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Accounting for Growth: Comparing China and India

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Through most of the twentieth century, only those in the high-income industrial countries, less than one-fifth of the world's population, have enjoyed the fruits of economic well-being. However, since 1980, China and India have achieved remarkable rates of economic growth and poverty reduction—and taken together, these countries comprise over a third of the world's population. The emergence of China and India as major forces in the global economy has been one of the most significant economic developments of the past quarter century.

This paper examines sources of economic growth in the two countries, comparing and contrasting their experiences over the past 25 years. In many respects, China and India seem similar. Both are large geographically and have enormous populations that remain very poor. In 1980, both had extremely low per capita incomes. The World Bank and the Penn World Tables show GDP per capita for India was roughly equal to the World Bank's 1980 average for all low-income countries, while per capita GDP for China was about two-thirds of the estimate for

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India.[1] Since 1980, both countries have sustained impressively rapid growth. As shown in Figure 1, GDP per capita has more than doubled in India and increased a remarkable seven-fold in China.

However, many details of their economic growth experiences are in fact quite different. In this paper, we investigate patterns of economic growth for China and India by constructing growth accounts that uncover the supply-side sources of output change for each economy. Some of the results confirm themes that have emerged from the prior literature on the economic development of the two countries. For example, China stands out for the explosive growth in its industrial sector, which in turn was fueled by China's willingness to act more quickly and aggressively to lower its trade barriers and to attract foreign direct investment inflows. In contrast, India's growth has been fueled primarily by rapid expansion of service-producing industries, not the more traditional development path that begins with an emphasis on low-wage manufacturing.

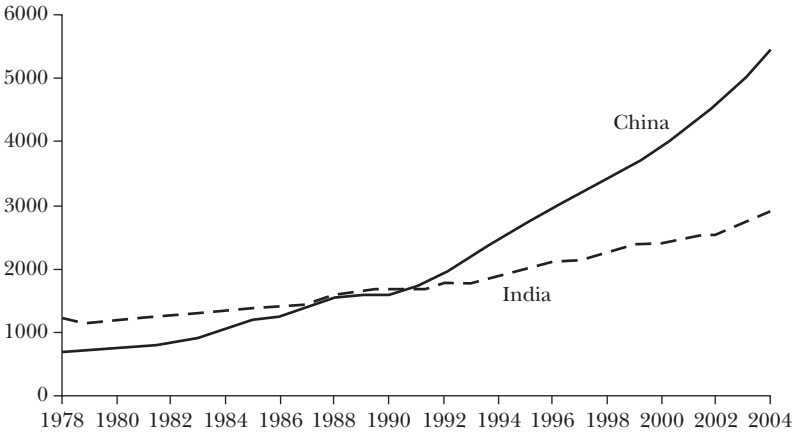
However, some new findings emerge as well. The decompositions of aggregate output growth enable us to compare experiences in these countries to one another as well as to experiences of other economies. In addition, we construct separate accounts for the three major economic sectors: 1) agriculture (which also includes forestry and fisheries); 2) industry (manufacturing, mining, construction, and utilities); and 3) services. (In the literature, these sectors are often referred to as primary, secondary, and tertiary, but we will stick to these more descriptive terms in this paper.) This level of detail enables us to highlight key differences in the development paths taken by China and India. It also enables us to assess the efficiency gains associated with the movement of workers out of agriculture, where they are frequently under-employed, into higher productivity jobs in industry and services.

Growth Accounting: An Overview

Growth accounting provides a framework for allocating changes in a country's observed output into the contributions from changes in its factor inputs—capital and labor—and a residual, typically called total factor productivity. The latter is best interpreted as a measure of gains in the efficiency with which the factor inputs are used.

[1] Some controversy exists in the literature about the relative income levels of China and India in 1980. China has not participated in past rounds of the International Comparison Project, and measures of GDP at purchasing power parity are quite speculative. India last participated in the International Comparison Project in 1985. Maddison (2001) shows the two countries with nearly equal levels of income per capita of about $1000 in 1980, but he obtained those values from a 1987 comparison of China to the United States and used a lower rate of growth between 1980 and 1987 than indicated by the official Chinese statistics.

Figure 1
GDP per Capita
(constant 2000 international purchasing power parity dollars)



Source: World Bank's 2006 *World Development Indicators.* This purchasing power parity measure of GDP standardizes for differences in the prices of common products across countries and over time.

This approach is based on a production function in which output is a function of capital, labor, and a term for total factor productivity. As discussed in more detail in Bosworth and Collins (2003), we essentially assume a Cobb-Douglas production function with fixed factor shares:

$$Y = AK^{\alpha}(LH)^{1-\alpha}.$$

Y, A, K, and α are measures of output, total factor productivity, physical capital services, and capital's share of income, respectively. The capital share, α, is assumed equal to 0.40 for both countries. L is labor, which is adjusted for improvements in educational attainment H as a proxy for skills; we use average years of schooling as a proxy for skill levels and assume a constant annual return of 7 percent for each additional year of education. We recognize that it would be preferable to rely on a more general formulation of the production process and to use the income shares of each factor to infer its contribution. However, the economies of developing countries have large numbers of self-employed persons, who derive income from both capital and their own labor, which makes it difficult to obtain meaningful measures of income shares. We believe that the simplifying assumption of a constant share for capital and labor has minimal effects on the overall conclusions. With this framework, along with data on output and inputs of capital and labor, we can then estimate total factor productivity as a residual term.

We report our results by dividing through both sides of the production function by labor input L and by taking logarithms of both sides. As a result, we

report our results in terms of decomposing the growth in output per worker $\Delta\ln(Y/L)$ into the contributions of growth in capital per worker $\Delta\ln(K/L)$, increases in education per worker $\Delta\ln(H)$, and a residual measure of the contribution of improvements in total factor productivity $\Delta\ln(A)$:

$$\Delta\ln(Y/L) = \alpha\,[\Delta\ln(K/L)] + (1 - \alpha)\Delta\ln H + \Delta\ln A.$$

Our actual calculation is slightly more complex, because when dividing the economies up into sectors, we also allow for the possibility of land acting as an additional input to production. As it turns out, however, this addition does not make a substantial difference to our results. In the tables presented here, the contribution from land is included with physical capital.

In interpreting the results from any growth accounting decomposition, two important cautions should be kept in mind. First, total factor productivity is not only a measure of technical progress. It also captures the effects of myriad other determinants of the efficiency of factor usage: government policy, political unrest, even weather shocks. Second, the results highlight *proximate* causes of economic growth, which are often not the same as underlying fundamental causes. For example, the decomposition might uncover that there have been increased contributions to economic growth from both capital inputs and total factor productivity—but this calculation alone would not enable us to infer how much of the increase in capital may have been induced by more efficient factor usage—or vice versa. With these cautions in mind, the approach provides useful benchmarks for analyzing economic performance.

To construct growth accounts requires measures of each country's outputs and factor inputs over time. The availability and quality of data can be a problem in studying less-developed economies. We return to a discussion of some of the key measurement issues at the end of the paper.

What Do Aggregate Growth Accounts Show?

Table 1 reports the growth accounts for the economies of China and India over the period 1978 to 2004. We first provide the results for the full 26-year period that corresponds to China's economic reform period. This time period also works fairly well for India, which also experienced a growth acceleration in the early part of this period, although the timing of the change in India is more controversial. We divide the period at 1993 for three reasons: it is a benchmark year for India's national accounts, and the second subperiod avoids a 1991 economic crisis in India and can be identified with India's post-reform era.

At the bottom of Table 1, we also report similar growth accounts for the East Asian economies excluding China (Bosworth and Collins, 2003). Their performance is of particular interest in the present context because it has so frequently been cited as a model for remarkable economic performance. These

Table 1
Sources of Growth: China, India, and East Asia, 1978–2004
(annual percentage rate of change)

Period/country		*Output*	*Employment*	*Output per worker*	*Contribution to output per worker of*		
					Physical capital	*Education*	*Total factor productivity*
1978–2004	China	9.3	2.0	7.3	3.2	0.3	3.6
	India	**5.4**	**2.0**	**3.3**	**1.3**	**0.4**	**1.6**
1978–1993	China	8.9	2.5	6.4	2.4	0.4	3.5
	India	**4.5**	**2.1**	**2.4**	**0.9**	**0.3**	**1.1**
1993–2004	China	9.7	1.2	8.5	4.2	0.3	3.9
	India	**6.5**	**1.9**	**4.6**	**1.8**	**0.4**	**2.3**
East Asia excluding China							
1960–1980		7.0	3.0	4.0	2.2	0.5	1.2
1980–2003		6.1	2.4	3.7	2.2	0.5	0.9
1980–1993		7.3	2.7	4.6	2.6	0.6	1.4
1993–2003		4.5	2.0	2.5	1.8	0.5	0.3

Source: Authors' estimates as described in text; Bosworth and Collins (2003).
Notes: The employment series is a census-comparable concept for both China and India. The East Asia comparison includes Indonesia, South Korea, Malaysia, Phillipines, Singapore, Taiwan, and Thailand. Growth rates may not sum due to rounding.

countries are also notable for the extent to which their growth appears to have been the result of extremely rapid gains in both physical capital and educational attainment.

Output, Employment, and Output per Worker

The first column of Table 1 shows each country's output growth. China's annual output growth averaged a whopping 9.3 percent during the entire period. India's annual growth rate is substantially lower, at 5.4 percent, but still well above the economy's 3.4 percent growth rate in the two decades before 1978. India's growth also accelerated by a full 2 percentage points between the two subperiods: 1978–93 and 1993–2004. The national accounts of each country provide our basic source for data on output for the total economy and the three major sectors: agriculture, manufacturing, and services. India's national accounts data are used without modification. However, as discussed below, we did make adjustments to the Chinese data by using an alternative price deflator for the manufacturing sector to address concerns that official series may overstate the rate of real growth.

As shown in the second column of Table 1, China and India experienced nearly identical rates of employment growth over the full period. At the level of the total economy, over a period of several decades, employment growth is largely determined by growth in the population of labor force age. The marked slowing of employment growth in China during the 1993–2004 period is also evident in estimates of the population of labor force age and reflects the sharp decline in the

birth rate during the 1970s. For both countries, the employment estimates reported here are based on the employment series that is most comparable to the concept used in census data.[2]

The third column shows growth in output per worker for each country and time period. We focus on this performance measure in much of the discussion below—both because it provides an indicator of labor productivity and because scaling by number of workers brings it closer to a measure of income per capita, which is a typical indicator of living standards. Although output growth in India accelerated considerably more between the first and second subperiods than in China, the slowdown in China's labor force growth meant that both countries experienced accelerations in labor productivity growth after 1993.

India's performance on the increase in output per worker since 1993 compares favorably with that achieved by East Asia in its heyday—that is, prior to the financial crisis of 1997–98. India's strong growth is overshadowed only by the even more remarkable performance of China. The comparison with East Asia also highlights the extent to which China's growth performance has exceeded prior norms. A few other countries have achieved growth rates comparable to China's growth for relatively short time periods: for example, Germany and Japan in their recoveries from World War II, and Taiwan and the Republic of Korea more recently. However, China's rapid growth has now lasted more than a quarter century.

Decomposing the Sources of Economic Growth

The remaining columns of Table 1 decompose increases in output per worker into the contributions from increased physical capital per worker, education (human capital per worker), and total factor productivity (the residual measure of efficiency). The very small contribution associated with land is included with physical capital. In both China and India, the growth in output per worker is

[2] For India, employment estimates are only available from the quinquennial household surveys, and values for intervening years must be interpolated. Estimates of the workforce follow international standards of including wage earners, the self-employed, and unpaid family members. As a result, they include a substantial number of underemployed workers. We use a measure based on a worker's primary activity (employed, unemployed, out of the labor force) in the prior year.

For China, we use data on employment from the population censuses, which begins in 1990. Consistent estimates for the earlier years were obtained from Holz (2006b), and we build in an adjustment for the data break in 1990. This series is conceptually most comparable with the data for India. However, it has also been subject to frequent revision, and little is known about the precise methods used to compute it. An alternative source of data on employment uses administrative data from the employment reporting system and extends back to 1952. Again, only limited information is available on the methods used to generate these series. Also, in the years prior to 1998, the administrative data include workers who were effectively laid off—although no official layoffs occurred (Holz, 2006b). Both employment series are published in the *China Statistical Yearbook*. In the 2005 edition, the series that is based on administrative reports is shown in table 5-6. The series that is closer to a census concept is shown in table 5-2. If we use the alternative administrative data, they imply about the same rate of employment growth for the full 1978–2004 period, but a larger portion of the growth occurs before 1993. Thus, we find that the average annual growth in output per worker is reduced by about 0.4 of a percentage point in 1978–93 and raised by an equivalent amount over the 1993–2004 period.

equally split between increases in physical and human capital per worker on the one hand and gains in total factor productivity on the other, although the values for China are twice those for India. As Table 1 shows, contributions to India's growth from capital deepening rose somewhat during the 1993–2004 period. However, the contribution of physical capital to India's growth remained well below those evident during the investment-led rapid growth experiences of the East Asia miracle. In contrast, China achieved a rate of capital deepening comparable to that for East Asia in the 1978–1993 subperiod, and a substantially higher rate more recently.

Our calculation of the sources of growth requires data on the quantities of capital and education.[3] Data on fixed capital are taken directly from each country's national accounts. India produces its own estimates of the capital stock by major sector, which we adopted. Other work we have done on India includes a more detailed discussion of the concern that low investment may be a constraint to growth (Bosworth, Collins, and Virmani, 2007). Recent data revisions for India show a strongly rising trend for gross private investment since 1993. However, total net investment averaged about 17 percent of GDP during 1999–2004, which we estimate is unlikely to support an annual output growth rate much above 7 percent. This data also shows declines in public sector investment as a share of GDP, which is worrisome given concerns about India's weak and deteriorating infrastructure.

In the case of China, information on physical capital investment from the provincial reports must be used to allocate the national data on gross fixed capital formation among the three major sectors (Hsueh and Li, 1999).[4] We constructed our own perpetual-inventory estimates of the capital stock assuming a geometric rate of depreciation of 0.06.

Data on educational attainment for China, India, and a group of East Asian comparison countries appears in Table 2. India's gains in education are near the East Asian average—however, India's educational attainment started from a very low level so that a similar percentage gain reflects a much smaller rise in actual years of schooling. Furthermore, Indonesia, with a comparable per capita income and initial educational level, was able to raise its average years of schooling by considerably more. In fact, India stands out from other Asian economies for its slow

[3] Our growth accounts include land as well as capital and labor as factor inputs to produce agriculture. In neither country are there available estimates of current market value of the land that would enable us to construct measures of the annual flow of capital services from land. Thus, we focus on the growth in the aggregate amount of land. Over the past quarter century, aggregate agricultural land expanded by about 9 percent for India and 3 percent for China. Using these measures, land played a minor role in explaining aggregate growth in China and India. For India, an estimate of the volume of land used in agricultural production is available annually. We use an estimate of total cropped land that adjusts for irrigated lands, which are sown more than once per year. For China we used a measure of total sown land area, available on-line from the China Data Center and included in a table entitled "Production Condition for Agriculture of China."

[4] In addition, the expenditure-side estimates of GDP have not yet incorporated the revisions that resulted from the last economic census and that are included in the output data. Thus, the data may be subject to revision in the near future.

Table 2
Measures of Educational Attainment, Asia, 1960–2000

	Average years of schooling			*Share with no schooling (percent)*		
	1960	*1980*	*2000*	*1960*	*1980*	*2000*
India	1.4	2.9	4.5	72	56	43
China	2.5	4.4	6.0	56	32	16
Indonesia	1.5	3.7	6.0	68	32	21
Korea	4.7	8.3	11.1	40	14	6
Malaysia	3.0	5.5	7.9	50	26	14
Taiwan	3.9	7.6	8.8	37	16	10
Thailand	3.5	4.2	6.8	34	14	10

Source: Barro and Lee (2000), Cohen and Soto (2001), India National Sample Survey Organization (NSSO), and authors' calculations.
Note: All persons aged 15 and over. The reported number is a simple average of the data in Barro and Lee, and Cohen and Soto. Data for India in 1980 and 2000 come from the NSSO surveys conducted in 1983–84 and 1999–2000, respectively.

progress in reducing the share of the population with no schooling. Measures of educational attainment for India and their contribution to labor quality are discussed more fully in Bosworth, Collins, and Virmani (2007). In addition, our own investigation found surprisingly low returns to primary education in India and a rising return to higher education, presumably implying an increasing shortage of the highly educated.

In China, the process of formal education was greatly disrupted by the Cultural Revolution of the late 1960s and early 1970s. In later years, an unusually large number of adults took advantage of remedial programs to raise their recorded educational levels, but the value of those programs is controversial. Young (2003) provides a useful overview of Chinese statistics on educational attainment that confirm the evidence of limited gains in educational attainment for the adult labor force. In particular, his analysis of the relationship between earnings and years of schooling finds surprisingly low returns. Knight and Shi (1996) also document a large divide in the educational attainment of rural and urban workers in China. In contrast to India, however, China does appear to have largely eliminated illiteracy. For example, UNESCO reports a literacy rate of 99 percent among youth aged 15–24 in China, compared with just 76 percent for India.

To obtain the measures of human capital used in our decomposition, we constructed indices of educational attainment. We were able to do this for each sector of the Indian economy using information from the quinquennial household surveys (Bosworth, Collins, and Virmani, 2007). For China, we relied on an average of prior estimates from Barro and Lee (2001) and Cohen and Soto (2001). Since we are unable to distinguish differential levels of education across sectors of the economy, we use a common education index. As noted earlier, our human capital index assumes that each additional year of schooling raises labor force productivity

by 7 percent. This figure is based on a large number of empirical studies relating wages and years of schooling (Bosworth, Collins, and Virmani, 2007).

The final column of Table 1 shows the contribution from changes in total factor productivity—that is, in the efficiency of factor usage. As noted earlier, gains in total factor productivity account for fully half of the increases in output per worker in China since 1978 and India since 1993. This feature sets both China and India apart from the East Asian miracle of the 1970s and 1980s, which was more heavily based on investments in physical capital. In addition, China stands out for the sheer magnitude of its gains in total factor productivity.

What Do Sectoral Growth Accounts Show?

International organizations, such as the United Nations and World Bank, have traditionally divided an economy into three sectors: Agriculture, the "primary sector," also includes forestry and fishing. Industry, the "secondary sector," is composed of manufacturing, construction, and utilities. The service or "tertiary sector" covers the remainder of the economy. For industrial countries, consistent data for sectoral-level analysis is readily available from the OECD. However, for developing countries, the availability of sectoral data on output and employment must be determined on an individual country basis from country sources. Table 3 reports sectoral growth accounts, again by country and time period.

Agriculture

Both China and India benefited from the Green Revolution, but improvements in the Chinese agricultural sector were also aided by more fundamental institutional reforms. China's economic reforms have taken place in a stepwise fashion beginning with the restoration of family farms in the late 1970s and the movement of large numbers of workers into rural enterprises. In the late 1980s and 1990s, growth was fueled by the devolution of fiscal and administrative powers to local governments, greater autonomy for state-owned industrial enterprises, and the steady introduction of market incentives. Domestic and foreign-owned private enterprises emerged as the drivers of the growth process, and China became committed to the development of a "socialist market economy."[5]

The output of China's agricultural sector has grown at a very rapid pace, 4.6 percent per year from 1978 to 2004, compared to a strong but less-spectacular 2.5 percent growth rate in India. Although both countries exhibited a slowing in the years after 1993, the agricultural sector continues to be a major contributor to

[5] Riedel, Jin, and Gao (2007) provide a much more extensive overview of the reform process, including more recent steps undertaken. Lin (1988) focuses on family farms and the emergence of the "household responsibility system."

Table 3
Sources of Growth by Major Sector, 1978–2004
(*annual percentage rate of change*)

Period/country/sector		*Output*	*Employment*	*Output per worker*	*Contribution to output/worker of*		
					Physical capital	*Education*	*Factor productivity*
Agriculture							
1978–2004	China	4.6	0.3	4.3	2.3	0.3	1.7
	India	**2.5**	**1.1**	**1.4**	**0.3**	**0.3**	**0.8**
1978–1993	China	5.2	0.9	4.3	2.2	0.3	1.7
	India	**2.7**	**1.4**	**1.3**	**0.1**	**0.2**	**1.0**
1993–2004	China	3.7	−0.6	4.3	2.3	0.2	1.7
	India	**2.2**	**0.7**	**1.5**	**0.6**	**0.3**	**0.5**
Industry							
1978–2004	China	10.0	3.1	7.0	2.2	0.3	4.3
	India	**5.9**	**3.4**	**2.5**	**1.5**	**0.3**	**0.6**
1978–1993	China	9.3	4.4	4.9	1.5	0.4	3.0
	India	**5.4**	**3.3**	**2.1**	**1.4**	**0.4**	**0.3**
1993–2004	China	11.0	1.2	9.8	3.2	0.3	6.1
	India	**6.7**	**3.6**	**3.1**	**1.7**	**0.3**	**1.1**
Services							
1978–2004	China	10.7	5.8	4.9	2.7	0.3	1.8
	India	**7.2**	**3.8**	**3.5**	**0.6**	**0.4**	**2.4**
1978–1993	China	11.3	6.5	4.7	1.8	0.4	2.5
	India	**5.9**	**3.8**	**2.1**	**0.3**	**0.4**	**1.4**
1993–2004	China	9.8	4.7	5.1	3.9	0.3	0.9
	India	**9.1**	**3.7**	**5.4**	**1.1**	**0.4**	**3.9**

Source: Authors' estimates as described in text. For China, the output data are the official series of the national accounts for agriculture and services, and the series for industry is based on the alternative price deflator discussed in the text.

growth of the aggregate economy.[6] China's growth in agricultural production is particularly impressive because it occurred against the backdrop of declining employment in this sector after 1993. At the same time, output per worker continued to expand at a very strong 4.3 percent annual rate. China achieved its gains through both substantial increases in capital per worker and rates of total factor productivity growth more than double those for India.[7]

[6] Fan and Zhang (2002) use household surveys of food consumption in China to argue that the official agriculture statistics may overstate the growth of output. We believe that the reliance on household surveys of food consumption to challenge the official production data is itself questionable; in other countries, household surveys are notorious for their underestimation of consumption. In addition, while Fan and Zhang are correct to point out that Laspeyres indexes overstate growth, the reliance on such indexes is not unique to China. Finally, any overestimate that occurs has not changed much over time, and certainly not be enough that it would greatly alter our finding of strong productivity growth.

[7] Rawski and Mead (1998) argue that the administrative employment data greatly overstate the share of China's workforce that is employed in agriculture and that as many as 100 million workers should be reclassified as actually working in nonagricultural jobs. They based their estimates on information on

While growth in agricultural output per worker is not nearly as impressive in India as it is in China, annual increases of more than 1 percent represent a significant improvement relative to the 1960s and early 1970s, in which there were little or no gains in agricultural productivity (Bosworth, Collins, and Virmani, 2007). What is striking for India, however, is that employment in the agricultural sector has continued to grow in the 1993–2004 period, albeit at a somewhat slower rate. We attribute this to an insufficient rate of expansion of employment opportunities in industry and services relative to India's population growth.

Industry

The industrial sector, which includes manufacturing, as well as construction, public utilities, and mining, differs dramatically in size between China and India. In China, this sector has consistently accounted for about half of GDP, whereas in India it has remained below 30 percent. During the 1978–93 period, the sector grew rapidly in both countries, with large increases in employment. Both also had similar rates of gain in capital per worker. However, China experienced a much faster rate of total factor productivity improvement.

In the period since 1993, China has achieved spectacular rates of growth in industrial output per worker. Employment growth slowed to only a little more than 1 percent per year, while output per worker has averaged nearly 10 percent annually. (Again, this figure is based on our use of the alternative price deflator for this sector, discussed later in this paper.) This result has been achieved by a doubling of growth in both the contribution of increased capital per worker and total factor productivity. India has also witnessed an acceleration of output growth in its industrial sector, but the magnitude has been much smaller and about half of the growth is attributable to increased employment. The rate of gain in India's labor productivity has been only about one-third that for China, the contribution of increased capital per worker has been much smaller, and India's gains in total factor productivity in this sector have averaged only a very modest 1 percent per year.

Services

India has attracted considerable attention for the rapid expansion of its service industries; however, the expansion of this sector has also been very strong in China. As shown in Table 3, China's services sector has grown as rapidly as its industrial sector and accounts for most of the growth in employment. Furthermore, China's output per worker in this sector has grown at a steady 5 percent annually over the full 26-year period. Since 1993, China has also had an increase in the contribution of capital per

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labor input requirements and acreage for various crops. We have not incorporated their adjustment in our measures of employment by sector. We use the alternative census-based series, and it is not clear how to adjust for workers who may be employed in both agriculture and nonagriculture. In any case, their adjustment has the greatest effect on the relative growth of the labor input prior to the mid 1980s, when it would sharply raise the growth of labor productivity in agriculture and lower it for the nonagricultural sectors. However, it matters little for post-1993 growth rates.

worker in services as large as that for industry. Where China's service sector has performed less well is in its weak rate of improvement in total factor productivity.

Services is the sector in which India comes closest to matching China's performance. India's output growth in the service sector accelerated after 1993, and the rate of improvement in output per worker exceeds 5 percent annually. It is also remarkable that India has achieved those gains with only a very modest contribution from increased capital per worker. Unlike for China, India's impressive performance in services is largely reflected in a rapid improvement of total factor productivity. In Bosworth, Collins, and Virmani (2007), we argue that these gains are somewhat puzzling and may be somewhat overstated. One would only expect to see such rapid total factor productivity gains in relatively modern service subsectors—such as finance and business services—that are most likely able to take advantage of technological changes in information and communication. However, these subsectors accounted for less than one-fifth of India's output of services in 2004. Much of India's output growth in services occurred in the biggest subsectors—such as wholesale and retail trade and transportation. These and other more traditional services account for fully 60 percent of India's total service sector output.[8]

Sector Shares

The top panel of Table 4 shows the distributions of output in both China and India measured in value-added terms in 1978, 1993, and 2004. In 1978, agriculture and services each accounted for roughly one-quarter of China's output, with industrial activities accounting for the remaining half. In contrast, agriculture was India's largest output share in 1978, with services and industry accounting for one-third and just one-quarter respectively. These differences have increased in subsequent years. By 2004, the output share of agriculture had declined by 20 percent in both economies. For China, this was split equally between increases in the industrial and service sectors. In contrast, India has seen only a small increase in the output share of its already relatively small industrial sector, with most of the expansion concentrated in services.

The bottom panel of Table 4 shows distributions of employment by sector. In 1978, these distributions appear quite similar for China and India; that is, both reported about 70 percent of their workers as being in the agricultural sector. Since then, workers have moved out of agriculture, but the decline in the share of employment in agriculture has been much larger for China: only 47 percent are still in agriculture, compared to 57 percent for India. In addition, China now has a larger portion of its workforce in services than does India.

Are these sectoral distributions unusual relative to those for similar economies? A recent International Monetary Fund (IMF) study (2006) compares actual output and employment shares in each sector with predicted shares, based on a regression analysis that controls for country characteristics such as output per

[8] Unfortunately, the data needed for a similar decomposition of China's service sector are not available.

Table 4
Value-Added and Employment by Industry as Share of Total
(percent)

Year/country	*Agriculture*	*Industry*	*Services*	*Total*
		Value added		
1978				
China	28	48	24	100
India	**44**	**24**	**32**	**100**
1993				
China	17	51	33	100
India	**33**	**28**	**39**	**100**
2004				
China	9	58	33	100
India	**22**	**28**	**50**	**100**
		Employment		
1978				
China	71	17	12	100
India	**71**	**13**	**16**	**100**
1993				
China	56	22	21	100
India	**64**	**15**	**21**	**100**
2004				
China	47	23	31	100
India	**57**	**18**	**25**	**100**

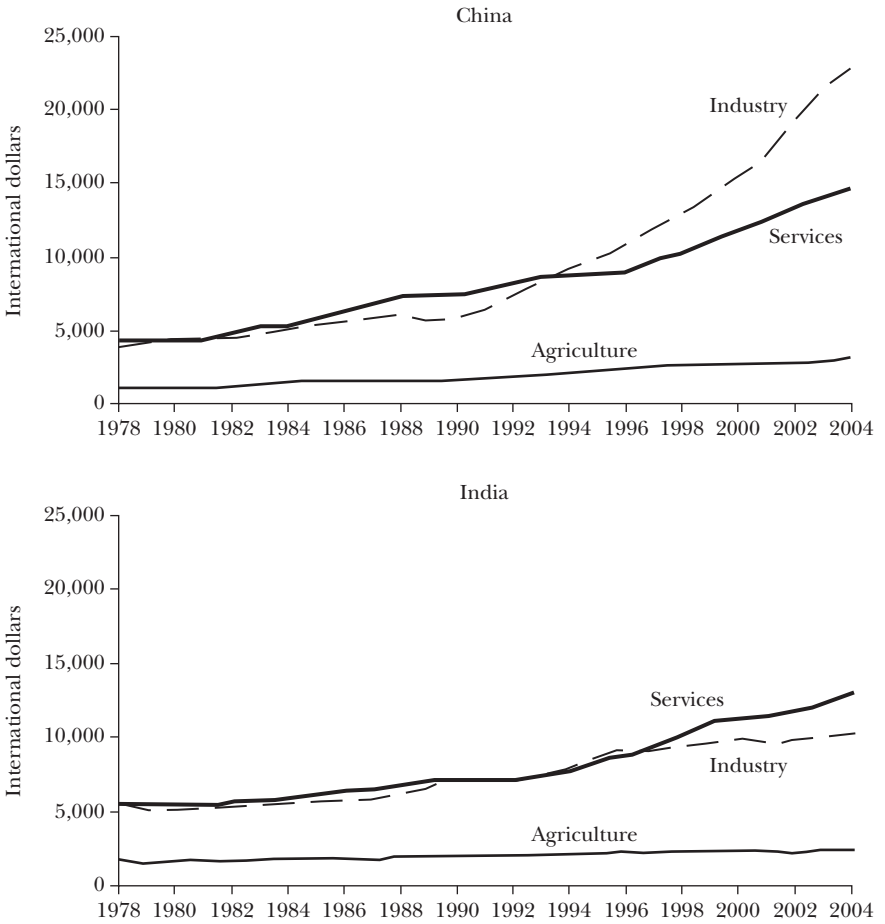
Source: China Data Center and *China Statistical Yearbook* (National Bureau of Statistics of China); India National Accounts; India National Sample Survey Organization.

capita, population, and geographic size. For both China and India, the study finds that agriculture's output share is about what one would expect. For India, the actual output shares for industry and services are also quite similar to predicted shares. In contrast, China's industrial sector accounts for an unusually large share of output, while its service sector accounts for a somewhat smaller share than predicted. The IMF analysis also highlights that the agricultural sector continues to employ a surprisingly large share of the labor force in both China and India, and that this high employment in agriculture is offset by a significantly smaller-than-predicted labor force share in the service sector.

Reallocation Effects

Output growth can be generated from the reallocation of resources into higher productivity activities, as well as from productivity gains within sectors. Indeed, this reallocation effect is potentially a very important source of growth for economies in which a large share of labor is initially underutilized in agriculture. We will contrast this dimension of the sources of growth for China and India. Our first step is to examine sectoral differences in labor productivity. We then decompose aggregate growth in

Figure 2
Output per Worker by Sector, China and India, 1978–2004
(international dollars of 2004)



Source: China Data Center and *China Statistical Yearbook* (National Bureau of Statistics of China); India National Accounts; India National Sample Survey Organization.

output per worker into the contributions from each sector and a residual, which can be interpreted as the effects from resource reallocation.

Figure 2 shows the evolution of output per worker by sector from 1978 to 2004. We use purchasing power parity exchange rates from the World Bank and constant 2004 prices to construct indicators that are comparable for the two countries. (The results are quite similar if market exchange rates are used instead.) The figure shows that the level of Chinese labor productivity in each sector was only about 70 percent that for India in 1978. But by 2004, Chinese output per worker in services, agriculture, and industry had risen to 110, 130, and 220 percent of India's levels, respectively.

The figures also highlight the substantial and growing sectoral differences in labor

Table 5
Sectoral Growth in Output per Worker, 1978–2004
(percentage contribution to growth)

	Total	*Agriculture*	*Industry*	*Services*	*Reallocation*
1978–93					
China	**6.4**	1.2	2.4	1.1	1.7
India	**2.4**	0.6	0.5	0.7	0.6
Difference	**4.0**	0.6	1.9	0.5	1.0
1993–04					
China	**8.5**	0.7	5.0	1.7	1.2
India	**4.6**	0.5	0.9	2.1	1.2
Difference	**3.9**	0.2	4.1	−0.4	0.0

Source: Authors calculations as explained in the text.

productivity for both economies. In 1978 for both India and China, output per worker was nearly identical in the industrial and service sectors, and roughly three times that for the agricultural sector. Since then, India has experienced relatively slow productivity growth in the agricultural sector, combined with an acceleration for services beginning in the mid 1990s. By 2004, Indian labor productivity in industry and services had risen somewhat to four and five times that for agriculture, respectively. Due to the rapid and sustained labor productivity in industry, the productivity differences are even larger for China. In 2004, the levels of output per worker in China were seven times higher in the industrial sector than in agriculture and five times higher in services than in agriculture. A recent IMF study (2006, p. 11) notes that "for the world as a whole, labor productivity in nonagricultural sectors is about three times higher than in agriculture." Thus, the sectoral productivity gaps that have emerged in India and especially China appear quite large.

How much of the aggregate economic growth in each country can be attributed to sectoral gains in output per worker? A simple measure of the contribution from each sector is provided by the sector's growth rate (from Table 3), weighted by its share in total value added at the outset of each subperiod (from Table 4). The difference between total growth and the sum of the sectoral contributions provides a (residual) measure of the effects due to resource reallocation.

Table 5 shows the resulting decompositions by period, for each country as well as the cross-country differences in each component. During the first subperiod, 1978–93, India's growth can be attributed in roughly four equal proportions to gains in each of the three sectors and gains from resource reallocation. In the more recent period, the main difference has been a trebling of the contribution from services and a doubling of the contribution from resource reallocations. As expected given the previous discussion, Chinese performance is dominated by the industrial sector, which accounts for more than a third of aggregate growth during the first period and more than half during the second. However, the magnitude of the reallocation in China is larger than that for India in the first period and of equal size in the second. With a higher rate of

overall growth, the reallocation effect falls from roughly one-fourth of the total before 1993 to just 15 percent more recently. The magnitude of these reallocation effects is comparable to those found by Bloom, Canning, Hu, Liu, Mahal, and Yip (2006) for an earlier sample period and by the International Monetary Fund (2006).

Table 5 also highlights a striking shift in the sources of the difference in economic growth between the two countries. During both 1978–93 and 1993–2003, China's average annual growth in output per worker exceeded that for India by nearly 4 percent. While strong Chinese industrial sector performance is the most important factor in the earlier period, relatively strong growth in China's agricultural and services sectors and a larger reallocation effect all contributed to the overall growth differential. In contrast, after 1993, *all* of the difference between China and India's labor productivity growth rates can be explained by the much larger contribution from China's industrial sector. After 1993, India's services sector shows a slightly higher rate of growth and the reallocation effects are of equal magnitude.

Some Data Concerns

The data concerns for China and India are quite different. For example, India has a very large informal sector, where output and employment are concentrated in small enterprises. Thus, construction of India's national accounts makes extensive use of large periodic surveys of households, rather than relying on reports from major enterprises. China, in contrast, can rely more heavily on reports from large industrial sector enterprises, but must still use household surveys to obtain high-quality information on some service-producing industries. Another difference is that India has had a coherent statistical system for decades. China is still in the process of converting its statistical reporting system from the old Soviet-style Material Product System (MPS) to the commonly recognized international system of Standard National Accounts (SNA). Yet another difference is that for India, a larger amount of methodological information about its economic statistics is available in English, but for China we lack some important details.

In this paper, the data that we use for India is essentially the government data on output and employment by sector, sometimes using the World Bank's purchasing power parity exchange rates to adjust over time. As a result, our growth accounts for India accord closely with prior research. We provide a detailed discussion of the data sources and issues for India in Bosworth, Collins, and Virmani (2007).

For China, on the other hand, there are two especially controversial issues related to measurement of output. Is China's rate of economic growth systematically overstated because its price indexes for calculating real output are too low? Is China's rate of economic growth slowing in recent years? We tackle these questions in turn.

Is China's Rate of Economic Growth Overstated?

China's real output data come from asking firms to report the change in their production based on prices of the prior year. The difficulty of making that calcu-

lation may lead many enterprises to report equal rates of nominal and real change, and thus to overstate real growth (Woo, 1998). This critique focuses mainly on prices for industrial goods. The price index for consumer services is also questionable, because the items included in that index are far from representative of the product mix of this sector, and because changes in these prices have been dominated by the elimination of a large array of subsidies and price controls for the services provided to households, particularly with regard to housing. The most extensive criticisms of the official output data for China are those of Maddison (1998), who, in his estimates, reduced the growth of China's GDP by an average of 2.4 percent per year for the 1952–95 period. Maddison's estimates are themselves controversial. They are severely criticized by Holz (2006a), and official estimates of output were recently revised *upward* to correct for an underestimation of services sector output during 1993–2004.

Some researchers have sought to construct alternative price indexes that could be used to deflate the nominal values (Young, 2003; Dekle and Vandenbrouck, 2006). We experimented with using the price indexes suggested by Young (2003). The alternative output measure for agriculture has a very similar growth rate to that reported in the official national account statistics. Woo's argument that firms may confuse nominal and real changes in output seems most applicable to the large enterprises of the industrial sector, where the alternative price indexes do indicate substantially more rapid inflation than the implicit price deflators embedded in the official data—implying a significantly slower rate of output growth. Ultimately, while we computed the growth accounts using both the official output measures and those based on the alternative price deflators, our preferred set uses the official output data for the agricultural and service sectors and the alternative price index only for the industrial sector. These calculations are the ones reported in the tables of this paper.

Finally, we note that research on other countries has highlighted severe problems in the construction of price indexes that result in an overestimate of inflation. The two major problems are the failure to incorporate substitution effects and inadequate allowances for quality change, which are both likely to be of substantial importance in China. While we agree that the current estimates of China's output growth leave substantial room for error, the evidence for overall significant bias seems unproven.

Is China's Growth Slowing?

A number of studies have expressed concern about what they perceive to be a slowing of the rate of China's total factor productivity growth in recent years (Kuijs and Wang, 2006; OECD, 2005; Zheng, Bigsten, and Hu, 2006). Our analysis finds no such slowing. We believe that the differences can be traced to two factors.

First, several studies report a slowing of China's overall output growth after 1993, which eventually leads in the growth accounting calculation to a lower level of total factor productivity. Our study incorporates the recent revisions in the national accounts that raised the level and growth of output in the services sector in China. China's official GDP statistics report a 10 percent growth rate for both the 1978–93 and

1993–04 periods; but as discussed a moment ago, we used an alternative price deflator that lowered the overall rate of growth of industrial sector output for the full post–1978 period, which has a bigger impact in reducing the estimate of growth in the early years of the time period we consider. Thus, we show a modest acceleration of annual GDP growth of 0.8 percentage points after 1993, compared to a 0.7 percent deceleration, for example, in the Kuijs and Wang (2006) study.

Second, several studies use a greater elasticity of output with respect to capital than our assumption of 0.4; for example, Kujis and Wang (2006) use a capital share of 0.5, Zheng, Bigsten, and Hu (2006) use the three alternatives 0.4, 0.5, and 0.6, and OECD (2005) uses 0.53.[9] In the case of India, this assumption does not matter greatly for the growth accounting decomposition because capital and labor inputs grow at relatively similar rates. In China, however, the rate of growth of the capital input is far in excess of that for labor, and this difference widens in the second subperiod. Thus, a high weight assigned to the capital input will produce an index of inputs that rises rapidly relative to output, leaving little room for improvement in total factor productivity.

We are dubious about the frequent assumption of a capital elasticity of 0.5 or higher in the growth accounting studies of China. Perhaps it can be traced to econometric studies, such as Chow and Li (2002), that obtain large coefficients on capital in regression estimates of an aggregate production function. However, an economy with a high rate of growth of output and capital relative to labor can appear to have a strong correlation between output and capital, and thus a high capital elasticity, without this regression coefficient being indicative of the underlying production process. We believe that the low quality of the data makes any estimate of the aggregate production function a bit dubious. Our estimates, like those of Young (2003) and the International Monetary Fund (2006) that use a similar capital elasticity, obtain a larger estimate of the contribution of total factor productivity.

Future Prospects

China's growth performance over the last 25 years has truly been extraordinary, but in recent years, India has also grown at a rate that matches the other industrializing economies of East Asia. However, some differences stand out between the two economies. India's growth has been strongest in various service-producing industries, while India's manufacturing sector has remained surprisingly weak. China's growth is remarkably broad across agriculture, industry, and services. Overall, the growth of services in China actually exceeds that of India. Using the most recent data, we find no support for some of the recent arguments that China is experiencing a significant deceleration of growth in total factor productivity due to wasteful and excessive expansions of capital investment.

[9] Heytens and Zebregs (2003) use both 0.56 and 0.63; however their study does not include the post-1998 period in which the others find a total factor productivity slowdown.

Despite their growth performance in recent years, China and India are still very poor countries relative to the United States. Using purchasing power parity exchange rates, which take into account differences in prices of goods and services across countries, China stands at 15 percent and India at 8 percent of the U.S. level of gross national income per capita. China is faced with a slowing of the increase in the population of labor force age, but it should be able to sustain its economic growth in future years, in large part by continuing to shift workers out of agriculture to higher productivity jobs in industry and services. India has an even larger share of its workforce still in agriculture, which offers still greater opportunities for reallocation to more productive sectors.

However, China has made much greater progress in raising the educational skills of younger workers. Indeed, China has essentially eliminated illiteracy among new entrants to the workforce (OECD, 2005). Enrollment rates are rising rapidly at every educational level, and 98 percent of China's primary school enrollees reach the fifth grade, compared to 60 percent for India. Despite an external reputation for having a large pool of highly educated persons, India faces serious deficiencies in the education of the bulk of its youth population.

With respect to capital accumulation, China is actually faced with an *excess* that could threaten to disrupt growth through overinvestment in some sectors. In addition to a national saving rate above 40 percent, the country is the recipient of private capital inflows equal to 10 percent of GDP. For China, a continued rate of output growth near 10 percent annually seems easily warranted from the supply side of the economy.

India faces a more constrained situation. While India's private saving rate has increased substantially over the past decade, much of this is drained off into the financing of a large public sector deficit. Similarly, private capital inflows have increased; but as a share of GDP, the flow is about half that of China. Current rates of capital accumulation are consistent with a GDP growth rate near 7 percent, but higher rates would require reductions in the public sector deficit or increases in capital inflows from abroad.

However, the differences in public borrowing between China and India may not be as great as they may appear. India's government borrows funds directly to finance its expenditures. China's government does not report a similar public sector deficit, but only because it covers the losses of state-owned enterprises with loans from domestic banks that are unlikely to be repaid. At some future date, the Chinese government will need to assume the debt directly.

The growth prospects for both China and India depend upon continued integration with the global economy to deepen and sustain their growth, including both trade in goods and services and also investment flows. In this respect, China has had extraordinary achievements in raising the ratio of total trade (imports plus exports) to GDP to 65 percent in 2004 compared to 14 percent in 1978. India was at the same 14 percent of GDP in 1978 and for many years lagged far behind China. Recently, however, India's trade has also expanded rapidly and reached 42 percent of GDP in 2004. From 2000–2004,

Table 6
Annual Growth in Exports, China and India, 1995–2004
(percent)

	1995–04	*1995–2000*	*2000–2004*
China			
Total exports	18.1	13.7	23.8
Goods	18.6	14.2	24.2
Services	14.0	9.7	19.7
India			
Total exports	12.6	9.5	16.6
Goods	10.1	6.7	14.5
Services	20.6	19.8	21.6

Share of goods in total exports

	1995	*2000*	*2004*
China	87.0	89.1	90.5
India	82.2	72.2	67.1

Source. World Bank's 2006 *World Development Indicators.*

China's exports expanded at a 24 percent annual rate, but India has also had extremely rapid growth in exports—17 percent per year—as shown in Table 6. However, the composition of exports has been much different. Just as with the sector composition of GDP, China's exports are concentrated in goods exports, whereas India's trade has a much larger services component. The extent of China's lead in goods trade is also evident in Table 7, which shows the commodity composition of exports. In fact, China's exports have grown seven-fold since 1993, compared with a multiple of only three-and-a-half for India. To put it another way, the volume of India's merchandise exports is similar to that of China a decade earlier.

China and India also differ substantially in terms of another measure of integration with the global economy: foreign direct investment inflows. In recent years, the inflows into China have exceeded $50 billion per year, and a few years ago they represented over 4 percent of GDP. The inflows into India have been about $5 billion and less than 1 percent of GDP. Foreign direct investment can be important in promoting access to global markets and the accumulation of technology and management skills, all of which have been significant in China's growth.

Overall, we conclude that the supply-side prospects for continued rapid growth in China and India, in terms of labor, physical capital, and reallocation across sectors, are very good. Ultimately, India will need to redress its inadequate infrastructure and to broaden its trade beyond the current emphasis on services. Only an expansion of goods production and trade can provide employment opportunities for its current pool of underemployed and undereducated workers. China has performed well in the international dimension but now needs to focus on development of domestic markets, reducing inefficien-

Table 7
Exports by Commodity Type, China and India, 1993–2004
(millions of U.S. dollars)

	China		*India*	
Commodity	*1993*	*2004*	*1993*	*2004*
Food and live animals	8,381	18,844	3,384	6,843
Beverages and tobacco	901	1,214	159	303
Crude materials, inedible, except fuels	3,041	5,753	1,299	5,514
Mineral fuels, lubricants, and related materials	4,112	14,497	496	6,895
Animal and vegetable oils, fats, and waxes	205	148	101	349
Chemicals and related products	4,590	25,995	1,539	9,106
Manufactured goods, classified chiefly by material	16,803	101,713	9,096	28,924
Machinery and transport equipment	15,222	268,218	1,513	7,763
Office machines and computers	1,647	87,101	116	388
Telecommunications and sound-recording equipment	4,522	68,497	48	236
Electrical machinery, apparatus, and appliances	4,437	61,137	228	1,546
Miscellaneous manufactured articles	38,093	155,813	4,287	13,285
Clothing, footwear, and travel goods	25,308	82,908	3,456	7,752
Other	395	1,131	363	864

Source: United Nations, Comtrade database, ⟨http://comtrade.un.org/db/⟩.

cies in its financial sector, and achieving a more balanced trade position. However, none of these concerns can diminish the amazing accomplishments of both countries and the progress that they have made in lifting two and a half billion people from abject poverty.

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