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The Sources and Sustainability of China's Economic Growth

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IN 1978, AT THE outset of its economic reform, China was the world's tenth-largest economy, with a GDP of about $150 billion, or less than 6 percent of U.S. GDP at the time. By 2005, however, China's economy, at $2.2 trillion, had grown to become the fourth largest in the world, behind only the United States at $12.5 trillion, Japan at $4.5 trillion, and Germany at $2.8 trillion. The above figures, which come from the World Bank, evaluate GDP at current exchange rates and do not take account of differences in the purchasing power of currencies. When measured instead at purchasing power parity (PPP), China is already the world's second-largest economy, with $8.9 trillion in output, nearly three quarters that of the United States. It has been suggested that, at current growth rates, China's GDP stated in PPP terms could exceed that of the United States as early as 2010.[1]

When China's GDP converted at current exchange rates does match that of the United States, assuming that China's population remains four times the U.S. population, Chinese income per capita will then be but one quarter that of the United States. By comparison, the purchasing power of the average Chinese resident will substantially exceed one quarter that of the average U.S. resident, perhaps rising to the vicinity of one half.

What changes will have to occur within China's productive sectors for China's GDP to match and ultimately surpass that of the U.S.? Today even China's coastal industry, the country's most technologically advanced region and sector, lags substantially behind the world technology frontier. Meanwhile a well-known feature of China's rapid economic transformation is the unequal advance, in terms of technological change and productivity, of different regions and sectors across this large and populous country. The regions and sectors that lag behind China's coastal industry also exhibit large disparities in productivity among themselves.

These large international and internal productivity gaps represent both advantages and disadvantages for China's ability to sustain high rates of GDP growth. The key advantage is that both the international gap and the internal gaps continue to provide multiple channels through which catch-up can proceed. A well-known disadvantage of the internal gaps is that the accompanying large differences in income threaten social stability. A further disadvantage of large internal productivity differences, to the extent they prove persistent, is that much of the burden of China's catch-up with the United States will fall on coastal industry. That is, if productivities in the regions and sectors outside China's coastal industry remain far below one quarter that of the United States, then coastal industry will have to achieve productivity levels well above one quarter that of the United States. Coastal industry will have to continue as the locomotive pulling the rest of the economy forward. Indeed, if China is to meet its ambitious goal of output parity with the United States, coastal industry may have to closely approach or even exceed U.S. productivity. Yet the history of other successful developing countries suggests that, as it does so, China's productivity growth is likely to slow substantially, in turn slowing the country's overall economic growth.

A number of questions emerge from this overview and frame the analysis in this paper: Within China, how much does China's coastal industry lag behind the global frontier? How much do China's other regions and sectors lag behind coastal industry? Is there evidence of catch-up or convergence of these regions and sectors with coastal industry? If so, what are the sources of such change? If instead there are growing disparities, what are the causes? To what extent can one expect that, as China's coastal industry closes in on the global technology frontier, the productivity growth of China's own technology frontier will slow?

We investigate these questions using panels of industry and firm-level data. However, any research agenda that seeks to assess a country's medium- to long-term economic growth prospects has to take into account that country's capacity for institutional adaptation, since institutions shape the incentives and prospects for such growth. This is particularly true for China, which remains engaged simultaneously in two transitions: from a centrally planned to a market economy, and from a less to a more developed country. Therefore we also speculate as to what institutional reforms will most directly bear on China's ability to close its international and internal productivity gaps. These reforms depend on the ability of China's political system to formulate and enforce the rules that reassign and clarify the property rights needed to sustain investment in technology development and to facilitate the flow of resources to the regions and sectors offering high returns.

During the past quarter century of reform, and largely to the surprise of most observers, China's economic performance has demonstrated considerable resilience. In addition to successfully weathering the Asian financial crises of the late 1990s, China has substantially restructured its state enterprise sector and opened itself to the international economy, including having adopted World Trade Organization (WTO) rules. For two decades now China has sustained an annual average rate of growth of GDP about 6 percentage points higher than that of the United States (about 9 percent versus 3 percent). If China can sustain that growth advantage into the future, then, assuming no change in exchange rates, its GDP unadjusted for PPP will catch up to that of the United States in twenty-five to thirty years.

When China's GDP does catch up to U.S. GDP, that fact will be of more than symbolic importance. Having established an economic system that is as large, if not as efficient, as that of the United States, China's consumption of natural resources, its participation in the international trading and financial systems, its contribution to global technological advance, and its influence in international relations and conflict management are likely to approach and in some cases exceed those of the United States.

The paper is organized as follows. The next section describes the basic model, partly inspired by Edward Denison's work, that we use to organize our analysis of China's catch-up prospects. We next examine the magnitude of the relevant productivity gaps, and we focus on the Chinese economy's dynamic catch-up processes for reducing both the international and the internal gaps. We then combine our empirical findings to discuss the prospects and challenges for China's GDP to catch up with that of the United States during the next twenty-five to thirty years. As already suggested, any analysis of China's catch-up prospects over such a horizon must take into account the role of institutions, including both the constraints they set and the opportunities they offer for shaping the pace at which the relevant productivity gaps are reduced. Finally, we focus on the political economy of China's economic growth, and we draw various conclusions from our analysis, including some policy implications.

[a]The Basic Model: Two Productivity Gaps

In his study of the process by which living standards in the major non-U.S. industrial economies narrowed the gap with, and ultimately caught up to, those in the United States, Denison identified several sources of this catch-up, three of which he viewed as key: resource reallocation, scale economies, and movement toward the international technological frontier (table 1).[2] In his study of China's long-run performance, Angus Maddison cites these same three sources of long-run growth:

> [extract]Countries in this situation of relative backwardness and distance from the technological frontier have a capacity for fast growth if they mobilise and allocate physical and human capital effectively, adapt foreign technology to their factor proportions and utilise the opportunities for specialisation which come from integration into the world economy.[3][end extract]

[table 1 about here]

A close examination of Denison's results suggests the following lessons:

--Within the current group of advanced industrial countries (members of the Organization for Economic Cooperation and Development, or OECD), labor productivity in the initially poorer countries grew faster than it did in the richer countries—a necessary condition for catch-up.

--Some labor productivity growth originated with capital accumulation (capital deepening), but for the lower-income economies the most important source of catch-up was growth in multifactor productivity (MFP).

--Among the sources of MFP growth, the creation of scale economies and resource reallocation were most important to the catch-up process. Movement toward the international technology frontier was less important for the group as a whole.

Although, statistically, the results in table 1 confirm the relative unimportance of movement toward the international frontier, arguably it is this factor that drives the other two. That is, without the continuous movement of the advanced industrial sector of a developing economy toward the international frontier, the potential gains from internal resource reallocation will eventually be exhausted. Furthermore, establishing scale economies depends substantially on acquiring state-of-the-art technologies that embody the potential to scale up. The international technology frontier is indeed synonymous with innovations that exploit scale economies.

Drawing on Denison's analytical perspective, one can think of China's growth trajectory as being driven by the ongoing reduction of two productivity gaps. The first is the international productivity gap, which reflects the substantial distance between the international technology frontier and China's technology frontier, which we define as the productivity of Chinese industry or, more specifically, as the productivity of industry in China's leading coastal areas. The second is the internal productivity disparity between China's coastal industrial sector and the country's lagging agricultural and services sectors and between coastal industry and the industrial sectors of China's other regions. Of course, the two gaps are not unrelated. Absent an equivalent increase in the productivity of the lagging sectors, as productivity growth in China's advanced industrial sector reduces the international productivity gap, it simultaneously must increase the internal productivity gap, creating the potential for growth through internal technology diffusion and factor reallocation.

The catch-up of China's advanced industrial sector toward the world frontier is fundamentally driven by technological advance, which in turn is driven by the integration of China's industrial economy with the world economy. This integration has been accelerating, spurred by China's accession to the WTO in 2001, the surge of foreign direct investment (FDI) into China during the past decade (China is now the world's largest recipient of FDI), and the rapid intensification of R&D spending, which facilitates the acquisition and diffusion of technology. Rapid movement of China's industrial economy toward the international frontier has been the driver of China's sustained rapid GDP growth. Although labor productivity in China's advanced industrial sector leads that of other regions and other sectors, in 2002 it was still less than one quarter that in the United States. Thus, even if China's entire labor force and capital stock were to be efficiently reallocated and were performing at the current level of the country's advanced industrial sector, China's GDP would still be smaller than U.S. GDP.

However, productivity differences across China's regions and sectors have not diminished during the reform period; indeed, ample evidence suggests that they have widened. China's catch-up thus will require not only the reallocation of labor and capital to the advanced sectors, but also the diffusion of productivity-enhancing technology in the other direction, to the backward sectors. Several institutional reforms will be needed to support the restructuring and upgrading of the backward regions and sectors, including land ownership reform, reductions in impediments to labor mobility and interregional trade, banking and corporate governance reform, and laws governing antitrust, bankruptcy, and mergers and acquisitions. (We examine the functions and political economy of these institutional requirements later in the paper.) If levels of productivity across regions and sectors within China do not converge, China's coastal industry will bear the burden of catch-up, which will make that catch-up more difficult given the tendency for productivity growth in a developing country to slow as its industrial frontier approaches the world productivity frontier.

[a]Measuring the Productivity Gaps: A First Look

We attempt here to assess the magnitude of China's international and internal productivity gaps. With respect to the latter, we examine in some detail the gaps in labor productivity between industry and agriculture, and between industry and services, both across China and within each of its four major regions. We report findings using both unadjusted employment data from China's National Bureau of Statistics (NBS) and data that correct for a possible overcounting of employment in agriculture and undercounting in the other sectors. Finally, we extend the analysis beyond labor productivity to capital and multifactor productivity.

[b]*The International Gap*[end]

Figure 1 illustrates labor productivity differentials for twenty-seven manufacturing industries at the two-digit standard classification level.[4] The figure shows productivity gaps between China's industries and the international frontier industries, defined as the corresponding industry in the United States or Japan, whichever of the two had the higher labor productivity.[5] Comparisons are made for 1995 and 2002, both for all Chinese industry and for industry in each of China's four major regions: coastal, northeastern, central, and western.[6] Since the Chinese provincial data are based on firm-level data from the large and medium-size enterprise (LME) data set of China's NBS (thus omitting presumably less efficient small firms), we anticipate some upward bias favoring China in these comparisons. On average for the twenty-seven industries and thirty-one provinces and autonomous municipalities (hereafter referred to simply as "provinces"), China's industrial labor productivity in 2002 was just one-seventh that of the international frontier. However, this difference represents a substantial gain compared with 1995, when labor productivity at the world frontier was sixteen times that of China. The figure shows that during this seven-year period, within the coastal region, all but four of the twenty-seven industries exhibited catch-up.[7]

[figure 1 about here]

[table 2 about here]

One industry that stands out in figure 1 is the food, beverage, and tobacco industry, where the rate of catch-up in 2002 seems substantially faster than in China's other industries. A key reason for this disparity is the existence of extremely high profits in the tobacco industry: 20.6 percent of total industrial costs in 2002 compared with an overall industrial profit rate of 5.6 percent.[8] Also, in that year estimated labor productivity in China's tobacco industry exceeded that for overall industry by nearly a factor of ten. For these reasons, which are likely to result from the government's restrictions on entry to the tobacco industry, we omit the food, beverage, and tobacco industry from our calculations in table 2, which focuses on regional differences in China's manufacturing productivity in relation to the international frontier.

[b]*The Internal Gaps*[end]

China's internal productivity gap can be described along two dimensions. The first is the gap between the advanced industrial sector and other, more backward sectors, especially the rural agricultural sector, in which much of China's labor force resides as underemployed or surplus labor. We also look at productivity gaps between Chinese industry and the Chinese services sector, as well as gaps across regions within the services sector. The second dimension of the internal productivity gap is that within industry across regions, and in particular between the advanced industrial sector, primarily concentrated in parts of China's coastal region, and the relatively backward industries located in the northeastern, central, and western regions. We examine the magnitudes of both types of gaps.

[c]*The Agricultural-Industrial Gap*.[end] Table 3 compares average labor productivity (output per worker) in the agricultural sector broadly defined (agriculture, forestry, and fishing) with that in the industrial (including construction) sector.[9] The last column in the table reports the ratio of the two productivities. The table reveals, first, that the agricultural-industrial productivity gap is large. In 2005 the average industrial worker produced more than seven times as much as his or her agricultural counterpart. Moreover, the gap has grown. From 6.1 in 1980, the ratio of industrial to agricultural productivity had shrunk by 1990 to 4.3, but thereafter it grew continuously until, at 7.1 in 2005, it surpassed the 1980 level.

[table 3 about here]

[c]*Regional and Sectoral Gaps*.[end] The data in table 3 provide a historical perspective on changes in the agricultural-industrial productivity gap, but they do not provide insight into the variety and range of productivity gaps that exist across regions and sectors, including the services sector. To provide this broader picture, table 4 uses official NBS data to compute the gaps for the industry, agriculture, and services sectors across the four regions for 1995 and 2004. We address both the magnitude of the gaps and whether, during 1995-2004, they have tended to widen or narrow. The table uses productivity in China's coastal industry, which we designate as China's technology frontier, as the point of reference in these comparisons.

[table 4 about here]

We examine first the gaps in 1995. Ratios of productivity in coastal industry to that of industry in the other three regions ranged between 1.78 (western) and 1.32 (northeastern). The largest ratios are those between coastal industry and the agricultural sector, which range from 4.47 (for coastal agriculture) to 10.22 (for western). The ratios between coastal industry and the services sector range from 1.05 (coastal) to 2.42 (western). For 2004, table 4 shows a tendency for the industry gaps to shrink, particularly that between the coastal and northeastern industrial sectors, where industry in the northeastern region appears to have surpassed that of the coast, even as the coastal industry-agricultural gaps increased substantially. The gaps between coastal industry and the services sector also tended to increase. Among the eleven pairwise cases, we find a widening of the gap from 1995 to 2004 in all but three. Although some convergence of labor productivity has occurred within industry, the productivity gap between industry and the agricultural and services sectors generally increased during 1995-2004.

[c]*Measurement Issues*.[end] The disparities between industry and agriculture and between services and agriculture may be somewhat overstated if workers who are temporarily migrating to the cities are included in the agricultural totals. Xiaoquan Ding, and Yang Du and Albert Park, argue that the data in the *China Statistical Yearbook* overstate the number of workers in agriculture.[10] According to Ding, "the official statistics on agriculture employment are based on the registered permanent residence system. Although this system impedes rural residents from obtaining urban registration, it cannot prevent rural residents from moving to cities and working in industries."[11] Ding asserts that many migrant workers living in cities and those working in township and village enterprises are erroneously classified as agriculture workers. Thomas Rawski and Robert Mead estimate that, in the early 1990s, the overcount may have been as high as 100 million, so that 230 million Chinese workers rather than the reported 330 million were actually working in agriculture.[12]

Loren Brandt, Chang-tai Hsieh, and Xiaodong Zhu construct an alternative series of sectoral employment figures to take this possible miscounting into account.[13] Their agricultural employment data are constructed by taking the NBS estimate, which is already adjusted for employment in rural township and village enterprises, and further correcting for those working in private firms or self-employed in nonagricultural activities. This correction results in a substantial shift in employment shares: whereas the NBS data for 1995 indicate that 52.2 percent of China’s workforce was employed in agriculture in that year, Brandt, Hsieh, and Zhu’s corrected figures set the share at 44.1 percent. The shares of the industrial and services sectors, recorded by the NBS as 23.0

percent and 24.8 percent, respectively, in 1995 rise to 27.1 percent and 28.8 percent under the corrections. The corrections by Brandt, Hsieh, and Zhu end in 2000; we therefore adjust the 2005 NBS figures by assuming that the decline in China's agricultural employment share from 2000 to 2005 proceeds at more or less the same rate as in Brandt's adjusted data for 1990-2000, that is, at an annual rate of 1 percent. Thus we assume that China's agricultural employment share in 2005 was 34 percent, which roughly corresponds to that in South Korea in 1982.[14] To complete the series, we reallocate the agricultural workers who are dropped in 2005 to the industrial and services sectors in the same proportions as the reallocations to these two sectors for 2000.

[figure 2 about here]

We first use these corrected agricultural and industry employment figures to adjust the labor productivity calculations shown in table 3.[15] With the adjusted figures, we find that the ratio of industrial to agricultural labor productivity for 1995 declines from 5.42 to 3.89; for 2005 the decline is from 7.11 to 4.47. Although the adjusted figures still show an increase in the industry-agriculture productivity gap from 1995 to 2000, this increase is substantially less than implied by the original NBS data.

We also use these adjusted employment data to correct the pattern of productivity gaps shown in table 4. Because the employment adjustments by Brandt and coauthors for industry and services are nearly identical for 1995 (1.18 and 1.16, respectively), as are our extensions for 2004 (1.24 and 1.20, respectively), and because the absence of provincial and regional corrections requires us to assume that the adjustments are uniform over each of the four regions, we do not recompute the ratios for coastal industry to noncoastal industry or for coastal industry to services. We do recompute the ratios for coastal industry to agriculture, which are shown in table 4. Although, as in table 3, the industry-agriculture gaps using the adjusted data grow substantially less than those using the original NBS data, the results do not change our basic conclusion that overall, in relation to coastal industry, the regional and sectoral productivity gaps grew from 1995 to 2004.[16]

[c]*Gaps between Backward and Advanced Industry: A Closer Look.*[end] A second measurement issue relates to the measures of regional industrial labor productivity using the data from the *China Statistical Yearbook*. These data show three provinces with

implausibly high or low levels of labor productivity in 2004: at the high end are Heilongjiang at 95,195 yuan per worker and Xinjiang at 102,551 yuan per worker. At the low end, Beijing's labor productivity is 68,126 yuan per worker. To check these productivity data, we use another set of NBS data that has been compiled for the "above-scale" (*guimo yishang*) enterprises with annual sales in excess of 5 million yuan.[17] In addition to focusing on just those enterprises that regularly report to the NBS, a further advantage of these data is that they exclude construction, a component for which the employment classifications are particularly questionable and whose exclusion allows for comparisons using the conventional definition of industry. When we compute the provincial comparisons using these data, we find that the labor productivity measure for Beijing moves into a plausible range, but those for Heilongjiang and Xinjiang remain implausibly high, as does Yunnan's in addition, exceeding industry's average labor productivity by 32, 74, and 50 percent, respectively. Closer inspection of these three provinces shows that each is dominated by either petroleum extraction or the tobacco industry, both of which enjoy extraordinary profits that account for their high value added per worker.[18] Therefore we drop these three provinces and recalculate the regional labor productivities using only the remaining ones. The productivity gaps for regional industry using these adjusted data are shown in table 4. Unlike the broader industry data, these do not show the northeast surpassing the coast. The adjusted data continue to show the central region lagging behind the coastal and northeastern regions and the western region lagging behind all other regions.

These adjustments do not make a substantial difference to the measures of agriculture and services productivity in relation to coastal industry shown in table 4. However, we note that the more narrow definition of industry, excluding construction and firms that do not qualify as "above scale," results in significantly higher average productivity for coastal industry (98,624 yuan per worker) than for the broad measure of industry (65,410 yuan per worker). This disparity not only underscores the tendency of the sectoral productivity gaps to increase when industry is limited to its more formal definition, but also begins to give some indication of the extent of productivity differences within the industrial sector, for example between formal industry and construction and between the "above scale" firms and the smaller industrial enterprises.

Table 2 also reports regional comparisons for the industrial sector. These measures, too, cover different set of firms from those in table 4. The data in table 2 are based on calculations of labor productivity for our sample of large and medium-size enterprises, which is still more limited than the larger population of above-scale firms.[19] It also covers manufacturing only (excluding mining and electric power generation) and compares levels for 1995 and 2002, the last year for which data are available in the Groningen data set. A further difference with the industry data in table 4 is that the table 2 data are deflated.[20]

Although these data are thus not directly comparable to those in table 4, they do provide a useful comparison across regions, in particular by omitting the mining and petroleum sectors, which inflate the comprehensive industry productivity measures for the northeastern and western regions. Table 2 shows that the 1995 gaps were large, with ratios to productivity in the coastal region ranging from 3.90 for the western region to 3.08 for the central region and 1.86 for the northeastern region. By 2002, labor productivity in the central and western regions had reduced the gap with the coastal region: the ratios for that year were 1.86 and 2.52, respectively. In contrast, labor productivity in the northeastern region fell behind that of the coast, with the ratio of productivities rising from 1.86 in 1995 to 2.07 in 2002. These manufacturing data that exclude construction, mining, and power generation show persistent gaps between coastal manufacturing and that in the other three regions. Although they show a narrowing of the gaps between the central and western regions and the coast, the gaps remain large. Combining our results in table 2 and table 4, we find that, when industry is defined broadly to include petroleum extraction, the northeast is catching up with coastal industry. When industry is limited to manufacturing, however, the northeast exhibits limited or no catch-up.

One shortcoming of our productivity comparisons thus far is that they focus exclusively on labor productivity to the exclusion of capital productivity and the broader measure, multifactor productivity. To remedy this exclusion, we use our NBS large and medium-size enterprise (LME) data set, which includes firm-level data, to regress the log values of labor productivity, capital productivity, and MFP on dummy variables for China's major regions with and without two-digit industry dummies.[21] These industry data include mining and petroleum extraction and power generation. Because the sample is limited to China's larger, more technologically advanced firms, one might anticipate that the underlying productivity differentials across regions are less than the differences shown for all industry.

One immediately apparent result, shown in table 5, which estimates the regional differences, and table 6, which summarizes the productivity differentials, is that, as in the industry comparisons shown in table 2 and figure 1, in 1995 the coastal region enjoyed a sizeable labor productivity advantage over each of the other three regions. The region that diverges most from the coastal region is the northeastern region, followed by the western and central regions. By 2004 all of these disparities had declined substantially.

[table 5 about here]

[table 6 about here]

By contrast, we observe no comparable overall narrowing of the capital productivity gap. In regressions without the industry dummies we observe a consistent increase in the capital productivity gap, as the coast substantially increases its capital efficiency relative to the other three regions. In these estimates, therefore, we find an overall convergence of labor productivity with a simultaneous divergence in capital productivity. In constructing the MFP measures, the larger weight afforded to labor productivity in part accounts for a pattern of overall convergence.

The inclusion of the industry dummies substantially alters the results. For labor productivity, including the industry controls magnifies the productivity disparities in both 1995 and 2004, although their inclusion does not overturn the result of a robust convergence of industrial labor productivity across regions. The industry dummies have the opposite effect on capital productivity, at least in 2004, tending to substantially reduce the productivity gaps between the coast and each of the other three regions, leaving the regional gaps in capital productivity only slightly altered relative to 1995. These industry effects largely reflect the high concentration of extractive industries, including petroleum and natural gas extraction and petroleum refining, in the northeastern and western regions. These capital-intensive industries, which exhibit high labor productivity, also exhibit low capital productivity.

These results reinforce the notion that industrial labor productivity across China's regions is converging but that coastal industry remains some distance ahead of the other regions. Although the results using industry data that include mining and power generation suggests more rapid catch-up than those using manufacturing alone, the inclusion of these capital-intensive industries also follows a pattern in which capital productivity in the three noncoastal regions is falling further behind that of the coast, thereby slowing but not reversing the catch-up of MFP. In the following two sections we investigate the dynamics of productivity catch-up both internationally and within China's industrial sector.

[a]Chinese Productivity and the International Frontier

A question that is central to the pace and timing of China's GDP catch-up is how productivity growth in Chinese industry responds to the gap between China's productivity and the international productivity frontier. Because many sources of productivity change, including resource shifts across industries and regions within China, are commingled in the aggregate data, we examine the importance of productivity gaps at the industry level. The firm-level data are aggregated to the industry level for each province, distinguishing twenty-seven industries and thirty-one provinces, so that the unit of observation in the regression is the "province-industry-year." We relate the rate of growth between 1995 and 2002 of these province-industry productivity observations to the gap between productivity in that province and industry and productivity at the international frontier in 1995. We estimate the following basic equation:

$$(1) \qquad [\ln(VA/L)_{i,j,2002} - \ln(VA/L)_{i,j,1995}] = \alpha_0 + \alpha_1 \ln(\mathrm{GAP\_FRONT}_{i,j,1995}) + \alpha_2[\ln(VA/L)_{\mathrm{FRONT},j,2002} - \ln(VA/L)_{\mathrm{FRONT},j,1995}] + \varepsilon,$$

where $\ln(\mathrm{GAP\_FRONT}_{i,j,1995}) = \ln(VA/L)_{\mathrm{FRONT},j,1995}, - \ln(VA/L)_{i,j,1995}$, and i indexes provinces and j industries. (The rates of growth are annualized.) To test for regional differences in the response, we include dummy values of α_1 for three of the four regions, where the dummy variables interact with the 1995 productivity gaps.

Our priors are that $\alpha_1 > 0$, reflecting the fact that industries and regions that are further behind the international productivity frontier can make bigger gains by exploiting the frontier technology, either by imitation or by importing technology or capital. One might anticipate that the sign on α_2 would likewise be positive, indicating that the more rapid is productivity growth during 1995-2002 for a frontier industry, the more generally available the useful technology and spillovers are in its lagging Chinese counterpart industry during the same period. Alternatively, China's comparative advantage may be greatest in industries such as textiles, apparel, and footwear, where productivity growth in the advanced industrial economies is slow. In this case such Chinese industries might grow rapidly, modernizing in the process, leading to a negative α_2. Similarly, a negative α_2 would also arise where productivity changes were exceptionally rapid in the frontier industries, providing little opportunity for Chinese firms to begin to catch up technologically, discouraging modernization. As these considerations suggest, the regression results should be interpreted as casting light only on medium-term responses in China's recent development. They are informative about the path that China is on but cannot be used with confidence to infer conditions well outside the data, such as long-run equilibrium conditions.

The estimation results, shown in table 7, are robust to alternative specifications and samples, showing that the rate of industrial productivity growth during 1995-2002 rises monotonically with the distance of the relevant industry from the corresponding frontier productivity level in 1995. The addition of the quadratic term becomes highly statistically significant when the constant, which itself is generally not statistically significant, is constrained to equal zero.

[table 7 about here]

The findings in table 7 are consistent with Denison's finding (table 1) that the rate of labor productivity growth in catch-up countries slows as these countries move toward the international productivity frontier. We further find, as shown by the large coefficient on the variable that interacts China's coastal region dummy with the gap variable, that coastal firms generally enjoy higher rates of productivity growth than do firms in the other three regions for every level of the productivity gap. The results reported for regression 7-5 in table 7 are mapped into figure 3, which shows how productivity growth in both the coastal and other regions relates to an industry's productivity gap, expressed as the ratio of frontier productivity to Chinese productivity in a given industry, assuming a 2 percent annual growth rate of productivity at the frontier. The figure illustrates the potential importance of pure technological catch-up at the firm level. The effects of gaps are highly significant, and the average productivity improvement of coastal industries in the face of international gaps is substantial at the level of the gap observed in most industries in 1995. For example, with a ratio between industry productivities of 10, which is smaller than that in many industries in that year, the implied rate of labor productivity growth is 11 percent a year in the coastal region, indicating a rapid reduction of such industry gaps even with substantial growth in frontier productivity. The predicted growth in productivity for a comparable gap in other regions is lower but still substantial (roughly 8 percent). The estimation results shown in table 7 and their illustration in figure 3 also imply that, at least for manufacturing, the northeastern, central, and western regions may enjoy rapid productivity growth but will not fully catch up to the coast, at least in the medium term. As the results show, productivity growth in these regions will grow as fast as that in coastal manufacturing only as long as a substantial productivity gap persists.

[figure 3 about here]

Factors that may explain this persistent disparity between the coastal and other regions include the concentration of FDI and R&D spending in the coastal region and the better development of institutional arrangements, including the legal system and human capital development in the coastal region. Together these factors may enable coastal industry to take greater advantage of international technology than industry in other regions can, even though its gap with the world frontier may be considerably smaller than those of industry in other regions. We return to these issues later in the paper.

[a]Sources of Internal Productivity Growth

Our investigation of the responsiveness of labor productivity growth in China's domestic industry to international productivity gaps has shown, with the existing large gap, an initial tendency for sustained labor productivity growth and catch-up, particularly in the coastal region. We also find, in tables 2, 4, 5, and 6, evidence within China's industrial sector of catch-up with coastal industry by the northeastern, central, and western regions, at least for labor productivity and MFP, if not for capital productivity. This part of the paper investigates the processes through which Chinese firms may or may not respond to productivity differentials *within* Chinese industry by closing the internal productivity gap. The analysis examines the following issues: What are the contributions of labor reallocation and capital accumulation to productivity growth? Can evidence be found of improved allocative efficiency within China's industrial sector, that is, a closing of productivity gaps arising from the reallocation of labor and investment to firms that offer higher returns? And what is the contribution of the exit and entry of firms to industrial productivity growth?

[b]*The Contribution of Labor Reallocation*[end]

As reported above, we find large differences in labor productivity among sectors and regions within China. Given these differences, the reallocation of labor from low- to high-productivity sectors or firms could have substantial effects on aggregate output and productivity. To clarify the potential importance of this mechanism for explaining the rapid growth of Chinese output in the last decade and its potential importance for future growth, we consider a two-sector model in which labor productivity in agriculture is designated P_a and that in industry gP_a. Assuming that neither productivity in agriculture nor productivity in industry changes significantly with the reallocation of labor, moving one unit of labor from agriculture to industry increases output by $(g - 1)P_a$.

Taking the labor force L_0 as given, with an initial fraction β of L employed in agriculture, aggregate output is

$$Q = [\beta P_a + (1 - \beta)gP_a]L_0 = [\beta + (1 - \beta)g]P_aL_0.$$

If labor moves out of agriculture at rate of b percent a year (that is, the percentage rate of change of β is $-b$), the percentage rate of change of Q is simply

(2) **{**$Q^{\bullet}/Q = \beta b(g - 1)/[\beta(1 - g) + g]$**}** $\frac{\dot{Q}}{Q} = \frac{\beta b(g-1)}{\beta(1-g)+g}$.

This expression can be used to calculate the growth in total output arising from reallocation across any two sectors whose productivities differ. Note that the crucial parameters for this calculation, g and β, enter nonlinearly.

Figure 4 shows how the contribution to output growth of annually reallocating 1 percent of the labor in the low-productivity sector to the high-productivity sector varies with g. The figure shows this relation for three different values of β, the initial fraction of labor in the low-productivity sector. Obviously, the larger is β, the greater is the contribution of reallocating a given percentage of the low-productivity workers. The fact of diminishing marginal returns to the size of the gap is not as obvious. The concavity of the response function reflects the fact that, for a given β and a given level of productivity in the low-productivity sector, a larger gap implies higher output in the high-productivity sector and a larger overall economy. Although the increase in total output from a reallocation of a unit is proportional to the productivity gap, it represents a smaller percentage of total output.

[figure 4 about here]

Figure 4 allows us to examine some of these effects quantitatively. The employment share of China's agricultural sector is currently around 0.4. Assuming a ratio of industrial to agricultural productivity of 5 (roughly the gap shown in table 3 for 1995), our model predicts that a 1 percent annual labor reallocation from agriculture to industry will result in approximately a 0.5-percentage-point contribution to annual GDP growth. Of course, much of China's industrial sector is also backward. As a further illustration, therefore, consider migration from, say, the 80 percent of the labor force now residing in the aggregate of China's relatively backward agricultural and industrial sectors. Assuming an average productivity ratio of 2.5 for this low-productivity "sector," if 1 percent of its labor migrates each year to the higher-productivity industrial sector, the result, as shown by the upper curve in figure 4, is a 1-percentage-point increase in annual GDP growth. This migration, of course, reduces the employment share of this low-productivity sector.

When it is only 0.5 (the middle curve in figure 4), the same 1 percent reallocation, given the same ratio of 2.5, generates additional GDP growth of less than 0.5 percentage points.

To summarize, two factors lead to a diminishing contribution to GDP growth from labor reallocation. The first of these, particularly with respect to agriculture, is the diminishing number of surplus workers as a share of the total workforce. The second, which acts as a drag on the ability of labor reallocation to sustain rapid GDP growth, is the fact that although widening gaps signal greater productivity gains for each migrating worker, they also imply smaller relative contributions to GDP growth, since increasing productivities in the advanced areas increase GDP. By entering the denominator of the GDP growth calculations, the higher GDP resulting from the larger gaps causes productivity gains from labor reallocations to make smaller proportionate contributions to overall growth.

[b]*Evidence of Efficient Reallocation among Industrial Firms*[end]

Differences in productivity across industries and regions can be as large as or larger than the average gap between agriculture and industry discussed above. To what extent does it appear that labor and capital have been reallocated from less to more productive industrial firms in China during the last decade? We first examine the behavior of firms in our NBS panel of large and medium-size enterprises that were operating and reporting in 1995, 2000 and 2004, testing to see if a firm's initial factor productivities affect subsequent growth in the firm's labor, capital, and value added. Later we will compare the behavior of these firms with that of firms that exit or enter during the period. We also examine the change in factor productivities themselves. To address these issues, the following equations are estimated for the two periods 1995-2000 and 2000-04:

(3) $\ln L_{i,t} - \ln L_{i,t-\iota} = \alpha_0 + \alpha_1 \ln MPL_{i,t-\iota} + \Sigma_j \beta_j (\ln MPL_{i,t-\iota} \times REG_j) + \varepsilon$

(4) $\ln K_{i,t} - \ln K_{i,t-\iota} = \beta_0 + \beta_1 \ln MPK_{i,t-\iota} + \Sigma_j \beta_j (\ln MPK_{i,t-\iota} \times REG_j) + \varepsilon$

(5) $\ln VA_{i,t} - \ln VA_{i,t-\iota} = \gamma_0 + \gamma_1 \ln MFP_{i,t-\iota} + \Sigma_j \gamma_j (\ln MFP_{i,t-\iota} \times REG_j) + \varepsilon$

(6) $\ln MFP_{i,t} - \ln MFP_{i,t-\iota} = \delta_0 + \delta_1 \ln MFP_{i,t-\iota} + \Sigma_j \delta_j (\ln MFP_{i,t-\iota} \times REG_j) + \varepsilon,$

where $MFP_{i,t} = (VA/K)_{i,t}^{\alpha}(VA/L)_{i,t}^{1-\alpha}$ and *MPL* and *MPK* are the marginal products of labor and capital, respectively. The inclusion of the interaction terms allows us to test the differences in adjustment dynamics across regions. (REG_i is a dummy variable taking on the value 1 for a firm in region *i* and zero otherwise, with the central region as the omitted region.)

The results in table 8 show that, in both 1995-2000 and 2000-04, changes in the employment of labor and capital across industrial firms were positively related to the firms' initial levels of labor and capital productivity, respectively. For example, in 2000-04, doubling *MPL* adds about 10 percentage points to the annual growth rate of labor in the central region. Except in the coastal region, growth of labor was more responsive in this later period than in 1995-2000. The increase in the northeast may reflect the extensive layoffs associated with sanctioned furloughs (*xiagang*) at state-owned enterprises, which were relatively concentrated in that region. The responsiveness of capital formation is similar to that of labor growth, with roughly the same elasticity of growth with respect to its own initial productivity. However, in all regions capital was somewhat more responsive in the earlier than in the later period. Although factor productivities thus play an important role in the allocation of labor and capital, they explain only a small fraction of the variation in labor and capital growth across firms. [table 8 about here]

The results for the value-added equation (equation 5) are somewhat surprising. Higher multifactor productivity in the initial year (1995 or 2000) slows the growth of value added. This result seems paradoxical since, having determined that high initial levels of factor productivity motivate the accumulation of labor and capital, one might have anticipated that high MFP would also lead to relatively rapid growth of value added. If, in fact, growth of value added tends to be slower among firms with high initial levels of MFP, this implies that the higher rates of growth of inputs of labor and capital are associated with substantially slower MFP growth. Such a relationship would be consistent with the idea that low-productivity firms were catching up with high-productivity firms in this period.

This productivity catch-up hypothesis is supported by the regressions in table 8, which show that firms with low initial MFP exhibit faster growth of MFP. This catch-up is likely to reflect a diffusion of technology within China's industrial system, as less productive firms access technologies that enable them to move toward industry's technology frontier. Our results also show that the coastal region exhibits less of a tendency for MFP to converge than do the other regions of China. During 2000-04, productivity catch-up is somewhat more pronounced in both the northeastern and coastal regions than it was in the earlier period.

One possible interpretation of the relative lack of catch-up in the coastal area is that that region serves as a cauldron of technology development, where the country's largest R&D performers and exporters can extend their technological advantages.[22]. The overall impression conveyed by table 8 is that China's industrial economy exhibits attributes of efficient reallocation that bode well for the ability of firms with lagging productivity to access the technologies and organizational changes needed to capture some of the productivity advantages of the more efficient firms. The results also show a degree of factor mobility, enabling resources to move to higher-productivity uses within China's industrial system. These dynamics represent an important engine for sustaining productivity growth outside coastal industry and for further reducing the productivity gap within China's domestic industrial economy.

Although these dynamic adjustment processes probably account for some of the interregional industrial productivity catch-up observed during 1995-2002 (table 2) and 1995-2004 (tables 4 and 6), we emphasize that this catch-up remains partial and uneven. Moreover, our results in table 7 and figure 3 strongly imply the existence of structural limits to full catch-up of manufacturing productivity in the northeastern, central, and western regions to that of the coast.

[b]*The Contribution of Exit and Entry*

The most important shortcoming of the above analysis of resource allocation and productivity convergence within China's industrial system is that it is limited to firms that survived over the entire period 1995-2004. Firms omitted from the balanced sample include many firms that entered or exited during the period, as well as restructured firms whose identity changed with restructuring, making it impossible to track them separately from exiting and entering firms. Together these processes of exit, entry, and restructuring are likely to have been an important element in improving productivity. We therefore extend the analysis to account for their impact.

Table 9 uses the full sample of firms over 1995-2004 to estimate the productivity differentials among three categories of firms: firms that survive in the LME data over the entire period 1995-2004 (that is, the firms included in the table 8 regressions), firms that exited from the data set, and firms that entered it. Separate dummy variables for the three types of firms are used for each of the three-year periods: 1996-98, 1999-2001, and 2002-04. We estimate differences between these firm categories for labor, capital, and multifactor productivity. The results for labor productivity show a distinct pattern in which, relative to the survivors in 1996-98, the exiting firms exhibit low productivity, whereas the entrants exhibit high productivity. During 1996-98 the labor productivity of exiting firms was 35 percent lower, and that of entering firms 36 percent higher, than that of the survivors in the same period. In the following three-year period, the corresponding numbers are 57 percent and 41 percent. Finally, in 2002-04 the labor productivity of exiting firms was 47 percent lower than that of survivors, but entrants were marginally *less* productive than the survivors.

[table 9 about here]

The importance of exit, entry, and restructuring to overall productivity depends on how frequently they take place. Our data show a high incidence of both exit and entry: nearly 146,000 firms either entered or exited the sample over the nine-year period, drawn from an annual population of 22,000 to 27,000 firms. The large numbers of both exiting and entering firms (roughly as many exited as entered), together with the significant differences between their average productivity and that of surviving firms, suggests that they are indeed an important source of China's industrial productivity growth, but without knowing the size of the firms involved, we cannot precisely measure their contribution.

We have not measured changes in capital productivity in China over the past decade in relation to the international technology frontier in a manner similar to our analysis of labor productivity in table 2. Based on data from the NBS-LME data set, figure 5 shows that, after bottoming out in 1998, capital productivity began to rise monotonically through 2005. This rise is consistent with our findings that firms with high capital productivity tend to capture new investment and that the exit-entry phenomenon contributes substantially to improvements in capital productivity. The correspondence between the path of capital productivity shown in table 5 and the returns to capital productivity from exit and entry is notable. As table 9 shows, the increase in capital productivity associated with new entry was insignificant during 1996-98 but turned highly significant during 1999-2001 and became still more robust during 2002-04.[23]

[figure 5 about here]

Although the incidence of exit and entry shows no sign of having abated during our nine-year sample, we do see a decline in the resulting productivity gain, at least for labor. The exiting firms in 2002-04 were not as unproductive as those that exited during the previous three-year period, and, unlike the entrants during 1996-2001, which were significantly more productive on average than their survivor counterparts, the entrants during 2002-04 were only about as productive as their cohort survivor group. This result suggests that either the firms for which the most value added could be captured tended to be restructured early, or, where there were multiple restructurings, that they were subject to diminishing returns. We anticipate that, over time, enterprise restructuring in China's industrial sector will make smaller contributions to overall productivity growth.

To summarize, we have analyzed three major sources of catch-up in China's economy. These are the reallocation of labor, whether from agriculture to industry or within the industrial sector; increased allocative efficiency based on the reallocation of capital and labor to the more productive firms and the diffusion of technology to the relatively backward firms to enable their productivity catch-up; and, finally, exit and entry, which we suggest is likely in part to be associated with enterprise restructuring. Although each of these is an important source of productivity growth, capable of narrowing the productivity gap between China's relatively backward regions and sectors and its more advanced ones, the contribution of each to continuing productivity growth and GDP growth is likely to diminish over time.

[a]How Sustainable Is China's International Catch-Up?

Whether China, in particular its coastal industry, can continue to close the gap with the advanced economies depends broadly on two factors. The first is China's ability to sustain and expand its capacity both to create and absorb new domestic technology and to absorb imported technology. The second factor, on which the first substantially depends, is China's ability, through the functioning of its political economy, to sustain momentum for the underlying institutional reforms that shape the incentives to develop and employ new technologies, accumulate capital, and reallocate labor. Here we discuss the capacity for sustained economic growth through technology development. The next section focuses on the political economy and institutional underpinning of China's economic growth.

The international productivity gap analysis reported in table 7 and depicted in figure 3 strongly suggests that China's coastal industrial economy can sustain high rates of productivity growth as it reduces its technology gap with the international frontier. A central theme of the endogenous growth literature, however, is that productivity growth is not sustained by manna from heaven; rather, it is the result of deliberate investment in technological opportunity that promises competitive risk-adjusted economic returns.

Here we investigate the sources and measures of technology development that are responsible for driving the technological advance of Chinese industry, particularly in the coastal region. Specifically, we examine the proposition that China has begun its science and technology (S&T) takeoff, as measured both by a rapid rise in R&D spending as a share of GDP and by a surge in patenting activity; we argue that, from a comparative and historical perspective, this takeoff is not likely to be reversed.

[b]*China's Science and Technology Takeoff*

The historical relationship between R&D spending and GDP in developing countries shows a striking pattern: as a country's R&D spending approaches 1 percent of GDP, it typically then accelerates abruptly, rising to the vicinity of 2 percent, and finally levels off in the range of 2 to 3 percent of GDP. This pattern is particularly robust for countries with large populations, and on average it takes place over the course of a single decade. Jian Gao and Jefferson characterize this phenomenon of an abrupt one-time increase in R&D intensity as the "science and technology takeoff."[24] They identify the statistical regularities of such takeoffs and the underlying theoretical and empirical conditions that might explain them.

Figure 6 shows the pattern of R&D takeoff for five countries. The three large OECD economies in the sample show a similar pattern of S&T takeoff. In each of these countries, when the ratio of R&D spending to GDP breached the 1 percent threshold, R&D spending continued to outpace GDP growth until R&D intensity stabilized in the range of 2 to 3 percent of GDP. The transition period lasted about ten years on average, ranging from about five years in the case of South Korea to about twenty years for Japan. [figure 6 about here]

Drawing on Charles Jones' modeling of endogenous R&D,[25] Gao and Jefferson identify four factors that, they argue, are now driving China's S&T takeoff. Briefly, these are a transition from the consumption of final goods that are low in technology content to goods high in technology content; the accumulation of complements to R&D, including investments in information technology and human capital; access to the world's knowledge base and expansion of technological opportunity through international trade and FDI; and exploitation of the wage-productivity gap, including the tendency for compensation of home-country R&D personnel to lag behind that of their OECD counterparts.

This phenomenon of R&D intensification is found most consistently in more populous countries, perhaps because their size allows for the creation of scale economies across a broad set of industries. In China the lure of FDI to exploit the potential of the country's domestic markets, as well as its comparatively high levels of basic education and literacy, may also be factors.[26]

Figure 6 shows that China, having achieved a ratio of R&D spending to GDP of 1.4 percent in 2005, is firmly engaged in its S&T takeoff. This rapid expansion of R&D spending has established an important channel through which China's industrial enterprises are able to imitate, adapt, and improve on foreign technologies. China's S&T takeoff, which represents growing capabilities of Chinese organizations to innovate and imitate, is arguably the critical mechanism for sustaining China's catch-up. Our historical and comparative perspective indicates that this catch-up is likely to be sustainable, as it was for the larger established OECD economies and for the now-high-income East Asian economies. If China follows the path of East Asia's recently industrialized economies—including South Korea, Taiwan, and Singapore, all of which have completed their S&T takeoffs—as well as the larger OECD economies, the intensity of China's R&D effort, if not yet its quality, is likely to approach that of the major advanced economies sometime during the next decade.

[b]*Patenting*[end]

Figure 7 shows the surge in patenting in China that began in 1999, in part reflecting the implementation of several key patent law changes in anticipation of China's accession to the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) of the WTO. Hu and Jefferson show that a critical driver of the patenting surge has been FDI.[27] Firms, especially domestic firms, that were particularly patent intensive were typically located in those three-digit industries that exhibited the highest FDI concentrations. This association suggests that the technology transfer associated with FDI opened up new technological opportunities for imitation. Domestic firms accounted for 60,000 to 70,000 invention patents in 2004 and for virtually all of the approximately 220,000 utility model patent applications filed that year.[28] This high incidence of patenting for both imitation (associated with utility model patents) and innovation indicates that China's firms are developing innovative capabilities that are enabling them to rapidly absorb the inflow of foreign technology.

[figure 7 about here]

Together the rapid rise in R&D spending and the rapid growth in patenting are key leading indicators of the capacity of China's economy to translate its growing resource base into new knowledge, which it can then embody in increasingly efficient production that draws it closer to international state-of-the-art methods. Figures 6 and 7 substantially round out the story of the catch-up of China's advanced industrial sector with the industrial capabilities of the OECD economies. The concentration of R&D and FDI in China's coastal economy helps to explain why China's coastal provinces appear to enjoy the structural advantages in productivity growth and international technology catch-up depicted in table 7 and figure 3.

[a]The Political Economy of China's Economic Growth

In any country, the political system is important for economic growth, because it defines the structure and functioning of the institutional arrangements that shape incentives and economic performance.[29] In China, a low-middle-income developing country whose transition from a planned economy remains incomplete, the functioning of the political system is critical in determining the nation's capacity to assign and clarify property rights. Clearly defined property rights are needed to strengthen incentives to accumulate and efficiently utilize economic resources, both labor and capital, including physical, financial, and human capital.

Table 10 identifies two bundles of institutional reforms that are particularly relevant to the ability of China's economy to accumulate and allocate the resources needed to reduce its productivity gaps. The first bundle relates to conditions that shape the capacity to reallocate labor from China's relatively backward, low-productivity sectors to higher-income sectors. These include elimination of the residency registration (*hukou*) system, the establishment of land ownership rights to facilitate the sale and consolidation of fragmented and unproductive agricultural plots, and the creation of a social insurance system. The second bundle of institutional arrangements relates to provisions that are needed to facilitate the development and diffusion of technology, the restructuring of enterprises, and more efficient capital utilization. For each of these institutions, table 10 identifies its importance for reducing the relevant productivity gap. The political factors that affect the likelihood of these institutional reforms being advanced are discussed later in this section. These generally consist of existing commitments that China's government has made and its increasing political responsiveness to China's residents, who have a stake in continued prosperity.

[table 10 about here]

To illustrate the importance of clarifying and reallocating property rights for China's future growth trajectory, we focus on just one of the reforms identified in table 10, namely, the role of corporate governance reform. Table 9 underscored the important contribution made by the exit and entry of firms to the advance of both labor and capital productivity in China's industrial sector.

To clarify the institutional character of the exit-entry phenomenon, we now compare the ownership structures of exiting and entering firms. Figures 8 and 9 show that they are very different. During 1996-2003 the majority of exiting firms were state-owned enterprises, followed by collectively owned enterprises and shareholding companies. By comparison, in 2001-03 fewer than 23 percent of new entrants and about twice that proportion of exiting firms were state-owned enterprises. All forms of non-state and non-collective ownership are more likely to be found among entrants than among exiting firms. Specifically, entrants are far more likely to be private, shareholding, foreign, or overseas firms than their exiting counterparts.[30] These results suggest that part of the exit-entry phenomenon is associated with restructuring involving a change in ownership form. There is a clear association between the institutional and political economy side of China's economy and its ability to create and sustain productivity growth through laws, regulations, procedures, and factor markets that are defined by the political system.
[figure 8 about here]

[a] How Sustainable Is China's Institutional Reform?

How likely is China to sustain the momentum of reform along the institutional dimensions defined in table 10? We suggest that the momentum of institutional reform is likely to continue, for three interrelated reasons. The first is based on China's record of institutional reform over the past twenty-five years, during which the political leadership has continuously engaged in the institutional reforms needed to sustain economic growth.[31] The historical record strongly suggests that China's political leadership is deeply vested in the reform process and will continue along the path of institutional change. The second reason is the set of prior commitments that frame Chinese law and the nation's political choices. Notable among these precommitments are China's membership in the World Bank and the International Monetary Fund and its accession to the WTO and the TRIPS agreement, which together require minimum standards with respect to openness, financial system reform, and enforcement of intellectual property rights.

The third reason why substantial institutional reform is likely to continue is that China's fast-emerging middle class and its growing force of entrepreneurs, who are now eligible to become Communist Party members, expect their political system and leaders to pursue policies that support sustained economic growth. Robert Barro finds support for the notion that political reform is endogenously driven by economic variables.[32] Using panel data from over 100 countries from 1960 to 1995, Barro concludes that the propensity for democracy is most robustly associated with a growing middle-class share of GDP, with years of primary schooling and a narrowing of the gap between male and female primary schooling, and with the absence of oil as an abundant natural resource. With China now enjoying the rapid growth of a middle class, with more females than males in primary school, and with a growing dependence on imported oil, China would seem to fit Barro's profile of a country that is on the threshold of important democratic innovations.

Our view is that although China has clearly not established an effective system of competitive political parties, the Communist Party's monopoly over political power has evolved from one that is near absolute to one that is, arguably at least, contestable.[33] To the extent the Party's power is a contestable monopoly, and given that its legitimacy and its ability to resist those elements that might challenge its authority rest squarely on China's ability to sustain rising living standards and social stability, the Party's economic policy priorities and policy initiatives are likely to continue, however haltingly, to be responsive to demands for social and political reform.

According to one report, "Chinese officials believe they need between 7% and 8% of their 10% growth rate simply to ensure domestic stability through providing jobs for the wave of migrants coming to booming cities … and services to restive rural communities."[34] The list of institutional reforms involving the clarification and reassignment of property rights needed to sustain productivity growth in China (table 10) and the reforms needed to buttress the Party's political legitimacy —specifically, the need to sustain rising economic prosperity and social order—are highly overlapping and interdependent. The experience of China's economic, institutional, and political reform process over the past two decades suggests a high likelihood that, through a series of challenges and responses and the learning associated with the reform process, facilitated by China's unusual openness to the flow of trade and ideas from the OECD countries, China's leadership will continue to advance institutional reforms that will effectively complement and exploit the factors underlying the sources of productivity advance.[35]

This optimistic projection tries not to disregard the magnitude of a variety of serious challenges to China's economic and political systems no matter how able and responsive the country's political leadership. China's sustained high rate of growth carries with it serious negative spillovers. Among those that have been well documented both in academic studies and in the popular press are growing income inequality, environmental degradation, risk and insecurity associated with a fragmented social insurance system, and corruption associated with ill-defined and poorly enforced property rights. Such developments confront China's leadership with difficult tradeoffs that increase the risk of derailing the nation's economic progress. Moreover, failure to curtail the negative spillovers from rapid growth may undermine the legitimacy of the political system and its ability to pursue the institutional reforms needed to continue China's catch-up with the international technology frontier and the reductions in internal productivity gaps, both of which are needed to sustain overall growth and rising living standards. Although the system faces real threats, China's reform accomplishments to date combined with an emerging middle and entrepreneurial class that is rapidly accumulating education and experience in a competitive international environment provide reassuring evidence that China is creating the civic capital needed to respond effectively to the challenges and opportunities associated with its ongoing economic transformation.

[a]Implications and Conclusions

We view China's economic advance as a process of reducing, in a more or less balanced way, several key productivity gaps. We find evidence that the pace of productivity catch-up varies substantially across these gaps. China's industrial economy is enjoying a rapid pace of catch-up with the world's industrial frontier. We further find large and growing differences in productivity between coastal industry and agriculture across China's regions. Productivity differences between coastal industry and the services sector in the four regions are not as great as those between industry and agriculture, but the gaps are significant and expanding. Although official Chinese data are likely to overstate the size and rate of increase of regional and sector productivity differences, our revised employment data also show large differences and a continuing spread in productivity gaps. Within China's industrial sector, we find evidence that the three noncoastal regions are making progress in closing the productivity gap with coastal industry. However, our analysis indicates that, at least in the medium term, manufacturing in the coastal region will maintain an insurmountable productivity lead over industry in China's other regions. Outside of industry, there is no evidence of a convergence of productivity across regions and sectors.

A key finding of this paper is that the main productivity gaps—the international gap, the gaps across regions within the industrial economy, and the industry-agriculture and industry-services gaps—all exhibit diminishing contributions to productivity growth as the gap narrows. As these gaps further diminish, it is very probable that China's productivity growth, particularly along the coast where catch-up with the international frontier is occurring most rapidly, will slow.

It is instructive to compare China's current pattern of productivity gaps with those exhibited by South Korea and Taiwan when their GDP per capita reached one quarter that of the United States, a milestone China will achieve when its GDP reaches that of the United States. When South Korea and Taiwan reached this milestone, their industrial labor productivity was just one-third the U.S. level. Since China's income per capita is presently only one-twenty-fourth of the U.S. level, China's labor productivity will have to rise sixfold before it achieves a GDP per capita that is one-quarter that of the United States. However, given that the industrial productivity of China's coastal region today is nearly one quarter that of the United States, an across-the-board sixfold scaling up of Chinese productivity would leave coastal industrial productivity at an unattainable level close to one and a half times that of the United States.

Clearly, as the industrial productivity of China's coastal region approaches that of the international frontier, China's GDP growth can be expected to slow sharply, and China will need to rely less on coastal industry as its engine of growth than it now does. This will require policies that more effectively integrate China's internal economy, to reduce the productivity gaps that now exist across its regions and sectors. Viewed from another perspective, in order for China's GDP to match that of the U.S., China's economy will have to begin moving down the right-hand side of Kuznets' inverted "U" curve, reducing productivity and income disparities across regions, sectors, and households.

Today, compared with South Korea and Taiwan, China leans more heavily on its coastal industrial economy for overall catch-up. This disproportionate reliance on international catch-up, even as large productivity gaps and unrealized productivity and GDP growth potential persist within the Chinese economy, will become an increasingly serious impediment to China's development. Continued institutional reform and policy initiatives that shift the emphasis of China's rapid growth from the coastal industrial economy to the economic integration of its internal regions and backward sectors should be a top priority.

Table 1. Sources of Growth in Labor Productivity during Catch-Up

Country	GDP per hour worked, 1950 (U.S. = 100)[a]	Average growth in GDP per hour worked, 1950-62 (percent a year)	Source of growth (percentage points)			Allocation of residual (percentage points)			
			Labor	Capital	Residual (MFP)	Improved resource allocation	Economies of scale	Reduced technology gap with U.S.	Advances in knowledge
Japan	14	6.45	0.77	1.17	4.57	1.07	1.88	1.41	
Italy	32	5.36	0.54	0.57	4.29	1.42	1.22	0.88	0.76
Germany	33	5.15	-0.12	0.93	4.43	1.00	1.59	0.83	0.75
Denmark	43	2.56	-0.11	0.77	1.94	0.67	0.64	-0.27	0.75
France	44	4.80	0.37	0.76	3.67	0.95	1.00	0.74	0.76
Norway	48	3.27	0.02	0.85	2.41	0.92	0.57	0.18	0.76
Belgium	50	2.64	0.36	0.28	2.02	0.51	0.51	0.07	0.76
The Netherlands	53	3.65	0.09	0.78	2.79	0.63	0.77	0.43	0.75
United Kingdom	56	1.63	0.10	0.37	1.18	0.12	0.36	0.04	0.75
United States	100	2.15	0.22	0.60	1.36	0.29	0.36	NA	0.75
Average (excluding U.S.)	41.4	3.95	0.22	0.72	3.03	0.81	0.95	0.36	0.76

Source: Fagenberg (1994). **[**
a. Index using 1970 relative prices.

Table 2. Industrial Labor Productivity at the International Frontier and in China, 1995 and 2002[a]

		Region[b]			
Year	All China	Coastal	Northeastern	Central	Western
1995					
Ratio of frontier productivity to productivity in China	16.1	8.5	15.9	26.3	33.3
Regional productivity as percent of coastal	53.1	100.0	54.2	32.3	26.0
2002					
Ratio of frontier productivity to productivity in China	7.1	4.3	8.9	8.0	10.9
Regional productivity as percent of coastal	60.5	100.0	48.4	54.0	39.7
Decline in ratio, 1995-2002 (percent)	55.9	49.4	44.0	69.6	67.3

Source: Groningen Growth and Development Centre, 60-Industry Database, September 2006 (www.ggdc.net); National Bureau of Statistics, China; authors' calculations.
a. Data exclude food, beverage, and tobacco industries.
b. Data are aggregations of firm-level data.

Table 3. Output per Worker in Chinese Agriculture and Industry

	Agriculture, forestry, and fishing			Industry and construction			
Year	Output (billions of yuan)	Employment (millions of workers)	Output per worker (yuan)	Output (billions of yuan)	Employment (millions of workers)	Output per worker (yuan)	Ratio of industrial to agricultural output per worker
1980	135.9	291.2	466.8	219.2	77.1	2,844.2	6.09
1985	254.2	311.3	816.4	386.7	103.8	3,725.4	4.56
1990							
Unadjusted	501.7	389.1	1,289.3	771.7	138.6	5,569.7	4.32
Adjusted[a]		319	1,572.7		169	4,566.3	2.90
1995							
Unadjusted	1,202.0	355.3	3,383.1	2,868.0	156.6	18,319.7	5.42
Adjusted		300	4,006.7		184	15,587.0	3.89
2000							
Unadjusted	1,471.6	360.4	4,083.0	4,555.6	162.2	28,088.0	6.88
Adjusted		278	5,293.5		199	22,892.5	4.32
2005							
Unadjusted	2,271.8	339.2	6,698.0	8,620.8	180.9	47,649.6	7.11
Adjusted		258	8805.4		219*	39,364.4	4.47

Source: *China Statistical Abstract,* 2006, pp. 20, 44; Brandt, Zhu, and Hsieh (forthcoming); authors' calculations.

a. Employment is adjusted for possible official overcounting of agricultural workers. This adjustment (computed by Brandt, Zhu, and Hsieh from 1978-2000) is extended to 2005 by assuming that the annual rate of decline in China's agricultural employment share from 2000 to 2005 was comparable to its rate of decline from 1990-2000.

Table 4. Ratios of Labor Productivity in Chinese Coastal Industry to Labor Productivity in Other Regions and Sectors, 1995 and 2004

	Region											
	Coastal			Northeastern			Central			Western		
Sector	1995	2004	Real productivity growth rate[a] (percent a year)	1995	2004	Real productivity growth rate (percent a year)	1995	2004	Real productivity growth rate (percent a year)	1995	2004	Real productivity growth rate (percent a year)
Industry												
Unadjusted[b]	1.00[c]	1.00[d]	12.51	1.32	0.86	17.89	1.64	1.48	13.77	1.78	1.56	14.22
Adjusted[e]		1.00			1.06			1.29			1.39	
Agriculture[f]												
Unadjusted	4.47	6.90	8.61	3.80	6.94	6.51	7.05	10.50	9.05	10.22	14.04	10.06
Adjusted[g]	2.60	3.60		2.73	4.36		4.84	6.40		4.59	8.44	
Services	1.05	1.50	6.82	1.70	1.98	9.33	2.24	2.96	7.71	2.42	3.67	6.00

Source: NBS *Statistical Abstract*; NBS *Comprehensive Statistical Data and Materials on 50 Years of New China*; Brandt, Zhu, and Hsieh (forthcoming); authors' calculations.

a. In constant yuan, deflated using sector-specific price indices.

b. Includes manufacturing, mining, and construction.

c. Output is 23,241 current yuan per worker.

d. Output is 65,410 current yuan per worker.

e. Includes manufacturing, mining, and electricity production and distribution; excludes construction; omits Heilongjiang,, Xinjiang, and Yunnan provinces.

f. Includes forestry and fishing.

g. Agricultural employment is adjusted for possible official overcounting as described in the notes to table 3.

Table 5. Estimates of Log Productivity Differences by Region

	Dependent variable					
	Labor productivity ($\ln VA/L$)		Capital productivity ($\ln VA/K$)		Multifactor productivity ($\ln MFP$)	
Independent variable	1995	2004	1995	2004	1995	2004
	Regressions omitting industry dummy variables					
Constant	2.412***	4.001***	-0.838***	-0.301***	0.885***	1.979***
	(0.017)	(0.015)	(0.016)	(0.016)	(0.015)	(0.013)
Coastal	0.421***	0.070***	0.110***	0.278***	0.275***	0.168***
	(0.021)	(0.017)	(0.019)	(0.018)	(0.018)	(0.025)
Northeastern	-0.267***	-0.069**	-0.390***	-0.275***	-0.325***	-0.166***
	(0.030)	(0.028)	(0.027)	(0.032)	(0.026)	(0.025)
Western	-0.045	-0.012	-0.106***	-0.099***	-0.074***	-0.053**
	(0.030)	(0.024)	(0.027)	(0.027)	(0.026)	(0.021)
No. of observations	20,653	27,088	20,653	27,088	20,653	27,088
Adjusted R^2	0.046	0.002	0.021	0.025	0.039	0.014
	Regressions including industry dummy variables					
Constant	1.983***	3.645***	-0.881***	-0.087**	0.637***	1.891***
	(0.067)	(0.039)	(0.019)	(0.044)	(0.061)	(0.036)
Coastal	0.506***	0.256***	0.132***	0.139***	0.330***	0.202***
	(0.019)	(0.017)	(0.019)	(0.019)	(0.018)	(0.015)
Northeastern	-0.253***	-0.065**	-0.392***	-0.300***	-0.318***	-0.175***
	(0.028)	(0.027)	(0.027)	(0.030)	(0.025)	(0.025)
Western	-0.040	-0.040*	-0.111***	-0.116***	-0.073***	-0.076***
	(0.028)	(0.022)	(0.027)	(0.025)	(0.025)	(0.021)
No. of observations	20,653	27,088	20,653	27,088	20.653	27,088
Adjusted R^2	0.174	0.109	0.066	0.124	0.101	0.076

Source: Authors' regressions using firm-level data.

a. Standard errors are in parentheses. Asterisks indicate statistical significance at the *10 percent, **5 percent, or ***1 percent level.

Table 6. Comparisons of Industrial Productivity Estimates by Region
Ratio of coastal productivity to productivity in indicated region

	Without industry dummy variables		With industry dummy variables	
Dependent variable and region	1995	2004	1995	2004
Labor productivity (VA/L)				
Coastal	1.00	1.00	1.00	1.00
Central	1.52	1.07	1.66	1.29
Northeastern	1.97	1.15	2.13	1.39
Western	1.58	1.08	1.73	1.34
Capital productivity (VA/K)				
Coastal	1.00	1.00	1.00	1.00
Central	1.12	1.32	1.14	1.15
Northeastern	1.65	1.74	1.69	1.55
Western	1.24	1.47	1.23	1.29
Multifactor productivity (MFP)				
Coastal	1.00	1.00	1.00	1.00
Central	1.32	1.18	1.39	1.22
Northeastern	1.83	1.39	1.90	1.45
Western	1.42	1.24	1.49	1.31

Source: Authors' regressions using the NBS large and medium-size enterprise data base.

Table 7. Estimates of the Response of Labor Productivity Growth to the International Productivity Gap, 1995-2002[a]

	Regression				
Independent variable	7-1	7-2	7-3	7-4	7-5
Constant	-0.077**	-0.069*	-0.064*		
	(0.037)	(0.038)	(0.038)		
lnGAP95	0.085***	0.070***	0.067***	0.020**	0.026*
	(0.024)	(0.025)	(0.025)	(0.008)	(0.009
lnGAP95 × coastal		0.015***	0.014***	0.017***	0.012*
		(0.004)	(0.004)	(0.004)	(0.004
lnGAP95 × northeastern		0.003		0.004	
		(0.004)		(0.004)	
lnGAP95 × western		0.003		0.004	
		(0.005)		(0.004)	
$(\text{lnGAP95})^2$	-0.004	-0.002	-0.0001	0.006***	0.005*
	(0.004)	(0.004)	(0.004)	(0.002)	(0.002
Growth rate of frontier productivity	-0.159***	-0.196***	-0.189***	-0.204***	-0.196*
	(0.052)	(0.049)	(0.048)	(0.050)	(0.050
Adjusted R^2	0.240	0.259	0.239	0.622	0.621

Source: Authors' regressions.
a. The dependent variable is the annual growth rate of labor productivity between 1995 and 2000, in percent a year. All regressions are on 589 observations. China observations for which VA/L > 1,000,000 yuan per worker are omitted. Standard errors are in parentheses. Asterisks indicate statistical significance at the *** 1 percent , **5 percent, or *10 percent level.

Table 8. Reallocation of Labor, Capital, and Output across Industrial Firms, 1995-2000 and 2000-04[a]

	Dependent variable and period				
	Annual growth rate of employment			Annual growth rate of the capital stock	
Independent variable	1995-2000	2000-2004	Independent variable	1995-2000	2000-2004
Constant	-0.431***	-0.610***	Constant	0.630***	0.194***
	(0.027)	(0.031)		(0.015)	(0.027)
ln$MPL_{i,t}$	0.125***	0.145***	ln$MPK_{i,t}$	0.177***	0.134***
	(0.010)	(0.010)		(0.028)	(0.024)
ln$MPL_{i,t}$ × coastal	-0.004	-0.020***	ln$MPK_{i,t}$ × coastal	-0.017	0.007
	(0.007)	(0.006)	dummy	(0.031)	(0.026)
ln$MPL_{i,t}$ ×	-0.022**	0.027***	ln$MPK_{i,t}$ ×	0.042	-0.000
northeastern	(0.011)	(0.010)	northeastern dummy	(0.040)	(0.036)
ln$MPL_{i,t}$ × western	-0.030	0.017*	ln$MPK_{i,t}$ × western	0.059	-0.004
	(0.010)***	(0.009)	dummy	(0.039)	(0.032)
No. of observations	2,639	2,684		2,639	2,684
Adjusted R^2	0.081	0.082		0.057	0.042
	Annual growth rate of value added			Annual growth rate of multifactor productivity	
Constant	0.865***	0.801***	Constant	0.954***	1.003***
	(0.031)	(0.035)		(0.031)	(0.030)
ln$MFP_{i,t}$	-0.436***	-0.323***	ln$MFP_{i,t}$	-0.555***	-0.467***
	(0.031)	(0.031)		(0.027)	(0.027)
ln$MFP_{i,t}$ × coastal	0.111***	0.018	ln$MFP_{i,t}$ × coastal	0.119***	0.058**
	(0.028)	(0.028)	dummy	(0.024)	(0.024)
ln$MFP_{i,t}$ ×	-0.063	-0.096**	ln$MFP_{i,t}$ ×	0.008	-0.049
northeastern	(0.048)	(0.047)	northeastern dummy	(0.041)	(0.041)
ln$MFP_{i,t}$ × western	-0.064	-0.022	ln$MFP_{i,t}$ × western	-0.014	0.009
	(0.040)	(0.039)	dummy	(0.035)	(0.034)
No. of observations	2,604	2,633		2,604	2,633
Adjusted R^2	0.134	0.088		0.241	0.186

Source: Authors' regressions.
a. Standard errors are in parentheses. Asterisks indicate statistical significance at the *** 1 percent , **5 percent, or *10 percent level

Table 9. Estimates of Productivity Differentials between Survivor Firms, Exiting Firms, and Entrants

	Dependent variable		
Independent variable	Labor productivity (*VA*/*L*)	Capital productivity (*VA*/*K*)	Multifactor productivity
Constant[a]	57.694***	1.150***	12.124***
	(0.522)	(0.080)	(0.092)
Survivors, 1996-1998	-6.343***	-0.409**	-1.590***
	(1.086)	(0.166)	(0.113)
Survivors, 1999-2001	4.667***	-0.433**	0.112
	(1.080)	(0.165)	(0.190)
Survivors, 2002-04	18.937***	-0.285	2.624***
	(1.270)	(0.194)	(0.224)
Exits,[b] 1996-98	-24.537***	-0.411***	-4.469***
	(0.911)	(0.139)	(0.161)
Exits, 1999-2001	-30.899***	-0.291***	-5.687***
	(0.0.596)	(0.091)	(0.105)
Exits, 2002-04	--16.733***	-0.271***	-3.568***
	(0.513)	(0.078)	(0.090)
Entrants,[c] 1996-98	12.149***	0.046	1.851***
	(0.564)	(0.086)	(0.099)
Entrants, 1999-2001	30.155***	0.661***	5.229***
	(0.572)	(0.087)	(0.101)
Entrants, 2002-04	16.232***	1.197***	5.460***
	(0.598)	(0.091)	(0.105)
No. of observations	167,683	167,683	167,683
Adjusted R^2	0.043	0.002	0.057

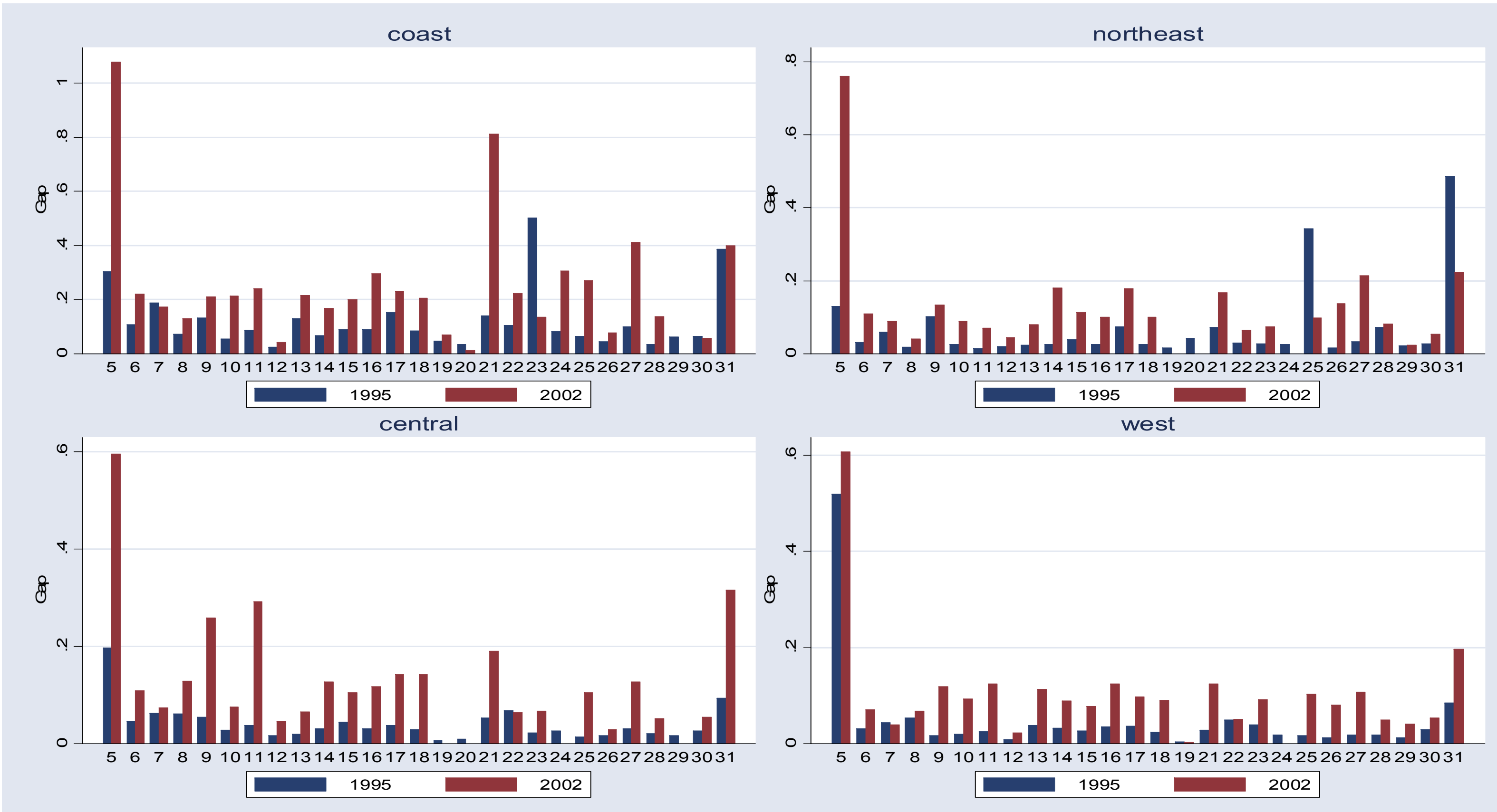
Source: Authors' regressions using the NBS large and medium-size enterprise data set.
a. The benchmark consists of firms in an earlier period that exit in a later period and firms in later periods that have netered in earlier periods. Estimated coefficients indicate that, for instance, the average labor productivity for these firms was 57,694 yuan per worker. Observations for which *VA*/*L* > 1,000,000 yuan per worker are omitted. Standard errors are in parentheses. Asterisks indicate statistical significance at the *** 1 percent , **5 percent, or *10 percent level.
b. Firms that report in year *t* but not in year *t* + 1.
c. Firms that report in year *t* but not in year *t* - 1.

Table 10. Areas Requiring Clarification and Reassignment of Property Rights in China

Reform	Importance
Institutional reforms affecting efficient labor reallocation	
Reform of the *hukou* system	To facilitate rural-urban migration
Land ownership reform	To enable consolidation of small farms and scale economies in farming and improve the ability of farmers wishing to migrate to liquidate their assets
Reform of the social insurance system	To increase labor mobility and facilitate enterprise restructuring
Institutional reforms affecting industrial restructuring and technology development	
Bank reform	To improve the efficiency of capital allocation
Regional integration	To reduce impediments to factor mobility, trade, and competition
Antitrust legislation and merger and acquisitions legislation	To facilitate enterprise restructuring and encourage the creation of firm-level scale economies
Corporate governance reform	To enhance firm efficiency and increase the returns to innovation
Intellectual property rights enforcement	Continuous strengthening needed to speed the transition from imitation to innovation

Source:

Figure 1: Productivity gap by region



5 Food, drink & tobacco; 6 Textiles; 7 Clothing; 8 Leather and footwear; 9 Wood & products of wood and cork; 10 Pulp, paper & paper products; 11 Printing & publishing; 12 Mineral oil refining, coke & nuclear fuel; 13 Chemicals; 14 Rubber & plastics; 15 Non-metallic mineral products; 16 Basic metals; 17 Fabricated metal products; 18 Mechanical engineering; 19 Office machinery; 20 Insulated wire; 21 Other electrical machinery and apparatus nec; 22 Electronic valves and tubes; 23 Telecommunication equipment; 24 Radio and television receivers; 25 Scientific instruments; 26 Other instruments; 27 Motor vehicles; 28 Building and repairing of ships and boats; 29 Aircraft and spacecraft; 30 Railroad equipment and transport equipment; 31 Furniture, miscellaneous manufacturing; recycling
Excludes firms that report negative value added.

Figure 2

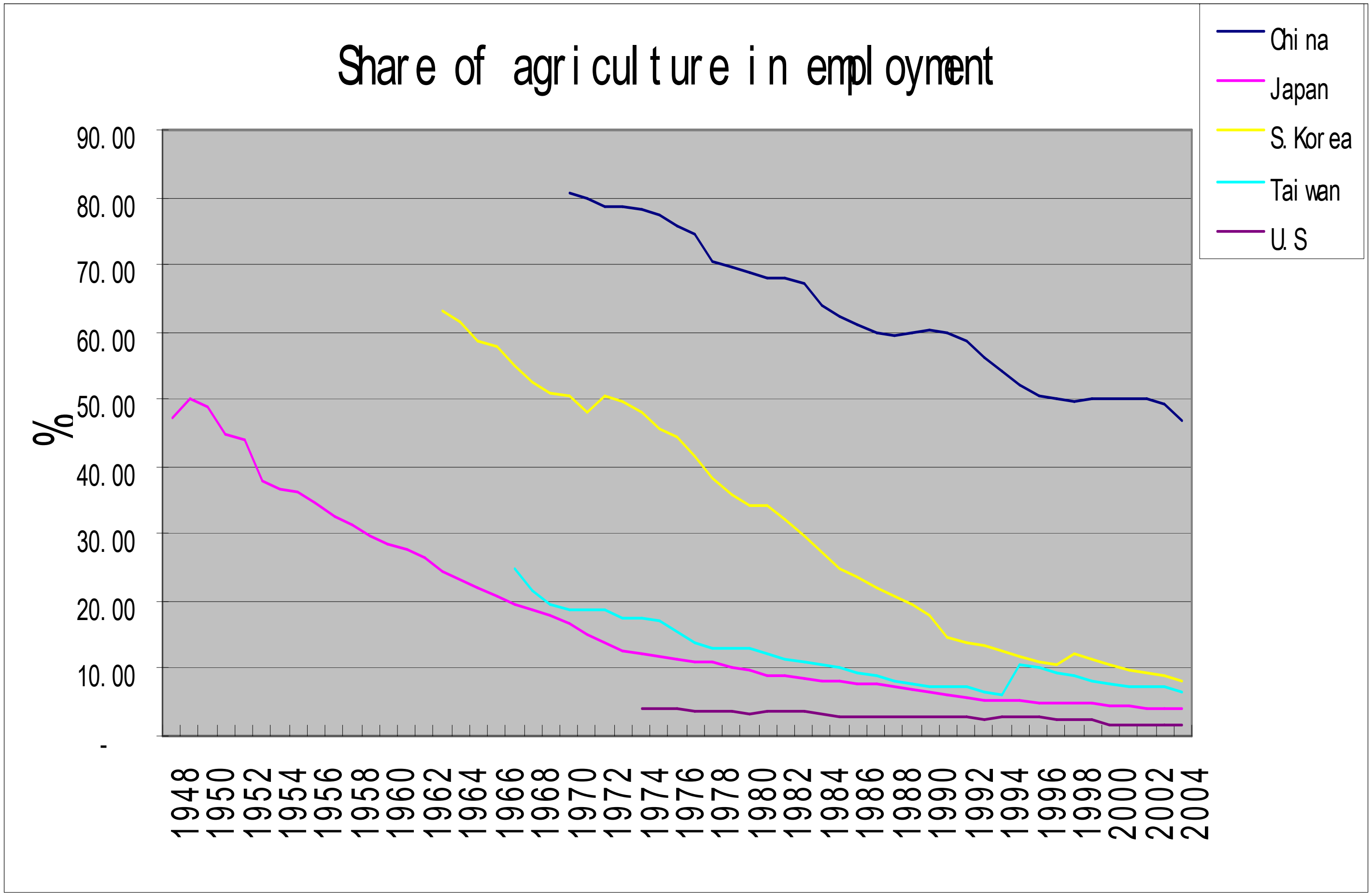

Share of agriculture in employment
China
Japan
S. Korea
Taiwan
U.S
%
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
-
1948
1950
1952
1954
1956
1958
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004

Figure 3
China's productivity gap reaction function

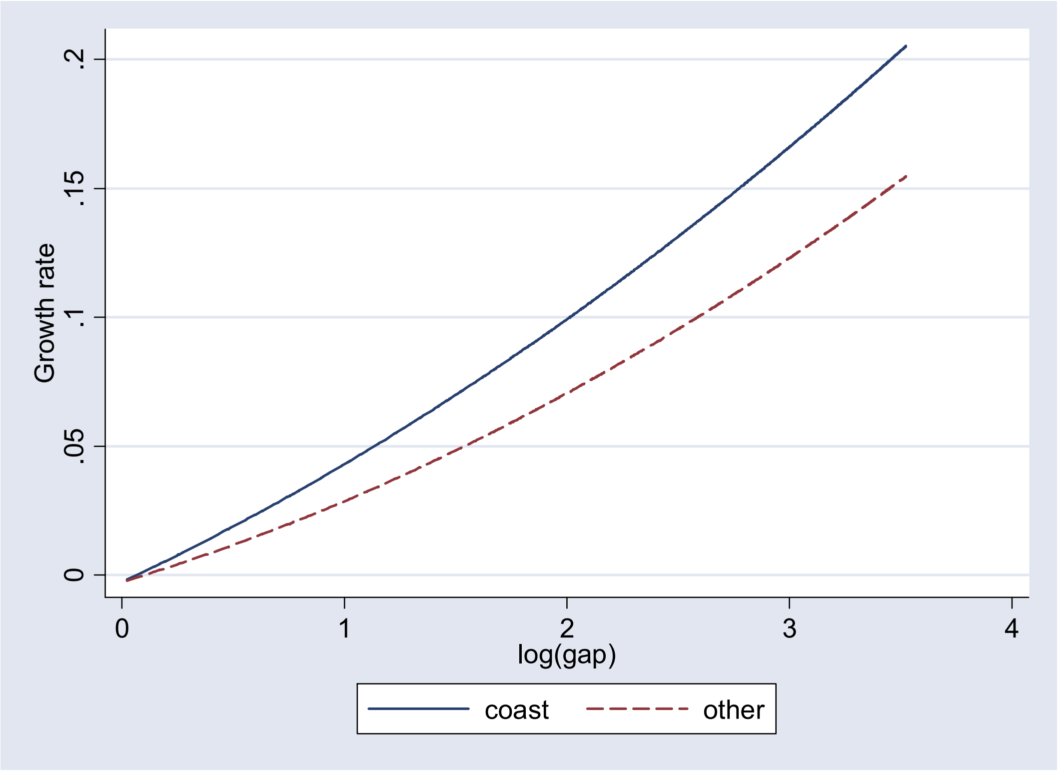


Figure 4

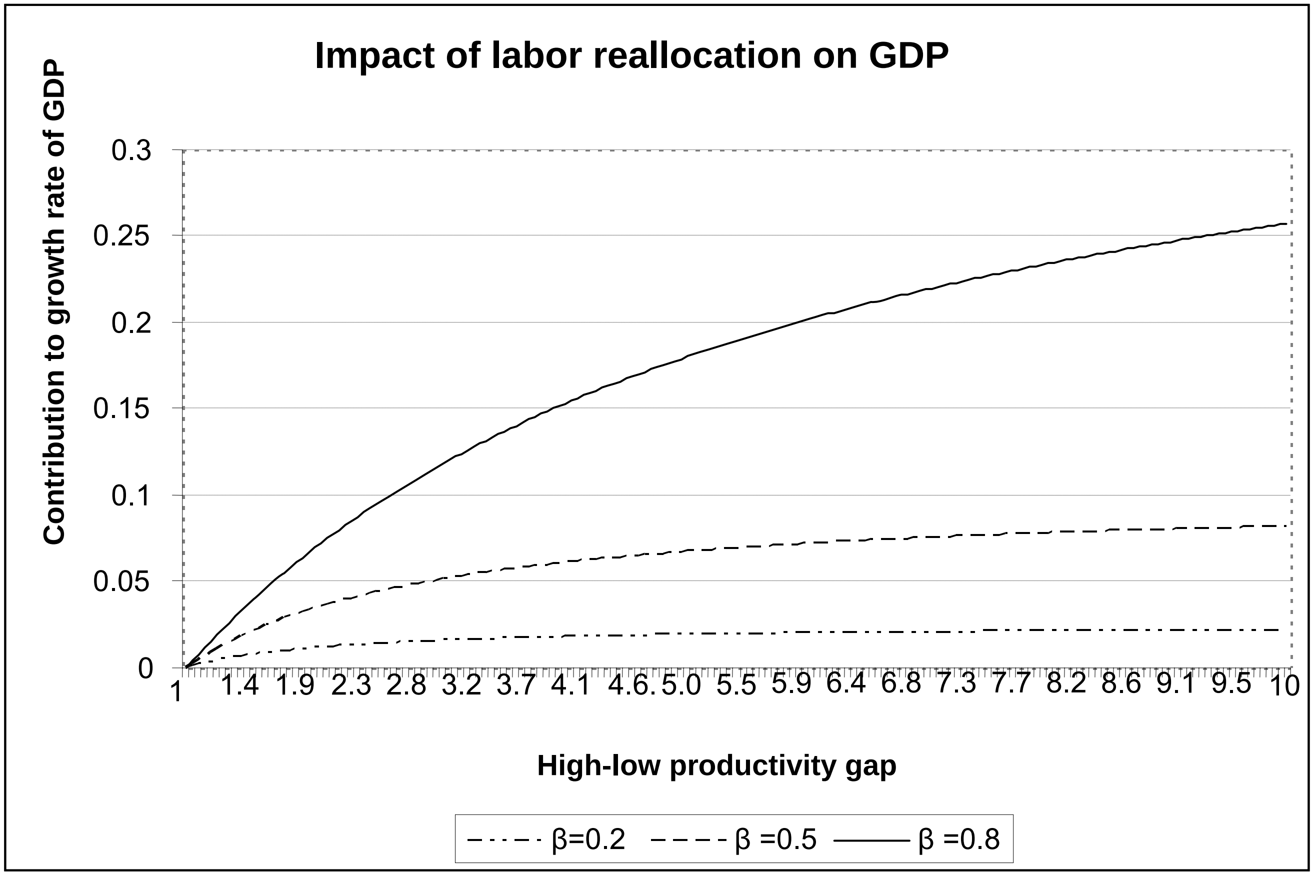

Impact of labor reallocation on GDP
Contribution to growth rate of GDP
0.3
0.25
0.2
0.15
0.1
0.05
0
1
1.4
1.9
2.3
2.8
3.2
3.7
4.1
4.6
5.0
5.5
5.9
6.4
6.8
7.3
7.7
8.2
8.6
9.1
9.5
10
High-low productivity gap
β=0.2
β =0.5
β =0.8

Figure 5. Value of Marginal Product, Capital (1995-2005)
(units = yuan of gross industrial output value per unit of net value of fixed assets)

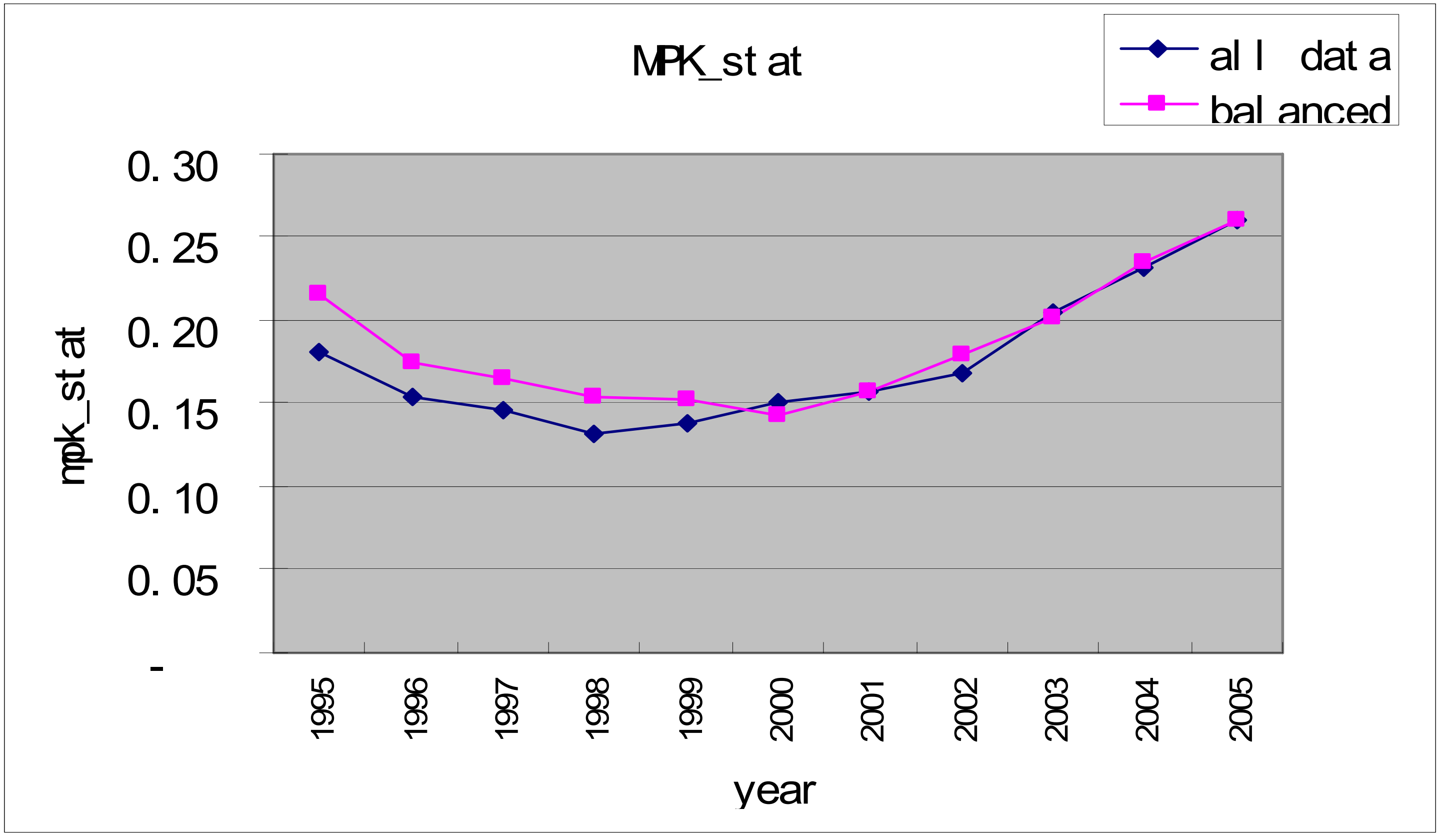


Figure 6

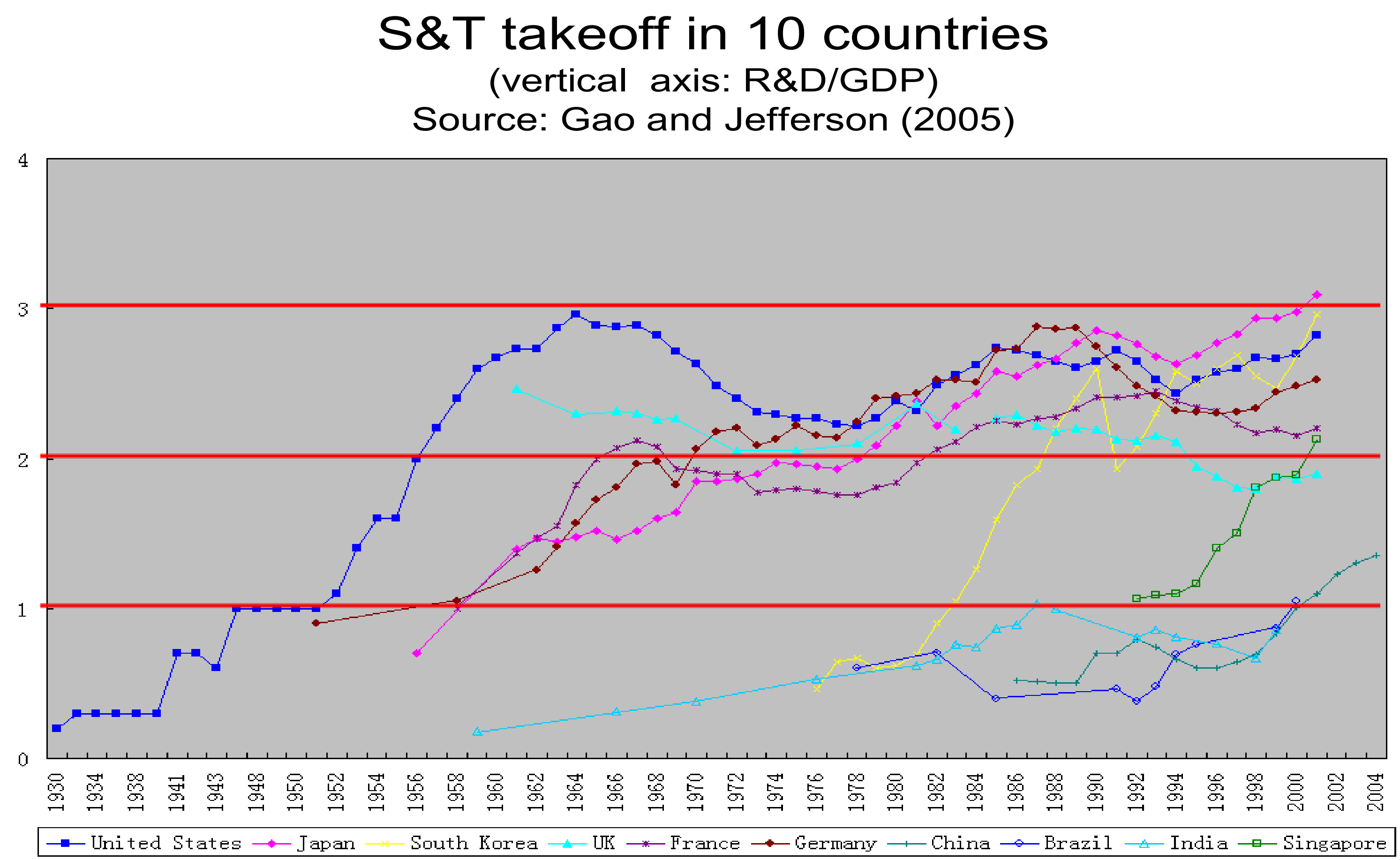
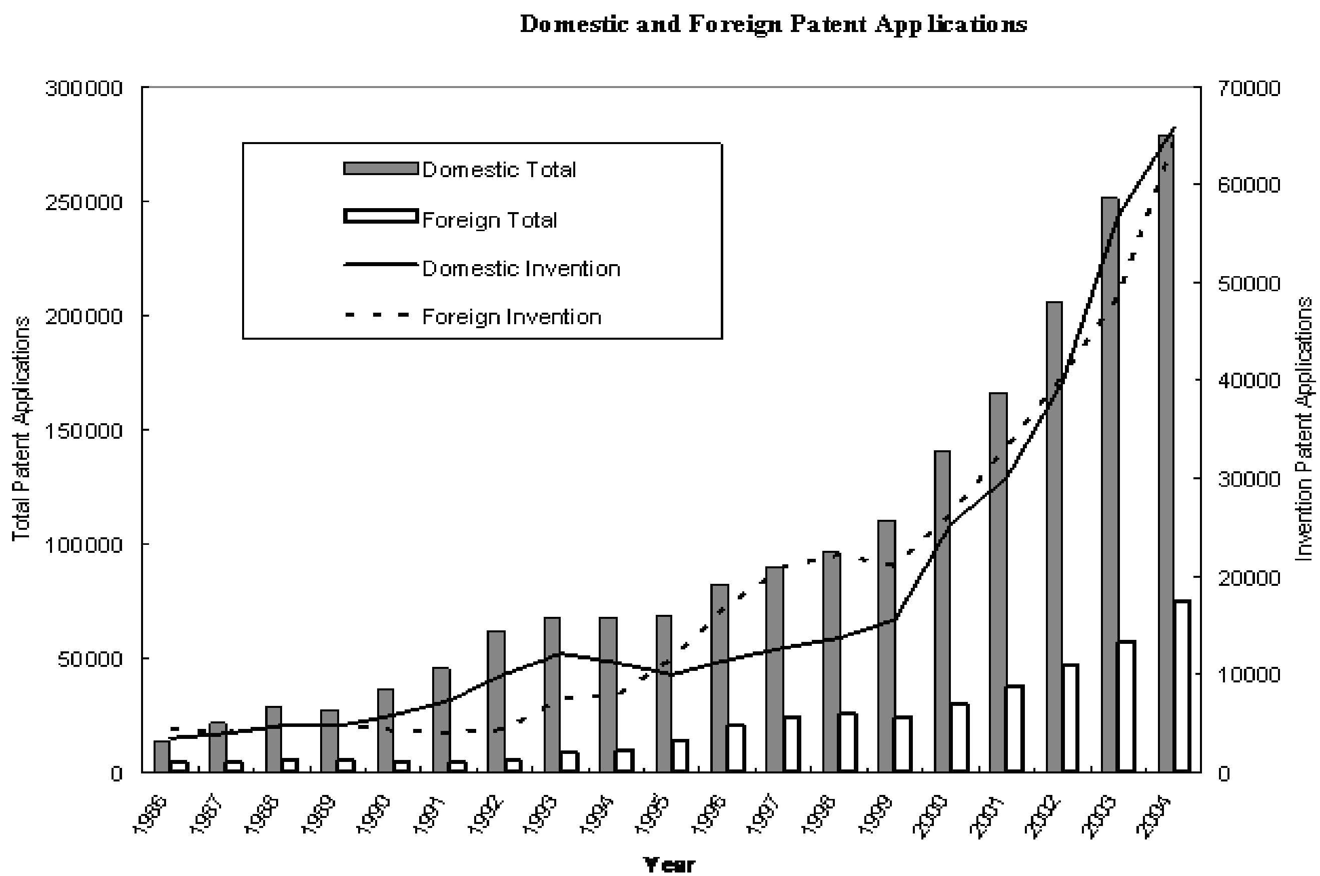
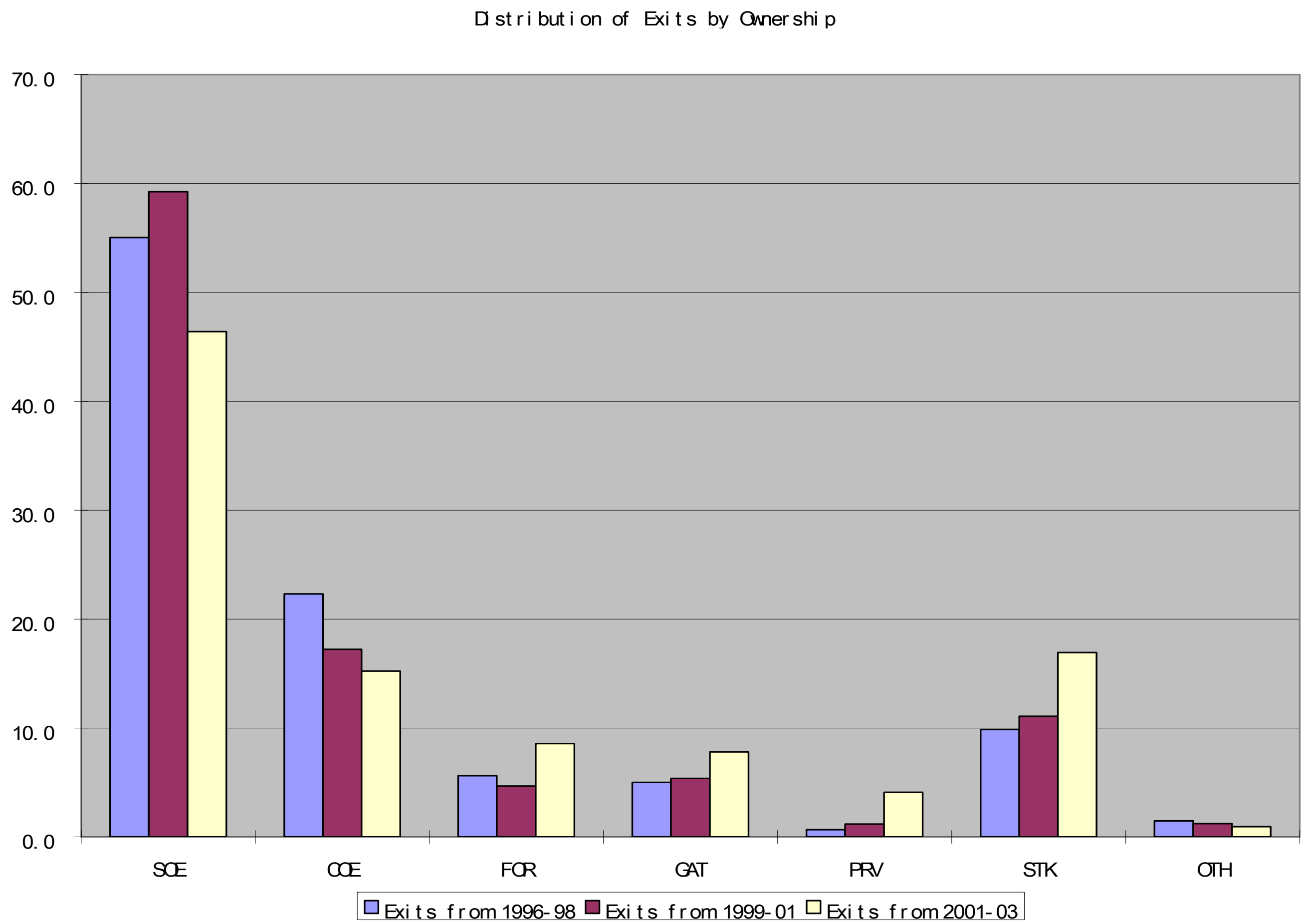

S&T takeoff in 10 countries
(vertical axis: R&D/GDP)
Source: Gao and Jefferson (2005)
0
1
2
3
4
1930
1934
1936
1938
1941
1943
1948
1950
1952
1954
1956
1958
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
United States
Japan
South Korea
UK
France
Germany
China
Brazil
India
Singapore

Figure 7



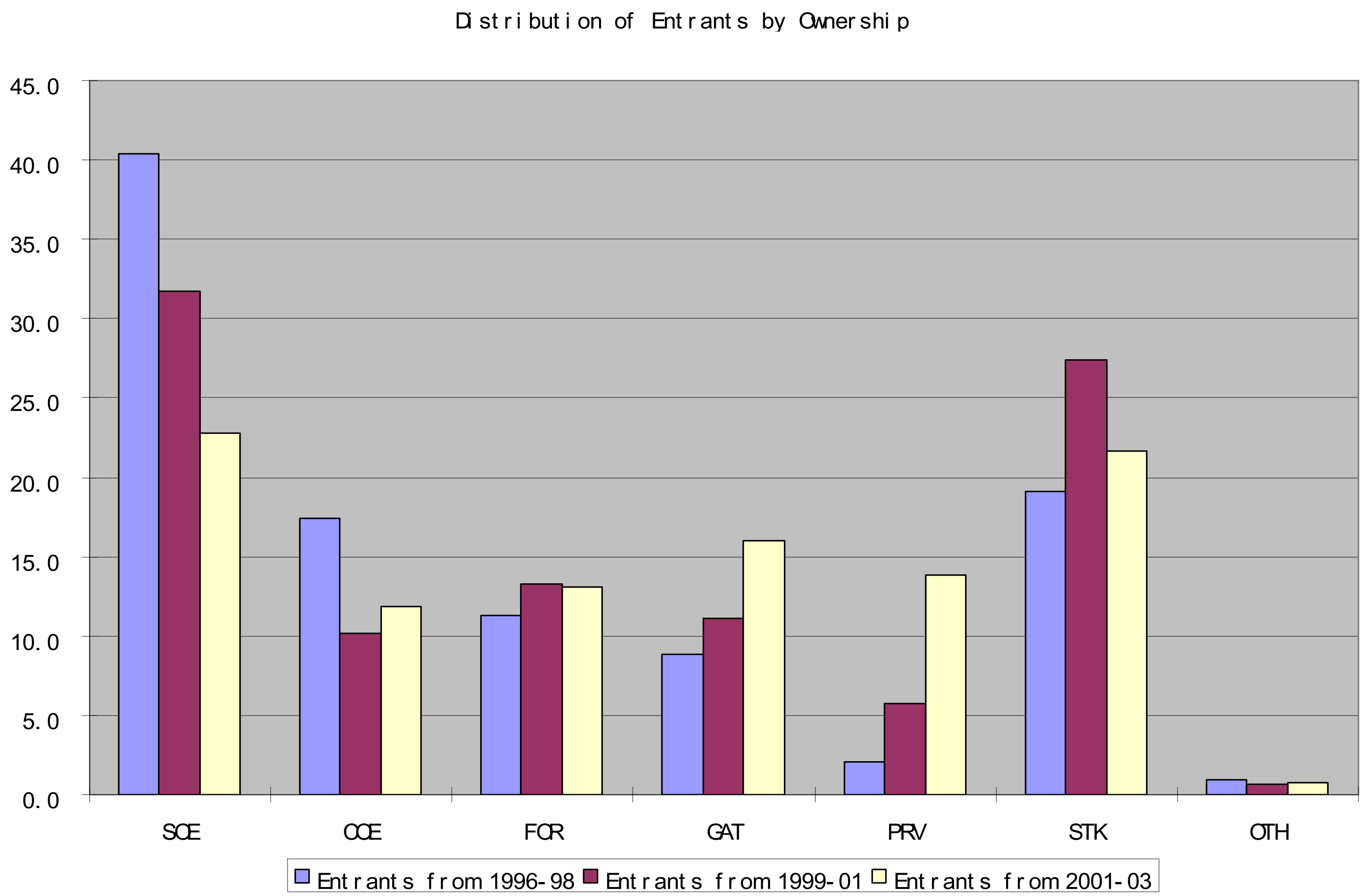
Source: Hu and Jefferson (2006)

Figure 8



Distribution of Exits by Ownership
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
SOE
COE
FOR
GAT
PRV
STK
OTH
Exits from 1996-98
Exits from 1999-01
Exits from 2001-03

Figure 9



Distribution of Entrants by Ownership
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
SOE
COE
FOR
GAT
PRV
STK
OTH
Entrants from 1996-98
Entrants from 1999-01
Entrants from 2001-03

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1. See, for example, Holz (2006, p. 41).

2. Denison (1967).

3. Maddison (1998. p. 17).

4. The industry productivity data for the United States and Japan are from the Groningen Growth and Development Centre, University of Groningen, The Netherlands (www.ggdc.net/dseries/60-industry.shtml); the industry data for the thirty-one Chinese provinces, autonomous areas, and municipalities are based on firm-level data from the large and medium-size enterprise data set compiled by China's National Bureau of Statistics.

5. Among the twenty-seven industries, in 2002 the U.S. industry represented the frontier in seventeen, and the Japanese industry in the remaining ten.

6. The coastal provinces are Beijing, Fujian, Guangdong, Hainan, Jiangsu, Shandong, Shanghai, Tianjin, and Zhejiang; the northeastern provinces are Heilongjiang, Jilin, and Liaoning; the central provinces are Anhui, Guangxi, Hebei, Henan, Hubei, Hunan, Inner Mongolia, Jiangxi, and Shanxi; and the western provinces are Chongqing, Gansu, Guizhou, Ningxia, Qinghai, Shaanxi, Sichuan, Xinjiang, Xizang, and Yunan.

7. For one of the twenty-seven industries, airplanes and spacecraft (29), data are unavailable for two of the four regions.

8. NBS (2003, p. 473).

9. Of course, for purposes of analyzing patterns of efficient factor allocation, the relevant measure is marginal, not average productivity. We assume that labor's output elasticities in industry are not vastly different from one another. In fact, Wang and Liu (undated) report estimates of labor's output elasticity in Chinese agriculture during 1990 in the range of 0.38 to 0.39. These are similar to the elasticity of 0.36 that we obtain for Chinese industry.

10. Ding (2001); Du and Park (2005).

11. Ding (2001, p. 23).

12. Rawski and Mead (1998).

13. Brandt, Zhu, and Hsieh (forthcoming) .

14. In fact, figure 2, once corrected using Brandt, Hsieh, and Zhu's estimates of China's employment shares, tracks very closely with South Korea's rate of decline over the range of 63 to 39 percent.

15. We further assume that the allocation of excess nonagricultural workers to industry and services is done in accord with the same proportional adjustments made to these sectors in 2000.

16. These results are consistent with those in Naughton (forthcoming, figure 9-2) that show an upward drift in China's Gini coefficient through the 1980s and 1990s, including a sharp increase for the period 1996-2002.

17. *China Statistical Yearbook 2005,* pp. 489, 494.

18. Specifically, profit per employee in the petroleum extraction industry is 23,382 yuan per employee; for cigarette manufacturing, it is 18,550 per employee, whereas for total (above-scale) industry, the profit rate is 1,860 yuan per employee (*China Statistical Yearbook 2005*, pp. 490, 491).

19. In 2005 industry excluding construction accounted for 86.8 percent of value added of total industry (that is, industry including construction, or what NBS calls "secondary industry"). Above-scale enterprises accounted for 87.3 percent and LMEs for 63.8 percent of industry output (excluding construction; *China Statistical Yearbook 2005*, pp. 52, 489, 512).

20. The regional data are deflated by deflating value added for each of the LMEs using a gross output price deflator constructed from current- and constant-price output deflators reported by each firm. At the provincial level, the firm-level data are aggregated using each firm's share in total provincial value added as the weight. The regional data are a simple average of the data for the included provinces.

21. We use a Cobb-Douglas index with weights of 0.64 for labor and 0.36 for capital. These are the values of the output elasticities of labor and capital, respectively, estimated under the restriction of constant returns to scale.

[22] In 2004, 30 of the 50 firms with the largest R&D expenditures were located in coastal provinces.

23. Jefferson and Su (2006) also find that restructuring (that is, conversions of state-owned enterprises into shareholding enterprises) results in higher capital productivity.

24. Gao and Jefferson (forthcoming).

25. Jones (1995).

26. The factors that drive the S&T takeoff are also those that account for the leveling off of R&D intensity, that is, the tendency for the advanced economies to share a similar set of conditions: similar levels of technology intensity in consumption and production, the creation of similar sets of physical infrastructure and human capital complements to R&D labor, a more or less identical international technology frontier, and comparable wages for R&D personnel. The equalization of these four factors across the advanced economies causes their R&D intensities to converge within a narrow range, thus bringing an end to the S&T takeoff.

27. Hu and Jefferson (2006).

28. The Chinese patent office grants invention patents and utility model patents; the latter have less stringent requirements and extend shorter protection than invention patents.

29. See North (1994).

30. Overseas funded enterprises are those with investment from residents of Hong Kong, Taiwan, or Macao. Firms with investment from residents of any other jurisdiction are called foreign funded enterprises.

31. Jefferson and Rawski (1994) and Qian (2000), among others, focus on the underlying structural conditions that have driven China's reform process.

32. Barro (1999).

33. These include Pei (1998) and Goldman (2005).

34. Frederick Kempe, "Departing Zoellick Looks Back on Pending Business with China," *Wall Street Journal,* June 27, 2006, p. A10.

[35] See Perkins and Rawski (undated) and Zheng and Bigsten (2006) for other assessments of the reforms needed to sustain China's economic growth.