



Contents lists available at ScienceDirect

## China Economic Review



## Sources of Chinese labor productivity growth: A structural decomposition analysis, 1987–2005 1

Ling YANG <sup>a,\*</sup>, Michael L. LAHR <sup>b</sup> 2<sup>a</sup> School of Economics and Finance, Xi'an Jiaotong University, Xi'an 710061, China 3<sup>b</sup> Center for Urban Policy Research, Rutgers, The State University of New Jersey, New Brunswick, NJ 08901-1982, United States 4

## ARTICLE INFO 5

## Article history: 6

Received 29 June 2009

Received in revised form 24 May 2010

Accepted 25 May 2010

Available online xxxxx

## JEL classification: 7

C67

F47

O11

O53

## Keywords: 8

China

Economic development

Interindustry change

Input–output analysis

Productivity change

Structural decomposition analysis

## ABSTRACT 9

We decompose labor productivity growth from 1987 to 2005 by examining six partial factors (both supply and demand): changes in value-added coefficients, labor inputs, shares of sectoral demands that are fulfilled domestically, input mix, and the intra-sectoral shares and intersectoral mix of final demand. Our analysis confirms that simply by virtue of its size and extremely low level of labor productivity, China's farm sector continues to weigh heavily in China's overall economic advances. Labor savings have levied the largest influence on the labor productivity on all sectors across all three study subperiods. We find that this transition is highly correlated with capital deepening that accompanies China's opening up process. Still, changes in the intra-sectoral shares and the intersectoral mix of China's final demand also have become quite strong, especially in recent periods. Due to ever-increasing competitive pressures as China continues to open, changes in industries value-added coefficients have tended to counteract some of the positive benefits of labor savings for most sectors. The effects on changes in labor productivity of technology change and changes in the use of imports have been comparatively negligible and any variation in their sectoral effects waning over time.

© 2010 Published by Elsevier Inc. 10

## 1. Introduction 11

For 2009, China's Government announced that its GDP growth was 8.7% (The Economic Times, 2010). 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% is a nightmare. In fact, since 1978 or so Beijing typically has viewed GDP growth of 8% as a minimum desired threshold. 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, at least in the near term, for Chinese officials to get 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 2008 its GNI per capita in terms of purchasing power parity (PPP) was only 12.8% of that of the United States, 17.1% of Japan, 21.4% of Korea's, and 59.6% 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, as it did even between 2007 and 2008 when it gained PPP by at least a percentage point against each of the above countries. 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. To do so, countries like China must adapt foreign technology efficiently and find a specialized niche in the world's market economy (Maddison, 2007).

\* Corresponding author.

E-mail addresses: lynnne@gmail.com (L. Yang), lahr@rci.rutgers.edu (M.L. Lahr).

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). 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 wholesale 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 that the structural shift bonus amounted to about a 20% of total growth from 1980 to 1990.

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 the focus on the national economy is at a very coarse level of industry definition. For example, most consider either manufacturing's 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 examines the country's labor shifts out of agriculture (Li and Haynes, 2008), which is dominated by small farms with constant returns to scale. In the main, the structural change literature ignores the interdependence of China's industries and regions.

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 in order to capture the essence of industry interdependence. Employing input–output tables for structural decomposition analyses can reveal the fullest extent to which changes in industries' input requirements and final demand lead to changes in overall productivity growth. Such analyses follow the thought of Krüger (2008) and Silva and Teixeira (2008), who by using formal analysis emphasize that supply-side and demand-side factors closely interact to shape the process of structural change. Empirically, however, most contributions lean heavily on neoclassical growth theory, which puts great emphasis on technology-driven growth and lacks treatment of demand-based factors. By invoking both the demand- and supply-side perspectives simultaneously, our research is differentiated from prior analyses of productivity change in China.

Hu and McAleer (2004) also apply an input–output framework to study China's structural change. They focus upon the nation's growth of gross output from 1992 to 1997, however. While somewhat connected, the focus of our research is productivity change, not change in gross value of shipments, which is akin to net business revenue. In the end, an input–output approach allows us to bring more information to bear upon the study of 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 changes in labor productivity growth into changes in value-added coefficients, labor inputs, domestic supplies, technology, intra-sectoral input shares, and interindustry 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. We overview how productivity has changed in China and perform the decomposition analysis. The final section concludes the paper.

## 2. Research approach

In this paper, we use a decomposition based on Jacob' (2003), where

$n$	represents the number of industries;	104
$\mathbf{v}$	vector of value added ( $n \times 1$ vector);	105
$\mathbf{e}$	vector of labor inputs ( $n \times 1$ vector);	106
$\lambda$	labor productivity (where $\lambda = v_i/e_i$ ) ( $n \times 1$ vector);	107
$\mathbf{A}$	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 $j$ ;	108 109
$\mathbf{I}$	identity matrix ( $n \times n$ matrix) with "1" in the diagonal and "0" elsewhere;	110
$\mathbf{B}$	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;	111 112
$\mathbf{y}$	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);	113 114
$\hat{\mathbf{E}}$	diagonal matrix with elements $e_i$ as the labor input per unit of output in industry $i$ in the diagonal and "0" elsewhere ( $n \times n$ matrix);	115 116
$\hat{\mathbf{V}}$	diagonal matrix with elements $v_i$ as the value-added per unit of output in industry $i$ in the diagonal and "0" elsewhere ( $n \times n$ matrix); and	117 118
$\hat{\mathbf{P}}$	diagonal matrix with elements $\rho_i$ as the domestic supply ratio (ratio of the total output minus export to total supply, that is, total output minus export and then plus import) in industry $i$ in the diagonal and "0" elsewhere ( $n \times n$ matrix).	119 120

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,<sup>1</sup>  $\mathbf{v} = \hat{\mathbf{V}} (\mathbf{I} - \hat{\mathbf{P}} \hat{\mathbf{A}})^{-1} (\hat{\mathbf{P}} \hat{\mathbf{B}}^o \mathbf{y}^o + \mathbf{B}^{ex} ex)$ , where  $\hat{\mathbf{A}}$  is the matrix of direct input coefficients derived based on all—  
 both domestic and imported—intermediate inputs employed in the production process, and  $\hat{\mathbf{B}}^o$  is a simple array of the column-  
 normalized final demand coefficient that is both domestically produced and imported,  $\mathbf{y}^o$  is a vector of aggregate demand by final  
 use sector (excluding exports). The sectoring for both of these variables are rural household consumption, urban household  
 consumption, government consumption, fixed capital formation, changes in inventory, and “error.”<sup>2</sup>  $\mathbf{B}^{ex}$  is the vector of column-  
 normalized export coefficients, and  $ex$  is the aggregate value of exports—a scalar.

$$\frac{\mathbf{v}_1}{\mathbf{v}_0} = \frac{\hat{\mathbf{V}}_1 (\mathbf{I} - \hat{\mathbf{P}}_1 \hat{\mathbf{A}}_1)^{-1} (\hat{\mathbf{P}}_1 \hat{\mathbf{B}}_1^o \mathbf{y}_1^o + \mathbf{B}_1^{ex} ex_1)}{\hat{\mathbf{V}}_0 (\mathbf{I} - \hat{\mathbf{P}}_0 \hat{\mathbf{A}}_0)^{-1} (\hat{\mathbf{P}}_0 \hat{\mathbf{B}}_0^o \mathbf{y}_0^o + \mathbf{B}_0^{ex} ex_0)}$$

and similarly we can get

$$\frac{\mathbf{e}_1}{\mathbf{e}_0} = \frac{\hat{\mathbf{E}}_1 (\mathbf{I} - \hat{\mathbf{P}}_1 \hat{\mathbf{A}}_1)^{-1} (\hat{\mathbf{P}}_1 \hat{\mathbf{B}}_1^o \mathbf{y}_1^o + \mathbf{B}_1^{ex} ex_1)}{\hat{\mathbf{E}}_0 (\mathbf{I} - \hat{\mathbf{P}}_0 \hat{\mathbf{A}}_0)^{-1} (\hat{\mathbf{P}}_0 \hat{\mathbf{B}}_0^o \mathbf{y}_0^o + \mathbf{B}_0^{ex} ex_0)}$$

where indices are time indicators.

Letting

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

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

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

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

we can decompose the change of value-added as:

$$\frac{\mathbf{v}_1}{\mathbf{v}_0} = \left( \frac{\hat{\mathbf{V}}_1 \mathbf{L}_1 (\hat{\mathbf{P}}_1 \hat{\mathbf{B}}_1^o \mathbf{y}_1^o + \mathbf{B}_1^{ex} ex_1)}{\hat{\mathbf{V}}_0 \mathbf{L}_1 (\hat{\mathbf{P}}_1 \hat{\mathbf{B}}_1^o \mathbf{y}_1^o + \mathbf{B}_1^{ex} ex_1)} \right) \left( \frac{\hat{\mathbf{V}}_0 \mathbf{L}_1 (\hat{\mathbf{P}}_1 \hat{\mathbf{B}}_1^o \mathbf{y}_1^o + \mathbf{B}_1^{ex} ex_1)}{\hat{\mathbf{V}}_0 \mathbf{L}_{01} (\hat{\mathbf{P}}_0 \hat{\mathbf{B}}_1^o \mathbf{y}_1^o + \mathbf{B}_1^{ex} ex_1)} \right) \left( \frac{\hat{\mathbf{V}}_0 \mathbf{L}_{01} (\hat{\mathbf{P}}_0 \hat{\mathbf{B}}_1^o \mathbf{y}_1^o + \mathbf{B}_1^{ex} ex_1)}{\hat{\mathbf{V}}_0 \mathbf{L}_0 (\hat{\mathbf{P}}_0 \hat{\mathbf{B}}_1^o \mathbf{y}_1^o + \mathbf{B}_1^{ex} ex_1)} \right) \left( \frac{\hat{\mathbf{V}}_0 \mathbf{L}_0 (\hat{\mathbf{P}}_0 \hat{\mathbf{B}}_1^o \mathbf{y}_1^o + \mathbf{B}_1^{ex} ex_1)}{\hat{\mathbf{V}}_0 \mathbf{L}_0 (\hat{\mathbf{P}}_0 \hat{\mathbf{B}}_0^o \mathbf{y}_0^o + \mathbf{B}_0^{ex} ex_0)} \right)$$

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:

$$\frac{\lambda_1}{\lambda_0} = \frac{\mathbf{v}_1}{\mathbf{e}_1} \div \frac{\mathbf{v}_0}{\mathbf{e}_0} = (1.1) \times (1.2) \times (1.3) \times (1.4) \times (1.5) \times (1.6)$$

with

$$\left( \frac{\hat{\mathbf{V}}_1 \mathbf{L}_1 (\hat{\mathbf{P}}_1 \hat{\mathbf{B}}_1^o \mathbf{y}_1^o + \mathbf{B}_1^{ex} ex_1)}{\hat{\mathbf{V}}_0 \mathbf{L}_1 (\hat{\mathbf{P}}_1 \hat{\mathbf{B}}_1^o \mathbf{y}_1^o + \mathbf{B}_1^{ex} ex_1)} \right) \tag{1.1}$$

<sup>1</sup> Final demand part in this equation is written in a simplified form. When its detailed components are involved in calculation, the equation is performed as the sum of each final demand category and their effects are accordingly calculated respectively. This also holds for all the following equations in the paper.

<sup>2</sup> The “error” is alternatively called “discrepancy” by national statistical agencies. It is a line item that expedites balancing of I–O accounts. It does not have any economic implication and thus its result will not be reported in the paper.

$$\left( \frac{\hat{\mathbf{E}}_1 \mathbf{L}_1 (\hat{\mathbf{P}}_1 \dot{\mathbf{B}}_1^o \mathbf{y}_1^o + \mathbf{B}_1^{ex} ex_1)}{\hat{\mathbf{E}}_0 \mathbf{L}_1 (\hat{\mathbf{P}}_1 \dot{\mathbf{B}}_1^o \mathbf{y}_1^o + \mathbf{B}_1^{ex} ex_1)} \right) \tag{1.2}$$

$$\left[ \left( \frac{\hat{\mathbf{V}}_0 \mathbf{L}_1 (\hat{\mathbf{P}}_1 \dot{\mathbf{B}}_1^o \mathbf{y}_1^o + \mathbf{B}_1^{ex} ex_1)}{\hat{\mathbf{V}}_0 \mathbf{L}_{01} (\hat{\mathbf{P}}_0 \dot{\mathbf{B}}_1^o \mathbf{y}_1^o + \mathbf{B}_1^{ex} ex_1)} \right) \left( \frac{\hat{\mathbf{E}}_0 \mathbf{L}_{01} (\hat{\mathbf{P}}_0 \dot{\mathbf{B}}_1^o \mathbf{y}_1^o + \mathbf{B}_1^{ex} ex_1)}{\hat{\mathbf{E}}_0 \mathbf{L}_1 (\hat{\mathbf{P}}_1 \dot{\mathbf{B}}_1^o \mathbf{y}_1^o + \mathbf{B}_1^{ex} ex_1)} \right) \right] \tag{1.3}$$

$$\left[ \left( \frac{\hat{\mathbf{V}}_0 \mathbf{L}_{01} (\hat{\mathbf{P}}_0 \dot{\mathbf{B}}_1^o \mathbf{y}_1^o + \mathbf{B}_1^{ex} ex_1)}{\hat{\mathbf{V}}_0 \mathbf{L}_0 (\hat{\mathbf{P}}_0 \dot{\mathbf{B}}_1^o \mathbf{y}_1^o + \mathbf{B}_1^{ex} ex_1)} \right) \left( \frac{\hat{\mathbf{E}}_0 \mathbf{L}_0 (\hat{\mathbf{P}}_0 \dot{\mathbf{B}}_1^o \mathbf{y}_1^o + \mathbf{B}_1^{ex} ex_1)}{\hat{\mathbf{E}}_0 \mathbf{L}_{01} (\hat{\mathbf{P}}_0 \dot{\mathbf{B}}_1^o \mathbf{y}_1^o + \mathbf{B}_1^{ex} ex_1)} \right) \right] \tag{1.4}$$

$$\left[ \left( \frac{\hat{\mathbf{V}}_0 \mathbf{L}_0 (\hat{\mathbf{P}}_0 \dot{\mathbf{B}}_1^o \mathbf{y}_1^o + \mathbf{B}_1^{ex} ex_1)}{\hat{\mathbf{V}}_0 \mathbf{L}_0 (\hat{\mathbf{P}}_0 \dot{\mathbf{B}}_0^o \mathbf{y}_0^o + \mathbf{B}_0^{ex} ex_1)} \right) \left( \frac{\hat{\mathbf{E}}_0 \mathbf{L}_0 (\hat{\mathbf{P}}_0 \dot{\mathbf{B}}_0^o \mathbf{y}_0^o + \mathbf{B}_0^{ex} ex_1)}{\hat{\mathbf{E}}_0 \mathbf{L}_0 (\hat{\mathbf{P}}_0 \dot{\mathbf{B}}_1^o \mathbf{y}_1^o + \mathbf{B}_1^{ex} ex_1)} \right) \right] \tag{1.5}$$

$$\left[ \left( \frac{\hat{\mathbf{V}}_0 \mathbf{L}_0 (\hat{\mathbf{P}}_0 \dot{\mathbf{B}}_0^o \mathbf{y}_0^o + \mathbf{B}_0^{ex} ex_1)}{\hat{\mathbf{V}}_0 \mathbf{L}_0 (\hat{\mathbf{P}}_0 \dot{\mathbf{B}}_0^o \mathbf{y}_0^o + \mathbf{B}_0^{ex} ex_0)} \right) \left( \frac{\hat{\mathbf{E}}_0 \mathbf{L}_0 (\hat{\mathbf{P}}_0 \dot{\mathbf{B}}_0^o \mathbf{y}_0^o + \mathbf{B}_0^{ex} ex_0)}{\hat{\mathbf{E}}_0 \mathbf{L}_0 (\hat{\mathbf{P}}_0 \dot{\mathbf{B}}_1^o \mathbf{y}_1^o + \mathbf{B}_1^{ex} ex_1)} \right) \right] \tag{1.6}$$

Eq. (1.1) represents the productivity effects of changes in the value-added fingers per unit of gross output by industry. Eq. (1.2) represents the effects of changed labor requirements per unit of gross output. Eq. (1.3) indicates the effect of changed domestic supply ratio both in intermediate input and final demand. Eq. (1.4) indicates the effects of changes in the interindustry structure because of technical change, factor substitution, etc. Eq. (1.5) represents the changes in the sectoral composition in each of the final demand categories. Eq. (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 Hoen (1998) find that the results for the average of these two polar decompositions are very close to the average of all possible decomposition forms.

$$\frac{\lambda_1}{\lambda_0} = \frac{\mathbf{v}_1}{\mathbf{e}_1} \div \frac{\mathbf{v}_0}{\mathbf{e}_0} = (2.1) \times (2.2) \times (2.3) \times (2.4) \times (2.5) \times (2.6)$$

$$\left( \frac{\hat{\mathbf{V}}_1 \mathbf{L}_0 (\hat{\mathbf{P}}_0 \dot{\mathbf{B}}_0^o \mathbf{y}_0^o + \mathbf{B}_0^{ex} ex_0)}{\hat{\mathbf{V}}_0 \mathbf{L}_0 (\hat{\mathbf{P}}_0 \dot{\mathbf{B}}_0^o \mathbf{y}_0^o + \mathbf{B}_0^{ex} ex_0)} \right) \tag{2.1}$$

$$\left( \frac{\hat{\mathbf{E}}_0 \mathbf{L}_0 (\hat{\mathbf{P}}_0 \dot{\mathbf{B}}_0^o \mathbf{y}_0^o + \mathbf{B}_0^{ex} ex_0)}{\hat{\mathbf{E}}_1 \mathbf{L}_0 (\hat{\mathbf{P}}_0 \dot{\mathbf{B}}_0^o \mathbf{y}_0^o + \mathbf{B}_0^{ex} ex_0)} \right) \tag{2.2}$$

$$\left[ \left( \frac{\hat{\mathbf{V}}_1 \mathbf{L}_{10} (\hat{\mathbf{P}}_1 \dot{\mathbf{B}}_0^o \mathbf{y}_0^o + \mathbf{B}_0^{ex} ex_0)}{\hat{\mathbf{V}}_1 \mathbf{L}_0 (\hat{\mathbf{P}}_0 \dot{\mathbf{B}}_0^o \mathbf{y}_0^o + \mathbf{B}_0^{ex} ex_0)} \right) \left( \frac{\hat{\mathbf{E}}_1 \mathbf{L}_0 (\hat{\mathbf{P}}_0 \dot{\mathbf{B}}_0^o \mathbf{y}_0^o + \mathbf{B}_0^{ex} ex_0)}{\hat{\mathbf{E}}_1 \mathbf{L}_{10} (\hat{\mathbf{P}}_1 \dot{\mathbf{B}}_0^o \mathbf{y}_0^o + \mathbf{B}_0^{ex} ex_0)} \right) \right] \tag{2.3}$$

$$\left[ \left( \frac{\hat{\mathbf{V}}_1 \mathbf{L}_1 (\hat{\mathbf{P}}_1 \dot{\mathbf{B}}_0^o \mathbf{y}_0^o + \mathbf{B}_0^{ex} ex_0)}{\hat{\mathbf{V}}_1 \mathbf{L}_{10} (\hat{\mathbf{P}}_1 \dot{\mathbf{B}}_0^o \mathbf{y}_0^o + \mathbf{B}_0^{ex} ex_0)} \right) \left( \frac{\hat{\mathbf{E}}_1 \mathbf{L}_{10} (\hat{\mathbf{P}}_1 \dot{\mathbf{B}}_0^o \mathbf{y}_0^o + \mathbf{B}_0^{ex} ex_0)}{\hat{\mathbf{E}}_1 \mathbf{L}_1 (\hat{\mathbf{P}}_1 \dot{\mathbf{B}}_0^o \mathbf{y}_0^o + \mathbf{B}_0^{ex} ex_0)} \right) \right] \tag{2.4}$$

$$\left[ \left( \frac{\hat{\mathbf{V}}_1 \mathbf{L}_1 (\hat{\mathbf{P}}_1 \dot{\mathbf{B}}_1^o \mathbf{y}_0^o + \mathbf{B}_1^{ex} ex_0)}{\hat{\mathbf{V}}_1 \mathbf{L}_1 (\hat{\mathbf{P}}_1 \dot{\mathbf{B}}_0^o \mathbf{y}_0^o + \mathbf{B}_0^{ex} ex_0)} \right) \left( \frac{\hat{\mathbf{E}}_1 \mathbf{L}_1 (\hat{\mathbf{P}}_1 \dot{\mathbf{B}}_0^o \mathbf{y}_0^o + \mathbf{B}_0^{ex} ex_0)}{\hat{\mathbf{E}}_1 \mathbf{L}_1 (\hat{\mathbf{P}}_1 \dot{\mathbf{B}}_1^o \mathbf{y}_0^o + \mathbf{B}_1^{ex} ex_0)} \right) \right] \tag{2.5}$$

$$\left[ \left( \frac{\hat{\mathbf{V}}_1 \mathbf{L}_1 (\hat{\mathbf{P}}_1 \dot{\mathbf{B}}_1^o \mathbf{y}_1^o + \mathbf{B}_1^{ex} ex_1)}{\hat{\mathbf{V}}_1 \mathbf{L}_1 (\hat{\mathbf{P}}_1 \dot{\mathbf{B}}_1^o \mathbf{y}_0^o + \mathbf{B}_1^{ex} ex_0)} \right) \left( \frac{\hat{\mathbf{E}}_1 \mathbf{L}_1 (\hat{\mathbf{P}}_1 \dot{\mathbf{B}}_1^o \mathbf{y}_0^o + \mathbf{B}_1^{ex} ex_0)}{\hat{\mathbf{E}}_1 \mathbf{L}_1 (\hat{\mathbf{P}}_1 \dot{\mathbf{B}}_1^o \mathbf{y}_1^o + \mathbf{B}_1^{ex} ex_1)} \right) \right] \tag{2.6}$$

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 interval. 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 tables, the differences are particularly less pronounced. The 1987 and 1992 tables, for example, have almost the same set of industries, 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 the 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 sake of sectoral consistency. Thus we compare 1987 to 1997, 1997 to 2002, and 2002 to 2005. We ignored the 1992 table because it reports only net exports instead of both exports and imports, which are available for the other tables.<sup>3</sup> 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.<sup>4</sup> 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 and 2005 tables to just 42 sectors. The detailed industries (sectors) are omitted here because of space constraints.

### 3.2. 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 the 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, and tertiary) employment data have 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 Peoples' Republic of China. Since 2002 a new set of industry definitions has been adopted by the National Bureau of National Statistics. While the reporting category for employment in private and individual enterprises remains the same, it cannot be gained for the 16-sector employment data.<sup>5</sup> We should note that since total employment data are based upon a survey of the population, the sum of the employment across sectors does not equal total employment.<sup>6</sup>

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% 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 having access to relatively detailed data on industries' 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. Of readily available national economic data, those on employment tend to be the most detailed for any nation. Hence, we estimated industry employment in secondary

<sup>3</sup> 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.

<sup>4</sup> We matched industries across years by carefully examining the definition and range officially published by the 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.

<sup>5</sup> This information was obtained through consultation with the National Bureau of National Statistics.

<sup>6</sup> See the 2009 China Statistical Yearbook.

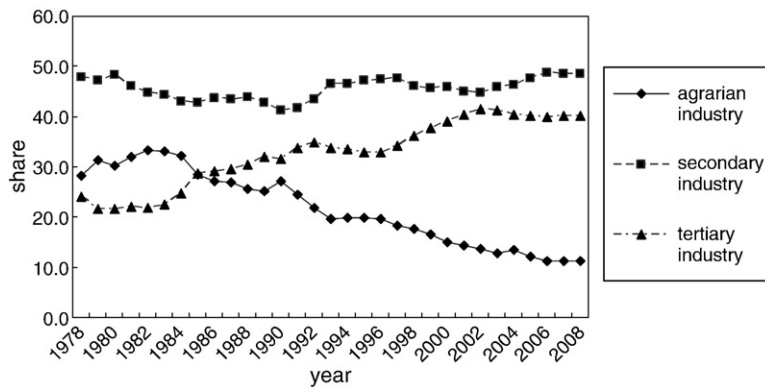


Fig. 1. GDP share for 3 sectors: 1978–2008.

industries (i.e., mining, manufacturing, and utilities) by using each industry's share of secondary industry workers 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 the *China Industry Economy Yearbook*.<sup>7</sup>

### 3.4. Sectoral compatibility of 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 enable the employment data to 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 for this period only the analysis examines China as a whole.<sup>8</sup>

## 4. Empirical analysis

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. Overview of productivity change in China

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 role of China's agricultural industries has declined largely at the expense of its growing tertiary industry. Indeed, almost half of agriculture's employment in 1978 has since become employed by China's secondary and tertiary industries. From Figs. 1 and 2 alone it is clear that labor productivity in the secondary industry is higher than that of both agriculture and the tertiary industry. It produces about half of the nation's GDP while using less than 30% of its employment.

In 1978 prices, Fig. 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. To get a clear understanding of labor shift's contribution to China's overall labor productivity, we used the traditional shift-share analysis,<sup>9</sup> which has been used by Pender (2003), Fagerberg (2000), and Van Ark and Timmer (2003) for the same purpose. The labor shift

<sup>7</sup> The *China Labor Statistical Yearbook* only provides detailed subsector data for enterprises wholly owned by people for 1987.

<sup>8</sup> We tried to get detailed subsector 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 the *China Statistical Yearbook*. We, therefore, concluded that using data from this source ought not to be used in our paper.

<sup>9</sup> Following Van Ark and Timmer, we also use period average as weights to make the decomposition invariant to a particular base, which is a little different from the other two papers.

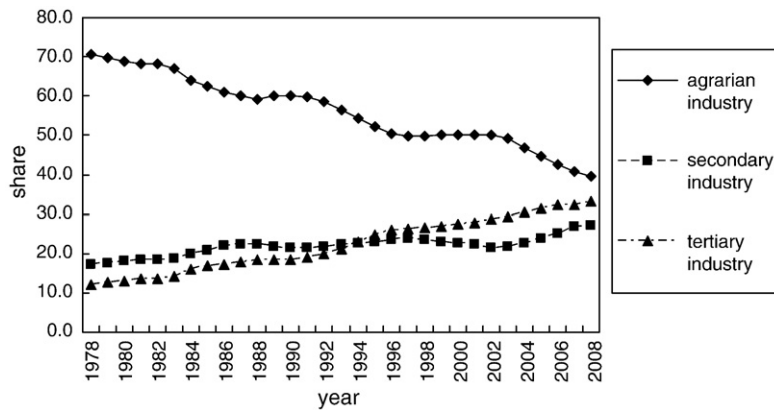


Fig. 2. Employment share for 3 sectors: 1978–2008.

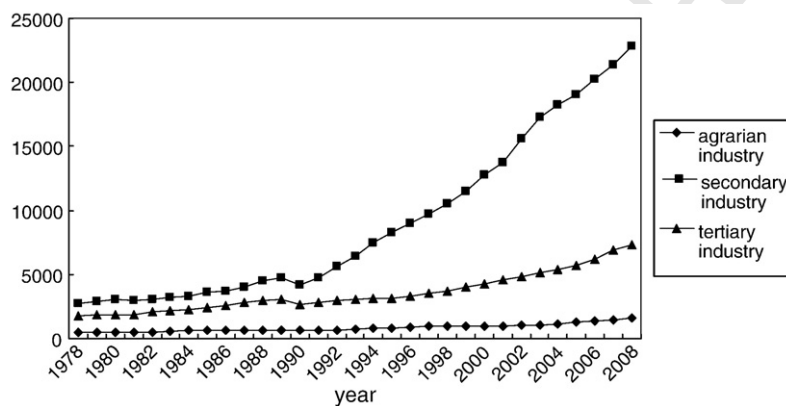


Fig. 3. Labor productivity for 3 sectors: 1978–2008 (1978 yuan per employee).

accounts for 24% for labor productivity growth from 1978 to 2005. Breaking into shorter periods, labor shift contributes about 32%, 17%, –13%, 31%, and 45% for 1978–1987, 1987–1997, 1997–2002, 2002–2005, and 2005–2008, respectively. The negative effect, which cropped up for 1997–2002 was mostly caused by large employment declines in the secondary industry, the industry with highest labor productivity. Fig. 2 shows that the employment share of the secondary industry began to decrease in 1998 and continued through to 2003. This is undoubtedly partially resulted from the recession induced by Asia economic crisis in 1997. Another important cause was the large number of workers laid-off as state-owned enterprises reformed.

#### 4.2. Descriptive analysis

China's labor productivity has been increasing continuously since 1987. Indeed, since 1997, it has grown at an annual average rate of about 11%, much higher than other time in recorded history. Labor productivity in China's primary industries has become somewhat lower and now even grows more slowly than in other sectors. The better returns gained from efforts in other industries undoubtedly explain most of the shift of resources out of the primary sector. Similarly, manufacturing's persistent outstanding performance 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 both Sawmill, paper and culture products and Metal processing and metal products grew fastest with Machinery and transportation equipment and Electrical and electronic products not far behind.

Limited data exist for the tertiary industry. 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 the industry developed best after China's accession to the World Trade Organization. It is at about this time that China's housing market transformed from a socialist system and toward a more 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 1**  
Labor productivity level (2005 yuan/employee), annual average growth rates (%) and factor contribution for labor productivity 1987–1997 (%).

Sector	1987	1997	Growth	V	E	P	A	B	y	B <sup>r</sup>	B <sup>u</sup>	B <sup>g</sup>	B <sup>c</sup>	B <sup>i</sup>	B <sup>ex</sup>	y <sup>r</sup>	y <sup>u</sup>	y <sup>g</sup>	y <sup>c</sup>	y <sup>i</sup>	ex
1	4862	7111	3.88	-3.78	158.61	-15.35	-36.05	-5.83	2.48	2.70	0.48	1.83	-3.06	-0.60	-11.87	-21.35	-16.36	3.26	34.01	-1.64	16.45
2	10,025	40,590	15.01	34.37	60.63	0.50	1.45	3.05	0.00	-2.21	6.08	-0.44	-0.20	0.22	2.51	2.05	-2.26	0.03	-0.38	-0.08	-4.04
3	6363	24,505	14.43	28.58	68.30	0.65	0.12	2.31	0.05	0.91	0.81	-0.01	0.02	0.08	0.70	0.02	0.76	-0.05	-0.28	-0.10	-0.40
4	8471	25,210	11.52	11.08	92.59	0.52	-0.46	-5.26	1.53	-0.56	-0.66	-1.12	-0.18	-0.26	-2.45	-0.43	-0.47	-0.67	-2.18	0.02	5.30
5	14,761	32,866	8.33	-27.52	147.07	-1.40	-12.48	-7.29	1.61	-0.08	-0.78	0.05	0.06	-0.56	-3.92	-0.38	0.01	1.02	-5.06	-0.16	3.73
6	15,562	24,049	4.45	-62.19	177.41	3.34	-13.12	-4.72	-0.72	0.25	0.00	0.07	-0.81	-1.42	-2.70	-0.65	-1.01	-0.31	4.04	0.22	-1.24
7	5833	18,591	12.29	8.71	95.65	-1.19	-0.05	-3.24	0.12	-0.45	-0.27	-0.02	-1.18	-0.51	-0.80	0.00	0.04	0.01	-0.42	-0.07	0.62
8	9921	20,875	7.72	-8.85	143.45	-0.68	-7.64	-26.23	-0.04	-0.72	-5.52	0.05	-1.93	-1.14	-16.49	-0.52	0.10	-0.85	2.23	1.77	-4.50
9	30,772	74,765	9.28	-7.52	150.79	-4.44	-28.22	-9.29	-1.31	-3.33	-4.83	-0.38	8.92	-1.19	-6.59	1.19	2.60	2.08	-3.53	0.88	-3.77
2–9	11,082	28,882	10.05	0.61	97.99	0.06	1.19	0.74	-0.60	-0.08	1.23	0.13	-0.35	0.13	0.18	-0.04	-0.77	0.50	1.77	-0.14	-1.77
10	97,983	106,184	0.81	-281.40	343.50	-0.07	109.36	-60.52	-10.87	-37.86	-39.41	-0.33	20.87	-0.07	-4.87	30.13	1.90	-7.25	-16.70	-2.99	-19.69
11	7954	12,438	4.57	-22.10	116.70	-0.30	2.59	2.47	0.65	0.69	-0.13	2.74	-0.12	-0.04	-0.37	-0.27	-0.91	-1.40	0.60	0.06	2.20
Total	6773	12,445	6.27	-6.39	108.83	-4.29	-7.15	6.93	2.07	3.13	1.98	1.49	-0.83	-0.07	-0.02	-10.15	-5.83	2.55	13.42	-0.45	6.60

Note:

1. The abbreviation are used to represent factors contributing to annual labor productivity growth: **V**, value-added per output; **E**, labor input per output; **P**, domestic supply ratio; **A**, technological change; **B**, intrasectoral shares which include **B<sup>r</sup>**, **B<sup>u</sup>**, **B<sup>g</sup>**, **B<sup>c</sup>**, **B<sup>i</sup>** and **B<sup>ex</sup>**, i.e., the effect of rural consumption, urban consumption, government consumption, fixed capital formation, changes in inventories and export; **y**, intersectoral mix of final demand, which includes **y<sup>r</sup>**, **y<sup>u</sup>**, **y<sup>g</sup>**, **y<sup>c</sup>**, **y<sup>i</sup>** and **ex**, that is, rural consumption, urban consumption, government consumption, fixed capital formation, changes in inventories and export.

2. Both **B** and **Y** factors have an item called "Other", which is the error item in I–O table without economic meaning, thus its results are not reported here and consequently the product of 6 constituent factors does not equal **B** and **y** respectively.

**Table 2**  
Labor productivity level (2005 yuan/employee), annual average growth rates (%) and factor contribution for labor productivity 1997–2002 (%).

Sector	1997	2002	Growth	V	E	P	A	B	y	B <sup>r</sup>	B <sup>u</sup>	B <sup>g</sup>	B <sup>c</sup>	B <sup>i</sup>	B <sup>ex</sup>	y <sup>r</sup>	y <sup>u</sup>	y <sup>g</sup>	y <sup>c</sup>	y <sup>i</sup>	ex
1	7174	9773	6.38	-14.35	113.02	-2.83	-15.87	5.52	14.51	4.26	6.95	-0.21	-3.59	1.37	-4.81	-0.93	-10.39	2.17	24.89	0.61	6.63
2	40,590	62,485	9.01	28.33	70.69	-0.34	3.91	-0.15	-2.44	-1.42	-4.05	0.00	0.15	4.57	0.86	-0.03	-0.50	-0.57	-0.35	-1.18	-1.60
3	24,505	27,348	2.22	-165.40	264.57	2.62	11.06	-15.98	3.13	-1.78	-8.86	0.00	0.07	0.38	-5.04	0.00	5.44	-0.27	-1.30	0.28	-2.46
4	25,210	63,480	20.28	1.65	98.59	0.35	0.37	-0.11	-0.84	-0.04	-0.12	-0.06	-0.33	-0.16	0.01	-0.01	-0.23	-0.83	0.55	0.07	0.69
5	32,866	47,538	7.66	-15.40	93.02	-0.92	18.03	1.24	4.03	-0.02	0.71	-0.15	0.30	1.98	0.47	0.00	-0.39	0.11	0.06	-0.28	1.04
6	24,049	60,951	20.44	15.91	85.48	0.04	-0.77	-0.37	-0.28	-0.02	-0.01	0.00	-0.03	-0.14	0.20	0.00	0.10	0.03	0.10	-0.09	-0.26
7	19,295	36,240	13.44	-23.24	121.89	-0.07	0.25	0.60	0.57	0.09	0.02	0.00	0.30	0.05	0.33	-0.01	-0.05	0.09	0.03	0.11	0.35
8	22,373	41,822	13.33	-11.01	110.18	0.27	4.75	-3.41	-0.78	-0.16	-0.12	0.00	1.16	4.29	-4.84	0.01	0.59	-0.05	0.67	-0.07	-1.72
9	59,284	112,376	13.64	14.34	68.11	-0.93	13.75	6.98	-2.25	1.64	1.07	-0.09	-0.45	-1.03	3.10	0.01	0.68	1.07	1.08	0.25	-2.68
2–9	28,371	48,872	11.49	-3.08	105.50	-0.30	-0.36	-0.66	-1.10	-0.39	-0.30	0.01	-0.18	0.41	-0.66	0.02	-0.26	0.59	-0.66	-0.05	-1.75
10	106,184	250,208	18.70	1.69	83.24	1.05	-4.16	19.93	-1.75	8.57	8.17	0.08	3.30	0.11	0.18	0.16	3.43	-0.23	-0.96	0.12	-2.36
11	12,608	24,162	13.89	10.73	91.90	-0.03	-0.96	-1.09	-0.55	-0.19	-0.29	-0.22	-0.22	0.02	-0.52	-0.01	-0.33	-0.21	0.40	-0.03	0.10
Total	12,445	20,783	10.80	0.30	84.92	-1.61	1.51	10.58	4.30	4.23	3.81	0.00	0.65	0.17	-0.05	-0.42	-2.19	2.17	6.04	0.24	5.03

t3.1  
t3.2  
t3.3  
t3.4  
t3.5  
t3.6  
t3.7  
t3.8  
t3.9

**Table 3**

Labor productivity level (2005 yuan/employee), annual average growth rates (%) and factor contribution (%) for labor productivity 2002–2005.

Sector	1987	1997	Growth	Factor	Contribution	Factor	Contribution	Factor	Contribution
Agrarian industry	5369	6791	8.15	V	−11.03	B <sup>r</sup>	3.27	y <sup>r</sup>	−0.64
Secondary industry	37,554	48,947	9.23	E	82.93	B <sup>u</sup>	9.66	y <sup>u</sup>	−4.07
Tertiary industry	25,364	30,891	6.79	P	−0.17	B <sup>g</sup>	−0.27	y <sup>g</sup>	1.87
Total	17,975	24,400	10.72	A	−1.37	B <sup>c</sup>	1.95	y <sup>c</sup>	7.17
				B	16.27	B <sup>i</sup>	−3.43	y <sup>i</sup>	−1.40
				y	13.37	B <sup>ex</sup>	3.40	ex	9.58

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

t3.10

4.3. Decomposition results

390

By taking natural log of factor values we can capture factors' importance for effecting change in labor productivity in Tables 1, 2, and 3.<sup>10</sup> When a value is larger than 0 it means that this factor makes a positive contribution to the growth of labor productivity. When it is less than 0, it dampened productivity.

The decomposition yields some general information on the study periods. For the three periods, labor savings effects consistently dominated. On an annual basis, it has declined in importance since 2002 and its contribution evolved from 108.8% to 84.9% to 82.9% 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.<sup>11</sup>

Such market-oriented reform also can be found in China's employment market. In July 1986, the government issued a regulation that state-owned enterprise could hire via contracts. This meant that such enterprises could not only hire but also fire personnel. In 1995, the labor contract system was implemented comprehensively. But it was not until 1998 that the government allowed employment to face the full force of the market economy. In 1995, 8.2 million workers had lost their jobs: The count had increased to 11.52 million by the end of 1997.<sup>12</sup> Labor savings at state-owned enterprises from 1998 to 2005 alone released about 28.7 million workers to the general labor force.<sup>13</sup>

We hypothesize that the market-oriented employment system should stimulate the work ethic and thus improve the efficiency of remaining workers. Of course, in selecting who leaves and who remains during the reformation, firms will tend to hold on to those workers most likely to be effective and efficient, resulting in a "cream skimming" process of worker retention.

Not coincidentally then, the quality of employment improved rather quickly after 1995: in 1996, employment with high school and college degree or above accounts for 11.3 and 2.8% respectively, while it becomes 13.1 and 6% in 2002 and 12.1 and 6.78 in 2005.<sup>14</sup> The result of this change in higher-quality employment should have induced further labor-saving effects—a finding we hope to uncover in the course of our research.

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 less than that for service industries during the period.

Following what we said above about how capital deepening should be a major cause of labor savings, we analyze the relationship between them.<sup>15</sup> Table 4 shows the change in the capital/labor ratio across periods as well as the share of foreign

<sup>10</sup> While the actual decomposition results are not reported here for the sake of space savings, they are available upon request.  
<sup>11</sup> Some differences in the decomposition of aggregate labor productivity exist from that discussed by 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.  
<sup>12</sup> Data from <http://job.workercn.cn/contentfile/2009/09/08/165159640893376.html>.  
<sup>13</sup> Data from the website of the National Bureau of Statistics of China [http://www.stats.gov.cn/tjfx/ztfx/jnggkf30n/t20081103\\_402513671.htm](http://www.stats.gov.cn/tjfx/ztfx/jnggkf30n/t20081103_402513671.htm).  
<sup>14</sup> Data from the China Labor Statistical Yearbook 2008.  
<sup>15</sup> Unfortunately, China's statistical system does not have stock capital data for either whole economy or industries. In fact, there are some papers about the estimation of total capital stock for whole China or provinces (Chow, 1993; Chow and Li, 2002; Chen et al., 1988; Jefferson et al., 1996; Li, 2003; Holz, 2006; Albala-Bertrand and Feng, 2007; Zhang, 2008), few papers estimate/use capital stock by industries (Huang et al., 2002; Sino-Canadian Capital Stock Estimation Project, 2003; Sun and Ren, 2008), yet these papers either cannot match our analysis in range (e.g., just for state-owned enterprises) and/or in period; or with the change of China's statistical reporting system, the method they use cannot be extended to recent years; or we have better dataset or ways to estimate capital stock by industry. Therefore, we estimate the capital stock for 50 industries from 1980 to 2005 with most detailed information that China's Statistical Bureau has published. We do not report the estimation process, here because of space limitation. Nonetheless, we would be pleased to send it to any interested readers. Here in Table 4, we only report eleven aggregated sector data consistent with our decomposition results.

investment and private investment for a few years. We adopt the ratio of capital stock to employment as an indicator of capital deepening. During the 1987–1997 period, sectors with relatively rapid capital deepening are sector 4 (Sawmill and paper), sector 5 (Petroleum and chemical products), sector 8 (Electric and electronic products), and sector 9 (Other manufacturing products). These sectors match up fairly well with the set of sectors that benefited from high labor-saving effects. The exception is sector 7 (Machinery and transportation equipment), although sector 10 (Finance, insurance and real estate) did experience a substantial change, but largely is its period of initial development, when many new banks and branches were established. The change in its ratio is not overly large, yet it does appear to contribute heavily to the sector's labor productivity change since the sector 10's annual productivity growth was only 0.8%. Similarly we found that sectors 4, 8, 9, and 11 also exhibit great change both in capital deepening and labor-saving effect for period 1997–2002.

We take a closer look at investment sources hoping they might shed more light on the subject. Private investment in China is a relatively recent phenomenon. Hence, its flow was rather slow through 1995. In that year it comprised just 29.2% of all investments in China. Unfortunately data by industry were not published until 1997, when it was revealed that sectors 4, 7, and 8 owned the largest shares of both private and foreign investments. This parallels the improvement of capital efficiency in these industries. This may also explain why sector 7 does not have the fastest growth in its capital–labor ratio but maintains a rather strong labor-saving effect. Similar things may also help us to understand the causes of a strong labor-saving effect for sectors 7 and 10 for the 1997–2002 period.

Besides capital deepening, international market pressure should also enhance labor savings. Not surprisingly then, most sectors with large rises in exports during both periods also tended to exhibit substantial labor-saving effects. In fact, international market pressure should also dampen value-added per output. We discuss this in more detail later.

After labor savings, change in input shares had the second largest effect on labor productivity change for the 1987 to 1997 period, albeit a net negative one. In both of the latest study periods, the effect of changes in input shares on productivity change, on the other hand, turned positive but was barely perceptible. Much of the negative effect for the 1987–1997 period apparently is embodied in effects from Primary industries and Other manufacturing and utilities, the latter of which is dominated by government-owned establishments. While at first glance a negative effect from changes in input shares might seem implausible, consider that this effect is independent of labor use. That is, changes in input shares pertain only to goods and services used to produce goods. Thus, it can represent technology change that enables labor savings. Of course, technology change need not induce labor savings, and can possibly even result only in a lowering of prices, which would increase value-added per unit of output.

At a sub-industry level, the effects of changes in input shares on labor productivity during both periods were hardly noteworthy. Changes in input shares for the Government-owned and Primary industries yield 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 changes in the input shares of these two industries did not assist their progress at the pace that it did in the balance of China's industries. The industries with the greatest improvements in labor productivity through changes in input shares from 1987 to 1997 were, surprisingly, service sectors.

From 1997 through 2002, the effects of changes in input shares 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.

Regardless of the industry, the effect of changes in input shares on productivity change tends to be small. This is undoubtedly because, compared to other factors, nationwide production structures as embodied in input–output tables tend to be fairly stable, at least over short periods. Still, we may find some trend in sectors especially for manufacturing industry. During the 1987–1997 period, the productivity of light industries maintains its contribution from input shares, and during the five years from 1997 to 2002 heavy industry made more progress from changes in input shares than it had in the prior ten-year period. This is all consistent with China's industrial development strategy as we discuss below.

From the 1940s to 1978, China followed the lead of the Soviet Union and pursued a development strategy that emphasized heavy industry, largely at the expense of ignoring light industry. From the start of reform to the end of 1980s, preferential policies have bolstered light industries in order to meet people's daily needs. This has led to greater priority toward the use of domestic raw materials, the development of infrastructure, greater availability of capital, freer foreign exchange, and (the so-called “sixth priority”) investment in light industries. We can test this by finding evidence that the value of capital stock in light industry increased by an average of more than 10% annually during 1980s.<sup>16</sup> Light industry experienced some of its most drastic change in the 1980s because many firms using traditional and labor-intensive technologies shuttered when their domestic competition rapidly improved their productivity.

Our analysis starts after this period of great change for light industry. This is largely because China did not publish an I–O table before 1987, however. We observe that changes in input shares provided little impetus to alter productivity for China's light

<sup>16</sup> See footnote 14 for details on the calculations.

industry between 1987 and 1997, thanks largely to well-established production modes introduced a decade earlier. Since the 1990s, China's attention has returned to heavy industry which is undoubtedly why we found that most heavy industries experienced a positive effect on productivity change from changes in input shares during the second period of our study.

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. Such a tendency is expected 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 the nation's economy 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, probably because of China's accession into the WTO by the end of 2001.

When examined by industry, the negative influence on labor productivity from value-added coefficients from 1987 to 1997 largely derived from international pressures. To test the idea, we calculate export's growth during the period and found that the four sectors with negative effects (sectors 5, 6, 8, and 9) are exactly those with the greatest export growth: the Primary metals industries; Petroleum, chemical, and nonmetal mineral products; Finance, insurance, and real estate; and Other services. Interestingly Electric and electronic products and Other manufacturing products and utilities have somewhat faster export growth than do the other two, respectively increasing by 16 and 8 times over the ten years. This confirms the perspective that pressure from world markets induces industries to be more competitive and, as a result, forces firms to be more efficient in their use of primary inputs, which results in decreases in the respective industry's value-added coefficient. 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 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 on labor productivity had less variance across sub-industries. Industries that had negative effects in the prior period appear to have experienced more moderate change. Indeed, two industries that had the heaviest dampening effects on productivity from changes in their value-added coefficients were industries that exhibited growth effects 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 to 1997, had them performing well in this role again during 1997–2002.

By examining export growth, the pattern of change can be more readily understood. Sector 8, 7, 4, 5 and 3 ranks are, respectively, the top export growth sectors during this latter period, with real export values in 2002 that range between 200% and 300% of their 1997 equivalents. At the same time, four of these five sectors display a negative change in value-added coefficient. (Sector 4, which is the exception, displays a positive change in its value-added coefficient, but its positive change is the smallest among those with an increasing value-added coefficient.) The negative effect of Electric and electronic products in both periods may also be because of its large role of processing imported products. Hence, its final product embodies little in the way of domestically produced technology and services.

While exporting may explain the pressures on manufacturing industries during the study period, institutional changes may be the equivalent motivator of change for service industries. It also marks the manner in which China has been “opening up.” During the 1987–1997 period, the negative effect on productivity change derived from value-added coefficients for Finance, insurance and real estate is the result of such major institutional changes. During early 1980, China's finance system consisted of just four state-owned banks: the Bank of China, the China Construction Bank, the China Agriculture Bank, and the Industrial and Commercial of China. During the late 1980s and early 1990s, about ten joint-stock banks were established in China. In 1996, China Minsheng Bank Corporation, the first national joint-stock commercial bank, was established. Similar change also occurred in the insurance industry. The increased competition clearly forced pre-existing, state-owned entities to decrease the share of output they could allocate to value added. This competition prevailed through 2002, although the private distribution of housing drastically slowed in 1998, the real estate sector developed rapidly, partly canceling the competitive advances in Finance and insurance sector. This may well be why we found little positive effect from changes in value added's share of output for this sector.

The domestic supply share was the fifth most important factor. In net it also affected labor productivity negatively in the first two periods but the effect became negligible from 2002 to 2005. The negative effect implies that imports were substituted for some domestic production that had higher-than-average labor productivity among China's industries. Of course, the use of imports also supports labor savings, but it also detracts from value added's overall contribution when imports substitute for highly productive 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 economywide effects 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. For both periods, the domestic supply share always has a small but positive effect for all light industries.

Final demand's effects, both changes in intra-sectoral shares and intersectoral mix, had the smallest magnitudes among the factors in the 1987–1997 timeframe. Both types enhanced labor productivity and are otherwise quite independent of all other effects. Final demand's intersectoral mix effect strengthened pronouncedly across the study periods, from 2.0% to 4.3% to 13.4%. Its intra-sectoral share effects also strengthened over time, from 7% to 10.6% to 16.3%. Thus in essence changes in final demand have been a fundamental cause of interindustry shifts in resource use. Another item of note is that from 1987 to 2005 the influence of final demand steadily has been increasing. Moreover, while both components of final demand have effected positive changes in labor productivity, changing distributions in the use of goods and services by households, exports, and government demands have contributed slightly more to labor productivity gains than have the changes in the relative mix of final demand across its component sectors. The influences of the latter have grown rapidly, however. This indicates that following the first ten years of China's reform, structural changes within each of the final demand sectors have played a more important role in the growth of labor productivity than has the relative size of the final demand sectors. Yet as the reform continues, the gap in influences between these two final demand factors has been closing.

Looking more deeply into the influences of final demand, we find that intra-sectoral share effects are primarily driven by relative changes in the differences between rural and urban consumption across all the periods. Changes in the consumption of urban households contribute more to productivity change during the last period than it did in the first two. Government consumption had a positive effect in the 1987–1997 period. But capital formation and inventory changes leveraged more influence in 1997–2002. For the last period, change in export composition shows a clear positive effect even larger than that of rural consumption, and capital formation continues to have small effect on labor productivity growth. With respect to the intersectoral mix of final demand between 1987 and 2002, capital formation, exports, and government consumption are consistently important in effecting positive labor productivity growth. Interestingly, export change increases in importance during the final five years of that period. In essence, then, the growing influence of the household sector was not due to any change in its relative size compared to other final demand sectors but strictly to shifts in what it purchased.

To get a better understanding of what was motivating the influence of household consumption, we investigated a bit further. We found that consumption shares grew mainly in the form of Food, Textile, and Primary industry products through 1997. Increased food consumption was peculiar to urban consumers as were exports. Increased consumption of exports, however, was enabled at the expense of equivalent domestic production. From 1997 to 2002, the industry whose share of overall final demand was increased most was Finance, insurance, and real estate. The shares of goods and services to final demand provided by the Primary and Government-owned industries all rose. In net, the above share effects suggest that the rising importance of household consumption was caused by startling increases in disposable income, which radically changed features of households' consumption bundles.

The prior paragraph focused on positive effects of changes in intrasectoral final demand shares. But there, of course, were compensating negative effects as well. Generally, however, they were somewhat negligible and consistent across final demand sectors from 1987 through 2002. Thus, the compensating share declines of the share rises discussed in the prior paragraph were shared somewhat equally across other industries. An exception was the rather large declining share of the Other manufacturing sector. Due to this sector's loose definition, however, inferences from and underlying its share change were difficult to develop.

Specific industry-based effects of macro shifts across final demand sectors were less evident through the study periods. Although for both periods, they apparently culminated in inducing enhanced labor productivity in the Primary industry through capital formation and exports. Particularly, Paper and Sawmill, Petroleum and Chemical products have been increasingly exported over both periods; Electronic and Electrical products have been beneficiaries of capital formation in both periods. Capital formation was also driven by Metal products in the 1987–1997 period but shifted to Paper and Sawmill products thereafter. Another thing we should note is that the macro effects of urban consumption are most contributed by the Finance, insurance and real estate sector, which appears to replace consumption of the uses of production from 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. As Wang and Szirmai (2008) suggest, we find that wholesale macroeconomic shifts from low- to high-productivity industries are a major cause. We forward that structural decomposition analysis (SDA) using input–output (I–O) tables is suited to analyze detailed causes of such extraordinary economic change. In particular, I–O-based SDA provides the ability to analyze supply and demand factors simultaneously. This ability is unique among econometric approaches; we consequently insinuate that other approaches tend to be inadequate for any comprehensive study of structural change.

Despite the fact that SDA enables us to control for demand factors, as well as supply factors generally examined, we confirm the well-known results that labor savings are a long-term, dominant cause of productivity growth: moreover, we confirm this for the case of China. The strength of this factor within each of the broad sectors examined has remained remarkably strong during the period of study 1987–2005, particularly compared to that for the economies of other countries that have been investigated using SDA.

Our analysis confirms that China's outstanding pattern of growth does stem from its movement of workers out of agriculture and into more productive economic activities. We also confirm that labor productivity growth in China is fortified by labor savings across all sectors of the economy. Indeed, we show that 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, we demonstrate that their independent effects on labor productivity change tend to be comparatively negligible and that 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, we find that the pressure from structural transformations generated by changes in the intra-sectoral shares and the intersectoral mix of China's final demand were quite strong. Moreover, our analysis demonstrate that the influence of these components of final demand rose faster than did the nation's industries' labor-saving propensities from 1987 through 2005. In particular, we find that households are becoming an economic driver not through how much they are spending but rather what they are spending their hard-earned cash upon. Moreover, we note that this phenomenon likely was not possible prior to real estate and banking reforms. Thus, our findings support Maddison's (2007) discussion of not only how real income rises in China altered 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, but that sector was 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 continue to be a substantial drag on China's economy. It is vital that Beijing ameliorates this condition. Of course, the industry's tendency for a lack of economies of scale and physical limitations generated by both 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.

Findings by Yang and Lahr (2008), Aroca, Guo and Hewings (2008), and Hu and McAleer (2004) 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, if effected, such enhancements undoubtedly would 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% or more will be difficult to sustain. In part, we suggest this because our results suggest that gains from further labor savings, outside of those from intersectoral shifts, appear to be waning and approaching levels observed in Japan and developed western nations. But we also suggest it because such reforms would improve the lot of the poorest and largely rural sectors of the economy. Enhanced income in rural economies would further boost the nation's consumption propensity, which, as we demonstrate, is fast becoming a major source of growth for China'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 a logical course for a policy strategy. For, as Rodrik (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 Amiti and Freund (2008) point out that the skill content of China's exports may not be all that sophisticated nor has it improved much despite the degree of export churning we have noted in the present analysis. Thus government nudges to engage its labor in higher value-adding production would only assure improvements that could take China into greater competition with high-profit, niche businesses (those with extensive rather than intensive margins) of developed world.

## 6. Uncited references

Hall & Jones, 1999	597
Ligang & Sheng, 2008	598
National Bureau of Statistics of China, 1991	599
National Bureau of Statistics of China, 1992	600
National Bureau of Statistics of China, 1995	601
National Bureau of Statistics of China, 1998	602
National Bureau of Statistics of China, 1999	603
National Bureau of Statistics of China, 2002	604
National Bureau of Statistics of China, 2006a	605
National Bureau of Statistics of China, 2006b	606
National Bureau of Statistics of China., 1987	607
National Bureau of Statistics of China., 2000	608
National Development Planning Commission, National Bureau of Statistics of China and China Economic Herald, 2002	609
Simpkins, 2009	610
Young, 2000	611
Zheng & Angang, 2006	612

## Appendix A

613

Table A1

The classification list.

Index	Sector	Industry
1	Agriculture, mining and construction	Agriculture; Coal mining and processing; Crude petroleum and natural gas extraction; Ferrous ore mining; Non-ferrous ore mining; Nonmetal mineral mining; Construction
2	Food and tobacco products	Food products; Wines, spirits and liquors; Tobacco products
3	Textile products	Textiles; Clothes, hats and shoes; Wearing apparel, leather, furs, down and related products
4	Sawmill, paper, printing and culture goods	Sawmills and furniture; Paper and products; Printing and record medium reproduction; Culture goods; Toys, sporting and athletic and recreation products
5	Petroleum, chemical and nonmetal mineral products	Petroleum processing and coking; Raw chemical materials; Medical and pharmaceutical products; Chemical fibers; Rubber products; Plastic products; Nonmetal mineral products
6	Metal smelting and pressing, metal products	Ferrous metals smelting and pressing; Non-ferrous metals smelting and pressing; Metal products
7	Machinery and transportation equipment	Machinery and equipment; Transport equipment
8	Electric and electronic products	Electric equipment and machinery; Electronic and telecommunication equipment; Instruments, meters, cultural and office machinery
9	Other manufacturing products and utilities	Other manufacturing products; Electricity, gas and water production and supply
10	Finance, insurance and real estate	Finance and insurance; Real estate
11	Other services	Wholesale and retail trade, catering trade; Other services

614

## References

615

- Albala-Bertrand, José M., & Feng, Hao (2007). Net capital stock and capital productivity for China and regions: 1960–2005. *Department of Economic Working Paper No. 610*. : University of London <http://www.econ.qmul.ac.uk/papers/doc/wp610.pdf>. 616
- Amiti, Mary, & Freund, Caroline (2008). The anatomy of China's exports. *World Bank Policy Research Working Paper 4628*. 617
- Aroca, Patricio A., Guo, Dong, & Hewings, Geoffrey, J. D. (2008). Spatial convergence in China, 1952–1999. In Guanghua Wan (Ed.), *Inequality and growth in modern china* (pp. 125–143). Oxford, U.K: Oxford University Press. 619
- Liu, Aying, Yao, Shujie, & Zhang, Zongyi (1999). Economic growth and structural changes in employment and investments in China, 1985–94. *Economics of Planning*, 32, 171–190. 620
- Chen, Kuan, Jefferson, Gary H., Rawski, Thomas G., Wang, Hongchang, & Zheng, Yuxin (1988). New estimates of fixed investment and capital stock for Chinese state industry. *China Quarterly*, 114, 243–266. 623
- Chow, Gregory C. (1993). Capital formation and economic growth in China. *The Quarterly Journal of Economics*, 108, 809–842. 624
- Chow, Gregory C., & Li, Kui-Wai (2002). China's economic growth: 1952–2010. *Economic Development and Cultural Change*, 51, 247–256. 625
- Dietzenbacher, Erik, & Hoen, Alex R. (1998). Deflation of input–output tables from the user's point of view: A heuristic approach. *Review of Income and Wealth*, 44, 111–122. 626
- Fagerberg, Jan (2000). Technological progress, structural change and productivity growth: A comparative study. *Structural Change and Economic Dynamics*, 11, 393–411. 629
- Fan, Shenggen, Zhang, Xiaobo, & Robinson, Sherman (2003). Structural change and economic growth in China. *Review of Development Economics*, 7, 360–377. 630
- Hall, Robert E., & Jones, Charles I. (1999). Why do some countries produce so much more output per worker than others? *Quarterly Journal of Economics*, 114, 83–116. 631
- Holz, Carsten A. (2006). New capital estimates for China. *China Economic Review*, 17, 142–185. 632
- Hu, Baiding, & McAleer, Michael (2004). Input–output structure and growth in China. *Mathematics and Computers in Simulation*, 64, 193–202. 633
- Huang, Y., Ren, R., & Liu, X. (2002). "Perpetual Inventory Approach to Capital Stock in Chinese Manufacturing", in Chinese. *Jingjixuejikan (China Economic Quarterly)*, 1, 377–396. 634
- Jacob, Jojo (2003). *Structural change, liberalization and growth: The Indonesian experience in an input–output perspective* available at <http://www.druid.dk/conferences/winter2003/Paper/jacob.pdf>. 635
- Jefferson, Gary H., Rawski, Thomans G., & Zheng, Yuxin (1996). Chinese industrial productivity: Trends, measurement issues, and recent developments. *Journal of Comparative Economics*, 23, 146–180. 636
- Krüger, Jens J. (2008). Productivity and structural change: A review of the literature. *Journal of Economic Surveys*, 22, 330–363. 640
- Li, Kui-Wai (2003). China's capital and productivity measurement using financial resources. *Economic Growth Center Discussion Paper No. 851*. : Yale University. 642
- Li, H., & Haynes, Kingsley E. (2008). Industrial structure and regional disparity in China: Beyond the Kuznets transition. *47th Southern Regional Science Association Annual Meeting in Washington, DC*. 643
- Ligang, Song, & Sheng, Yu. (2008). The impact of reform on economic growth in China, a principal component analysis. *UNU-Wider Research Paper* available online at [http://www.wider.unu.edu/publications/working-papers/research-papers/2008/en\\_GB/rp2008-12/](http://www.wider.unu.edu/publications/working-papers/research-papers/2008/en_GB/rp2008-12/). 644
- Lo, Dic (2007). China's economic growth and labor employment: Structural change, institutional evolution, and policy issues. *Report Submitted to the International Labor Organization*, [http://www.networkideas.org/ideasact/Jun07/Beijing\\_Workshop\\_07/Dic\\_Lo.pdf](http://www.networkideas.org/ideasact/Jun07/Beijing_Workshop_07/Dic_Lo.pdf). 647
- Maddison, Angus (2007). Chinese economic performance in the long run. *Development Centre of the Organization for Economic Co-operation and Development*, 2nd edition <http://www.doughertyfilms.com/papers/maddison2007.pdf>. 648
- National Bureau of Statistics of China. (1991). *1987 Input–output tables of China*. Beijing: China Statistics Press. 649
- National Bureau of Statistics of China 1992. 1993. *China Industry Economy Statistical Yearbook*. China Statistics Press: Beijing. 650
- National Bureau of Statistics of China. (1995). *1992 Input–output tables of China*. Beijing: China Statistics Press. 651
- National Bureau of Statistics of China. (1997). *1950–1995 China statistical yearbook on investment in fixed assets*. Beijing: China Statistics Press. 652
- National Bureau of Statistics of China 1997. 1998. 1999. 2003. 2004. 2005. 2006. *Statistical Yearbook of the Chinese Investment in Fixed Assets*. China Statistics Press: Beijing. 653
- National Bureau of Statistics of China 1998. 2003. 2009. *China Statistical Yearbook*, Beijing, China Statistics Press: Beijing. 654
- National Bureau of Statistics of China. (1999). *1997 Input–output tables of China*. Beijing: China Statistics Press. 655
- National Bureau of Statistics of China. (2002). *1950–2000 Statistics on investment in fixed assets of China*. Beijing: China Statistics Press. 656