level of an industry or for the full sample. We are told that both entrances and exits were frequent, and that the number of entrants and exits was roughly equal, but we know nothing of their size.

Finally, what the authors call capital productivity is simply the output-capital ratio. We can observe in figure 5 that the growth of output exceeded that of the capital stock in this data set and that the output-capital ratio rose substantially after 1997, despite the incredible rates of investment that China has sustained over the past decade.

The remainder of the paper addresses some issues concerning the sustainability of China's growth. Much of that discussion seems to be drawn from an earlier paper by one of the authors that addresses R&D and patenting behavior in China. However, given the large remaining productivity gaps demonstrated between Chinese firms and their international counterparts, China should be able to sustain its growth for many years through a technological catch-up, without the need to focus on new innovations.

Gunter Ranzig: This paper is laudable in its aims, ambitious in its scope, and provocative in its argument, but somewhat disappointing in its execution. The objective is to capture the sources of China's astonishing past growth and its prospects for the future. Inescapable, China has made a dramatic recent entry onto the international scene, economically and politically as well as strategically. Consequently, there is a lot of discussion, in the professional economic literature as well as policy experts, concerning the sources of that performance and, even more, concerning the system's prognosis, because China is now seen as a major player, whether as a trade new locomotive for the global economy or as a birthed new threat to the established international economic order.

Gary Jefferson, Albert Ho, and Jian Su have chosen to analyze China's past and future by examining the extent of catch-up, both of China's income toward that of the United States and Japan, depending on the industry. At times, the authors refer to multiple gaps, between regional agriculture and coastal industry, between regional services and coastal industry, between interior industry and coastal industry, and between coastal industry and the international frontier. However, they frame their analysis, in what they call the "basic model," in terms of only two gaps, international and internal, and this is a source of some confusion.

Gary H. Jefferson, Albert G. Z. Ho, and Jian Su

Following Edward Denison, the authors first place heavy emphasis on the catch-up of China's coastal industry toward the international frontier. Since the coastal provinces are the most economically advanced, international convergence is not likely to be very pronounced, but, so the argument goes, they give rise to externalities such as technical diffusion that narrow the internal gap and help to sustain over time the impact of the coast's gradual convergence with the frontier. I have a basic problem with any definition of technological catch-up that is expressed in terms of labor productivity differentials. For example, the authors find that industrial labor productivity in 2002 in China's advanced coastal provinces was less than a quarter that in the United States or Japan. Defining technology gaps in this fashion is highly questionable, since one would expect rich countries to exhibit much higher industrial labor ratios, and therefore higher labor productivity. The much preferred measure would seem to be differences in total factor productivity (TFP), independent of the extent of capital deepening. Simply substituting labor productivity for TFP requires some rather heroic assumptions concerning the concavity of revenue income shares or factor price equalization. Indeed, in all their treatment of productivity gaps, the authors appeal to factor reallocation, presumably with technology fixed, as a source of TFP growth. In their analysis they calculate the marginal productivity of labor as proportional to average labor productivity. If they were truly dealing with the marginal rather than the average productivity of labor, the authors' argument that aggregate TFP can be enhanced, even in the unlikely absence of any technical change, simply by reallocating labor in ways that eliminate existing gaps in marginal productivity would make sense. But this is not what the authors have in mind. Estimates of TFP that exclude the contribution of innovation and rely entirely on reallocation are not realistic even in the case of the interaction between domestic agricultural and nonagricultural production, let alone, and they are certainly with the authors' emphasis on FDI, R&D, and patents when dealing with the catch-up of China's coastal industries to the international frontier. As their box-end table 1 powerfully illustrates, factor reallocation represents only one, and by no means the dominant, component of the TFP growth in virtually all countries.

In their empirical analysis, the authors divide the two with each of several of the gaps they have suggested as relevant. With respect to the international gap, they address two important issues: the existence initially of
a sizable productivity gap caused an observable process of convergence? And does the resulting reduction of that gap over time imply a decline in China’s future potential productivity growth? The authors find that the larger the gap, the larger the catch-up is all of China’s regions. But they also find that China’s coastal industry enjoys higher rates of productivity growth than the more backward regions, which runs counter to the conventional convergence story. To explain this, the authors go outside their model, invoking higher concentrations of FDI and R&D as well as certain locational and industrial agglomeration advantages in the coastal region. But these are the very factors that directly determine endogenous TFP rather than labor productivity.

The authors find, using data to twenty-seven Chinese industries and thirty-one provinces, that China’s industrial labor productivity has converged toward the international frontier in recent years. For example, labor productivity in the coastal region moved from one ninth of the international frontier in 1995 to one fourth in 2002, “demonstrating the degree of catch-up.” However, an important result is likely due in large part to the more rapid pace of capital accumulation in China than in the United States or Japan; even if China had experienced no growth of GDP in recent years. Even if we accept the authors’ definition of catch-up and focus on the coastal region primarily (as in the top panel of their Figure 1), it would have been helpful to examine why, as they note, the food, beverage, and tobacco industry stands out, in having labor productivity that is ten times that of industry as a whole. Is that because of an unusually high capital-labor ratio in this industry, or because of an unusually high rate of profit caused by government-imposed barriers to entry, as they claim?

The authors next discuss a variety of internal productivity gaps between agricultural and domestic industry, between industry and services, and across regions within the services and industrial sectors, but, confusingly, they claim to empirically examine only two of these. Comparing domestic agriculture and industry, they find (Table 3) that the ratio of industrial to agricultural labor productivity rose from 0.6 in 1980 to 1.4 in 2005, after initially declining with the shift from commune to the responsible system in agriculture. However, with agricultural labor presumably largely unskilled and any comparison with “average industrial workers” rather than exclusives with specialized unskilled industrial workers (for example, in construction or textiles) makes very little sense. In addition, I have a problem with the authors’ reclassification effect, which is related mainly to the size of the productivity gap and the fraction of labor in the low-productivity agricultural sector (see their equation 2 and Figure 4). The authors neglect the possibility of technological change in agriculture, which historically almost inevitably accompanies the labor reallocation process. Moreover, I fail to see why the fraction of nonlabor population in agriculture should affect the annual rate of reallocation. After all, that rate depends less on how many workers are available for transfer in any one year than on their ability to move and be absorbed by higher-productivity nonagricultural activities. This is not to dispute the point that the large gains in GDP growth arising from labor reallocation to a dualistic economy are likely to diminish over time as the agricultural labor surplus itself diminishes.

The conceptual and empirical core of the paper, dealing with the internal productivity gaps across nonagricultural sectors, is presumably to be found in the implementation of their equation 3 to 5. However, the relevance for gap reduction of equations 3 and 4, which indicate how initial marginal func-
tions productivity yields changes in the subsequent demand for labor and capital, is not at all clear to me. Equations 5 and 6, which do bring in TFP, bear a family resemblance to the Cowan equation, even through the rates of growth of both labor and capital inputs are not included, and even though we know TFP in that context to be exogenous residual. It is also here where the later discussion of FDI, R&D, and gauging would have been introduced to provide explicit endogenous behavioral elements. The authors follow this discussion with a very interesting and novel analysis, based on input-output data, of the contribution of the turnover (exit and entry) of firms to labor productivity change, by comparing these firms with firms that survive over the same 1995–2004 period. Not surpris-
singly, exiting firms nearly of enter exhibit substantially lower, and entering firms substantially higher, productivity than surviving firms. Later on, the authors “most importantly” identify many of the exiting firm as state enterprises and many of the entrants as restructured or greenfield private enterprises. Two questions arise, however. First, it is reasonable to believe that out of a total annual population of 22,000 to 27,000 firms, more than 16,000 (14,600 + 9) either entered or exited each year from 1996 to 2004. How-
ever, as the authors admit, the number of firms that gives no indication of the relative size of the these categories under discussion.

A potentially more serious issue arises with respect to the NBS panel data used for the analysis that includes only large and medium-size enterprises. As Han and Jefferson acknowledge elsewhere, “the vast majority of
these [enterprises in China's industrial sector] are small household enter-
pri ses.** This must be especially true for the township and village enter-
prise sector and for the rapidly expanding private enterprise sector over the most
recent decade. The exclusions of these firms from the analysis must cast
considerable doubt on the findings.

Finally, in their discussion of the sustainability of China's productivity
growth, the authors refer to defining technical progress in terms of labor
productivity. I agree that there continue to exist large opportunities to re-
allocate labor from agriculture to other sectors, and undoubtably these are
best expressed in terms of technological and institutional changes. These
follow a section on "China's Science and Technology Talents," which seems to
ask what changes in R&D or in patenting have caused the changes
in China's industrial TFY. The authors accept the empirical regularity of a
"science and technology takeoff" when R&D reaches 1 percent of GDP, and
they provide some interesting and generally plausible arguments as to why,
with the help of R&D and FDI inflows, China has already reached this point.

Here again, however, the published R&D figures, which focus entirely
on the official reports of large and medium-size firms, public and private,
do not really convey a credible indication of a country's true R&D activity.
For example, in the other East Asian economies cited in the paper, the kind
of informal blue-collar R&D that takes place on the factory floor and in the
labors of "dai" has been shown to be extremely important in generating the
adaptive technical changes that are often less than spectacular individually,
but massive, and subtly-innovating, in the aggregate. The missing discussion of patents indicates not only that FDI-related foreign patents
played a major role in stimulating domestic innovation, but instead that
these were dwarfed by the explosion of relatively low-tech, re-enforcement-
thrusting, household patents, presumably heavily concentrated in smaller firms.
My educated guess would be that those utility models, in China as earlier
in the case of Japan, amount to more than simple imitation (or reverse
engineering); rather, they also represent individually modeled bits, in turn,
massive adaptive changes in both the process and product quality dimen-
sions. Unfortunately, the perhaps interesting discussion of R&D, FSI, and
patenting intensity is not at all integrated with the rest of the paper. It is, of
course, no surprise that these variables are generally weighted more heav-
ily in the coastal provinces, for their precise impact on the closing of the
various gaps and China's overall growth trajectory is not really demon-
strated. And again, they could be modeled as concentrating directly to TFY,
not to the various factor productivities.

Finally, although I applaud the authors' effort, at the end of the paper, we
include some important political economy and institutional dimensions,
that discussion is necessarily ex cathedra. I find myself in full agreement
with much of their argument—that to sustain its growth China needs to take
into account such concerns as a worsening income distribution, environ-
mental degradation, uncertain property rights (especially in agriculture),
corruption, and lagging political reforms, and that even under optimistic
assumptions about continued institutional reforms (and the authors are
clearly optimistic), the shrinkage of China's various productivity gaps,
especially the international one, is likely to mean smaller contributions to
overall growth in the future. After all, what successful middle-income
developing country has been able to maintain real growth rates in the 8 to
9 percent range as it approaches economic maturity?

General discussion: William Nordhaus complimented the authors on
their analysis of Chinese firms' productivity, which provided valuable insights
into the sources of China's remarkable growth. But he also expressed reser-
vations about some of the more aggregate results. Because much of the
underlying data are constructed using Lasperez indices, estimates of pro-
ductivity growth in the Chinese economy and its various sectors are biased
upward. Edward Denison showed long ago that the increase in productivity
that results from moving labor from low-productivity to high-productivity
sectors largely disappears when the more appropriate chain-weighted quan-
tity indices are used. This increase in measured productivity, or "Denison
effect," can be quite large, accounting for over 1 percentage point of re-
ported productivity growth in Italy from 1952 to 1965. For example, Nord-
haus noted that for Chinese national accounts use Lasperez indices with
1995 planning prices; he expected that a substantial fraction of productivity
growth might on the order of one-third of a percentage point, would dis-
appear once the Chinese move to chain-weighted indices.

Nordhaus also pointed out that output indices used by the authors need to take into account differentials in price levels across regions and
firms. It is not clear what methodology Chinese authorities follow to deal
with this issue, and no method is completely satisfactory. For example, the

methodology based on the consumer price index, where each model has to be matched by another, has difficulty dealing with such differences. Norrman remarked that cross-country comparisons of the level of productivity, and by implication estimates of the rate of convergence, are even more problematic than within-country comparisons. The authors do not attempt to allow for the difference between purchasing-power parity (PPP) and market exchange rates. In the case of China, it seems likely that the survey is the predominant productivity and overestimates the gap between China and the advanced economies. Furthermore, some countries produce mostly nontraded. A further difficulty in the level comparisons is that internationally supplied inputs, such as steel, are likely be underestimated. Norrman noted, however, that the available PPP data for China are far out of date. The Penn World Tables have PPP estimates on living Kevins's data from 1975, with some updates, including from a bilateral city comparisons from 1995 between Hong Kong and Guangzhou; a scheduled ten-city study is still pending. Without more recent data, reliable PPP adjustments are not feasible.

David Autor thought it would be interesting to decompose productivity growth in Chinese industry into components that change faster, and those that change more slowly. He mentioned studies by Jan van Oort and James Schmitz, Jr., that look at productivity changes following transitions that made the environment more competitive. Both these authors focused not only on the least-productive firms and those that have been productive. Autor wondered whether changes in regulations in China had related effects and had resulted in less dispersion in productivity at the industry level. Also, given the large dispersion in firm productivity within industries, it would be interesting to know whether the low-productivity firms are the present "way's" sample also have lower costs of the kind explored by Wendy Dodson and Asli Kaayali in their paper in this volume.

Wendy Dodson wondered whether the Chinese authorities are today actually devoting resources to the creation of new knowledge; or if they are still primarily preoccupied with catching up with the existing stock of knowledge. Gary Jefferson replied that his impression was that the Chinese authorities' intention is to put more emphasis on creation of new knowledge. Indeed, from the patent data it seemed that the firms themselves are focusing more on invention than they have in the past.

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