Can China Escape the Middle-Income Trap?:

Productivity Catch-Up in China's Manufacturing Sector

Paul Deng
Copenhagen Business School
Copenhagen, Denmark
pdd.eco@cbs.dk

Gary H. Jefferson
Brandeis University
Waltham, MA 02450
jefferson@brandeis.edu

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Abstract

China's gap in industrial labor productivity with the United States has been steadily shrinking over recent decades. In this paper we examine the main sources of gap reduction and the potential for further catch-up. Using Chinese above-scale firm-level data during 1998-2007 period and BEA industry -level data in the US, we first document the respective rates of growth of labor productivity, gap reduction, and contributions to overall catch-up of China's manufacturing sector during 1998-2007. We then aggregate the firm-level data to the 3-digit industry level to estimate a productivity gap reduction function and find that the key drivers for the productivity convergence are the initial technology gap, increased R&D spending, firm's ownership restructuring, and industry level entry-exit ratio, a measure of competitive dynamism. A key finding is that the catch-up dynamic entails the break out of a small number of firms within each industry rather than catch-up of lagging firms. We then use these finding to investigate on-going patterns of catch-up during 2007 to 2011.

1.0 Introduction

It is widely expected that sometime within the near future, whatever the measure, China's GDP will have surpassed that of the U.S.[1] When that transition comes to pass, however, because China's population will be nearly four times that of the U.S., China's level of GDP per capita, or labor productivity, will be barely one-quarter that of the U.S. More challenging than the timing of China-U.S. GDP catch-up is the question concerning the path that the productivity of China's labor force is likely to take over the next years and decades. With manufacturing established as a leading sector in China's economy, the U.S.-China gap in manufacturing productivity is likely to drive the pace and degree with which China's overall living standards converge to those of the U.S.

The magnitudes of the U.S.-China manufacturing productivity disparity are summarized in Figure 1 and Figure 2. While the period 1998-2007 on which this analysis largely focuses is a comparatively short span of China's 35-year reform history, it is arguably the most important 10-year span of China's industrial transformation. During this decade, China's GDP grew nearly two-and-one-half fold. Industrial output, the key driver, grew more than two and one-half fold.[2] Overall labor productivity in manufacturing grew from $3,978 per worker in 1998 to $17,960 in 2007, a period that enjoyed substantial price stability.[3]

On the institutional side, China's ascension to the WTO in 2001 was associated with a substantial decline in industrial tariffs while total trade, including both exports and imports, grew by more than a factor of six. Foreign direct investment (FDI) more than quadrupled during this

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[1] World Bank, PPP

[2] In constant yuan prices. NBS (2012), p. 48.

[3] Both numbers are in current USD.

10-year period.[4] With the surge of trade and FDI, key avenues of technology transfer expanded. Furthermore, R&D spending dramatically accelerated, so that by 207, it had grown to 1.6% of GDP, up from just 0.65% of GDP in 1998. Spending on imported technology more than quadrupled.

Within this 13-year time period, our analysis employs a firm-level data set that spans 1998-2007. During this ten-year period, as the total number of industrial enterprises operating in China doubled to 336,768 from 165,118, the number of SOEs declined from 48,142 in 1998 to just 7,196 in 2007.[5] Extensive enterprise restructuring was both a contributing cause and a consequence of China's surge in industrial production and productivity.

In this paper we construct a model of gap reduction in which China's manufacturing productivity is substantially driven by two conditions: its productivity gap with corresponding industries in the U.S. and by the growth of labor productivity at the frontier. In addition, other factors, including enterprise restructuring, R&D, and spillovers from foreign direct investment (FDI) are hypothesized to be propelling Chinese productivity growth.

We investigate two dynamic processes. The first is the queuing up of industries for the catch-up process in which some industries, such as apparel take the lead, and others, such as petroleum processing, appear to hold back. The second dynamic process focuses on firm-level behavior within the catch-up industries; it focuses on the behavior of firms with respect to patterns of R&D intensity, exit and entry. Specifically, it looks at whether catch-up is largely a phenomenon of the break out of first movers or a pattern involving within-industry firm catch-up and productivity convergence.

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[4] China's total trade in goods and services increased from $371 billion in 1998 to $2.38 trillion in 2007; China's annual FDI inflow during the same period increased from $24.8 billion to $101 billion.

[5] These numbers include China's above-scale enterprises, i.e., all of its SOEs and all non-SOEs reporting annual sales in excess of 5 million Yuan. For state-controlled enterprises, the number declined from 53,970 in 1998 to 9,875 in 2007.

To investigate our empirical analysis of the extent of and patterns of catch-up of manufacturing productivity in China with the U.S., we use three sets of data, two Chinese and one U.S. The two Chinese data sets include a panel of firm-level data covering 1998-2007; the second is a panel of 2-digit industry level data extending over the period 1998 to 2011. Finally, for purposes of defining the international frontier, we use 2- and 3-digit U.S. SIC data; together with the Chinese data, we estimate the gap that separates Chinese industrial labor productivity from that of China.

We initially use the 2-digit, 1998-2011 data to prepare a set of summary statistics that define the respective performance of Chinese and U.S. industries over the period since 1998. These summary statistics address the following questions:

> What is the overall pattern of China-US productivity growth and catch-up? Which were the leading and lagging industries in catch-up? Given differences in the respective shares of industrial output, which industries were the major contributors to catch-up?

We then use a panel of firm-level data spanning the period 1998-2007 to investigate an additional set of questions concerning the factors that differentiate the speed of both firms and industry catch-up. We do this by aggregating the firm-level data to the 3-digit level. With the aggregated data we can investigate issues relating to both industry catch-up patterns and the within-industry behavior of firms. In this section we address the following industry-specific questions:

> How does the size of the industry productivity gap affect the productivity growth of Chinese manufacturing industries and their ability to narrow the gap? Is the relationship between the gap and catch-up linear or non-linear? What portion of the growth of frontier industry productivity spills over to the corresponding Chinese industries? To what extent do industry R&D spending, FDI intensity, and export orientation, either independently or through their interaction with the size of the gap, promote catch-up?

We also use our firm-level data to examine the following specific within-industry firm dynamics:

> How does the firm's ownership designation affect the pace of and propensity for catch-up? To what extent is industry catch-up associated with a shift from physical investment to knowledge investment? To what extent is industry catch-up associated with individual firms exhibiting first mover tendencies thus increasing the spread of within-industry firm productivity versus within-industry catch-up or exit of lagging firms that narrows the productivity dispersion?

While our findings build on prior intuition concerning the drivers of successful catch-up, they are nonetheless remarkable for uncovering and clarifying the avenues of catch-up. First, we find a pattern of catch-up across a wide range of industries. More notable, by 2007, China had arguably effectively established its own internal manufacturing frontier such that within 10 of the 18 industries, China had established productivity levels that had either exceeded the average of their U.S. counterpart firms (5) or had advanced to more than 85 percent of the average U.S. frontier level (5). We also find that while the most robust contribution to catch-up is the size of the productivity gap, R&D intensification and the dynamics of exit and entry contribute substantially to convergence. Another notable finding is the tendency of an inverted-U pattern of within-industry catch-up in which we find emergent break-out firms that lead to a significant increase in the within-industry productivity spread, which we document. Projecting forward, we anticipate that as whole-industry catch-up evolves, through processes of technology transfer and liquidation, the within-industry spread of firm productivity levels become more tightly bunched, as the industry's gap with the international frontier declines, thus tracing out the inverted-U pattern of firm productivity dispersion over the catch-up process.

The following section presents a review of the relevant literature on catch-up, examining a range of literature on country, industry, and firm-level catch-up dynamics. Our paper uses a somewhat distinct, perhaps controversial, measure of productivity, to measure the productivity gap and catch-up; that is labor productivity rather than total factor productivity as used in papers on growth accounting. In Section 3 we explain and justify this choice of measure. Section 4 describes the various data sources and data sets that we use for our study. Section 5 provides an overview from the macroeconomic and industry level of the nature of China's manufacturing productivity gap with the US and the process of catch-up. In Section 6, we focus on the factors that either drive or impede the process of catch-up at the firm level. While the magnitude of the productivity gap stands out as the key driver, a variety of other factors differentiate patterns of firm catch-up. While Section 6 formulates a model of labor productivity growth and employs a balanced subsample of the firm-level data to estimate the drivers of productivity growth. Section 7 uses an aggregation of the unbalanced firm level data set to the 3-digit level to analyze the role of entry and exit and industry characteristics that drive industry catch-up. By focusing on the top quintile of Chinese firms, Section 8 documents China's emerging manufacturing frontier. Section 9 investigates two key stylized facts of catch-up – the role of break-out in catch-up and the contribution of R&F intensification. Section 10 uses more recent data to extend the catch-up analysis for the years 2007-2011. Finally, Section 11 concludes the paper with a discussion of our findings, attempts to answer the question posed in the title of the paper, and suggestions for further research on the subject.

2.0 Literature Review

The literature on catch-up spans whole country economies, specific industries, and individual firms. Our review includes literature from each of these three types of catch-up with a focus on locating the catch-up dynamics that are common to our understanding of firm and industry catch-up issues. We infer from this analysis a plausible scenario for the growth of China's living standards in relation that of the U.S.

We start with Gershenkron (1966) who investigated the "advantages of backwardness" for developing countries. The general prediction of the theory is that the more "economically backward" a country, the more we will see:

1. more rapid rates of industrial growth;
2. more rapid growth spurts rather than gradual growth rates;
3. larger scale of plants and of firms and a greater emphasis on up-to-date technology. Late comers can purchase machinery from early producers; with the advantage of a clean start, the late-comer can skip early smaller phases of growth.
4. a more active role by the government and large banks in supplying capital and entrepreneurship. The backward country generally needs more institutional help in organizing its newly-emerging industries.

Each of these conditions finds relevance to the Chinese experience.

Nancy Stokey (2012) studies the interaction between technology, a publicly available input that flows in from abroad, and human capital, a private input that is accumulated domestically, as the twin engines of growth in a developing economy. The model displays two types of long run behavior, depending on policies and initial conditions. For the purpose of accelerating growth, the model shows that policies that promote technology inflows are much more effective than subsidies to human capital accumulation.

Fagerberg, Srholec, and Knell (2007) explore the question why some countries perform much better than other countries. Their paper outlines a synthetic framework, based on Schumpeterian logic, for analyzing this question. Four different aspects of competitiveness are identified: technology, capacity, demand, and price. Based on a sample of 90 countries on different levels of development during 1980–2002, the paper underscores the importance of technology, capacity, and demand competitiveness for growth and development. Price competitiveness seems generally to be of lesser importance.

The following papers emphasize the role of technology transfer and diffusion as a key engine in the catch-up process.

Fagerberg and Verspagen (2002) discuss and outline a perspective on economic growth based on evolutionary theorizing. Consistent with this perspective, capitalist development is shown to be a process of alternating periods of convergence and divergence, with some signs of a shift towards divergence recently. They also show that the importance of innovation for economic growth has increased lately, while at the same time imitation, (or diffusion) has become more demanding.

In his JEL review, Keller (2004) concludes that for most countries, foreign sources of technology are of dominant importance (90 percent or more) for productivity growth. Keller concludes that instead of simply being far from the frontier, the success of countries is in part explained by how their firms engage in international economic activities. Early on, international trade has been suggested as a major channel for technology diffusion. With regard to imports, Keller believes that overall the evidence now supports the notion that importing is associated with technology spillovers. However, we do not know yet how strong diffusion is through embodied technology in intermediate goods versus other technology diffusion associated with imports. Keller notes that while the econometric evidence on learning-by-exporting effects is unclear, he does not see evidence in favor of strong important learning-by-exporting effects. The literature on learning effects for domestic firms from FDI seems to be closer to a consensus than the trade literature is right now. For instance, both micro-econometric studies and case studies point in the same direction. The evidence suggests that there can be FDI spillovers, but they do not occur everywhere to the same degree. The remaining questions include the following: how large are vertical compared to horizontal spillovers, and which firms—stronger or weaker—benefit most from spillovers.

Acemoglu, Aghion, and Zilibotti (2006) analyze an economy where firms undertake both innovation and adoption of technologies from the world technology frontier. The selection of high-skill managers and firms is more important for innovation than for adoption. As the economy approaches the frontier, selection becomes more important. Countries at early stages of development pursue an investment-based strategy, which relies on existing firms and managers to maximize investment but sacrifices selection. Closer to the world technology frontier, economies switch to an innovation-based strategy with short-term relationships, younger firms, less investment, and better selection of firms and managers. We show that relatively backward economies may switch out of the investment-based strategy too soon, so certain policies such as limits on product market competition or investment subsidies, which encourage the investment-based strategy, may be beneficial. However, these policies may have significant long-run costs because they make it more likely that a society will be trapped in the investment-based strategy and fail to converge to the world technology frontier.

Aghion et al. (2005) investigate the relationship between product market competition and innovation. They find strong evidence of an inverted-U relationship using panel data. They develop a model where competition discourages laggard firms from innovating but encourages neck-and-neck firms to innovate. Together with the effect of competition on the equilibrium industry structure, these generate an inverted-U. Two additional predictions of the model—that the average technological distance between leaders and followers increases with competition, and that the inverted-U is steeper when industries are more neck-and-neck—are both supported by the data.

Hence, much of the general cross-country literature exploring the question of catch-up focuses on technology, innovation, and competition. Much of the extensive literature on China's economic performance and prospects during the past two decades of the reform period bear directly or indirectly on the issue of China's capacity to sustain robust rates of productivity growth that can enable China to close the gap in living standards with the U.S. We focus on several articles that directly address the matter of catch-up.

Eichengreen, Park, and Shin (2012) use international data starting in 1957 to construct a sample of cases where fast-growing economies slow down. The evidence suggests that rapidly growing economies slow down significantly, in the sense that the growth rate downshifts by at least two percentage points, when their per capita incomes reach around $17,000 US in year-2005 constant international prices, a level that China should achieve by or soon after 2015. Among their more provocative findings is that growth slowdowns are more likely in countries that maintain undervalued real exchange rates.

Brandt, Van Biesebroeck, Zhang (2012) present a comprehensive set of firm-level total factor productivity estimates for China's manufacturing sector that spans her entry into WTO. They find that the weighted average annual productivity growth for incumbents is 2.7% for a gross output production function and 7.7% for a value added production function over the period 1998-2006. Of the various sensitivity checks they carry out, controlling for the increase in labor quality and labor hours, as proxied by the rising real wage, has the largest (downward) effect on the productivity estimates. They further document that new entrants are a particularly dynamic force and that firms experience large productivity declines before exiting from the sample. Overall, net entry contributes roughly half to total TFP growth; hence catch-up analysis must be cognizant of the respective contributions of entering and exiting firms.

Wu, (2001) joins the debate of whether Chinese manufacturing experienced a significant catch-up with or a process of falling behind the world's advanced economies. It calculates a new set of industry-of-origin China-US PPPs for major manufacturing industries at 1987 prices. Then using a newly constructed data set, it derives China's comparative labor productivity level in manufacturing for 1952-97. The results show that China's comparative labor productivity increased from about 3.0 in 1952 to 7.6 in 1997 (USA=100), but with a long stagnation at around 4.5 between 1958 and 1990. A clear catch-up process has been observed since the 1990s when China's market-oriented reform deepened.

Jefferson, Hu, and Su (2006) document how China's economic transformation is proceeding at different rates across different regions and sectors; China's most advanced regional sector, coastal industry, still lags well behind the world's technology frontier. This paper explores the implications of these internal and international productivity disparities for China's ability to sustain rapid economic growth. When China's GDP catches up to U.S. GDP, Chinese living standards still will be only one quarter those of the United States. If, at that time, productivity in some major regions and sectors remains far below the average, coastal industry may have to achieve productivity that approaches or even exceeds U.S. productivity. Coastal industry's productivity growth is then likely to slow substantially, impeding China's overall economic growth. The paper examines the need for policies that facilitate economic integration across regions, to enable the lagging regions and sectors to catch up to coastal industry, and the prospects for continued institutional reform.

Following 2011 in which China provided the largest number of patent applications internationally, Hu, Peng, and Lijing (2014) investigate whether China's patenting ascendancy has been propelled by Chinese firms' increasing technological sophistication or their much greater propensity to seek patents. Hu et al differentiate the two potential explanations by estimating a patents production function and by relating a firm's patents in force to its labor productivity. Their main findings are: 1) the patenting surge has been an across-the-board phenomenon, with more rapid growth coming from industries and regions that were previously not actively applying for patents; 2) the correlation between patents and R&D and that between patents and labor productivity have become weaker, particularly for utility models and for regions and firms that were less innovative; and 3) the willingness to acquire patents has significantly increased. Taken together, these results suggest that non-innovation related forces may have played an important role in driving China's recent patenting surge.

These are but a sliver of the capable, extensive, and fast-expanding literature on China's capacity to achieve catch-up with the more economically advanced economies. Together these papers underscore the importance of technology development and transfer, the differentiation of productivity advance across regions and sectors, and questions concerning the capacity to sustain its productivity advance so as to substantially narrow the distance it suffers with the OECD country population.

3.0 Measurement Issues: The Manufacturing Productivity Gap

In this paper, to measure the size of the China-US productivity gap, we use value added per worker in the manufacturing sector. We do not use a measure of productivity for the whole economy, nor do we use total factor productivity, i.e., a geometric combination of labor and capital productivity, the alternative measure of the growth of efficiency and living standards. The reason for our focus on labor productivity in the manufacturing sector is that our model assumes that the key driver of catch-up is the magnitude of the labor productivity gap in the manufacturing sector. In the following discussion, we justify the focus on manufacturing and labor productivity.

a. Manufacturing: The PPP model implies that tradable goods, principally manufacturing goods, fix wage levels in the economy. The process of wage equalization as between the manufacturing and non-manufacturing sector is represented by the two-sector Fei-Ranis model. With prices of tradable goods set in world markets and the technical dimension of physical output per worker fixed, the value of labor's productivity measured in world prices becomes an exogenous benchmark for labor compensation across an economy with a substantial tradable goods sector. The proportion of the workforce in China's agricultural sector has been declining rapidly; in the U.S. and other OECD economies, agriculture accounts for approximately one percent of the total work force.

b. Labor productivity. In this paper, productivity is measured in terms of labor productivity, i.e. value added per worker. We assume that investment at the firm and industry levels is a function of the gap in labor productivity and that investment that ensues from the gap leads to capital deepening and rising labor productivity. In this respect, we implicitly accept the growth model characterization of the neoclassical growth process in which long-run growth moves from (approximate) steady state to (approximate) steady state in accord with Harrod-neutral labor-augmenting technical change.

Another way of understanding our singular use of labor productivity relates to the dual approach for measuring TFP using growth accounting. Hsieh (1999) demonstrates the equivalency of the primal and dual approaches to growth accounting. That is, totally differentiating the national income identify, $Y = rK + wL$, with respect to time and simplifying, he shows that

$$y\wedge = S_K k\wedge + S_L l\wedge = S_K r\wedge + S_L w\wedge$$

where $y^\wedge = (dY/Y)/(dL/L)$ and $S_K = rK/pY$ and $S_L = wL/pY$, where p = the GDP price level. Rearranging, we see that $TFP^\wedge = y^\wedge - S_K k^\wedge + S_L l^\wedge = S_K r^\wedge + S_L w^\wedge$. Furthermore, we note that in the case in which technical change is Harrod-neutral such that capital's marginal product is unchanged and $r^\wedge = 0$, the measure of the growth of TFP reduces to the growth of the wage. Under the assumption of competitive labor markets, once a rise in capital productivity has prompted capital deepening so that investment retreats to its long-term return, productivity transforms to the purely labor-augmenting variety in which labor productivity captures the entirely of productivity advance. While this assumption is not entirely accurate, returns to capital in China do not appear to have changed markedly from 1998 to 2007. Moreover, if we use the primal approach to measure TFP, the estimate of TFP may be subject to serious bias arising from errors of measurement of the net capital stock as well as errors in estimating the respective factor income weights.

For the reasons just explained, this study using various measures of manufacturing labor productivity – levels, rates of growth, and the productivity gap between China and the U.S. – to evaluate recent patterns and future prospects relating to China's ability to escape the middle-income trap.

4.0 Data

Our analysis is based on three data sources. The first is BEA-BLS industry data set, from which we obtained industry-level labor productivity measures for US manufacturing. The data include series on value added and employment, the two variables used to construct measures of labor productivity. Initially, we use the data spanning 1998 to 2007 covering eighteen 2-digit manufacturing sectors. Later we extend our use of this series through 2011.

In addition to the BEA-BLS industry data set, we use two Chinese industry data sets. The first, industry level data, is drawn from the China Statistical Yearbook. The Chinese statistical system includes 31 industries. We combine and harmonize these with the 18 manufacturing classifications used in the BEA-BLS data set (See Appendix A for details of industry matching). These data are also available through 2011.

The second source of Chinese industry data is a set of firm-level data, generally known as the above scale (*guimo yishang*) firm-level data. This firm-level data, which also cover the years 1998 to 2007, consists of all of the state-owned enterprises and all non-state-owned enterprises that produce annual sales of 5 million Yuan or greater. In 1998, the data set consisted of 165,118 enterprises; by 2007, the number had grown to 336,768. Our firm-level analysis focuses on three categories of firms: the survivors who report in both 1998 and 2007, the entering firms, and the exiting firms. In 2007, the numbers of firms that fall into each of these categories are 34,699, 263,918, and 3,571[6] respectively.

5.0 Overview of the U.S. - China Manufacturing Gap

Table 1-1 shows key comparisons of the industry level data, which span the years 1998-2007. The first column shows substantial disparities in the 1998 industry-level labor productivity data, ranging from a low of 2,215 USD per worker in the textile industry to a high of 8,912 USD per worker in the petroleum and coal products industry. The nearly four-fold disparity in VA per worker between these industries is likely to result from substantial differences in the capital intensities of the textile industry, of which parts are extremely labor intensive, versus the petroleum and coal products industry, which is largely driven by heavy equipment with a relatively sparse workforce. We note from Column (14) in Table 1-2, that 5 of

[6] The number of exiting firms is from year 2006, which existed in 2006 and exited in 2007.

the 18 industries accounted for nearly 55% of the average valued added share during 1998-2007, while the remaining 13 industries accounted for a minority of the manufacturing production.

As shown in Column (9) or Table 1-2, during 1998-2007 all of China's industries enjoyed exceptionally robust annual rates of productivity growth. The highest recorded annual rate of productivity growth was recorded by primary metals (24.7%), machinery (20.7%), chemical products (19.5%) and petroleum and coal products (19.2%). While these rates are unadjusted for inflation, annual rates of inflation over this period were generally negligible. The cumulative increase in the producer price index for industrial products was just 5.8%.[7] The extraordinary rates of productivity growth during this period underscore this exceptional period of growth and transformation occurring over the 10 years falling between the 1997 Asian Financial Crisis and the Global Financial Crisis beginning in 2008.

Column (10) in Table 1-2 shows that annual rates of productivity growth in the U.S. frontier industries were also robust, having averaged 5.4% and reaching 13.6% in the petroleum and coal products industry. Only one industry exhibited productivity growth rates of less than two percent; productivity growth in the other 16 industries all fell in the range of two to seven percent. Notwithstanding robust productivity growth in U.S. manufacturing, the disparities in productivity growth as between Chinese industry and the frontier U.S. industries imply substantial levels of catch up. The cumulative proportions of catch-up or gap-reduction are shown in Column (8) in Table 1-1.

As shown in Column (5), the initial gaps in 1998, measured as the log of the ratio of labor productivities, all fall in the range of two to four. Comparing columns (1) and (2) for 1998, labor productivity in China's petroleum and coal products industry, chemical products, machinery, non-metallic mineral products, and paper products are all about one-thirtieth the productivity

[7] Based on the Price Indices reported in Table 9-1, p. 311, NBS, 2012.

levels of their U.S. counterparts. Comparing, at the lower end of the productivity gap, several industries cluster around productivity levels that are 10% of their U.S. counterparts.

By 2007, we find a shrinking of the China-U.S. gap, as expected, although the distribution of shrinkage is rather disparate, ranging from an overall reduction of only 9% in the apparel and leather products industry, to 58% and 45% reductions in the primary metals industry and wood products and machinery industries respectively. Only five Chinese industries reported catch-up of less than 20 percent; these comparatively low catch-up rates transpired in four of the five U.S. industries in which annual productivity growth stood out at 6.4% or higher. The largest degree of catch-up – gap reductions of more than 40% or more – transpired in six industries, five of which reported among the lowest rates of productivity growth in the U.S., all below 4%, and one at 6.1%. With 19% annual productivity growth in China and 14% growth in the U.S., the petroleum and coal products industry was clearly an outlier in which it appears that global productivity surged.

Finally, Table 1-2 examines the contributions that each of the 18 industries made to China's overall gap reduction. The respective industry contributions are a function of two factors – the extent of gap reduction within each industry and each industry's share of value added within total industry, shown in Column (14). Column (15), which reports the industry contributions to gap reduction, shows disparate results. While five of the 18 industries contributed one percent or less, for a total contribution of 3.8%, the five largest contributors accounted for 65% - more than two-thirds – of the total gap reduction. In descending order of their contributions, these are the primary metals industry, the food and beverage industries, chemical products, machinery, and motor vehicles and parts.

6.0 A Model of Firm-level Productivity Growth

In this section, we model the key drivers – and impediments – to firm labor productivity growth. In our firm level regression, we define the firm-level productivity gap as the natural log difference of labor productivity between US industry j and the individual Chinese firm i in industry j, as in Equation (2) below:

$$GAP_{ijt} = \ln\left(\frac{VA_{jt}}{L_{jt}}\right)_{US} - \ln\left(\frac{VA_{ijt}}{L_{jit}}\right)_{CN} \tag{2}$$

$$\begin{aligned} gLP_{ij,t-(t-n)} = {} & \beta_0 + \beta_1 GAP_{ij,t-n} + \beta_2 GAP^2_{ij,t-n} + \beta_3 gFrontier_{j,t-(t-n)} \\ & + \beta_4 RDI_{ij,t-n} + \beta_5 SOE\_Share_{ij,t-n} + \beta_6 FOR\_Share_{ij,t-n} \\ & + \beta_7 EXPI_{ij,t-n} + \beta_8 CR5_{j,t-n} + \beta_s X_{s,ij,t-n} + \mu_j + \tau_t + \varepsilon_{ijt}, \end{aligned} \tag{3}$$

Where i, j, and t stand for firm, industry and year, respectively; t-n is the beginning year and t is the end year of a period with n being the gap in between. gLP_i is firm's annualized labor productivity growth. Note that by including the quadratic term in Equation (3), we allow for the possibility that the Chinese firm's productivity growth response to the gap with the corresponding frontier industry may be non-linear. Equation (3) also includes the rate of productivity growth of the frontier industries, or $gFrontier_j$. We might expect β_3, the coefficient on frontier industry productivity growth, to be positive. This implies that the faster growing the frontier, with trade, investment, and technology spillovers, Chinese firms in those industries with high global productivity growth should themselves exhibit higher growth rates.

RDI_i is R&D intensity, measured by cumulative R&D expenditure divided by value added. SOE_Share_i is the state capital share of the total capital for firm_{ijt}. Similarly, FOR_Share_i is the foreign capital share of the firm's total capital share. EXPI_i is export intensity, measured by exports divided by the firm's total output. Finally, $CR5_j$ is the firm output concentration ratio, measured by the top 5-firms's total output divided by the total industry output in industry j.

We first plot the crude relationship between firm labor productivity growth gLP and the initial gap, without controlling for anything. The scatterplot is reported in Figure 3. We see a strong positive relationship between the two. The estimation results are reported in Table R-1, R-2 and R-2b. Table R-1 reports regression results of a single nine-year difference, 2007-1998, while Table R-2 reports results from the 5-period stacked regression. We first divide the ten-year period into 5 equal periods, with 5 years in each period, i.e., 1998-2003, 1999-2004, 2000-2005, 2001-2006, and 2002-2007, then we stacked the five periods together and run a pooled regression. One constant feature in Columns (2) – (9) is the robustness of the gap and gap_sq estimates. The positive estimates for both of these regressors implies rates of productivity growth that rise exponentially with the size of the gap. Taken alone, this result implies that as the gap diminishes, the impetus for further productivity growth and probable catch-up diminishes. However, Columns (3) – (9) show that the productivity growth of lagging firms in China is also a function of the rate of growth of productivity at the frontier. The results indicate, however, that at least during the relevant 5-year sample period, only a quarter or less of the productivity growth of the frontier transfers to the firms in our sample.

The subsequent regressors in our sample identify firm-specific characteristics that affect the firm's productivity growth. R&D intensity matters; firms that dedicate a larger portion of their earnings to R&D raise productivity more rapidly. The following three ownership dummies show that ownership composition also matters. Relative to domestic non-SOEs, including collectively-owned firms, SOEs and foreign-owned firms, exhibit somewhat slower rates of productivity growth. Finally, larger firms exhibit slower productivity growth. This result is understandable, since larger firms are more likely to have achieved scale economies and a measure of technological sophistication relative to their still smaller counterparts.

We also estimate a panel version of Equation (3) using firm fixed effects. The results are included in Table R-2b. Compared to the results in Table R-2, one big change is the sign reversal of the coefficient for the quadratic term of gap variable. This indicates that if we only look at the within-firm variation, gap tends to have a positive yet marginally declining impact on firm-level labor productivity growth; while if we look at the overall effect, including the cross-section effect, gap's positive effect on firm's productivity growth is marginally increasing.

7.0 Modeling Industry-Level Gap Reduction

In fact, in this paper, we are most interested in modeling, understanding, and predicting the capacity of China's manufacturing sector to achieve significant, on-going reductions in the size of its productivity gap with U.S. manufacturing. As part of that catch-up process, in addition to the factors that we identified above that drive firm-level productivity, from an industry catch-up perspective, the dynamic process of firm entry and exit should also be expected to substantially impact overall industry-level productivity growth and catch-up.

For this purpose, we estimate an equation that is similar to Equation (4), with gap reduction as the dependent variable. That is, rather than use the annual rate of individual firm productivity growth, we use the annual rate of productivity catch-up or gap reduction, measured as *Gap_Reduction = gGR = gLP – gFrontier*. If we were to substitute *gGR* for *gGL* in Equation (3) using the same firm-level sample as that used to estimate the results shown in Table R-2b, we would anticipate that the estimates of β_1 and β_2 as well as the coefficients on the other dependent variables would be similar to those in Table R-2b, except that the new estimate on *gFrontier* would be β_3-1.

However, Equation (4) below embeds two major changes. The first is that it is estimated using aggregations of firm-level data to the 3-digit level. Furthermore, it is estimated with the addition of variables that represent the proportion of firms that exit or enter over the full sample period. Those that both exit and enter one or more times are referenced as "transit" firms. Together the proportion of firms of a one of the four status variables – survivor, entry, exit, and transit – sum to unity. In order to estimate the contributions of the survivor, entry, exit, and transit firms, the proportion of exiting firms within each 5-year period is used as the reference.

The gap reduction estimation equation is:

$$
\begin{aligned}
GAP\_Reduction_{j,t-(t-n)} = {} & \beta_0 + \beta_1 GAP_{j,t-n} + \beta_2 GAP^2_{j,t-n} + \beta_3 gFrontier_{j,t-(t-n)} \\
& + \beta_4 \beta_5 SOE\_Share_{j,t-n} + \beta_6 FOR\_Share_{j,t-n} \\
& + \beta_7 EXPI \quad + \beta_8 CR5_{j,t-n} + \beta_9 entry \quad ratio_{j,t-n} \ + \\
& \beta_{10} exit \quad ratio_{j,t-n} + \beta_{11} transit \quad ratio_{j,t-n} + \beta_s X_{s,j,t-n} \ + \\
& \mu_j + \tau_t + \varepsilon_{jt},
\end{aligned}
$$

We summarize the basic statistics of survivors, entrants, exits, and survivors in Table 2. We can understand the importance of the distinction among these four firm type by the fact that among the 165,118 firms in the above scale sample in 1998, only 37,999 or 19.7% survived for the 2007-1998 differenced regression shown in Table R-1. Alternatively, among the 336,742 firms that exist in the 2007 data set, 83.9% are new entrants, i.e., they did not exist in the data set in 1998. The goal of this section is to assess the contribution of exiting and entering firms to the growth of industry productivity and catch-up. Again, we focus this analysis of the exit-entry contribution by aggregating firm-level data into 3-digital industry level data.

Viewed by firm count, the number of exits and entrants somewhat overstates the impact of their impact on China's overall productivity performance and catch-up. This is because the surviving firms are typically the larger firms; whereas the exits and entrants are typically smaller firms. Indeed, in 1998, the firms in the survivor panel represent 40.0% of total value added; while in 2007, those same firms account for 24.8% of total value added industrial output.

Comparing the results in Table R-2 and R-3, one surprising difference between the firm-based and industry-based estimates is the reversal of the sign on the quadratic gap term, suggesting that at the industry level, there may be diminishing returns to the motivating effect of gap distance on productivity growth. Table R-3 also shows at the industry level that R&D intensity is associated with slower not faster productivity growth. While this result may reflect reverse causality, so that industries that are more advanced and more proximate to the international frontier expend more on R&D, it is puzzling that the estimate should have reversed the result shown at the firm level in Table R-2. As with the firm-level estimates, we see that the scale effect is also negative.

The key innovation of this regression is the inclusion of the proportion of firms within each industry, which over each 5-year period, are either survivor firms, exiting firms, entering firms, or those making multiple transitions both entering and exiting from the industry. The results in Column (9) show that the survivor firms exhibit the highest rates of productivity growth, exceeding those of the entering, exiting, and transitioning firms by statistically significant margins. At least these results suggest that for the sample periods in the regression, new entry does not facilitate industry productivity growth and catch-up. In fact, recent entries appear to depress productivity growth by more than the presence of soon-to-exit and transitioning firms. The fruition of exit appears to contribute to an unambiguous rise in industry productivity growth.

8.0 Firm Catch-up: Stylized Facts

We use the firm-level data to explore patterns of firm catch-up. Specifically, we address two questions. The first is whether the industry catch-up process involves catch-up by laggard-firms catching up or exiting, hence causing a tighter within-industry distribution of firm productivity or, alternatively, if the catch-up phenomenon is primarily a dynamic in which a portion of the firms establish themselves as first movers thus breaking away from the majority of the firms and thereby spreading the distribution of within-industry firm performance.

a. Within-industry - break away or convergence? As whole industries exhibit catch-up, do we observe a pattern of some firms sprinting ahead or do the laggards tend to catch up? Figure 4 shows a scatter of 3-digit industries with the coordinates of the standard deviation of labor productivity of the included firms plotted against the magnitude of the gap with the U.S. frontier. The scatter conveys a distinct suggestion of a catch-up pattern in which a growing standard deviation is associated with catch-up. The inverted-U pattern tends to be confirmed by the associated regression shown in Table 4, although the flattening of the tail suggests that the pattern may be more that of a normal curve than an inverted U.

This finding has important policy implications for countries engaged in the catch-up process in which it appears that it is critical for industries in these countries to establish their own indigenous frontiers consisting of firms that are able to break away from the less dynamic firms within the industry.

b. Knowledge vs. physical capita investment. Acemoglu, Aghion, and Zilibotti (2006) find those whole country economies that exhibit catch-up exhibit substantial shifts from physical capital investment to knowledge capital investment. We use our 1999-2007 firm-level data set to test this hypothesis at the firm level. The test can provide insight into a key instrument that break out firms may systematically employ as they become first or early movers in the catch-up process.

Table 5 shows a robust relationship between R&D intensity as measured as the ratio of R&D expenditure/value added. The relationship remains robust for both industry fixed effects and firm-level fixed effects. These results indicate that R&D intensification is a critical avenue for industries and firms to achieve substantial progress toward closing the gap with the international frontier.

9.0 China's Emerging Manufacturing Frontier

The findings of the previous section suggest that at least in some of the industries we should expect to find break-out firms that are establishing a frontier of comparatively highly productive firms within China's manufacturing sector. These firms may or may not represent a substantial reduction of the gap they experience with respect to the average level of productivity across U.S. firms. To test for the emergence of a Chinese firm frontier, we compute the average productivity of the top quintile of China's firms within each 2-digit industry for both 1998 and 2007. This allows both for comparing China's emergent frontier with the U.S. productivity average as well as observing the evolution of the frontier over the decade from 1998 to 2007. The results are shown in Table (China's frontier).

The first two columns of Table (China's frontier) show the average productivity of China's manufacturing firms in relation to the U.S. average, i.e., our synthetic international frontier. For the average, these are 5% in 1998 and 14% in 2007. The 3rd and 4th columns show the average of China's top quintile firms relative to the same U.S. average. The differences between the Chinese averages in the first two columns and the Chinese frontier in the second two columns are striking. In 1998, while the average productivity among the population of China's manufacturing firms was but 5% of the U.S. average, the top quintile of Chinese firms extended to 55% percent of the U.S. average. By 2001, the ratios had risen to 14% and 77% respectively. In 1998, two Chinese industries –apparel, leather, and allied products and primary metals had top quintile averages that exceeded the U.S. average. By 2007, five Chinese top quintiles had emerged to exceed their U.S. industry counterpart averages. Another seven of the industries had achieved productivity levels that were 80% or more of the U.S. average.

These results strongly suggest that during the past decade, China has established a robust set of firms that themselves represent an indigenous manufacturing frontier. It may be that the most salient challenge for most Chinese companies is to close the performance gap with counterpart domestic firms rather than firms abroad.

10.0 Projecting Forward: 2007-2011

We extend our analysis forward from 2007 in two ways. The first is to solve one of the basic versions of our estimation equation, i.e., the regression estimated in Column (3) of Table R-3: $GAP\_Reduction\_a_{\ t,t-5}$= a + b1*$GAP_{t-5}$ + b2*GAP_sq_{t-5} + b3*$gFront\_a_{t,t-5}$ + $u_i + \tau_{t,t-5} + e_{it}$.

The results included in Column (3), include the following: a (the constant) = - 0.582, b1 = 0.315, b2 = -0.026, and b3 = -0.699. Given that the equation is estimated using fixed effects, the u_i terms drops out of the calculation. In order to simulate the steady state size of the US – China manufacturing productivity gap, we set the rate of growth of GAP reduction in Eq. (1) equal to zero. Under this condition, the gap will be motivating a rate of manufacturing labor productivity growth that is exactly equal to the rate of growth of manufacturing productivity by the international technology frontier (i.e., U.S. productivity growth). Hence, with manufacturing productivity growth in China and the U.S. growing at the same rate, the gap remains fixed; China's manufacturing productivity catch up and the catch-up of overall living standards ceases. Setting gap_reduction = 0, we obtain,

$$GAP = [\left(\frac{b1}{2b2}\right)^2 - \frac{a + gFront_a}{b2}]^{1/2} - \frac{b1}{2b2}.$$

At gGR = 0, Figure (annual gap reduction) shows as a result of the quadratic term, the calculation yields two solutions. In addition, we solve the gap reduction equation with and without the time trend. Given that the relevant range of gap observations is typically less than five, the solution is on the lower end of the Gap axis. Without the time trend, the solution is in the range of 2.5; with the time trend, the solution is approximately 1.9.

Figure (comparing China-US) shows the respective scatter plots for 1998-2003 and 2006-2011. The earlier fitted line is consistent with the results shown in Table R-3, the gap reduction estimation results. By contrast, the more recent results exhibit no apparent positive association between the size of the initial t-5 gap and the subsequent rate of gap reduction. A clue concerning the contrast is shown in Table R-3b in which we estimate the gap reduction equation for 9 five-year periods using the 2-digit data spanning 1998-2011. The basic OLS regressions yield coefficient estimates of the gap variables that are either insignificant or very small. By contrast, the fixed-effects estimates exhibit robust positive estimates of the relationship between the size of the gap and the rate of gap reduction. However, much of the movement in the individual within-industry changes in the relationship between the gap and gap reduction are in a northerly and northwestern direction. This shift is particularly noticeable, for example, for the apparel and leather industry, whose shift from 1998-2003 to 2006-2011 is almost in a direct northerly direction, while machinery moves substantially westward. These and other industry shifts account for the shift in the fitted curve upward and to a more horizontal position.

A key result is shown in Table 7, which shows a widening of the different in labor productivity growth from 11.4% during the 1998-2007 period to 16.5% during the 2006-2011 period. The effect was to reduce the measured gap in overall manufacturing productivity from a factor of 8.25 in 2006 to 3.60 in 2011, less than one half of difference just five years earlier. Given the international financial crisis and China's relatively robust – and unsustainable – stimulus program during this episode of global recession, we take this result with caution. In addition, the appreciation of China's currency during this time from about 8 Rmb/$ to 6.2Rmb/$ accounted for approximately 20% of the cumulative catch-up during the recent 2006-2011 period.

11.0 Conclusion

This paper covers substantial territory. It mostly draws on firm-level Chinese data in relation to measures of U.S. manufacturing productivity over the period 1998-2007. Key findings for this period include:

- During the period under study – 1998-2011 – China's manufacturing sector shows substantial catch-up with the U.S. from a gap of about 1/20th of the U.S. level to approximately one-quarter of the U.S. level.
- During the 1998-2007 period, the most important driver of labor productivity growth and gap reduction is the productivity gap between Chinese and U.S. manufacturing industries. This finding is robust both across and within China's 3-digit manufacturing industries.
- The larger the portion of surviving firms, the greater the rate of gap reduction. Large proportions of firms that eventually exit, or have entered or transitioned in and out, serve to slow the rate of gap reduction.

- Industries that have most reduced the size of the gap are those with break-out firms that tend to have pulled away from the median productivity levels in their industries; this rather than catch-up or exits by lagging firms so as to reduce the performance spread seems to be a key avenue of catch-up.
- R&D intensification is strongly associated with the phenomenon of gap reduction.

The paper uses these findings and data extending through 2011 to extend the finding for the earlier period. Key findings for the extended analysis include:

- Projecting the 1998-2007 analysis forward, it appears that when China's manufacturing growth has completed its potential for catch-up, i.e. when the rate of gap reduction = 0, the gap in manufacturing productivity and living standards is likely to be in the vicinity of one-half that of the U.S.
- The propensity to catch-up actually accelerated during the period 2006-2011, such that U.S. manufacturing in 2011 was approximately 3.60 times that of China versus 8.25 in 2006 and about 20 times in 1998.
- The degree of catch-up in the manufacturing sector has been extraordinary, however, in recent years it has probably facilitated by the so-called Great Recession, which China was able to offset during 2009-2011 more effectively than the U.S. Also, during this time, the Chinese Rmb appreciated relative to the dollar, accounting for approximately 20% of the cumulative 2006-2011 gain.

A key assumption of this paper is that China's manufacturing sector will drive wages and living standards across the Chinese economy, at once motivating a shift of workers to the urban industrial and service sectors, enabling an elevation of agriculture productivity and wages. Rising wages will further spill into China's rapidly growing service sector. Furthermore, relatively backward areas are assumed to be able to absorb and utilize the technologies that have become well-established as the drivers of rising wages in China's coastal industries. The spread of such gains will require extensive reform of labor and capital markets as well as extensive time as they have required even in the more advanced OECD economies.

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Figure 1

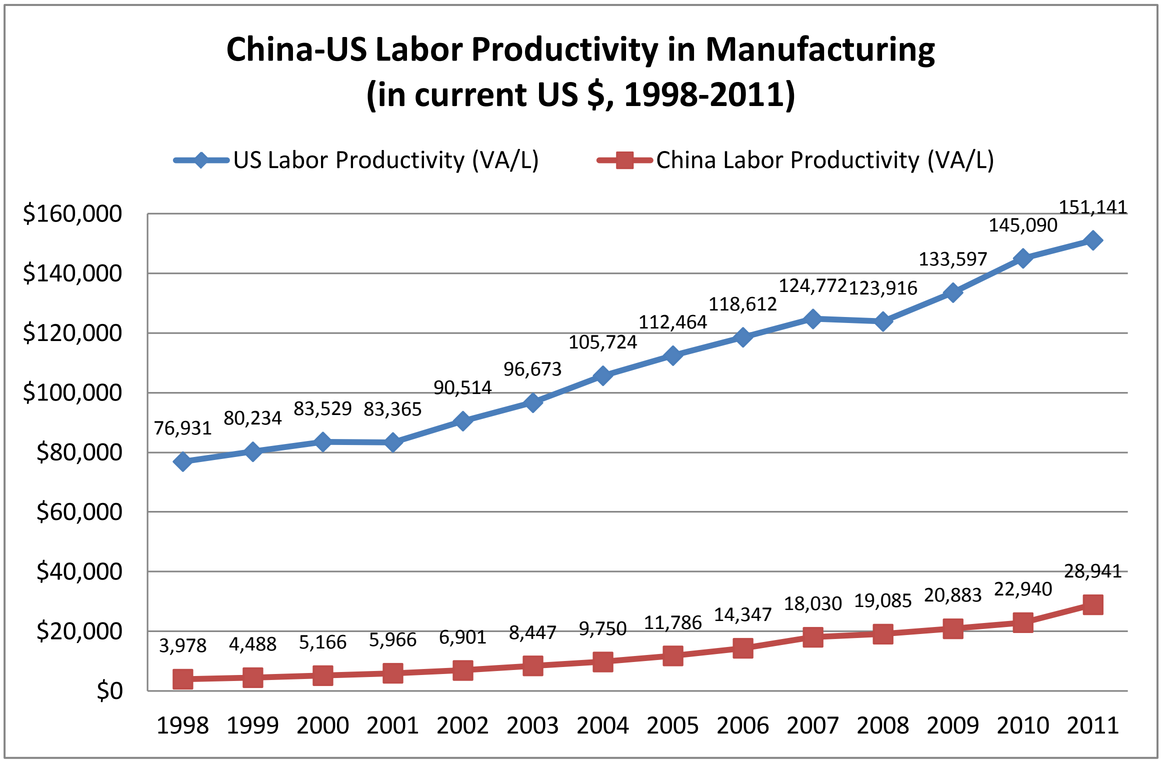

China-US Labor Productivity in Manufacturing
(in current US $, 1998-2011)
US Labor Productivity (VA/L)
China Labor Productivity (VA/L)
$160,000
$140,000
$120,000
$100,000
$80,000
$60,000
$40,000
$20,000
$0
76,931
80,234
83,529
83,365
90,514
96,673
105,724
112,464
118,612
124,772
123,916
133,597
145,090
151,141
3,978
4,488
5,166
5,966
6,901
8,447
9,750
11,786
14,347
18,030
19,085
20,883
22,940
28,941
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011

Figure 2

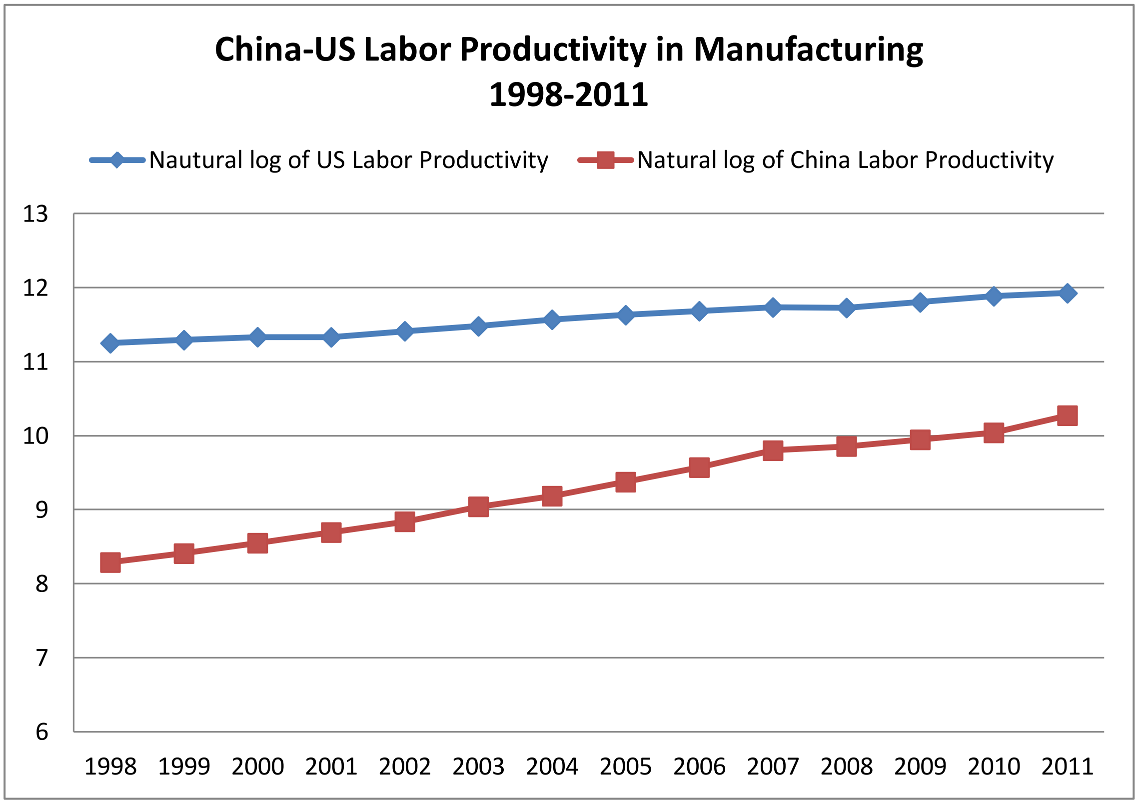
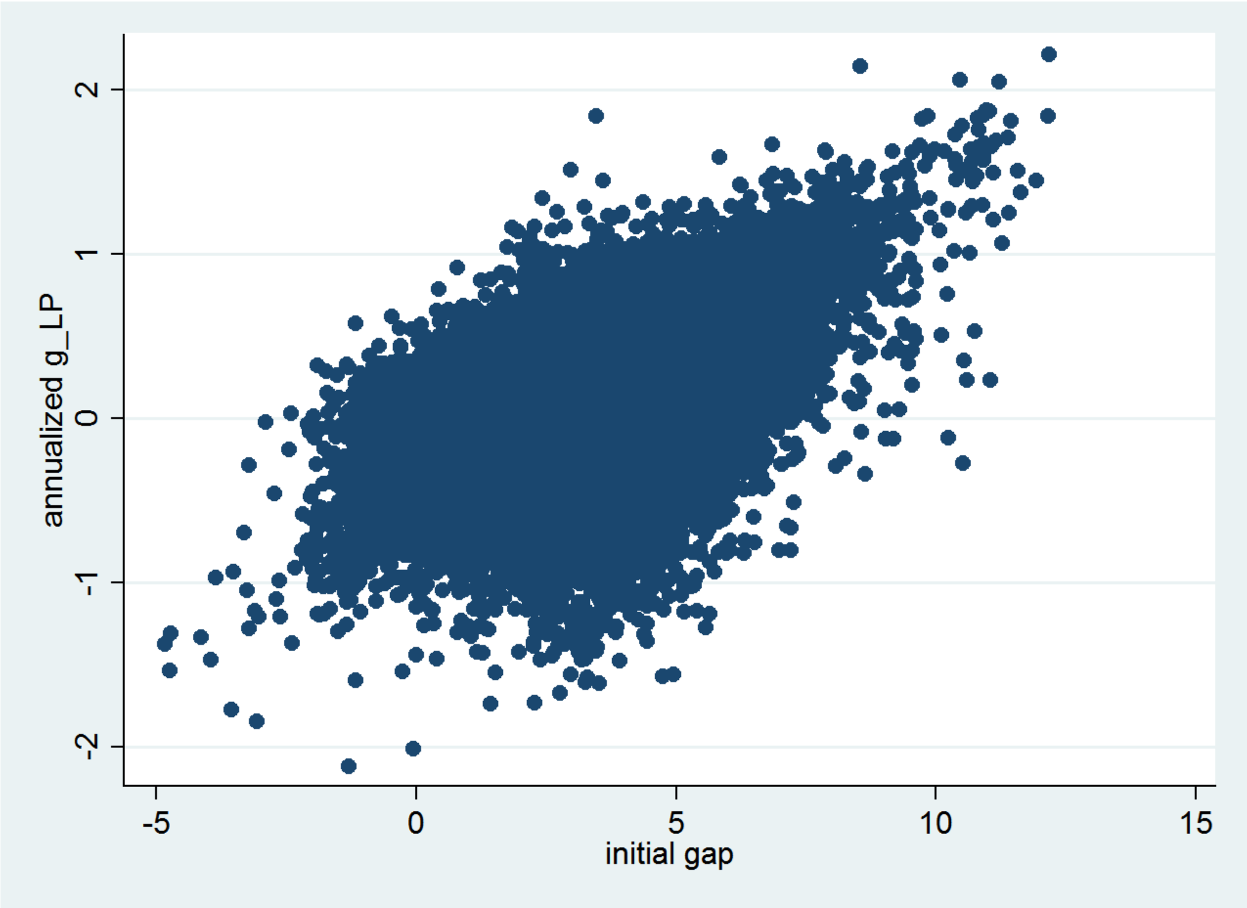

China-US Labor Productivity in Manufacturing
1998-2011
Nautural log of US Labor Productivity
Natural log of China Labor Productivity
13
12
11
10
9
8
7
6
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011

Figure 3
Firm Labor Productivity Growth and their Initial GAP with International Technology Frontier



(Note: the graph includes observations of 5-stacked periods, i.e., 1998-2003, 1999-2004, 2000-2005, 2001-2006, and 2002-2007).

Table 1-1. 2-Digit Summary Statistics of China-US Industrial Productivity Catch-up, 2007-1998

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Industry Description	**LP_98, China, current US$**	**LP_98,US, current US$**	**LP_07, China, current US$**	**LP_07,US, current US$**	**GAP (lnratio) , 1998**	**GAP (lnratio), 2007**	**GAP Reduction (2007-1998)**	**% of Catch-up**
Total Manufacturing	3,978	76,931	17,960	124,772	2.962	1.938	1.024	**34.6%**
Food and beverage and tobacco products	7,266	81,119	27,937	109,739	2.413	1.368	1.045	**43.3%**
Textile mills and textile product mills	2,215	44,294	10,313	66,131	2.995	1.858	1.137	**38.0%**
Apparel and leather and allied products	3,346	34,440	7,335	61,008	2.331	2.118	0.213	**9.1%**
Paper products	3,222	88,212	16,562	131,302	3.310	2.070	1.239	**37.4%**
Printing and related support activities	3,764	49,986	12,565	63,124	2.586	1.614	0.972	**37.6%**
Petroleum and coal products	8,912	401,661	50,259	1,364,903	3.808	3.302	0.507	**13.3%**
Chemical products	4,217	154,064	24,373	263,961	3.598	2.382	1.216	**33.8%**
Plastics and rubber products	4,066	67,125	13,062	93,229	2.804	1.965	0.839	**29.9%**
Wood products	3,206	45,619	12,749	55,569	2.655	1.472	1.183	**44.6%**
Nonmetallic mineral products	2,612	76,868	14,215	89,046	3.382	1.835	1.547	**45.7%**
Primary metals	4,171	75,539	38,472	130,966	2.896	1.225	1.671	**57.7%**
Fabricated metal products	3,846	65,517	14,464	87,316	2.835	1.798	1.037	**36.6%**
Machinery	2,472	76,842	15,866	106,741	3.437	1.906	1.531	**44.5%**
Computer and electronic products	6,799	85,102	17,189	157,578	2.527	2.216	0.311	**12.3%**
Electrical equipment, appliances, and components	4,770	64,879	17,716	108,463	2.610	1.812	0.798	**30.6%**
Motor vehicles, bodies and trailers, and parts	4,376	80,851	22,436	114,823	2.916	1.633	1.284	**44.0%**
Furniture and related products	4,173	46,994	9,311	66,376	2.421	1.964	0.457	**18.9%**
Miscellaneous manufacturing	3,143	69,323	8,171	125,361	3.094	2.731	0.363	**11.7%**

Table 1-2. Summary Statistics of China-US Industrial Productivity Catch-up, 2007-1998

	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Industry Description	**LP Growth, annual rate**	**Frontier Growth, annual rate**	**LP Growth Differenc e, annual rate**	**VA_Share, 1998**	**VA_Share, 2007**	**VA_share_ average**	**Contribution by industry in GAP reduction, %**
Total Manufacturing	16.7%	5.4%	**11.4%**	100.0%	100.0%	100.0%	**100.0%**
Food and beverage and tobacco products	15.0%	3.4%	**11.6%**	16.0%	11.8%	13.9%	**13.5%**
Textile mills and textile product mills	17.1%	4.5%	**12.6%**	6.4%	5.2%	5.8%	**6.2%**
Apparel and leather and allied products	8.7%	6.4%	**2.4%**	4.9%	4.0%	4.4%	**0.9%**
Paper products	18.2%	4.4%	**13.8%**	2.1%	1.9%	2.0%	**2.3%**
Printing and related support activities	13.4%	2.6%	**10.8%**	1.2%	0.7%	1.0%	**0.9%**
Petroleum and coal products	19.2%	13.6%	**5.6%**	3.5%	3.3%	3.4%	**1.6%**
Chemical products	19.5%	6.0%	**13.5%**	11.3%	11.1%	11.2%	**12.7%**
Plastics and rubber products	13.0%	3.7%	**9.3%**	3.7%	3.3%	3.5%	**2.7%**
Wood products	15.3%	2.2%	**13.1%**	0.7%	1.1%	0.9%	**1.0%**
Nonmetallic mineral products	18.8%	1.6%	**17.2%**	6.0%	5.2%	5.6%	**8.1%**
Primary metals	24.7%	6.1%	**18.6%**	8.8%	14.4%	11.6%	**18.1%**
Fabricated metal products	14.7%	3.2%	**11.5%**	2.9%	3.2%	3.1%	**3.0%**
Machinery	20.7%	3.7%	**17.0%**	8.1%	8.7%	8.4%	**12.0%**
Computer and electronic products	10.3%	6.8%	**3.5%**	8.5%	9.7%	9.1%	**2.7%**
Electrical equipment, appliances, and components	14.6%	5.7%	**8.9%**	5.9%	6.5%	6.2%	**4.6%**
Motor vehicles, bodies and trailers, and parts	18.2%	3.9%	**14.3%**	7.2%	7.4%	7.3%	**8.8%**
Furniture and related products	8.9%	3.8%	**5.1%**	0.5%	0.7%	0.6%	**0.3%**
Miscellaneous manufacturing	10.6%	6.6%	**4.0%**	2.2%	1.7%	2.0%	**0.7%**

Table 2. Basic statistics of survivors, exits, entrants and transits, 1998-2007										
	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Survivors										
VA/L	42,889	46,712	48,917	55,867	65,545	77,247	94,065	107,998	122,918	151,088
VA Share	40.0%	42.3%	37.1%	36.7%	37.1%	34.8%	30.7%	29.1%	26.3%	24.8%
Firm Share	19.7%	20.0%	19.9%	19.0%	17.9%	16.6%	11.8%	12.0%	10.8%	9.6%
Exits										
VA/L	29,008	30,250	34,177	37,433	42,143	53,186	66,233	88,228	101,312	N/A
VA Share	49.5%	39.1%	29.7%	19.7%	14.7%	10.0%	3.9%	2.6%	1.1%	N/A
Firm Share	71.0%	55.6%	43.8%	27.9%	20.3%	13.4%	4.4%	2.9%	1.5%	N/A
Entrants										
VA/L	N/A	44,386	87,257	76,312	75,352	83,753	88,272	106,429	125,152	147,253
VA Share	N/A	3.9%	14.8%	24.2%	28.6%	36.6%	48.8%	56.3%	63.3%	68.9%
Firm Share	N/A	3.5%	8.3%	18.4%	25.9%	36.2%	53.6%	65.4%	74.3%	83.9%
Transits										
VA/L	38,964	36,212	46,843	46,067	51,696	63,285	74,532	93,556	116,021	146,538
VA Share	10.5%	14.7%	18.4%	19.4%	19.6%	18.6%	16.7%	12.0%	9.3%	6.3%
Firm Share	9.3%	20.8%	27.9%	34.8%	35.9%	33.9%	30.2%	19.7%	13.5%	6.5%
Total										
VA/L	34,384	37,148	45,677	52,049	59,748	73,026	86,136	104,582	123,331	148,140
Firm Share	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
# of firms	165118	162,031	162,879	171,251	181,552	196,216	276,477	271,813	301,933	336,742

Table 3. Profile of survivors, exits, entrants and transits, by industry (1998-2007)								
Industry	Avg. share of survivors (% of total)	Avg. share of exits (% of total)	Avg. share of entrants (% of total)	Avg. share of transits (% of total)	Avg. labor productivity of survivors	Avg. labor productivity of exits	Avg. labor productivity of entrants	Avg. labor productivity of transits
Total Manufacturing	14.9%	26.1%	41.7%	24.0%	82,811	56,532	82,628	65,492
Food and beverage and tobacco products	11.8%	31.8%	39.7%	23.7%	167,056	169,122	104,708	107,800
Textile mills and textile product mills	13.8%	26.6%	43.9%	22.7%	48,423	25,333	44,133	38,206
Apparel and leather and allied products	14.8%	23.8%	42.8%	25.2%	37,306	33,530	34,640	34,091
Paper products	14.8%	27.9%	41.4%	22.8%	74,248	37,179	75,671	46,712
Printing and related support activities	15.7%	32.6%	36.0%	22.5%	62,227	31,928	66,327	47,916
Petroleum and coal products	14.4%	25.9%	39.6%	26.6%	166,056	183,766	255,458	172,144
Chemical products	17.4%	26.1%	40.8%	22.4%	102,341	46,397	100,983	78,094
Plastics and rubber products	15.9%	24.5%	43.1%	23.2%	63,369	38,052	61,256	51,402
Wood products	8.2%	27.0%	43.3%	28.5%	63,245	32,316	52,204	44,665
Nonmetallic mineral products	15.2%	28.2%	40.2%	23.2%	51,733	31,526	56,862	44,156
Primary metals	12.5%	26.3%	41.4%	26.7%	129,340	78,790	141,387	105,092
Fabricated metal products	14.3%	23.7%	43.4%	25.3%	70,832	46,120	61,681	50,456
Machinery	17.2%	25.8%	42.0%	21.8%	62,796	30,759	64,038	55,352
Computer and electronic products	19.8%	22.0%	41.9%	22.7%	117,902	69,385	110,457	72,502
Electrical equipment, appliances, and components	18.2%	23.1%	42.9%	22.4%	89,777	60,559	72,376	83,429
Motor vehicles, bodies and trailers, and parts	18.7%	25.5%	40.3%	22.1%	94,189	38,021	104,657	72,496
Furniture and related products	10.8%	25.6%	44.1%	26.5%	53,329	35,259	46,008	40,983
Miscellaneous manufacturing	15.2%	23.8%	43.2%	24.4%	36,437	29,534	34,455	33,367

Table 4. Profile of survivors, exits, entrants and transits: Average productivity growth and value-added share, by industry (1998-2007)								
	Avg. productivity growth				Avg. value added share			
industry	survivors	exits	entrants	transits	survivors	exits	entrants	transits
Total Manufacturing	12.3%	9.4%	14.5%	14.1%	32.4%	20.2%	38.2%	15.0%
Food and beverage and tobacco products	11.5%	30.4%	12.7%	12.8%	33.6%	24.8%	30.5%	16.6%
Textile mills and textile product mills	13.3%	8.5%	13.1%	16.0%	28.0%	24.1%	38.7%	15.5%
Apparel and leather and allied products	7.3%	7.1%	10.7%	8.9%	29.1%	21.7%	38.7%	16.5%
Paper products	11.8%	9.4%	14.7%	17.0%	29.5%	23.2%	41.2%	12.6%
Printing and related support activities	7.6%	-0.1%	13.8%	15.2%	38.9%	18.4%	35.7%	12.4%
Petroleum and coal products	15.4%	0.8%	23.5%	14.3%	28.8%	13.1%	47.3%	16.8%
Chemical products	15.2%	11.2%	17.6%	16.2%	36.8%	18.6%	34.7%	15.2%
Plastics and rubber products	9.0%	5.3%	11.7%	12.6%	32.6%	20.3%	39.0%	14.1%
Wood products	12.8%	11.0%	16.2%	13.1%	20.1%	24.7%	41.2%	20.6%
Nonmetallic mineral products	14.7%	10.2%	19.2%	16.3%	25.9%	25.0%	39.9%	15.7%
Primary metals	24.1%	22.6%	22.6%	22.8%	37.1%	18.4%	36.0%	14.0%
Fabricated metal products	11.0%	9.7%	13.3%	13.9%	29.7%	20.5%	40.2%	15.7%
Machinery	18.3%	12.9%	17.2%	20.1%	35.9%	20.8%	34.5%	14.3%
Computer and electronic products	8.7%	4.2%	4.8%	5.0%	43.6%	12.7%	39.6%	9.3%
Electrical equipment, appliances, and components	13.0%	14.4%	16.4%	14.7%	34.9%	19.9%	34.3%	16.2%
Motor vehicles, bodies and trailers, and parts	15.4%	7.5%	10.3%	13.2%	46.2%	13.7%	32.2%	12.5%
Furniture and related products	4.6%	-0.9%	8.1%	11.9%	21.4%	22.9%	44.7%	17.8%
Miscellaneous manufacturing	7.4%	5.0%	14.7%	9.6%	31.4%	21.3%	38.5%	14.8%

Table 5. Profile of survivors, exits, entrants and transits and their contributions to gap reduction (1998-2007)												
	Industry gap reduction by firm type				VA-share weighted industry gap reduction by firm type				Contribution of different firm type to total industry gap reduction			
industry	survivors	exits	entrants	transits	survivors	exits	entrants	transits	survivors	exits	entrants	transits
Total Manufacturing	0.749	0.438	0.937	0.913	0.243	0.089	0.357	0.137	29.4%	10.7%	43.3%	16.6%
Food and beverage and tobacco products	0.817	2.417	1.063	0.937	0.275	0.600	0.324	0.156	20.3%	44.3%	23.9%	11.5%
Textile mills and textile product mills	0.877	0.455	0.876	1.124	0.246	0.109	0.339	0.174	28.3%	12.6%	39.1%	20.0%
Apparel and leather and allied products	0.167	0.098	0.454	0.315	0.049	0.021	0.176	0.052	16.3%	7.1%	59.0%	17.5%
Paper products	0.753	0.449	1.081	1.221	0.222	0.104	0.445	0.153	24.0%	11.3%	48.1%	16.6%
Printing and related support activities	0.539	-0.188	1.124	1.219	0.210	-0.035	0.401	0.152	28.8%	-4.7%	55.1%	20.8%
Petroleum and coal products	0.251	-1.183	0.443	0.144	0.072	-0.155	0.210	0.024	47.9%	-102.7%	138.7%	16.0%
Chemical products	0.910	0.535	1.093	1.004	0.335	0.100	0.380	0.153	34.6%	10.3%	39.3%	15.8%
Plastics and rubber products	0.570	0.283	0.823	0.889	0.186	0.057	0.321	0.125	26.9%	8.3%	46.6%	18.1%
Wood products	1.037	0.823	1.409	1.070	0.209	0.203	0.581	0.220	17.2%	16.8%	47.9%	18.1%
Nonmetallic mineral products	1.259	0.791	1.715	1.408	0.326	0.198	0.684	0.222	22.8%	13.8%	47.9%	15.5%
Primary metals	1.699	1.459	1.492	1.587	0.630	0.269	0.536	0.222	38.0%	16.2%	32.4%	13.4%
Fabricated metal products	0.787	0.658	1.004	1.048	0.234	0.135	0.404	0.164	25.0%	14.4%	43.1%	17.5%
Machinery	1.405	0.908	1.275	1.566	0.505	0.189	0.441	0.223	37.2%	13.9%	32.5%	16.5%
Computer and electronic products	0.249	-0.251	-0.172	-0.082	0.108	-0.032	-0.068	-0.008	17570.8%	-5154.4%	-11067.6%	-1248.8%
Electrical equipment, appliances, and components	0.736	0.784	1.137	0.890	0.257	0.156	0.390	0.145	27.1%	16.5%	41.1%	15.2%
Motor vehicles, bodies and trailers, and parts	1.117	0.391	0.705	0.925	0.516	0.054	0.227	0.116	56.6%	5.9%	24.9%	12.7%
Furniture and related products	0.149	-0.434	0.493	0.806	0.032	-0.099	0.220	0.144	10.7%	-33.5%	74.3%	48.4%
Miscellaneous manufacturing	0.155	-0.102	0.846	0.360	0.049	-0.022	0.326	0.053	11.9%	-5.4%	80.3%	13.1%

Table R-1. OLS regressions of firm labor productivity growth, 2007-1999

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	gLP_a	gLP_a	gLP_a	gLP_a	gLP_a	gLP_a	gLP_a	gLP_a
gap99	0.0408***	0.0411***	0.0424***	0.0423***	0.0437***	0.0318***	0.0327***	0.0444***
	(22.90)	(23.04)	(23.58)	(23.82)	(24.08)	(16.81)	(17.27)	(24.47)
gap99_sq	0.00495***	0.00492***	0.00455***	0.00480***	0.00468***	0.00609***	0.00603***	0.00464***
	(18.41)	(18.32)	(16.71)	(17.96)	(17.10)	(21.44)	(21.23)	(16.99)
gFront_a		0.0927***	0.135***	0.137***	0.130***	0.132***	0.129***	0.127***
		(4.49)	(6.01)	(6.25)	(5.80)	(5.90)	(5.74)	(5.65)
RD/VA_99			0.00595***		0.00585***	0.00523***	0.00513***	0.00575***
(firm level RD intensity)			(7.28)		(7.16)	(6.43)	(6.31)	(7.05)
PFT/VA_99_j			8.327***		8.116***	7.652***	6.667**	7.126**
(industry level)			(2.83)		(2.76)	(2.61)	(2.27)	(2.43)
EXP_Sales_99_j			-0.000703***	-0.00109***	-0.000845***	-0.000569***	-0.000546***	-0.000818***
(industry level)			(-6.94)	(-10.27)	(-8.28)	(-5.46)	(-5.25)	(-8.02)
lnRD_99_i				0.00473***				
(firm level R&D stock)				(19.10)				
lnPFT_99_j				-0.00290***				
(industry level)				(-5.54)				
d_SOE99					-0.0314***			-0.0383***
					(-12.74)			(-14.85)
d_Foreign99					0.00698***			0.00517***
(dummy=1 if wholly foreign owned)					(3.64)			(2.69)

d_cov					0.0244***	0.00957***	0.00918***	0.0262***
					(7.31)	(3.28)	(3.15)	(7.84)
SOE_share_99						-0.0275***	-0.0333***	
(state capital share)						(-12.50)	(-14.53)	
FDI_share99						-0.0251***	-0.0256***	
(incl. both wholly owned and JVs)						(-13.73)	(-14.04)	
Scale_99							0.0104***	0.0106***
(firm size category, 1 to 3)							(9.01)	(9.12)
_cons	-0.0574***	-0.0620***	-0.0602***	-0.0235***	-0.0618***	-0.0350***	-0.0488***	-0.0755***
	(-19.16)	(-19.58)	(-16.74)	(-2.92)	(-16.77)	(-9.24)	(-11.95)	(-18.99)
N	37999	37999	37999	37999	37999	37777	37777	37999
R-sq	0.2809	0.2813	0.2842	0.2900	0.2877	0.2865	0.2881	0.2893

(t statistics in parentheses * p<0.1, **p<0.05, ***p<0.01)

Table R-2. Pooled OLS regressions of firm labor productivity growth for the following five periods:
1998-2003, 1999-2004, 2000-2005, 2001-2006, 2002-2007

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	gLP_a	gLP_a	gLP_a	gLP_a	gLP_a	gLP_a	gLP_a	gLP_a	gLP_a
Gap	0.0913***	0.0595***	0.0605***	0.0616***	0.0616***	0.0600***	0.0588***	0.0636***	0.0623***
	(276.57)	(59.91)	(61.02)	(61.95)	(62.59)	(60.84)	(59.76)	(64.93)	(64.59)
gap_sq		0.00511***	0.00504***	0.00484***	0.00594***	0.00614***	0.00645***	0.00637***	0.00683***
		(33.95)	(33.51)	(32.08)	(39.58)	(40.92)	(43.01)	(42.85)	(46.58)
gFront_a			0.247***	0.245***	0.218***	0.227***	0.224***	0.279***	0.164***
			(29.53)	(29.39)	(26.40)	(27.46)	(27.11)	(31.13)	(18.23)
rdva_1				0.00287***	0.00266***	0.00265***	0.00259***	0.00275***	0.00263***
				(15.28)	(14.31)	(14.23)	(13.95)	(14.97)	(14.54)
d_SOE_1					-0.0816***	-0.0854***	-0.111***	-0.117***	-0.102***
					(-75.14)	(-78.08)	(-87.73)	(-91.78)	(-79.99)
d_foreign_1						-0.0311***	-0.0311***	-0.0222***	-0.0228***
						(-27.05)	(-27.11)	(-19.08)	(-19.96)
d_cov (conversion dummy=1, if SOE was converted to non_SOE)							0.0847***	0.0876***	0.0848***
							(39.92)	(41.51)	(40.79)
constant	-0.164***	-0.121***	-0.136***	-0.137***	-0.135***	-0.129***	-0.128***	-0.120***	-0.167***
	(-156.97)	(-73.66)	(-79.11)	(-79.77)	(-79.69)	(-75.14)	(-74.89)	(-61.07)	(-80.37)
industry dummies	No	No	No	No	No	No	No	Yes	Yes
year dummies	No	No	No	No	No	No	No	No	Yes
N	298252	298252	298252	298252	298252	298252	298252	298252	298252
R-sq	0.2041	0.2072	0.2095	0.2101	0.2248	0.2267	0.2308	0.2458	0.2689

Table R-2b. Panel regressions of firm labor productivity growth for the following five periods:
1998-2003, 1999-2004, 2000-2005, 2001-2006, 2002-2007

	(1) gLP_a	(2) gLP_a	(3) gLP_a	(4) gLP_a	(5) gLP_a	(6) gLP_a	(7) gLP_a	(8) gLP_a
gap	0.0595***	0.201***	0.204***	0.210***	0.210***	0.210***	0.210***	0.210***
	(59.91)	(174.05)	(177.64)	(187.89)	(188.53)	(188.12)	(188.12)	(188.09)
gap_sq	0.00511***	-0.000839***	-0.00106***	-0.00102***	-0.00105***	-0.00108***	-0.00108***	-0.00107***
	(33.95)	(-5.23)	(-6.61)	(-6.61)	(-6.81)	(-6.93)	(-6.93)	(-6.84)
gFront_a					0.236***	0.236***	0.236***	0.236***
					(17.96)	(17.95)	(17.96)	(17.97)
rdva_1						0.000226	0.000226	0.000221
						(1.49)	(1.49)	(1.45)
d_SOE_1							0.00108	-0.0214***
							(0.41)	(-5.34)
d_foreign_1							-0.0110***	-0.0109***
							(-3.35)	(-3.32)
d_cov								0.0252***
								(7.52)
constant	-0.121***	-0.481***	-0.538***	-0.590***	-0.591***	-0.591***	-0.590***	-0.588***
	(-73.66)	(-232.59)	(-58.37)	(-65.86)	(-66.00)	(-66.01)	(-65.78)	(-65.49)
industry dummies	No	No	**Yes**	Yes	Yes	Yes	Yes	Yes
firm fixed effects	No	**Yes**	Yes	Yes	Yes	Yes	Yes	Yes
year dummies	No	No	No	**Yes**	Yes	Yes	Yes	Yes
N	298252	298252	298252	298252	298252	298252	298252	298252
R-sq	0.2072	0.4871	0.4928	0.5232	0.5241	0.5241	0.5241	0.5242

Table R-3. 3-digit industry level gap reduction regression, 5-period panel

(5 periods: 1998-2003, 1999-2004, 2000-2005, 2001-2006, 2002-2007)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	Independent variable: ***rate of growth of*** *gap reduction (annualized)*										
gap	-0.0208	-0.0372*	0.315***	0.316***	0.320***	0.333***	0.333***	0.331***	0.276***	0.284***	0.296***
	(-0.87)	(-1.70)	(11.03)	(11.05)	(11.14)	(10.89)	(10.95)	(10.86)	(8.74)	(9.16)	(9.60)
gap_sq	0.0124***	0.0181***	-0.0265***	-0.0265***	-0.0264***	-0.0302***	-0.0299***	-0.0299***	-0.0224***	-0.0229***	-0.0247***
	(2.89)	(4.61)	(-5.61)	(-5.62)	(-5.53)	(-5.90)	(-5.87)	(-5.89)	(-4.22)	(-4.40)	(-4.78)
gfront_a	-0.830***	-1.030***	-0.699***	-0.693***	-0.659***	-0.640***	-0.631***	-0.644***	-0.640***	-0.583***	-0.523***
	(-11.37)	(-15.01)	(-12.34)	(-12.15)	(-11.26)	(-11.23)	(-11.09)	(-11.12)	(-8.21)	(-7.52)	(-6.65)
RD/VA				-0.0290	-0.0255	-0.0123	-0.0176	-0.0201	-0.0708*	-0.0775**	-0.0604
				(-0.94)	(-0.83)	(-0.43)	(-0.61)	(-0.70)	(-1.78)	(-1.98)	(-1.55)
SOE_share					-0.0737**	-0.0756**	-0.0731**	-0.0730**	0.0232	0.0661*	0.0860**
					(-2.07)	(-2.14)	(-2.08)	(-2.08)	(0.63)	(1.75)	(2.28)
foreign_share						-0.489***	-0.441***	-0.439***	-0.228***	-0.213***	-0.178**
						(-6.64)	(-5.87)	(-5.84)	(-2.95)	(-2.81)	(-2.36)
export intensity							-0.0826***	-0.0841***	-0.0554*	-0.0743**	-0.0723**
							(-2.74)	(-2.79)	(-1.77)	(-2.40)	(-2.36)
concentration ratio								-0.0358	-0.0558*	-0.0658**	-0.0654**
								(-1.20)	(-1.80)	(-2.16)	(-2.17)
entry_ratio									-0.0898*	0.0116	0.0627

									(-1.79)	(0.21)	(1.12)
survivor_ratio										0.337***	0.401***
										(4.33)	(5.07)
transit_ratio											0.135***
											(3.41)
constant	0.106***	0.0728**	-0.582***	-0.582***	-0.573***	-0.551***	-0.541***	-0.526***	-0.454***	-0.557***	-0.633***
	(3.05)	(2.30)	(-12.90)	(-12.91)	(-12.29)	(-11.21)	(-11.02)	(-10.38)	(-8.52)	(-9.70)	(-10.38)
Industry fixed effects	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time effects	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	800	800	800	800	799	762	762	762	610	610	610
R-sq	0.2292	0.3688	0.6809	0.6814	0.6859	0.7097	0.7134	0.7141	0.6989	0.7112	0.7186

Figure 4. Within-industry pattern of catch-up

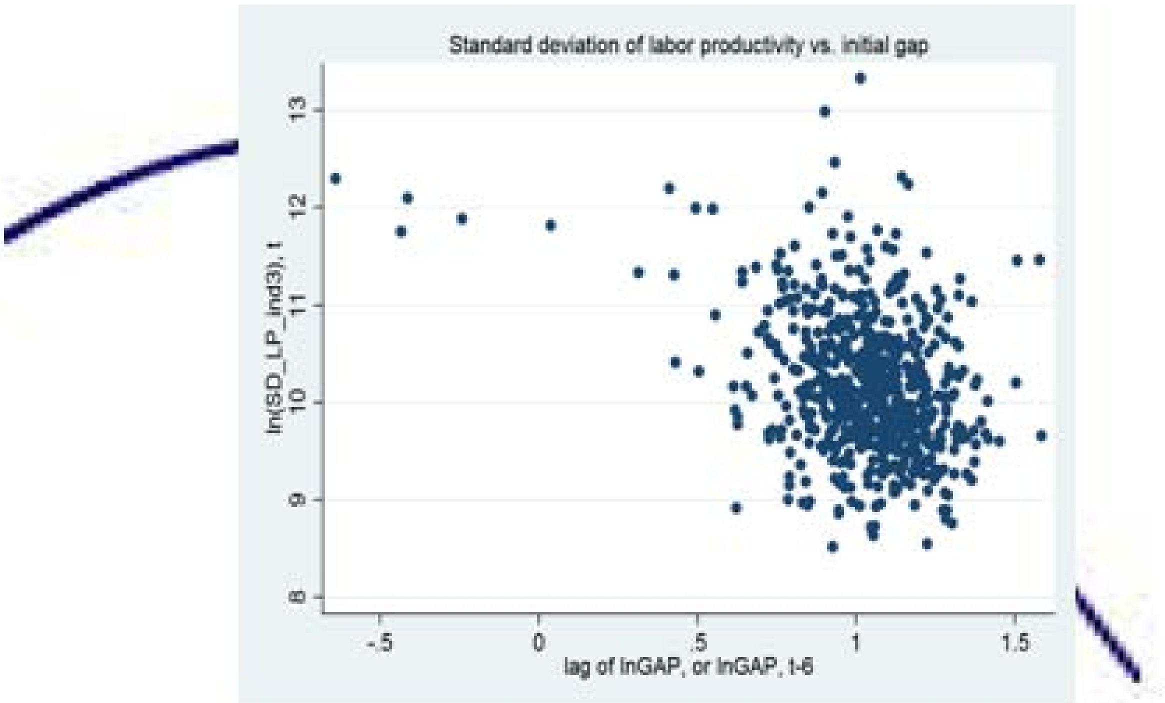


Table 6. Within period pattern of catch-up - regression

PD1

Standard deviation of industry (3-digit) labor productivity and the initial gap

	(1)	(2)	(3)	(4)
	dependent var: log (SD_LP)j, t			
logGAP, t-5	-1.182***	-1.203***		
	(-11.00)	(-6.12)		
logGAP_sq, t-5		0.0156		
		(0.13)		
logGAP, t-6			-1.085***	-1.627***
			(-8.81)	(-5.39)
logGAP_sq, t-6				0.349**
				(1.97)
constant	11.26***	11.26***	11.28***	11.45***
	(100.04)	(95.65)	(86.21)	(73.08)
N	800	800	640	640
R-sq	0.1318	0.1318	0.1085	0.1139

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Table 7: Pattern of catch-up: Knowledge capital vs. physical capital

Shift to R&D investment

The relationship between R&D intensity and the initial gap

	(1)	(2)	(3)	(4)	(5)
	dependent variable: log (RD_STOCK/VA), t				
		OLS			Tobit
log(GAP), t-5	-0.010***	-0.015***	-0.003***	-0.045***	-0.071***
	(-15.82)	(-23.96)	(-4.48)	(-24.71)	(-39.44)
constant	0.050***	0.025***	0.043***	-0.214***	-0.353***
	(72.04)	(22.43)	(6.88)	(-98.40)	(-90.47)
industry dummy	No	Yes	Yes	No	Yes
firm fixed effects	No	No	Yes	No	No
N	294,582	294,582	294,582	294,582	294,582
R-sq	0.0008	0.0381	0.0002	0.0024	0.0965

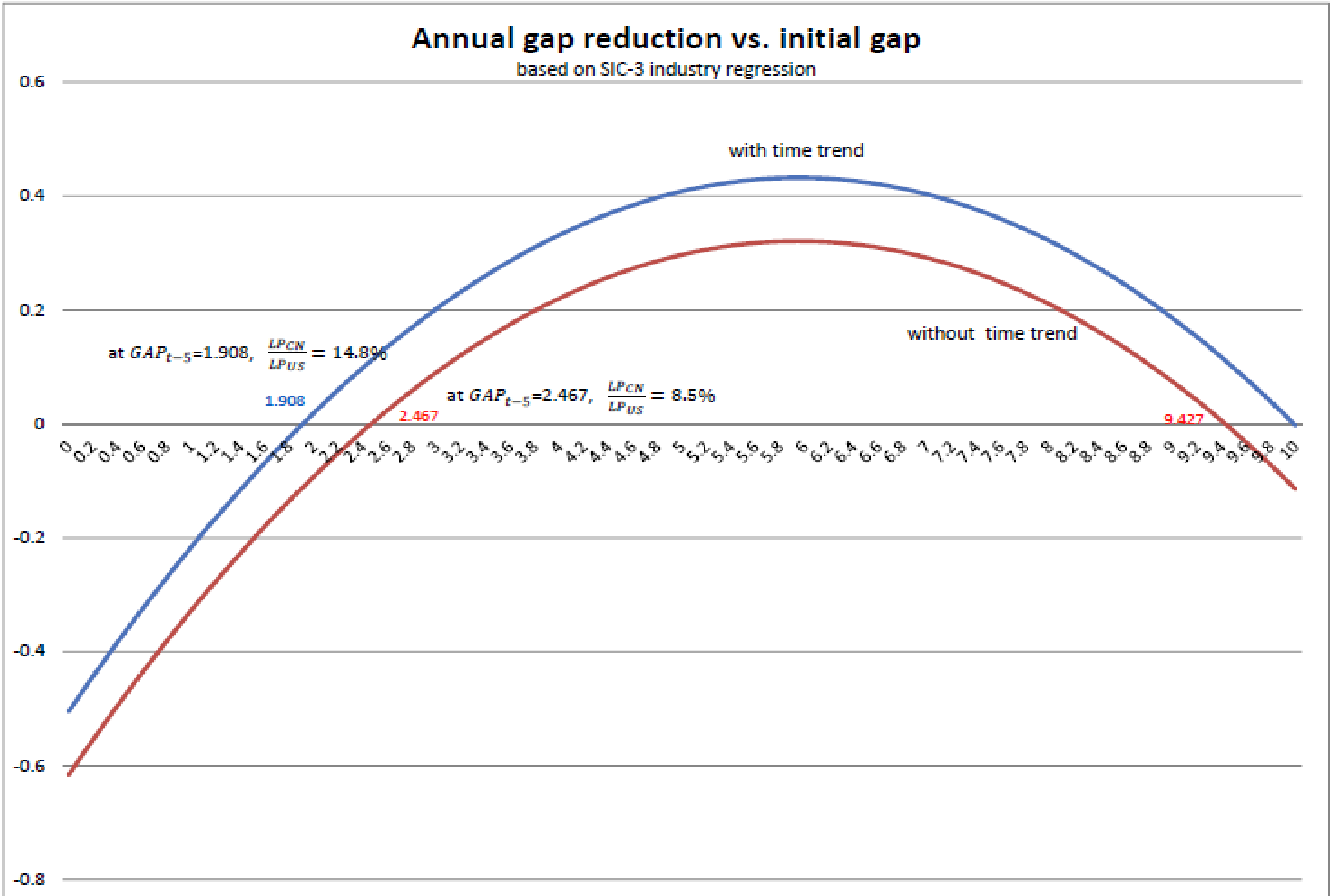
Note: We added 1 to R&D intensity measure when taking log.

18

Labor productivity by major industry sectors:
Industry mean and top quintile average relative to frontier

industry	average LP as frontier		top quintile LP vs. frontier	
	1998	2007	1998	2007
Total Manufacturing	5%	14%	55%	77%
Food and beverage and tobacco products	9%	25%	49%	114%
Textile mills and textile product mills	5%	16%	63%	93%
Apparel and leather and allied products	10%	12%	108%	76%
Paper products	4%	13%	32%	51%
Printing and related support activities	8%	20%	42%	100%
Petroleum and coal products	2%	4%	19%	21%
Chemical products	3%	9%	32%	49%
Plastics and rubber products	6%	14%	60%	80%
Wood products	7%	23%	49%	110%
Nonmetallic mineral products	3%	16%	31%	92%
Primary metals	6%	29%	217%	155%
Fabricated metal products	6%	17%	52%	121%
Machinery	3%	15%	47%	80%
Computer and electronic products	8%	11%	63%	67%
Electrical equipment, appliances, and components	7%	16%	61%	89%
Motor vehicles, bodies and trailers, and parts	5%	20%	40%	92%
Furniture and related products	9%	14%	70%	87%
Miscellaneous manufacturing	5%	7%	66%	56%

TT



Annual gap reduction vs. initial gap
based on SIC-3 industry regression
with time trend
without time trend
at GAP_{t-5}=1.908, $\frac{LP_{CN}}{LP_{US}} = 14.8\%$
1.908
at GAP_{t-5}=2.467, $\frac{LP_{CN}}{LP_{US}} = 8.5\%$
2.467
9.427

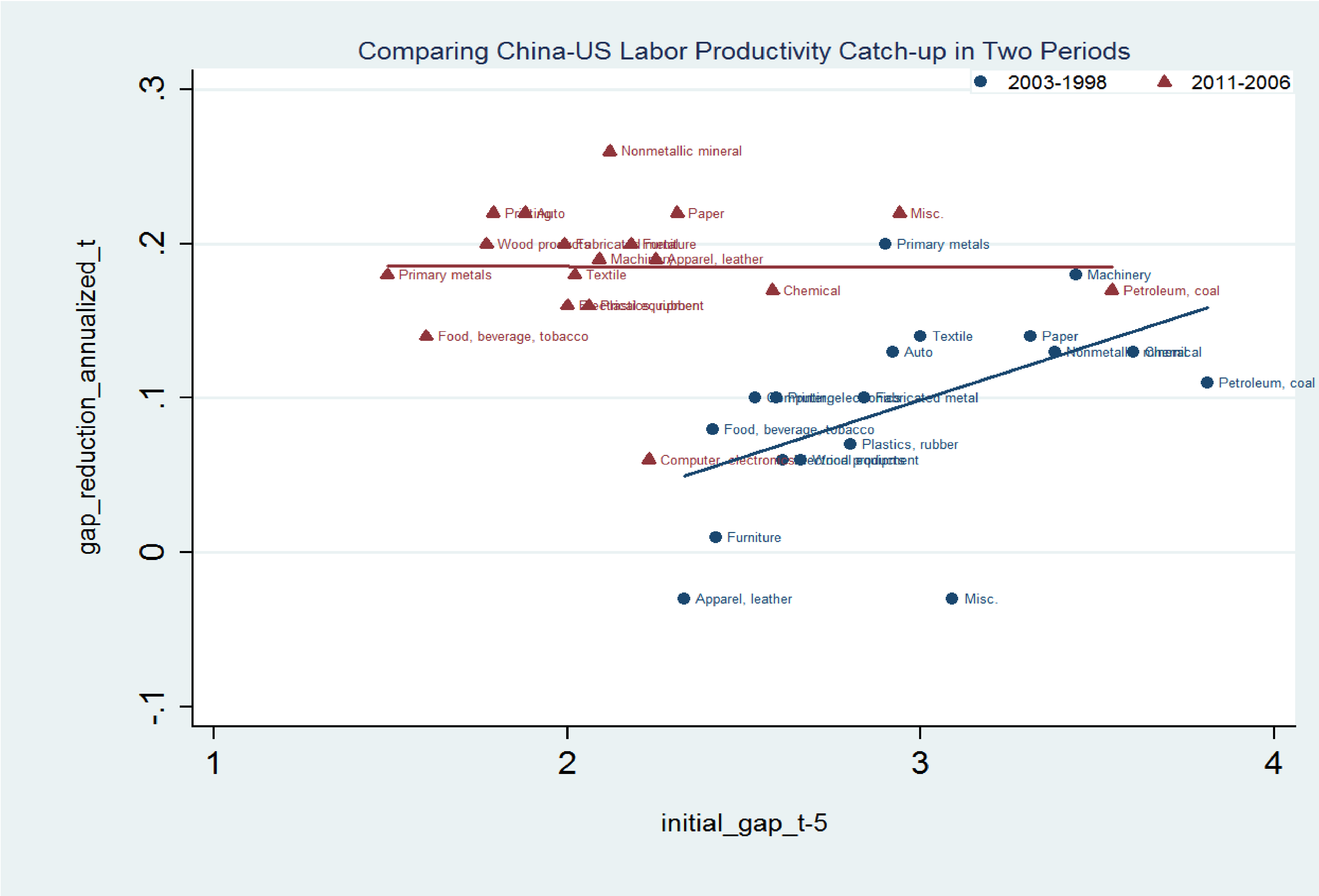

Comparing China-US Labor Productivity Catch-up in Two Periods
2003-1998
2011-2006
gap_reduction_annualized_t
initial_gap_t-5
-.1
0
.1
.2
.3
1
2
3
4
Nonmetallic mineral
Paper
Misc.
Primary metals
Textile
Chemical
Food, beverage, tobacco
Primary metals
Machinery
Petroleum, coal
Textile
Paper
Auto
Petroleum, coal
Food, beverage, tobacco
Plastics, rubber
Furniture
Apparel, leather
Misc.

Table 9. Summary Statistics of China-US Industrial Productivity Catch—up, 2006-2011						
Total manufacturing	LP_06, China current US$	LP_06, US current US$	LP_11, China current US$	LP_11, US current US$	GAP, 2006	GAP, 2011
	14,347	118,612	41,816	151,141	2.11 (8.25)	1.28 (3.60)
Table 2. Summary Statistics of China-US Industrial Productivity Catch —up, 2011-2006						
Total manufacturing	GAP reduction, annual rate (2006-2011)	China LP growth, annual rate	US frontier growth, annual rate	LP growth difference, annual rate	---	---
	0.166	21.4%	4.8%	16.5%		

Appendix A

Industry matching table between BEA industry and China's industry classification (2002 GB)

Industry no.	Industry description (BEA-BLS)	SIC 2-digit industry (China 2002 GB)
	Manufacturing	
	Nondurable goods	
1	Food and beverage and tobacco products	13, 14,15,16
2	Textile mills and textile product mills	17
3	Apparel and leather and allied products	18,19
4	Paper products	22
5	Printing and related support activities	23
6	Petroleum and coal products	25
7	Chemical products	26,27,28
8	Plastics and rubber products	29,30
	Durable goods	
9	Wood products	20
10	Nonmetallic mineral products	31
11	Primary metals	32,33
12	Fabricated metal products	34
13	Machinery	35,36
14	Computer and electronic products	40,41
15	Electrical equipment, appliances, and components	39
16	Motor vehicles, bodies and trailers, and parts	37
17	Furniture and related products	21
18	Miscellaneous manufacturing	24,42,43