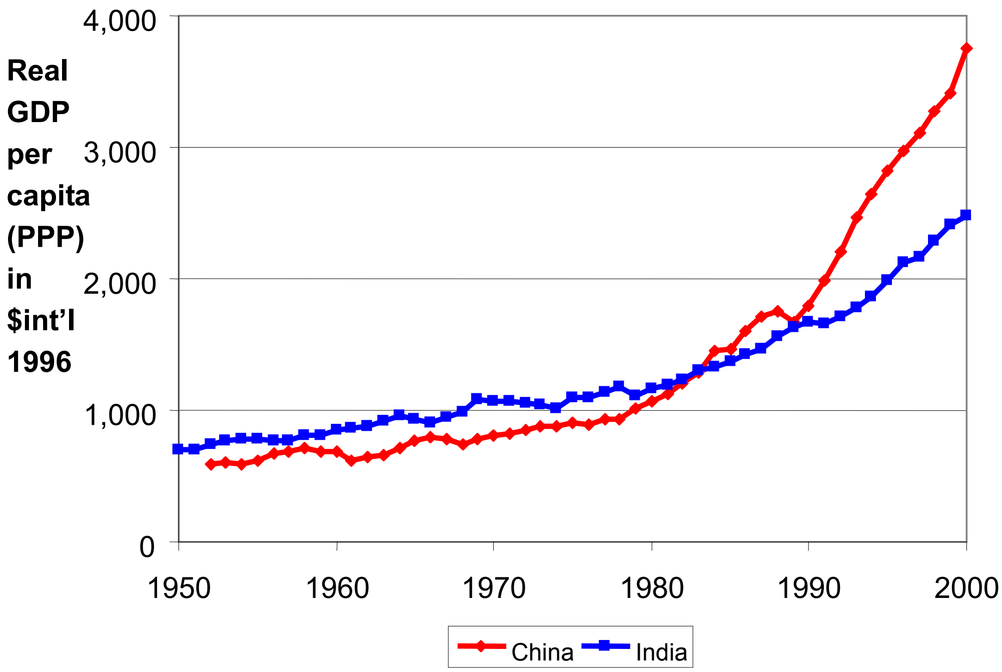
	China	India
Increase in Predicted Annual Average Percentage Growth in GDP per Capita between 1960-65 and 1995-2000	2.7	1.9
Effect of higher life expectancy	2.5	1.3
Effect of increased trade	1.1	0.6
Effect of increase in working-age share	0.9	0.7
Effect of higher levels of schooling	0.5	0.5
Effect of improved bureaucratic quality	0.2	0.2
Effect of industrialization	0.0	0.1
Effect of investment rate	0.1	0.0
Effect of higher level of income per capita	-2.4	-1.5

Table 8
Value of Increases in GDP per Capita, Life Expectancy, and Full Income

	GDP per Capita	Life Expectancy	Full Income Gain
China			
1973	$870	61.4 years	
1982	$1210	68.8 years	
2000	$3750	71.1 years	
Value of Increase 1973-2000	$2880	$704	$3584
Value of increase 1982-2000	$2540	$202	$2742
India			
1965	$927	46.8 years	
1980	$1160	54.7 years	
2000	$2480	61.8 years	
Value of Increase 1965-2000	$1553	$1224	$2777
Value of increase 1980-2000	$1320	$574	$1894

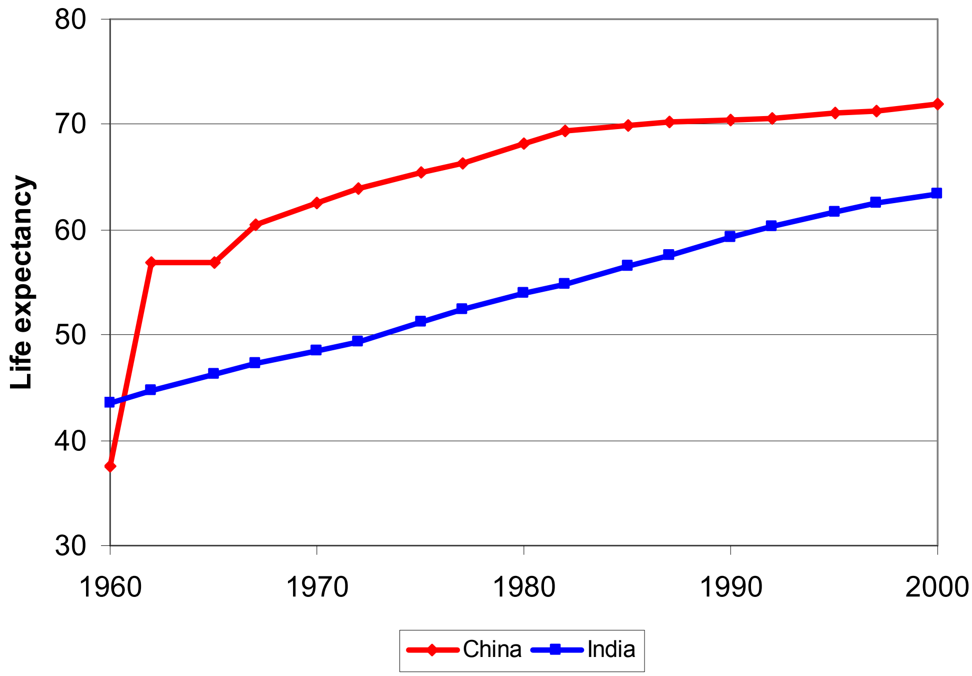
The value of life expectancy increase is the increase in annual income that would have given an equivalent welfare gain with a fixed level of life expectancy (the equivalent variation).

Figure 1
Real Income per Capita



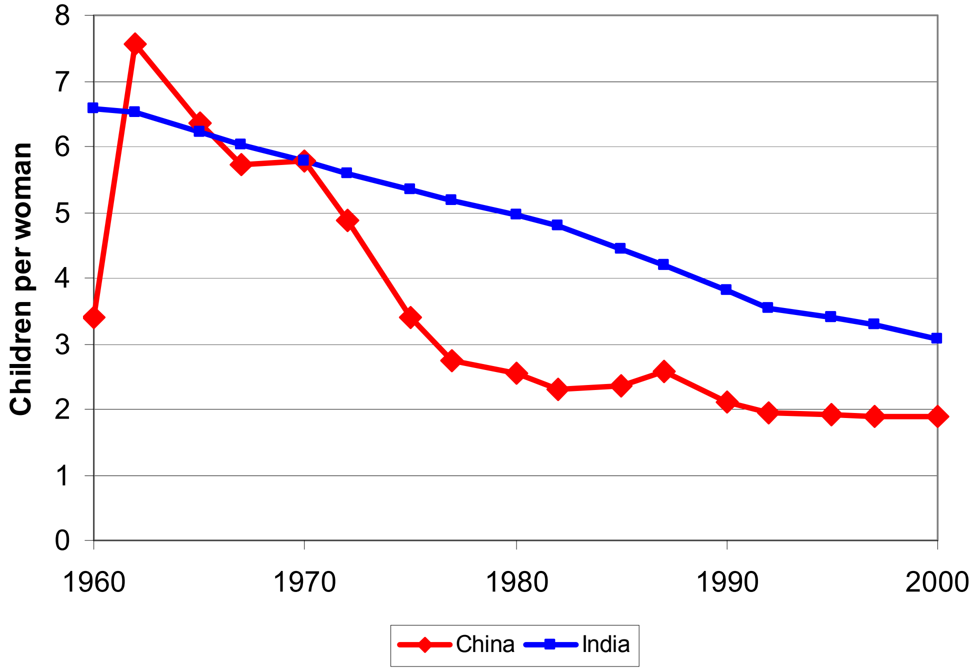
Source: Heston and Summers (1991), as updated in Heston, Summers, and Aten (2002)

Figure 2
Life Expectancy



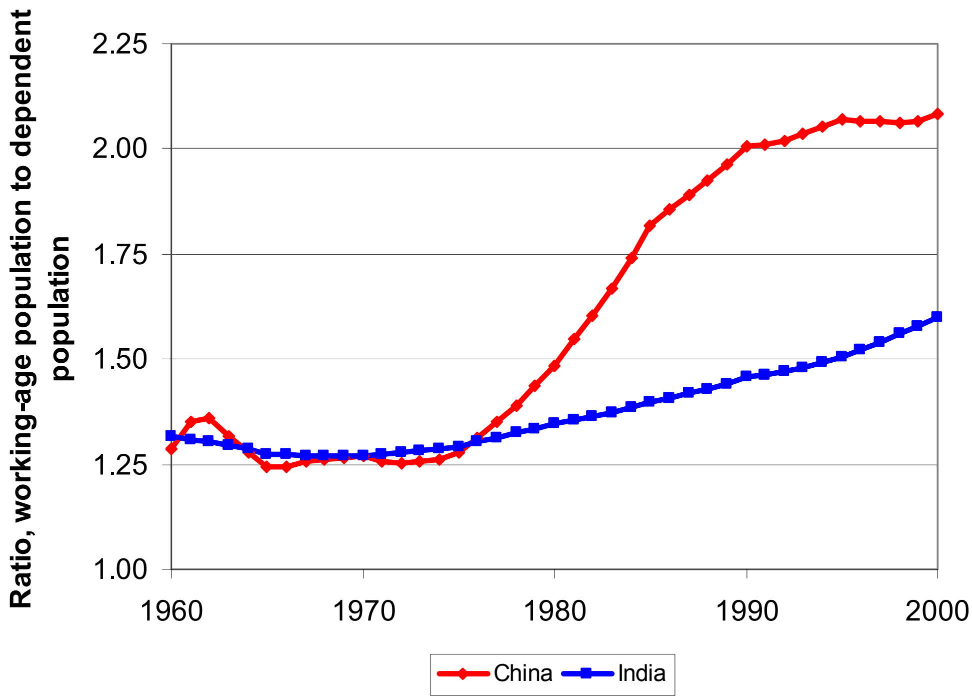
Source: World Bank (2005).

Figure 3
Total Fertility Rate



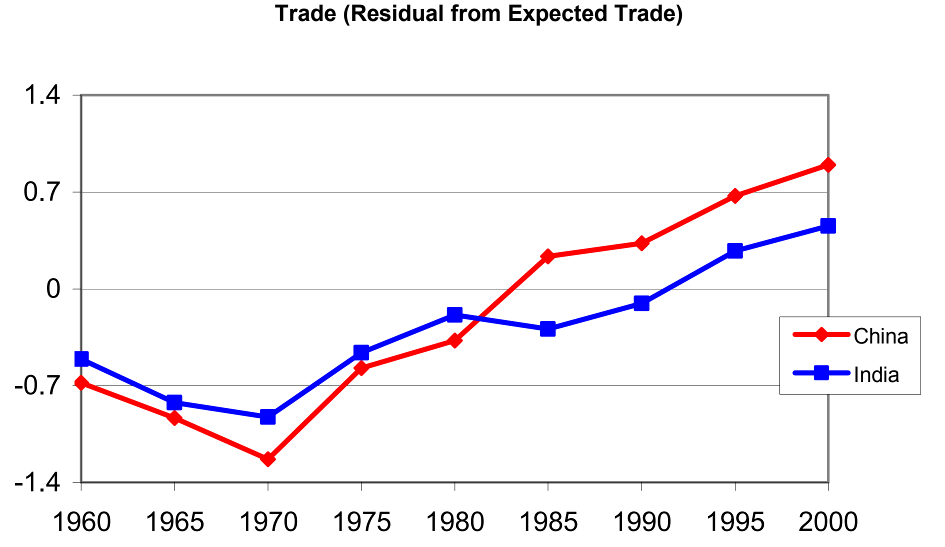
Source: World Bank (2005).

Figure 4
Ratio of Workers to Dependents



Source: World Bank (2005).

Figure 5
Trade (Residual from Expected Trade)



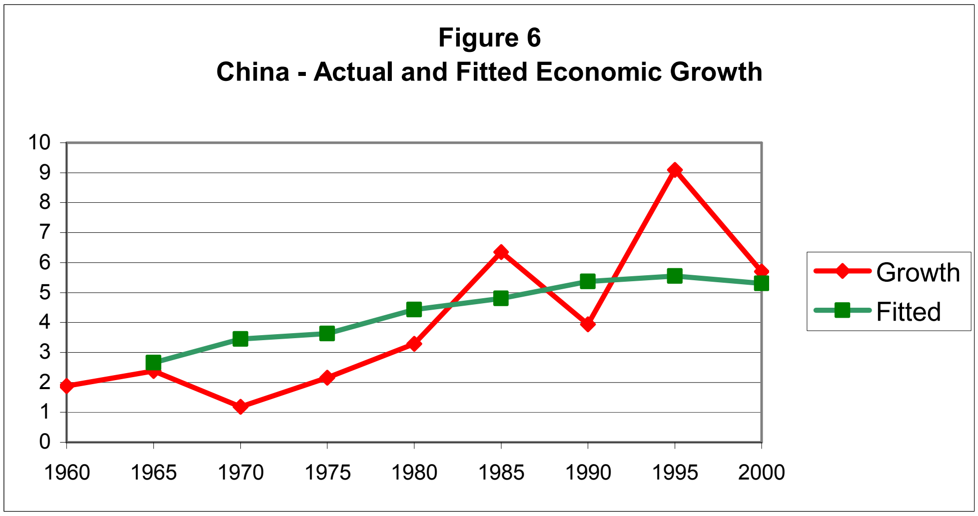


Figure 6
China - Actual and Fitted Economic Growth
10
9
8
7
6
5
4
3
2
1
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
Growth
Fitted

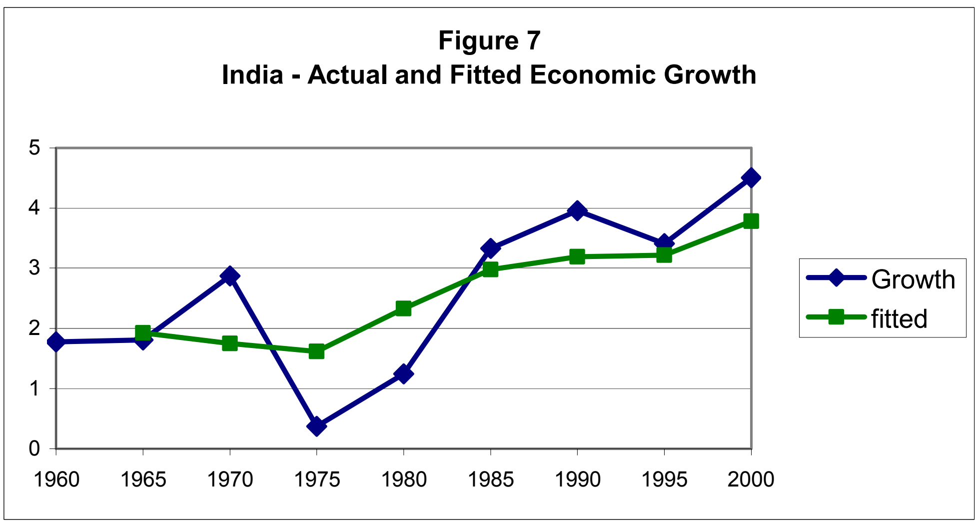


Figure 7
India - Actual and Fitted Economic Growth
5
4
3
2
1
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
Growth
fitted

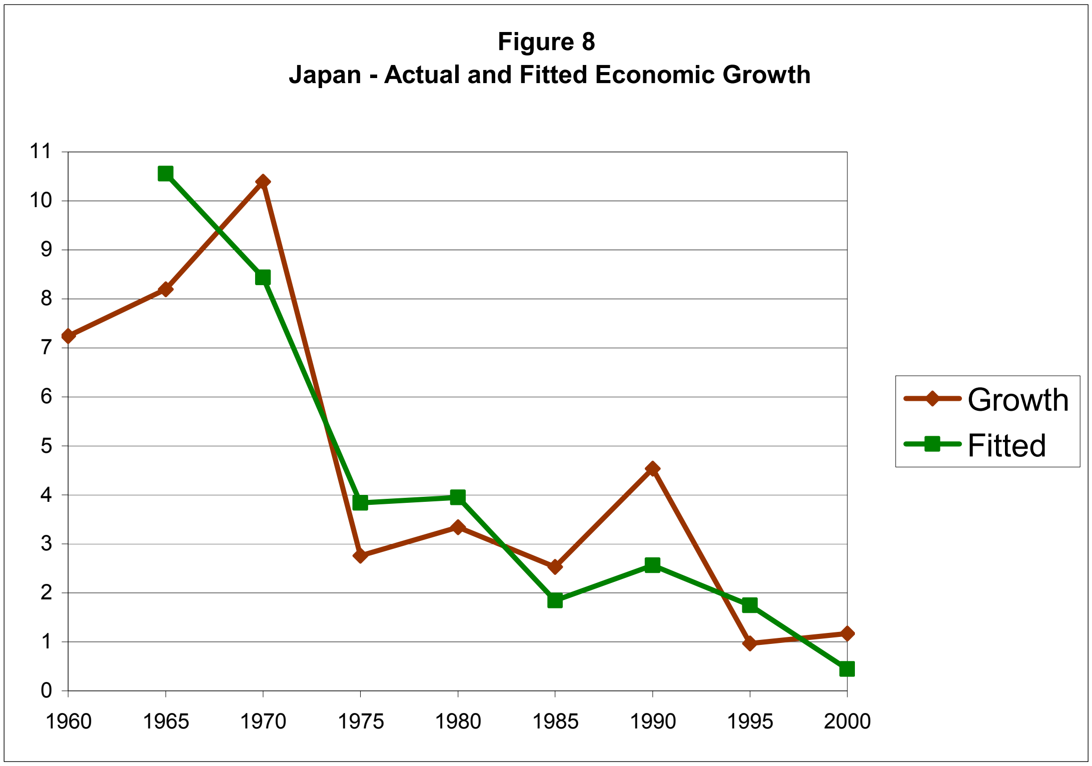


Figure 8
Japan - Actual and Fitted Economic Growth
11
10
9
8
7
6
5
4
3
2
1
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
Growth
Fitted