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Sources of Chinese Labor Productivity Growth: A Structural Decomposition Analysis, 1987-2005

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Abstract:
Using four input-output tables and disaggregated data on total employment, we decompose labor productivity growth from 1987 to 2005. We do so by examining six partial factors: changes in value-added coefficients, labor inputs, shares of sectoral demands that are fulfilled domestically, technology, and the intra-sectoral shares and intersectoral mix of final demand. Our analysis confirms that simply because by virtue of its size and extremely low level of labor productivity, change involving China's farm sector weighs heavily. Indeed, it is largely due to labor shifts out of farming and some modest (and possibly consequential) rises in the industry's productivity that, among the six factors, labor-savings effects have levied the largest influence on the labor productivity upon all sectors across all three periods covered by our research. Nonetheless, changes in the intrasectoral shares and the intersectoral mix of China's final demand were quite strong and across the periods of study persistently and significantly increased their influence. Due to ever competitive pressures that have been increasing as China continues to open its economy to international markets, changes in value-added coefficients have tended to counteract some of the positive benefits of labor savings across time for most sectors. The effects on changes in labor productivity of technological change and changes in the use of imports have been comparatively negligible and variation in their sectoral effects waning over time.

Keywords: Structural change, Labor productivity growth, China

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Sources of Chinese Labor Productivity Growth: A Structural Decomposition Analysis, 1987-2005

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ABSTRACT: Using four input-output tables and disaggregated data on total employment, we decompose labor productivity growth from 1987 to 2005. We do so by examining six partial factors: changes in value-added coefficients, labor inputs, shares of sectoral demands that are fulfilled domestically, technology, and the intra-sectoral shares and intersectoral mix of final demand. Our analysis confirms that simply because by virtue of its size and extremely low level of labor productivity, change involving China's farm sector weighs heavily. Indeed, it is largely due to labor shifts out of farming and some modest (and possibly consequential) rises in the industry's productivity that, among the six factors, labor-savings effects have levied the largest influence on the labor productivity upon all sectors across all three periods covered by our research. Nonetheless, changes in the intrasectoral shares and the intersectoral mix of China's final demand were quite strong and across the periods of study persistently and significantly increased their influence. Due to ever competitive pressures that have been increasing as China continues to open its economy to international market markets, changes in value-added coefficients have tended to counteract some of the positive benefits of labor savings across time for most sectors. The effects on changes in labor productivity of technological change and changes in the use of imports have been comparatively negligible and variation in their sectoral effects waning over time.

1. Introduction

China's GDP is expected to expand by 7.5 percent in 2009 (Pesek, 2009). In developed countries such growth would be a pipe dream. In a rapidly developing country like China, it is moderate growth and GDP growth on the order of 5.0 percent is a nightmare. In fact, since 1978 or so Beijing typically has viewed GDP growth of 8 percent as a minimum desired threshold. Indeed, it has a real concern that, with low or no growth, rising unemployment could pose a threat to social stability and the legitimacy of government. With this in mind, it is clearly important for Chinese officials to have a better understanding of the factors that enable sustained GDP growth in China.

Much of its leaders' concerns stems from China's relatively low-income per capita. In 2007 its GNI per capita in terms of purchasing power parity (PPP) was only 11.8 percent of that of the United States, 15.6 percent of Japan's and Germany's, 22.5 percent of Korea's, and 58.5 percent of Brazil's (World Bank, 2009). But Beijing's concerns are heavily mitigated when the purchasing power of most households edges upward at a sufficient pace. Fortunately, countries at China's present distance from the technology frontier have the capacity for rapid growth if they can exploit and allocate available resources effectively, which includes adapting foreign technology efficiently and finding a niche in the world's market economy (Maddison, 2007).

Researchers have in fact attributed China's economic success largely to the country's federal policies of pushing educational attainment, household savings, and the shipment of exports (Zheng, Bigsten, and Hu, 2008). And at least through the early to mid 1990s, China's long-run economic growth was sustained by rising productivity across most, if not all, industries. This growth by industry was accompanied by a fundamental structural shift nationwide from low-productivity sectors toward those with higher productivity (Fan et al., 2003). Indeed, the shifts in employment and investments among industries in China lead to a distinctive regional development pattern, which yielded important policy implications regarding spatial disparities in economic growth and income (Yang and Lahr, 2008; Liu et al. 1999). Wang and Szirmai (2008) found the structural shift bonus amounted to about a 20 percent of total growth from 1980-2002.

Wu (2006) and others, however, have expressed some concern about recent evolutions in China economy into a pattern of so-called “extensive” growth, which is characterized by an expansion of imported inputs and less by domestic productivity growth. Zheng, Bigsten, and Hu (2008) attribute this extensive growth to China’s various waves of reforms favoring short-run, capital-intensive growth. Lo (2007) suggests that in order for such capital deepening to be a viable economic trajectory in China, special care must be taken to assure that labor force growth does not outpace employment growth in the short to medium run. Zheng, Bigsten, and Hu (2008), therefore, advocate balancing short- and long-run total factor productivity (TFP) improvements and less strictly on capital deepening.

Research focusing upon productivity and structural change in China is fairly thick. Still most of it just examines the national economy at a very coarse level of industry definition. For example, most consider either manufacturing share of the whole economy or a basic economic break out into just three sectors—primary, secondary, and tertiary industries. In fact the literature on structural change in China is dominated by examinations of the country’s shift of labor out of agriculture (Wang and Szirmai, 2008), which in China is dominated by small farms with constant returns to scale. In the main, the interdependence of China’s industries and regions has been ignored.

Because of a lack of literature on the effect of detail and industry interdependence on productivity changes in China, we opt to employ China’s series of input-output tables to examine the country’s economic change. Input-output tables often reflect the greatest industry detail possible for a country, while also capturing the essence of their interdependence. Employing them in a structural decomposition analysis can reveal the full extent to which changes in industries' input requirements and final demand lead to changes in overall productivity growth. Thus, our research is differentiated from prior analyses of Chinese productivity change by also enabling the perspective of demand side, as well as the supply side, which is the basis for most of the extant literature on productivity change which leans on neoclassical growth theory.

Hu and McAleer (2004) also apply an input-output framework to study China's structure change. They decompose to discover factors affecting the nation's growth of gross output from 1992 to 1997. While highly connected, the focus of our research is productivity change, not change in gross value of shipments. In the end, an input-output approach allows us to examine more information about the sources of productivity change in China.

At this point China has produced input-output tables from 1987 to 2005. Using concordant employment data for those years, we decompose the sources of aggregate labor productivity growth into the portion directly and indirectly caused by the changes of value-added coefficient, labor input, domestic supply, technology, intra-sectoral shares and intersectoral mix.

The paper is organized as follows: we begin with the description of the decomposition method applied in the paper, next is the data introduction and treatment, then the descriptive analysis and decomposition result. The final section concludes the paper.

2. Methodology

In this paper, we use Jacob (2003) decomposition, where

n represents the number of industries:
v: vector of value added ($n \times 1$ vector);
e: vector of labor inputs ($n \times 1$ vector);

λ: labor productivity (where $\boldsymbol{\lambda} = v_i/e_i$) ($n \times 1$ vector);

A: matrix with input coefficient ($n \times n$ matrix), with typical element of a_{ij} denoting the input of product i per unit of output in industry j**;**

I: Identity matrix ($n \times n$ matrix) with "1" in the diagonal and "0" elsewhere;

B: Normalized final demand ($n \times k$ matrix), where each cell is derived as the ratio of the corresponding cell in the final demand matrix to its respective column sum;

y: Aggregate final demand for each of k categories (rural consumption, urban consumption, government consumption, gross fixed capital formation, inventory stock, export and other) ($k \times 1$ vector);

$\hat{\mathbf{E}}$: Diagonal matrix with elements e_i the labor input per unit of output in industry i in the diagonal and "0" elsewhere ($n \times n$ matrix);

$\hat{\mathbf{V}}$: Diagonal matrix with elements v_i the value-added per unit of output in industry i in the diagonal and "0" elsewhere ($n \times n$ matrix);

$\hat{\mathbf{P}}$: Diagonal matrix with elements ρ_i the domestic supply ratio (ratio of the total output to total supply, that is, the sum of total output and import) in industry i in the diagonal and "0" elsewhere ($n \times n$ matrix) ;

The value-added vector can be represented as follows:

$$\mathbf{v} = \hat{\mathbf{V}}(\mathbf{I} - \mathbf{A})^{-1}\mathbf{B}\mathbf{y}$$

Then we have,

$$\mathbf{v} = \hat{\mathbf{V}}(\mathbf{I} - \mathbf{P}\dot{\mathbf{A}})^{-1}\hat{\mathbf{P}}\dot{\mathbf{B}}\mathbf{y} ,$$

where $\dot{\mathbf{A}}$ is the matrix of direct input coefficients derived based on the total – domestic and imported as well, that is, intermediate inputs employed in the production process, and $\dot{\mathbf{B}}$ is the normalized coefficient derived from the final demand both domestically produced and imported component.

$$\frac{\mathbf{v_1}}{\mathbf{v_0}} = \frac{\hat{\mathbf{V}}_1(\mathbf{I} - \hat{\mathbf{P}}_1\dot{\mathbf{A}}_1)^{-1}(\hat{\mathbf{P}}_1\dot{\mathbf{B}}_1)\mathbf{y}_1}{\hat{\mathbf{V}}_0(\mathbf{I} - \hat{\mathbf{P}}_0\dot{\mathbf{A}}_0)^{-1}(\hat{\mathbf{P}}_0\dot{\mathbf{B}}_0)\mathbf{y}_0}$$

and similarly we can get

$$\frac{\mathbf{e}_1}{\mathbf{e}_0} = \frac{\hat{\mathbf{E}}_1(\mathbf{I} - \hat{\mathbf{P}}_1\dot{\mathbf{A}}_1)^{-1}(\hat{\mathbf{P}}_1\dot{\mathbf{B}}_1)\mathbf{y}_1}{\hat{\mathbf{E}}_0(\mathbf{I} - \hat{\mathbf{P}}_0\dot{\mathbf{A}}_0)^{-1}(\hat{\mathbf{P}}_0\dot{\mathbf{B}}_0)\mathbf{y}_0}$$

where indices are time indicators.

Letting

$$\mathbf{L}_0 = [\mathbf{I} - (\hat{\mathbf{P}}_0 \dot{\mathbf{A}}_0)]^{-1},$$

$$\mathbf{L}_1 = [\mathbf{I} - (\hat{\mathbf{P}}_1 \dot{\mathbf{A}}_1)]^{-1},$$

$$\mathbf{L}_{01} = [\mathbf{I} - (\hat{\mathbf{P}}_0 \dot{\mathbf{A}}_1)]^{-1},$$

$$\mathbf{L}_{10} = [\mathbf{I} - (\hat{\mathbf{P}}_1 \dot{\mathbf{A}}_0)]^{-1},$$

we can decompose the change of value-added as:

$$\frac{\mathbf{v}_1}{\mathbf{v}_0} = \left(\frac{\hat{\mathbf{V}}_1 \mathbf{L}_1 \hat{\mathbf{P}}_1 \dot{\mathbf{B}}_1 \mathbf{y}_1}{\hat{\mathbf{V}}_0 \mathbf{L}_1 \hat{\mathbf{P}}_1 \dot{\mathbf{B}}_1 \mathbf{y}_1}\right)\left(\frac{\hat{\mathbf{V}}_0 \mathbf{L}_1 \hat{\mathbf{P}}_1 \dot{\mathbf{B}}_1 \mathbf{y}_1}{\hat{\mathbf{V}}_0 \mathbf{L}_{01} \hat{\mathbf{P}}_0 \dot{\mathbf{B}}_1 \mathbf{y}_1}\right)\left(\frac{\hat{\mathbf{V}}_0 \mathbf{L}_{01} \hat{\mathbf{P}}_1 \dot{\mathbf{B}}_1 \mathbf{y}_1}{\hat{\mathbf{V}}_0 \mathbf{L}_0 \hat{\mathbf{P}}_0 \dot{\mathbf{B}}_1 \mathbf{y}_1}\right)\left(\frac{\hat{\mathbf{V}}_0 \mathbf{L}_0 \hat{\mathbf{P}}_0 \dot{\mathbf{B}}_1 \mathbf{y}_1}{\hat{\mathbf{V}}_0 \mathbf{L}_0 \hat{\mathbf{P}}_0 \dot{\mathbf{B}}_0 \mathbf{y}_1}\right)\left(\frac{\hat{\mathbf{V}}_0 \mathbf{L}_0 \hat{\mathbf{P}}_0 \dot{\mathbf{B}}_0 \mathbf{y}_1}{\hat{\mathbf{V}}_0 \mathbf{L}_0 \hat{\mathbf{P}}_0 \dot{\mathbf{B}}_0 \mathbf{y}_0}\right)$$

Similarly we have the decomposition for the change of labor input, combining two then we have the decomposition equation for the change of labor productivity:

$$\frac{\boldsymbol{\lambda}_1}{\boldsymbol{\lambda}_0} = \frac{\mathbf{v}_1}{\mathbf{e}_1} \div \frac{\mathbf{v}_0}{\mathbf{e}_0} = (1.1)\times(1.2)\times(1.3)\times(1.4)\times(1.5)\times(1.6)$$

with

$$(1.1) = \left(\frac{\hat{\mathbf{V}}_1 \mathbf{L}_1 \hat{\mathbf{P}}_1 \dot{\mathbf{B}}_1 \mathbf{y}_1}{\hat{\mathbf{V}}_0 \mathbf{L}_1 \hat{\mathbf{P}}_1 \dot{\mathbf{B}}_1 \mathbf{y}_1}\right)$$

$$(1.2) = \left(\frac{\hat{\mathbf{E}}_1 \mathbf{L}_1 \hat{\mathbf{P}}_1 \dot{\mathbf{B}}_1 \mathbf{y}_1}{\hat{\mathbf{E}}_0 \mathbf{L}_1 \hat{\mathbf{P}}_1 \dot{\mathbf{B}}_1 \mathbf{y}_1}\right)$$

$$(1.3) = \left[\left(\frac{\hat{\mathbf{V}}_0 \mathbf{L}_1 \hat{\mathbf{P}}_1 \dot{\mathbf{B}}_1 \mathbf{y}_1}{\hat{\mathbf{V}}_0 \mathbf{L}_{01} \hat{\mathbf{P}}_0 \dot{\mathbf{B}}_1 \mathbf{y}_1}\right)\left(\frac{\hat{\mathbf{E}}_0 \mathbf{L}_{01} \hat{\mathbf{P}}_1 \dot{\mathbf{B}}_1 \mathbf{y}_1}{\hat{\mathbf{E}}_0 \mathbf{L}_1 \hat{\mathbf{P}}_0 \dot{\mathbf{B}}_1 \mathbf{y}_1}\right)\right]$$

$$(1.4) = \left[\left(\frac{\hat{\mathbf{V}}_0 \mathbf{L}_{01} \hat{\mathbf{P}}_1 \dot{\mathbf{B}}_1 \mathbf{y}_1}{\hat{\mathbf{V}}_0 \mathbf{L}_0 \hat{\mathbf{P}}_0 \dot{\mathbf{B}}_1 \mathbf{y}_1}\right)\left(\frac{\hat{\mathbf{E}}_0 \mathbf{L}_0 \hat{\mathbf{P}}_0 \dot{\mathbf{B}}_1 \mathbf{y}_1}{\hat{\mathbf{E}}_0 \mathbf{L}_{01} \hat{\mathbf{P}}_0 \dot{\mathbf{B}}_1 \mathbf{y}_1}\right)\right]$$

$$(1.5) = \left[\left(\frac{\hat{\mathbf{V}}_0 \mathbf{L}_0 \hat{\mathbf{P}}_0 \dot{\mathbf{B}}_1 \mathbf{y}_1}{\hat{\mathbf{V}}_0 \mathbf{L}_0 \hat{\mathbf{P}}_0 \dot{\mathbf{B}}_0 \mathbf{y}_1}\right)\left(\frac{\hat{\mathbf{E}}_0 \mathbf{L}_0 \hat{\mathbf{P}}_0 \dot{\mathbf{B}}_0 \mathbf{y}_1}{\hat{\mathbf{E}}_0 \mathbf{L}_0 \hat{\mathbf{P}}_0 \dot{\mathbf{B}}_1 \mathbf{y}_1}\right)\right]$$

$$(1.6)= \left[\left(\frac{\hat{\mathbf{V}}_0 \mathbf{L}_0 \hat{\mathbf{P}}_0 \dot{\mathbf{B}}_0 \mathbf{y}_1}{\hat{\mathbf{V}}_0 \mathbf{L}_0 \hat{\mathbf{P}}_0 \dot{\mathbf{B}}_0 \mathbf{y}_0}\right)\left(\frac{\hat{\mathbf{E}}_0 \mathbf{L}_0 \hat{\mathbf{P}}_0 \dot{\mathbf{B}}_0 \mathbf{y}_0}{\hat{\mathbf{E}}_0 \mathbf{L}_0 \hat{\mathbf{P}}_0 \dot{\mathbf{B}}_0 \mathbf{y}_1}\right)\right]$$

Equation (1.1) represents the productivity effects of changes in the value-added fingers per unit of gross output by industry. Equation (1.2) represents the effects of changed labor requirements per unit of gross output. Equation (1.3) indicates the effect of changed domestic supply ratio both in intermediate input and final demand as well. Equation (1.4) indicates the effects of changes in the interindustry structure because of technical change, factor substitution and etc. Equation (1.5) represents the changes in the sectoral composition in each of the final demand categories. Equation (1.6) shows the effects of changes in macro final demand between categories.

Since structural change decomposition is not unique, there is also the other polar decomposition with reverse weights. Dietzenbacher and Los (1998) find that the results for the average of these two polar decompositions are very close to the average of all possible decomposition forms.

$$\frac{\boldsymbol{\lambda}_1}{\boldsymbol{\lambda}_0} = \frac{\mathbf{v}_1}{\mathbf{e}_1} \div \frac{\mathbf{v}_0}{\mathbf{e}_0} = (1.1)\times(1.2)\times(1.3)\times(1.4)\times(1.5)\times(1.6)$$

$$(2.1)= \left(\frac{\hat{\mathbf{V}}_1 \mathbf{L}_0 \hat{\mathbf{P}}_0 \dot{\mathbf{B}}_0 \mathbf{y}_0}{\hat{\mathbf{V}}_0 \mathbf{L}_0 \hat{\mathbf{P}}_0 \dot{\mathbf{B}}_0 \mathbf{y}_0}\right)$$

$$(2.2)= \left(\frac{\hat{\mathbf{E}}_0 \mathbf{L}_0 \hat{\mathbf{P}}_0 \dot{\mathbf{B}}_0 \mathbf{y}_0}{\hat{\mathbf{E}}_1 \mathbf{L}_0 \hat{\mathbf{P}}_0 \dot{\mathbf{B}}_0 \mathbf{y}_0}\right)$$

$$(2.3)= \left[\left(\frac{\hat{\mathbf{V}}_1 \mathbf{L}_{10} \hat{\mathbf{P}}_1 \dot{\mathbf{B}}_0 \mathbf{y}_0}{\hat{\mathbf{V}}_1 \mathbf{L}_0 \hat{\mathbf{P}}_0 \dot{\mathbf{B}}_0 \mathbf{y}_0}\right)\left(\frac{\hat{\mathbf{E}}_1 \mathbf{L}_0 \hat{\mathbf{P}}_0 \dot{\mathbf{B}}_0 \mathbf{y}_0}{\hat{\mathbf{E}}_0 \mathbf{L}_{10} \hat{\mathbf{P}}_0 \dot{\mathbf{B}}_0 \mathbf{y}_0}\right)\right]$$

$$(2.4)= \left[\left(\frac{\hat{\mathbf{V}}` \mathbf{L}_1 \hat{\mathbf{P}}_1 \dot{\mathbf{B}}_0 \mathbf{y}_0}{\hat{\mathbf{V}}_1 \mathbf{L}_{10} \hat{\mathbf{P}}_1 \dot{\mathbf{B}}_0 \mathbf{y}_0}\right)\left(\frac{\hat{\mathbf{E}}_1 \mathbf{L}_{10} \hat{\mathbf{P}}_1 \dot{\mathbf{B}}_0 \mathbf{y}_0}{\hat{\mathbf{E}}_1 \mathbf{L}_1 \hat{\mathbf{P}}_1 \dot{\mathbf{B}}_0 \mathbf{y}_0}\right)\right]$$

$$(2.5)= \left[\left(\frac{\hat{\mathbf{V}}_1 \mathbf{L}_1 \hat{\mathbf{P}}_1 \dot{\mathbf{B}}_1 \mathbf{y}_0}{\hat{\mathbf{V}}_0 \mathbf{L}_1 \hat{\mathbf{P}}_1 \dot{\mathbf{B}}_0 \mathbf{y}_0}\right)\left(\frac{\hat{\mathbf{E}}_1 \mathbf{L}_1 \hat{\mathbf{P}}_1 \dot{\mathbf{B}}_0 \mathbf{y}_0}{\hat{\mathbf{E}}_1 \mathbf{L}_1 \hat{\mathbf{P}}_1 \dot{\mathbf{B}}_1 \mathbf{y}_0}\right)\right]$$

$$(2.6)= \left[\left(\frac{\hat{\mathbf{V}}_1 \mathbf{L}_1 \hat{\mathbf{P}}_1 \dot{\mathbf{B}}_1 \mathbf{y}_1}{\hat{\mathbf{V}}_1 \mathbf{L}_1 \hat{\mathbf{P}}_1 \dot{\mathbf{B}}_1 \mathbf{y}_0}\right)\left(\frac{\hat{\mathbf{E}}_1 \mathbf{L}_1 \hat{\mathbf{P}}_1 \dot{\mathbf{B}}_1 \mathbf{y}_0}{\hat{\mathbf{E}}_1 \mathbf{L}_1 \hat{\mathbf{P}}_1 \dot{\mathbf{B}}_1 \mathbf{y}_1}\right)\right]$$

By taking the natural logarithm, we can achieve the percentages of contribution of each factor.

3. Data

3.1 China's input-output tables

In 1974, China constructed its first input-output (I-O) table. It was in physical terms only and for the year 1973. It followed up on this by constructing a table for 1981 in both monetary and physical terms. In 1988, China decided that starting with its 1987 table it would begin producing survey-based tables in monetary terms only in each five year intervals. As a result, China has since produced benchmark tables for 1987 (118 sectors), 1992 (119 sectors), 1997 (124 sectors), and 2002 (122 sectors). As is the practice in many other countries, China also constructed I-O tables with less sectoral detail in selected intermediate years—in 1990 (33 sectors), 1995 (33 sectors), 2000 (42 sectors), and 2005 (42 sectors).

China has revised its Industrial Classification for National Economic Activities in 1994 and again in 2002. Accordingly, its I-O tables bear some differences in both the definition and breadth of industry coverage. Some were removed, and some were disaggregated into several parts and/or distributed into existing industries or to form new ones. Nevertheless, the tables remain fundamentally comparable. For any two contiguous two tables, the differences are particularly less pronounced. The 1987 and 1992 tables, for example, have almost the same set of industry, except that a new industry, Scrap and waste, exists in the 1992 table. Between 1992 and 1997 some minor changes were made in both the manufacturing and tertiary sectors. The 1997 table largely differs from 2002 table in the tertiary sector. The 2005 table is an aggregated extrapolation of the 2002 benchmark, but sectorally the two are otherwise perfectly consistent. In our analysis, we perform decompositions between pair of contiguous tables for the sale of sectoral consistency. Thus we compare 1987 to 1997, 1997 to 2002, 2002 to 2005. We ignored the 1992 table is because only reports net exports instead of both export and import, which is available for the other tables.[1] The break out is needed to enable the calculation of China's domestic supply ratio for each year, data required in our decompositional form. We should note here that China's I-O tables do not distinguish imports between their possible intermediate and final uses. We therefore can only apply the domestic supply ratio, rather than a full matrix of imports, as shown in the decomposition equations. As the reader may note, we generally limited our analysis to benchmark tables, but made an exception in the case of the 2005 table since it lets us examine the latest possible trends.

For the purposes of our analysis, we adjust the tables to make them as sectorally comparable as possible.[2] This resulted in aggregating the 1987 and 1997 tables to 99 comparable industries, the 1997 and 2002 tables to 100 comparable industries, and the 2002

[1] In fact, 1987 table is also published with only net export reported, with Mr. Shuchang Qi's help, we got the export and import columns for industries.

[2] We matched industries across years by carefully examining the definition and range officially published by National Bureau of Statistics of China, like prior to 1997 (1997 included), repair and maintenance of equipment was an independent industry but after that it is part of related industries. Therefore when decomposing change from 1997 to 2002, we distribute the repair and maintenance industry across the 20 related industries using each industry's own share of intermediate inputs, final demand, or value-added. For calculations between 1987 and 1997, we kept this industry as it existed.

and 2005 tables to just 42 sectors. The detailed industries (sectors) are omitted here because of space constraints.

3.2 The deflation of the tables

All the I-O tables we planned to use were published in current prices. To make the data comparable, we adjusted them all to prices for the year 2005. We used RAS and, as suggested by Dietzenbacher and Hoen (1998), aggregated after deflating. For the value of shipments belonging to the farm sector, we adjusted each table using the agriculture producer price index from the website of Ministry of Agriculture of the People's Republic of China. We use the ex-factory's price index from *2006 China Urban Life and Price Yearbook* for industries in the secondary sector. Unfortunately, the industry categories in the yearbook are generally not quite as detailed as in I-O table. Thus for some industries, we applied the best approximate price index. No ideal price index exists for industries in the tertiary and construction industries. In these cases, we applied an implicit GDP price deflator, which we derived by dividing published nominal GDP by real GDP for these industries.

3.3 Employment data

China's statistical system provides several types of employment data by industry. Super-sectors (farm, secondary, tertiary) employment data has been reported since 1952; Employment data is reported from 1978 to 2002 for 16 sectors. Both of these sets of data are available from the *China Statistical Yearbook* and *China Labor Statistical Yearbook*. The employment data for 16 sectors is also available in the form of employees in enterprises in cities and towns and as employees in villages from the National Bureau of National Statistics. The data of employees employed by private and individual enterprises is from State

Administration for Industry and Commerce of P. R. China. Since 2002 a new industry definition has been adopted by National Bureau of National Statistics. While the reporting category for employment in private and individual enterprises remains the same, thus this part of employee cannot be gained for the 16-sector employment data.[3] We should note that since total employment data are gathered via a survey of the population, the sum of the employment across sectors does not equal total employment.[4]

Further detail in industry employment data can be found in China's census of population. China has now had five population census investigations—those in 1953, 1964, 1982, 1990, and 2000. Since 1980s, China has also undertaken a 1 percent survey in selected intervening years—1987, 1995, and 2005. Unfortunately, these years do not pair up with the years of our investigation.

China (Labor) Statistical Yearbook provides data on administrative staff and workers by detailed subsector for various years. The employment counts in these data are consistently less than the total employment counts from the censuses, however. Workers in this set of yearbooks are not clearly defined. Szirmai et al. (2005) use tens of pages to show that these data include just workers in cities and towns. The data thus cannot also be directly used in our analysis. Thus despite have access to relatively detailed data on industries' for intermediate and final uses of goods and services, we were quite surprised to learn that our analysis of productivity in China would be limited in part by access to sufficiently detailed employment data. We nonetheless estimated industry employment in secondary industries (i.e., mining, manufacturing, and utilities) by using each industry's share of secondary industry workers

[3] This information was obtained through consultation with National Bureau of National Statistics.
[4] See 2008 China Statistical Yearbook.

from this data source. We suggest that this is a reasonable approach for secondary industries since it is unlikely that there is much difference between workers' shares and total employment shares by location, in the city (town) or in the village. This is probably less true for farm-oriented and tertiary industries. We calculated workers' shares for 1997 and 2002 from the *China Statistical Yearbook* and for 1987 from *China Industry Economy Yearbook.*[5]

3.4 Comparison between input-output table and employment data

Our goal in the decomposition calculations was to preserve as much information as possible. Therefore after aggregating adjoining input-output tables into comparable sectors, we only aggregated further when performing an operation with employment data. To make employment data comport with data from the input-output table, we aggregated them into 9 from the original 16 industries in which they are reported, although some calculations were performed using 38 sectors. We aggregated our results into four and eleven sectors, respectively, for the decompositions of change from 1987 to 1997 and from 1997 to 2002. The four sectors were agriculture, mining and construction, manufacturing and utilities, finance and real estate, and other services. The eleven sectors include only more detail in manufacturing, which are shown later when we report empirical results. For the 2002 to 2005 decomposition the employment data were available only for three sectors, hence our end analysis could only be done for China as a whole.[6]

4. Empirical analysis

[5] The *China Labor Statistical Yearbook* only provides detailed subsector data for enterprises wholly owned by people for 1987.

[6] We tried to get detailed sub-sector employment data for 2005 using available data from a 1% sample survey. Unfortunately, we found major structural differences between these data and what is essentially as census that is published in *China's Statistical Yearbook*. We, therefore, concluded that using data from this source ought not to be used in our paper.

Before we launch into the decomposition, let us first sketch out China's economic growth since it undertook economic reforms. This should provide some extra background for the discussion of results later.

4.1 General information

Since 1978 when the reforms were first undertaken, China's secondary industry has accounted for almost half of the total GDP. Like elsewhere worldwide, the large role that China's agriculture industries played in GDP and employment declined at the expense of its growing tertiary industry, although employment in the secondary industry rose (Figures 1 and 2). Indeed, almost half of agriculture's employment in 1978 became employed by the other two industries during the past 30 years. From Figures 1 and 2 alone it is clear that the secondary industry labor productivity is higher than that in both agriculture and the tertiary industry. It produces about half of the GDP using less than 30 percent of the nation's employment. In 1978 prices, Figure 3 shows explicitly that labor productivity in the secondary industry has been soaring since 1990 and at a pace not only unprecedented but also not even closely paralleled by the other two sectors of the economy.

Figure 1 GDP share for 3 sectors 1978:-2008[7]

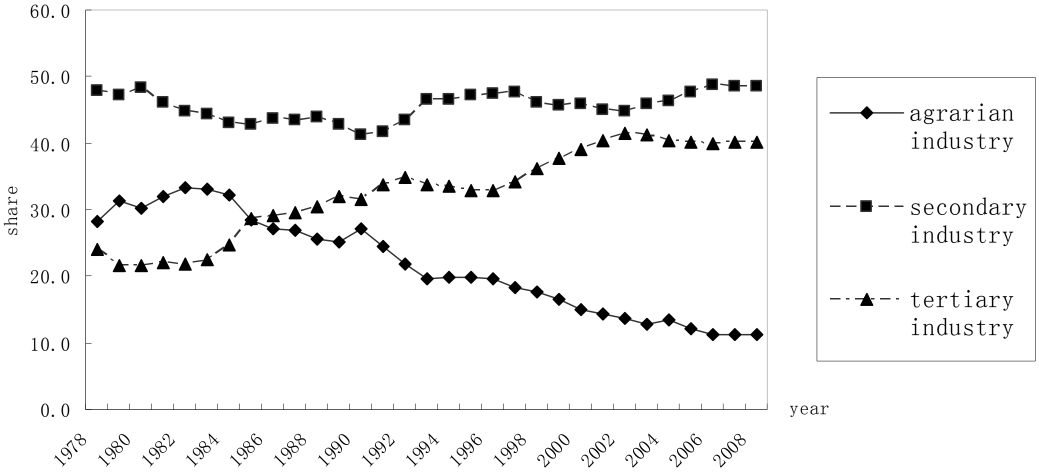
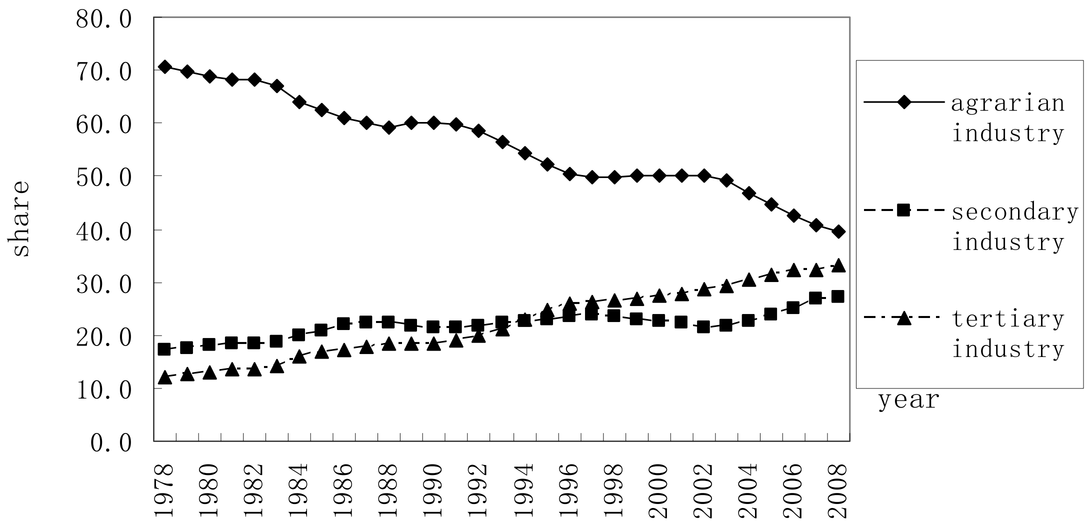


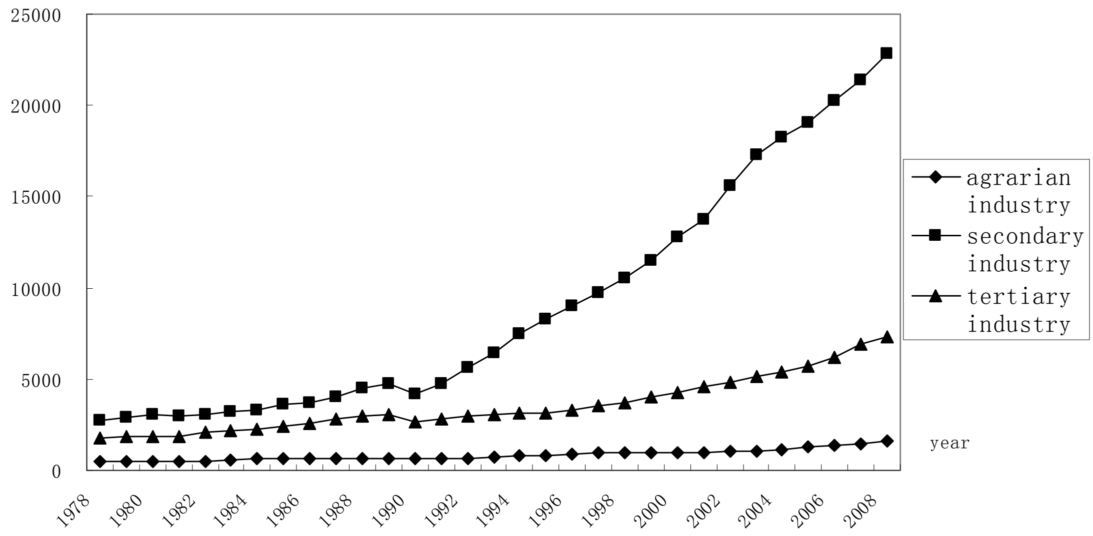
Figure 2 Employment share for 3 sectors: 1978-2008[8]



7 The data from 1978 to 2007 comes from 2008 China Statistical Yearbook, and the data for 2008 is from "Statistical Communiqué of the People's Republic of China on the 2008 National Economic and Social Development".

8 The data from 1978 to 2007 comes from 2008 China Statistical Yearbook, and the data for 2008 is from "Statistical Communiqué of the People's Republic of China on the 2008 Labor and Social security Development".

Figure 3 Labor productivity for 3 sectors: 1978-2008 (1978 yuan per employee) [9]



4.2 Descriptive analysis

China labor productivity has been increasing continuously since 1987. Indeed, since 1997, it has grown at an annual average rate of about 11 percent, much higher than other time in recorded history. The labor productivity in China's primary industries is obviously lower and grows more slowly than it is in other sectors, which undoubtedly explains most of the shift of resources out of that industry. Manufacturing's persistent outstanding performance similarly explains the shift of China's resources into it. Of course, a look at manufacturing's sub-industries provides a somewhat less even story (See Tables 1 and 2). Early on Food processing and Textile products grew quickly, but later Sawmill, paper & culture products and Metal processing & metal products grew fastest with Machinery and transportation equipment and Electrical and electronic products not far behind.

9 Calculated from data sources in footnote 7 and 8.

Table 1. Labor productivity in 2005 Yuan/employee
and annual average growth rates, 1987-1997

Sector[10]	1987	1997	Growth %
1	4,862	7,111	3.88
2	10,025	40,590	15.01
3	6,363	24,505	14.43
4	8,471	25,210	11.52
5	14,761	32,866	8.33
6	15,562	24,049	4.45
7	5,833	18,591	12.29
8	9,921	20,875	7.72
9	30,772	74,765	9.28
subtotal 2-9[11]	11,082	28,882	10.05
10	97,983	106,184	0.81
11	7,954	12,438	4.57
total	6,773	12,445	6.27

Table 2. Labor Productivity in 2005 Yuan/employee
and Growth Rates, 1997-2002

Sector[12]	1997	2002	Growth %
1[13]	7,174	9,773	6.38
2	40,590	62,485	9.01
3	24,505	27,348	2.22
4	25,210	63,480	20.28
5	32,866	47,538	7.66
6	24,049	60,951	20.44
7	19,295	36,240	13.44
8	22,373	41,822	13.33
9[14]	59,284	112,376	13.64
subtotal 2-9	28,371	48,872	11.49
10	106,184	250,208	18.70
11	12,608	24,162	13.89
total	12,445	20,783	10.80

[10] For the sector definition, please see the appendix. Here we did not present 38-sectors' labor productivity for space limitation.
[11] This item is calculated by the original employment data of manufacturing and utilities, we also present it here and in the following calculation for reference.
[12] For the sector definition, please see the appendix
[13] This value is a little different from that in Table 1 because we adjust "Logging and transport of timber and bamboo" into agrarian industry to match with the input-output table in 2002.
[14] This value is also a little different from that in table 1 and it has been mentioned in footnote 2.

For tertiary industry limited data exist. Still we can observe that, of all sectors that are detailed, labor productivity in the finance and real estate industry appears to have experienced the fastest growth from 1997 to 2002. From this we infer that this industry developed best after China's accession to the World Trade Organization. It is at about this time that China housing market transformed from a socialist system to a market-oriented one. That is prior to 1998, workplaces distributed housing to workers but charged them a nominal fee. After 1998, workers were able to buy the house of their choice but were typically handed a subsidy from their workplace. Clearly such opening up stimulated China's real estate industry greatly. Nonetheless, other service industries also sustained a rapid growth.

Table 3 Labor productivity in 2005 Yuan/employee
and growth rates, 2002-2005[15]

Sector	2002	2005	Growth (%)
Agrarian industry	5,369	6,791	8.15
Secondary Industry	37,554	48,947	9.23
Tertiary industry	25,364	30,891	6.79
Total	17,975	24,400	10.72

4.3 Decomposition results

Tables 4, 5, and 8 display our decomposition of the changes in labor productivity. When a value is larger than 1 it means that this factor makes a positive contribution to the growth of labor productivity. When it is less than one, it dampened productivity. From the first column of Tables 5 and 8 and the last row of Table 8, it is immediately apparent that all the sectors have experienced labor productivity growth across all periods. By taking natural log of factor values in Tables 6, 7 and 8 we can capture factors' importance for effecting change in labor

[15] The labor productivity based on 3 sector may be a little smaller than that above, because as mentioned before, the sum of 16 sector does not equal to the total employment (in 2002, the difference is about 13.51), however, it is consistent with the sum of 3 sector's employment.

productivity.

Table 4 Labor productivity decomposition results 1987-1997

Sector	growth	V			E			P			A (L)			B			Y		
		Value-added coefficient			Labor input coefficient			Domestic supply ratio			Technological change			Change in Y's Intrasectoral shares			Change in Y's Intersectoral mix		
1	1.463	0.984	0.988	0.986	1.852	1.836	1.844	0.954	0.913	0.933	0.846	0.896	0.871	0.988	0.976	0.982	1.006	1.010	1.008
2	4.049	1.562	1.674	1.617	2.349	2.324	2.336	1.015	1.000	1.008	1.021	1.020	1.020	1.060	1.024	1.042	1.004	0.997	1.001
3	3.851	1.456	1.482	1.469	2.649	2.379	2.510	0.998	1.020	1.009	0.992	1.011	1.002	1.005	1.060	1.032	1.003	0.999	1.001
4	2.976	1.125	1.132	1.129	2.933	2.558	2.739	1.007	1.014	1.011	0.962	1.030	0.995	0.911	0.975	0.943	1.022	1.009	1.015
5	2.226	0.832	0.776	0.803	3.412	3.076	3.240	0.984	0.992	0.988	0.861	0.951	0.905	0.899	0.992	0.945	1.029	0.996	1.013
6	1.545	0.776	0.751	0.763	2.401	1.949	2.163	1.042	0.990	1.016	0.848	1.050	0.944	0.947	1.012	0.979	0.991	1.003	0.997
7	3.187	1.119	1.094	1.106	3.088	2.976	3.032	0.979	0.993	0.986	0.997	1.002	1.000	0.943	0.984	0.963	1.002	1.000	1.001
8	2.104	0.931	0.945	0.938	3.600	2.290	2.871	0.965	1.001	0.982	0.885	0.992	0.937	0.730	0.983	0.847	1.007	0.997	1.002
9	2.430	0.983	0.890	0.935	5.102	2.875	3.830	0.920	0.996	0.957	0.627	0.957	0.774	0.855	1.000	0.925	0.984	0.997	0.990
Subtotal 2-9	2.606	1.022	0.992	1.007	2.558	2.551	2.554	1.000	1.002	1.001	1.001	1.022	1.011	1.004	1.009	1.007	0.992	0.997	0.995
10	1.084	0.816	0.786	0.801	1.315	1.311	1.313	1.002	0.997	1.000	1.034	1.152	1.091	0.982	0.925	0.953	0.994	0.990	0.992
11	1.564	0.881	0.933	0.906	1.695	1.674	1.684	0.994	1.003	0.998	1.023	1.000	1.012	1.024	0.999	1.011	1.007	0.999	1.003
total	1.837	0.958	0.966	0.962	2.001	1.890	1.944	0.979	0.961	0.970	0.932	0.984	0.958	1.043	1.046	1.045	1.007	1.017	1.012

Note: each factor has 3 columns, first columns refer to results of Equation (1), second columns to results of Equation (2) and last one is fisher index, which is the geometric average of two polar decompositions.

Table 5 Labor productivity decomposition results 1997-2002

Sector	growth	V Value-added coefficient			E Labor input coefficient			P Domestic supply ratio			A (L) Technological change			B Change in Y's Intrasectoral shares			Y Change in Y's Intersectoral mix		
1	1.362	0.953	0.957	0.955	1.431	1.430	1.430	0.989	0.990	0.990	0.950	0.952	0.951	1.002	1.043	1.022	1.071	1.023	1.047
2	1.539	1.115	1.145	1.130	1.380	1.333	1.356	0.997	1.000	0.999	1.023	1.011	1.017	0.983	1.016	0.999	0.998	0.982	0.990
3	1.116	0.831	0.831	0.831	1.337	1.341	1.339	1.007	1.000	1.004	1.024	1.002	1.013	0.967	0.998	0.982	1.007	1.001	1.004
4	2.518	1.014	1.017	1.016	2.531	2.433	2.482	1.009	0.998	1.004	0.984	1.023	1.004	0.986	1.013	0.999	1.002	0.982	0.992
5	1.446	0.953	0.936	0.945	1.501	1.325	1.410	0.998	0.994	0.996	1.007	1.137	1.070	0.998	1.010	1.004	1.008	1.023	1.015
6	2.534	1.168	1.149	1.159	2.246	2.167	2.206	0.999	1.002	1.000	0.977	1.009	0.993	0.996	0.996	0.996	0.989	1.006	0.997
7	1.878	0.858	0.869	0.863	2.166	2.181	2.174	0.999	1.000	0.999	1.004	0.999	1.002	1.008	1.000	1.004	1.007	1.000	1.004
8	1.869	0.901	0.968	0.934	2.105	1.919	2.010	1.010	1.003	1.007	1.038	1.022	1.030	0.962	1.004	0.983	0.996	0.997	0.997
9	1.896	1.111	1.083	1.097	1.570	1.534	1.552	0.993	0.994	0.993	1.076	1.108	1.092	1.003	1.091	1.046	1.018	0.954	0.985
subtotal2-9	1.721	0.984	0.985	0.984	1.769	1.770	1.770	0.998	0.999	0.999	0.994	1.002	0.998	0.994	1.000	0.997	1.002	0.986	0.994
10	2.356	1.004	1.024	1.014	2.061	1.998	2.029	1.011	1.008	1.010	0.955	0.975	0.965	1.207	1.164	1.185	0.972	1.000	0.986
11	1.916	1.073	1.073	1.073	1.823	1.818	1.821	1.000	1.000	1.000	0.997	0.991	0.994	0.988	0.998	0.993	0.997	0.996	0.996
total	1.670	1.004	1.000	1.002	1.596	1.540	1.568	0.989	0.992	0.990	1.002	1.013	1.008	1.022	1.097	1.059	1.047	0.999	1.022

Note: each factor has 3 columns, first columns refer to results of Equation (1), second columns to results of Equation (2) and last one is fisher index, which is the geometric average of two polar decompositions.

Table 6 Factor contribution for labor productivity 1987-1997 (%)

Sector	V	E	P	A	B	Y
1	-3.71	160.83	-18.23	-36.30	-4.77	2.09
2	34.36	60.67	0.57	1.42	2.94	0.07
3	28.52	68.25	0.66	0.15	2.34	0.07
4	11.13	92.39	1.00	-0.46	-5.38	1.37
5	-27.42	146.91	-1.51	-12.47	-7.07	1.61
6	-62.18	177.35	3.65	-13.25	-4.88	-0.69
7	8.69	95.70	-1.22	0.00	-3.25	0.09
8	-8.60	141.79	-2.44	-8.75	-22.32	0.27
9	-7.57	151.24	-4.95	-28.85	-8.78	-1.13
Subtotal 2-9	0.73	97.90	0.10	1.14	0.73	-0.52
10	-275.11	337.62	0.00	107.98	-59.68	-9.96
11	-22.07	116.53	-0.45	2.67	2.45	0.67
total	-6.37	109.31	-5.01	-7.06	7.24	1.96

Table 7 Factor contribution for labor productivity 1997-2002 (%)

Sector	V	E	P	A	B	Y
1	-14.90	115.77	-3.25	-16.26	7.04	14.87
2	28.35	70.64	-0.23	3.91	-0.23	-2.33
3	-168.68	265.99	3.64	11.77	-16.55	3.64
4	1.72	98.44	0.43	0.43	-0.11	-0.87
5	-15.34	93.16	-1.09	18.35	1.08	4.04
6	15.87	85.09	0.00	-0.76	-0.43	-0.32
7	-23.38	123.22	-0.16	0.32	0.63	0.63
8	-10.92	111.63	1.12	4.73	-2.74	-0.48
9	14.47	68.71	-1.10	13.76	7.03	-2.36
Subtotal 2-9	-2.97	105.17	-0.18	-0.37	-0.55	-1.11
10	1.62	82.56	1.16	-4.16	19.81	-1.65
11	10.84	92.18	0.00	-0.93	-1.08	-0.62
total	0.39	87.71	-1.96	1.55	11.18	4.24

Table 8 Labor productivity decomposition results and factor contribution 2002-2005

Factor	Polar 1	Polar 2	Fisher index	Factor contribution (%)
V	0.953	0.983	0.968	-10.65
E	1.295	1.285	1.290	83.41
P	0.998	1.001	1.000	0.00
A	1.005	0.986	0.996	-1.31
B	1.034	1.067	1.051	16.29
Y	1.060	1.020	1.040	12.85
growth		1.357		100

The decomposition yields some general information on the study periods. To compare the decomposition results across time we transform results in to annualized factor contributions. Still, direct decomposition results can yield much information.

For the three periods, labor savings effects consistently dominated. On annual basis, it declined in importance over time, however as its contribution evolved from 109.3 percent to 87.7 percent to 83.4 across the three study periods Thus, returns to capital deepening appear to have attained decreasing returns to scale in China. Of course, China also has moved ever closer to the international production frontier since engaging itself ever more intensely in market-oriented activities.[16] In any case, labor savings at state-owned enterprises from 1998 to 2005 alone released about 28.7 million workers to the general labor force.[17]

Perhaps not surprisingly during the 1987-1997 period, labor productivity in China's manufacturing industries were the greatest beneficiaries of labor savings. Agriculture followed. During the 1997-2002 period the picture changed somewhat when labor savings in some manufacturing industries (in the Food, Textile, and Petroleum and chemical products industries) slowed pronouncedly. Indeed labor savings in these industries were lower than they were in the Primary and Government-owned industries! Nonetheless, labor savings in the Sawmills, paper, and printing industry; Primary metals; and Machinery and transportation equipment buoyed the net effect of labor savings on manufacturing, which was below that for service industries during the period.

From 1987 to 1997, after labor savings, technological change had the second largest effect, albeit with a net negative impact on labor productivity. The effect of technology change on the other hand turned positive but was barely perceptible in both of the latest study periods. Much of the negative effect for the 1987-1997 period apparently is embodied in effects from Primary industries and Other manufacturing

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[16] Some differences in the decomposition of aggregate labor productivity exist from that discussed by the authors in Yang and Lahr (2008). The differences arise because the multiregional input-output tables we used in that paper were built up from provincial input-output tables and not shared down from the national table. Thus the sum across regions of the various components of the multiregional tables do not sum to China's input output tables for the same year.

[17] Data from the website of National Bureau of Statistics of China http://www.stats.gov.cn/tjfx/ztfx/jnggkf30n/t20081103_402513671.htm

and utilities, the latter of which is dominated by government-owned establishments. While at first glance a negative technology change effect might seem implausible, consider that this effect is independent of labor use. That is, technological change pertains only to the mix on goods and services used to produce goods. Thus, it represents the technological change that can enable labor savings.

At a sub-industry level, the effects of technological change on labor productivity during both periods show little that is noteworthy. Technological change in the Government-owned and Primary industries showed the greatest dampening effects on productivity growth for the 1987-1997 period. Since these two industries are known to have experienced little benefit from injections of foreign capital through this period, this result undoubtedly indicates that technology in these two industries simply did not progress anywhere close to the pace that it did in the balance of China's industries. The industries with the greatest improvements in labor productivity through technological change from 1987 to 1997 were, surprisingly, the service sectors.

From 1997 through 2002, the effects of technology change showed less variance across industries, largely through an apparent lack of display of strong dampening effects. Although far less substantial than in the prior period, technological change in the Primary industry continued to lag behind that for other industries in its ability to stimulate labor productivity gains. But the Government-owned and Petroleum and chemical industries, both of which also had technological change that dampened labor productivity in the prior period, in the 1997-2002 period experienced technological change that advanced labor productivity.

The third largest effect for the 1987-1997 period was generated via changes in value added's share of output by industry, which also tended to have a net negative effect on labor productivity's growth. This implies that this ratio tended to reduce over time. This is tendency across economies worldwide due to enhanced international competition. Nonetheless, the degree to which this factor contributed in China is no doubt due to the speed with which it has been acclimating to international market pressures. Of course, this effect also supports labor savings since labor income is a component of value added. The effect of value added's share of output on labor productivity turned positive but essentially contributed not at all during the 1997-2002 period but then returned to its strong dampening effect on productivity from 2002 to 2005.

When examined by industry, the negative influence on labor productivity from value added coefficients from 1987-1997 largely derived from international pressures on the Primary metals industries; Petroleum, chemical, and nonmetal mineral products; Finance, insurance, and real estate; and Other services. Of course, because of its size and low productivity, China's Primary industries also weighed in on a national scale. But the positive roles from 1987 to 1997 of value added coefficients from the Food; Textile; and Sawmill, paper, and printing industries on labor productivity are tougher to explain since it implies that the value added coefficients for these industries rose during the period. The only likely rationale that sticks out is that these industries tend to produce for the domestic market. Thus a captive and growing market would permit the producers to raise profits and prices without deleterious effects.

From 1997 to 2002, the effect of value added coefficients had less variance across sub-industries. Industries that had negative effects in the prior period appear to have experience more moderate change. Indeed, two industries that had the heaviest dampening effects on productivity from changes in their value added coefficients were industries that experienced growth effects through them in the prior period—the Textile and the Machinery and transportation equipment industries. Moreover, the industry with labor productivity receiving the most benefit from value added coefficients during the 1997-2002 period was one of the worst performers in the prior period—the Primary metals industry. Nonetheless, the Food industry, which had a beneficial change for its labor productivity from value added coefficients from 1987-1997, had them perform well in this role again during 1997-2002.

The domestic supply ratio, which was the fifth most importance factor, in net also affected labor productivity negatively in the first two periods but became negligible from 2002 to 2005. The negative effect implies that imports were substituted for some domestic goods that had higher than average labor productivity among China's industries. Of course, the use of imports also supports labor savings, but they also can detract from value added's contribution when they substitute for high-productivity domestic production. As with all other factors not pertaining to final demand, this one displays less dispersion across industries in the 1997-2002 period than it did for the 1987-1997 period. In this case, however, effects generated by the Primary industry appear to dominate the measure's economywide effects in both periods through 2002. For 1987-1997, the only other industry to display productivity dampening effects that are below the economywide average is the Government-owned industry. In the 1997-2002 period, the Primary industry is the only industry displaying a factor score that is at or below the economywide average for the domestic supply ratio.

Final demand's effects, both intra-sectoral shares and intersectoral mix, had the smallest magnitudes among the factors in the 1987-1997 timeframe, although both enhanced labor productivity and are otherwise quite independent of all other effects. Final demand's cross-sector mix effect strengthened pronouncedly across the study periods, from 2.0 percent to 4.2 percent to 12.8 percent. Its intra-sectoral share effects also contributed more over time, from 7.2 percent to 11.1 percent to 16.3 percent. Thus in essence final demand changes have been fundamental in causing interindustry shifts in resource use. Moreover, while both components of final demand have effected positive changes in labor productivity, changing distributions in the use of goods and services by the household, export, and government demands have contributed slightly more to labor productivity gains than have the changes in the relative mix of final demand across its three main component sectors.

By industry, increased consumption shares in the form of Food and Textile industry products contributed heavily to the share effects through 1997. In the 1997-2002 period the main contributing industry to the share factor of final demand was Finance, insurance, and real estate, although the Primary and Government-owned industries contributed as well. These share effects appear to reflect the rising importance of household consumption, as disposable income rapidly rose in China.

Specific industry-based effects of macro shifts across final demand sectors were less evident through the study periods. Although for the 1997-2002 period, they apparently culminated in inducing enhanced labor productivity in the Primary industry.

5. Conclusion

We are inquisitive about China's extraordinary economic growth. It appears that China's nationwide labor productivity growth has been more rapid than that for any of its major component industries. Wang and Szirmai (2008) suggest that macroeconomic shifts from low- to high-productivity industries can be a cause. Structural decomposition analysis using input-output tables is suited to analyze in more detail what can cause such extraordinary economic change.

Structural change can take on many mantles: changes in production inputs, the substitution of capital or labor, changes in the disposition of production between intermediate and final demand, changes in consumption patterns, and so on. We use a decomposition developed by Jacob (2003) to analyze three Chinese benchmark I-O tables to analyze growth from 1987-2002. We also compare the 2002 benchmark table with China's 2005 estimated table—the latest available at the time this paper was written.

It is well known that in China labor productivity has been driven mainly by manufacturing while farming has been a drag on progress in productivity. Indeed, despite rural-urban migration and some strong productivity advancement in the 1980s, primary industries still maintain 40 percent of total employment. Meanwhile, it is also known that international pressures have reduced firms' profits, which should have a productivity-reducing effect. But a rapidly developing domestic market through rising disposable incomes is also transforming the set of goods and services consumed by households and government. This latter may help explain why service industries may have become a recent source or productivity growth.

Our analysis shows that China's outstanding pattern of growth does stem from its movement of workers out of agriculture and into more productive economic activities. It is, however, fortified by labor savings across all sectors of the economy. Indeed, labor savings continue to far outpace the effect of international competition, which places downward pressure on establishments' income-generating abilities. While technological change and the substitution of imports for domestically produced goods may be enabling labor savings, their independent effects on labor productivity change tend to be comparatively negligible and the magnitude of their effects varies modestly across sectors and time. The directions of these effects tend to vacillate as well during the study period.

Meanwhile, pressure for structural transformations generated by changes in the intrasectoral shares and the intersectoral mix of China's final demand were quite strong and clearly rose faster than the nation's industries' labor-savings propensities from 1987 through 2005. Maddison (2007) discusses how increases in real income in China altered not only the basket of agricultural goods (more meat and fish) and the amount of manufactured goods consumed, but also how it transformed demand for higher-quality housing.

We also found that low technology sectors like Food; Textile; Sawmill and paper products were prime sources of growth through most of the 1990s. From 1997 to 2002, Sawmill and paper products continued to be a main source of productivity growth, and they were joined by the Primary metals, Machinery and transportation equipment, Electric and electronic products, and China's tertiary industries. In general, however, industry-level effects were less pronounced in this later period.

Nonetheless, the agriculture sector's low level and growth in labor productivity continues to be a substantial drag on China's economy. It is vital that Beijing ameliorate this condition. Of course, the industry's tendency for a lack of economies of scale and physical limitations generated by the typical small size of China's farms and the nation's topological geography pose ponderous hurdles. Thus, as Maddison (2007) suggests in the case of agriculture, it may be that increasing imports of farm goods, as opposed to Japan's model of high-cost self-sufficiency policies, could be a viable policy avenue for Beijing to pursue.

Yang and Lahr (2008), Aroca, Guo and Hewings (2008), and Hu and McAleer (2004) findings suggest that China's continued development could be enhanced via improvements in the nation's freight transportation system. We were not able to track the transformation of the transportation service industries separately in our present analysis. Nonetheless, such enhancements would essentially improve the apparent productivity of farm and manufacturing establishments located in China's interior by making them more cost competitive with those near the coast.

We emphasize agrarian and transportation service reforms because the farm sector remains the 800-pound gorilla of the Chinese economy. Without productivity improvements in that sector, Beijing's goal of annual GDP growth of 8 percent or more is difficult to sustain. Moreover, such reforms would improve the lot of the poorest sectors of the economy. Improved income in rural economies would further boost the nation's consumption propensity, which has already become a major source of growth for the country's economy.

China's 11th five-year plan calls for its economy to depend on science and technology and the expansion of market-based institutions. Continuing to milk the cash cow is logical course for a policy strategy. For, as Rodick (2006) mentions, government policies can largely claim to be responsible for China's domestic capabilities in consumer electronics and other advanced areas during the late 1990s and early 2000s. But Schott (2008) and Ami and Freud (2008) point out that the skill content of China's exports may not be all that sophisticated and nor has it improved much despite the degree of export churning we have noted in the present analysis. Thus government nudges in this direction should only assure improvements that could take China in to greater competition with high-profit, niche businesses (those with extensive rather than intensive margins) of developed world.

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Appendix

Table A.1 The Classification List

Index	Industry	Index	industry
1	Agriculture	20	Chemical fibers
2	Coal mining and processing	21	Rubber products
3	Crude petroleum and natural gas extraction	22	Plastic products
4	Ferrous ore mining	23	Nonmetal mineral products
5	Non-ferrous ore mining	24	Ferrous metals smelting and pressing
6	Nonmetal mineral mining	25	Non-ferrous metals smelting and pressing
7	Food products	26	Metal products
8	Wines, spirits and liquors	27	Machinery and equipment
9	Tobacco products	28	Transport equipment
10	Textiles	29	Electric equipment and machinery
11	Clothes, hats and shoes	30	Electronic and telecommunication equipment
12	Wearing apparel, leather, furs, down and related products	31	Instruments, meters, cultural and office machinery
13	Sawmills and furniture	32	Other manufacturing products
14	Paper and products	33	Electricity, gas and water production and supply
15	printing and record medium reproduction	34	Construction
16	Culture goods, Toys, sporting and athletic and recreation products	35	Wholesale and retail trade, catering trade
17	Petroleum processing and coking	36	Finance and insurance
18	Raw chemical materials	37	Real estate
19	Medical and pharmaceutical products	38	Other services

Table A.2 Aggregation of Industries

4 sector	11 sector	38 sector
1.Agriculture, mining and construction	1. Agriculture, mining and construction	1, 2-6,34
2. Manufacturing and utilities	2. Food and tobacco products	7-9
	3. textile products	10-12
	4. Sawmill, paper, printing and culture goods	13-16
	5. Petroleum, chemical and nonmetal mineral products	17-23
	6. Metal smelting and pressing, metal products	24-26
	7. Machinery and transportation equipment	27,28
	8. Electric and electronic products	29-31
	9. Other manufacturing products and utilities	32,33
3. Finance and real estate	10. Finance, insurance and real estate	36,37
4. Other services	11. Others	35,38