経済研究
Vol. 64, No. 1, Jan. 2013

小特集：アジアにおける長期経済発展

Measuring Industry Level Employment, Output and Labor Productivity in the Chinese Economy, 1987-2008*

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This paper introduces the procedures of constructing the first version of China Industrial Productivity Database (CIP Round 1.0), a first of its kind that covers output and employment indicators of 33 industries for the period 1987-2008. At this stage the CIP Project does not attempt to challenge the official output estimates for the aggregate and major sectoral levels. However, outstanding methodological and data issues are discussed which has important implications for adjusting official estimates at the aggregate level at later stages. The paper also conducts a quality check aiming to invite constructive comments and suggestions. Analytical measures using the data show that the Chinese economy achieved nearly a fourfold growth in labor productivity over this period, averaging 6.6% per annum. While the "post and telecommunication" service and "transportation equipment manufacturing" industries experienced super-fast labor productivity growth (16.3% and 15.1%), the "mining" and "petroleum refinery" industries experiencing the slowest or even negative labor productivity growth (1.6% and −1.9%). China benefited from a positive "labor reallocation effect" alongside the reforms in the early 1990s. But the effect turned negative following the Asian financial crisis in 1997-98 and its deflationary aftermath, before it became positive again after China's WTO entry in 2001. A quality check suggests that after controlling for the per capita real PPP GDP and labor participation rate, China's labor productivity per hour appears to be 11 percent higher than that of Japan. Given that Japan's labor productivity was 20 to 28 percent higher than that of Taiwan and South Korea, which is plausible, it is reasonable to argue that China's official GDP estimates may have to some extent exaggerated its real GDP.
JEL Classification Codes: E24, C82, O47

1. Introduction

China's rapid economic growth and integration with the world economy in the past three decades, especially since its industrial reform in the mid 1980s, have had a profound and global impact on resource allocation, technology transfer, efficiency and productivity performance, and hence changes of factor costs. Obviously, any sensible study of the China phenomena requires a set of carefully constructed industry-level input and output indicators that satisfy the standard of a production function framework and a consistent coverage and classification that ensure an accounting coherence between industries and their aggregates at various levels ultimately confined to or controlled by the national accounts. However, lack of such data has been a main obstacle to a better understanding of the Chinese economy.

The China Industrial Productivity (CIP) Database Project aims to fill the gap. It is undoubtedly a very challenging task not only because there are serious inconsistencies and structural breaks in the available official data but also because there are lot of missing data for the key indicators required. It is not that we have to rely on limited information to make assumptions to solve these data problems but the assumption making has to consider that we are facing a massive and very complicated economy that is highly diversified in resource endowments and the level of development and highly unequal in income distribution among population and across regions. Government interventions, institutional deficiencies and vested interest groups have not only affected the operation of the economy but also influenced the generation of the economic data.

To make the Chinese data comparable in international comparison programs, the CIP project is in principle designed in line with the principles used in the European Union KLEMS and world KLEMS (standing for capital, labor, energy, materials and services, respectively) projects in constructing input, output and productivity accounts, though compromises have to be made in order to bypass some difficult data problems.

It should also be noted that the CIP Project is based on a series of earlier data work by me and my associates to construct historical input and output data for Chinese manufacturing, mining and utility industries, as well as for the aggregate economy. These studies cover 39 two-digit level mining, manufacturing and utility industries, but with some indicators only available for a broader classification of 24 industries. They aim to make the industry data conceptually consistent and reconcilable with the national industrial totals (see Wu, 2002a, 2007, 2008, 2011b and 2012a; Wu and Yue, 2010). On the other hand, my work on the aggregate economy aims to fix problems in the national "control totals" and make them consistent over time (Maddison and Wu, 2008; Wu 2011a). The basic data work idea of the CIP Project is to construct the same variables for the non-industrial sectors with my work on mining, manufacturing and utility industries to define the boundary of the industrial economy and my work on the national "control totals" to define the boundary of the total economy. This also provides a good opportunity to revisit my previous studies on the industrial sector by checking the coherence between the industrial sector and non-industrial sectors and between sectors and national "control totals".

At this stage of the CIP Project, the expansion of my database from the industrial sector to the non-industrial sectors can only concentrate on the measurement of output including both gross output and value added, hence implying the measurement of intermediate inputs, and the measurement of labor employment including both numbers employed and hours worked.

The next section of the paper describes the coverage and classification of the CIP Database Round 1.0 (hereafter CIP 1.0). Section 3 introduces the basic methodological framework for the construction of productivity accounts, which defines the concept of gross output, value added, intermediate input, and quantity of employment (numbers and hours) constructed in the CIP 1.0. Sections 4 and 5 describe the data construction procedures for output and employment indicators, respectively, and discuss outstanding issues or unsolved problems. Next, based on the constructed data, Section 6 first presents the growth and structural changes of China's industrial output and employment, and it then decomposes China's labor productivity performance into the contribution of individual industries and the labor reallocation effect across industries. Section 7 is designed to check the quality of the CIP data by conducting an international comparison. Finally, Section 8 concludes the study with research priorities for the next stage of the CIP Project.

2. Coverage and Classification

Coverage

The CIP Database Round 1.0 covers the entire Chinese economy that is defined by the Chinese System of National Accounts (CSNA) for the period 1987-2008 with industries classified by the Chinese Standard of Industrial Classification (CSIC). It should be noted that this period began with China's first SNA-type Input-Output Table (CIOT) for 1987 and published five full CIOTs with a five-year interval. Conceptually, at any level of industry breakdown, the output accounts, including intermediate inputs and value added, are matched with the employment accounts in China.

In the CIP Project, to ensure a consistent coverage we revisit the coverage problem of the industrial sector that is intensively discussed in my earlier studies. In the official statistics, there are always inconsistencies between industry statistics, labor statistics and the national accounts. While the labor statistics and the national accounts give estimates for the total economy and its broad sectors, the industrial statistics mainly focuses on enterprises by certain criteria that can be regularly monitored through a reporting system. However, its coverage has been changed several times without a clear and transparent explanation.

For most of the planning period, the available industry data could only cover the state-owned enterprises (SOEs). In 1980, this coverage was enlarged to include all the enterprises that were classified as independent accounting units at or above the rural township administrative level regardless their ownership types. In 1998, an ownership and designated-size hybrid approach was introduced to redefine the coverage, which included all SOEs plus non-SOEs with an amount of total annual sales of five million yuan or more.[1)] Unfortunately, the industrial data using these different criteria over time cannot be coherently or logically reconciled. It is worse that from 2005 onwards the sum of the value added by the enterprises covered (i.e. SOEs and those at/above the "designated size") became increasingly greater than the industrial GDP reported in the national accounts (Wu, 2011a).[2]

To maintain the consistency at industry level and to ensure the output sum of industries reconcilable with the national totals, the CIP introduces a "formal sector" concept to ensure a conceptually-consistent coverage of the industrial enterprises within the reporting system over time. The idea is that the "formal sector" embraces all industrial enterprises that are legally registered as business entities with an independent accounting status, regardless their ownership type, administrative level or size. Output or employment that falls between the "formal sector" and the "control total" at the same industry level is defined as output produced or workers hired by the "informal sector". This ensures a consistent treatment to data of various sources and standards and the principles in making assumptions to deal with inconsistency problems.

After the total industrial economy is defined, the difference in any input or output measure between the two levels of "control totals" of the economy, i.e. the "national total" and the "industrial total", is logically the "non-industrial total" that includes agriculture, construction and all services. Construction and most of services have similar coverage problems as observed in industry but they are more difficult because of less survey or census data available for these sectors than for the industrial sector. The CIP Project tackles the problems by a similar approach as used in my work for the industrial sector. After the coverage of all services is defined, the rest is belonged to agriculture. One may reasonably argue that at this stage of economic development in China there must be a fairly fuzzy line between the agricultural sector and the rest of the economy, especially the informal sector of the economy. This means that there must be a large number of seasonal, temporary, part-time and multi-job workers who shift back and forth between agriculture and manufacturing, construction and other services. This problem is handled by using a concept of "effective hours worked" as discussed later.

Industrial Classification

The official industry statistics are available at two-digit level but based on different standards of industrial classification introduced at different times, namely CSIC/1972, CSIC/1985, CSIC/1994 and CSIC/2002. To make it consistent over time, the CSIC/2002 is used as a standard system to re-classify the historical data and to adjust the coverage at industry level.

The CIP 1.0 industrial classification standard (Table A1) is in principle in line with the classifications of the EU/KLEMS, a research program at the Groningen Growth and Development Center, University of Groningen (GGDC). The CIP 1.0 data are available for 32 industries of regrouped 33 EU/KLEMS industries (Timmer, *et al.*, 2007). It should be noted that in our SUTRAS-based re-construction of CIOT series (see below) (Temurshoev and Timmer, 2010), we adopt a slightly different classification from Table A1 due the available data in available CIOTs. That is, industry group 50t52 is split into industry 51 (wholesale trade and commission trade services, except motor vehicles and motorcycles) and 52 (retail trade services, except motor vehicles and motorcycles; repair services of personal and household goods), utilizing the information taken from the China Economic Census 2004. Industry 67 (services auxiliary to financial intermediation) is included in 65 (financial intermediation services, except insurance and pension funding services). Industry 71 (renting services of machinery and equipment without operator and of personal and household goods; for 1997 only) and 72 (computer and related services) are included in 73 (research and development services).

3. A Methodological Framework for Measuring Productivity

We begin with the industry-level production function and show how this allows us to quantify the sources of output growth, and in particular the role of labor input and how it is measured.

In principle, we follow the growth accounting methodology developed by Dale Jorgenson and his associates as outlined in Jorgenson, Gollop and Fraumeni (1987) and more recently in Jorgenson, Ho and Stiroh (2005). As in other studies in this field (e.g. O'Mahony and Timmer, 2009), we also follow their notation as close as possible. Note that, although at this stage of the CIP data construction we can only concentrate on the measuring of output and quantity of employment at industry level, it is important to conduct our data work in this standard framework and follow its principles in data construction.

To assess the contribution of various inputs to the aggregate economic growth, we take the growth accounting approach, which has been theoretically motivated by the seminal contribution of Jorgenson and Griliches (1967) and put in a more general input-output framework by Jorgenson *et al.* (1987). It is based on the production possibility frontier where industry gross output is a function of capital, labour, intermediate inputs and technology which is indexed by time. Each industry, indexed by j, can produce a set of products and purchases a number of distinct intermediate inputs, capital and labour inputs to produce its output. The production function is given by

$$Y_j = f_j(K_j, L_j, X_j, T) \qquad (1)$$

where Y is output, K is an index of capital service flows, L is an index of labour service flows and X is an index of intermediate inputs,[3] either purchased from domestic industries or imported.

Under the assumptions of competitive factor markets, full input utilization and constant returns to scale, the growth of output can be expressed as the cost-share weighted growth of inputs and technological change (A^Y), using the translog functional form that is common in such analyses:

$$\Delta \ln Y_{jt} = \bar{\nu}_{jt}^K \Delta \ln K_{jt} + \bar{\nu}_{jt}^L \Delta \ln L_{jt} + \bar{\nu}_{jt}^X \Delta \ln X_{jt} + \Delta \ln A_{jt}^Y$$

$$\text{where } \bar{\nu}_{jt}^K = \frac{P_{jt}^K K_{jt}}{P_{jt}^Y Y_{jt}}\ ;\ \bar{\nu}_{jt}^L = \frac{P_{jt}^L L_{jt}}{P_{jt}^Y Y_{jt}}\ ; \qquad (2)$$

$$\bar{\nu}_{jt}^X = \frac{P_{jt}^X X_{jt}}{P_{jt}^Y Y_{jt}} \text{ and } \bar{\nu}_{jt}^K + \bar{\nu}_{jt}^L + \bar{\nu}_{jt}^X = 1$$

Each element on the right-hand side of (2) indicates the proportion of output growth accounted for by growth in intermediate inputs, capital services, labour services and technical change as measured by the change of A^Y or total factor productivity (TFP), respectively. It is common to define aggregate input, say labour related to our case, as a Törnqvist quantity index of individual labour types as follows

$$\Delta \ln L_{jt} = \sum_l \bar{w}_{h,jt}^H \Delta \ln H_{h,jt} \qquad (3)$$

where $\Delta \ln H_{h,jt}$ indicates the growth of hours worked by labour type h and weights $\bar{w}_{h,jt}^H$ are given by the period average shares of each type h in the value of labour compensation controlled by the labor income accounts as in the input-output table. This is similar for K ($\Delta \ln K_{jt} = \sum_x \bar{w}_{k,jt}^K \Delta \ln K_{k,jt}$) and X($\Delta \ln X_{jt} = \sum_x \bar{w}_{x,jt}^X \Delta \ln X_{x,jt}$). As we assume that marginal revenues are equal to marginal costs, the weighting procedure ensures that inputs which have a higher price also have a larger influence in the input index. So for example a doubling of hours worked by a high-skilled worker gets a bigger weight than a doubling of hours worked by a low-skilled worker.

However, at this stage of the CIP Project, for inputs we can only measure the quantity of employment in numbers employed (N) and hours worked (H), not yet cost-weighted for the non-industrial sectors.[4]

4. Measuring Gross Output and Value Added

Although China in principle switched to the System of National Accounts (SNA) in 1992 and has since continuously improved its national accounts through surveys and censuses, some of the concepts and practices used by China's National Bureau of Statistics (NBS) are in some areas and to some extent still influenced by the old Material Product System (MPS) (for details see Xu, 1999 and 2009). The official estimates of gross domestic product or value added have been criticized in the literature for upward bias in growth rate and downward bias in level (Maddison, 1998; Keidel, 1992).[5] In the current CIP Project, unlike the work in Wu (2011a and 2011b) and in Maddison and Wu (2008), we do not intend to provide alternative estimates to the NBS estimates before we complete the measures of all input and output indicators based the "cleaned" official data. To make it clearer before proceeding ahead, our data work procedures described here focus only on identifying major inconsistencies in the official data, filling gaps, and making adjustment to inconsistencies and structural breaks accordingly. The procedures inevitably change "distributions" among industries and sectors, but they in principle do not challenge the "control totals" at various levels.

However, we will check whether the official control totals, especially the official aggregate GDP (GVA), is reliable in an international comparison at the end of the paper.

GVO and GVA in Nominal Terms

The indicators of GVO and GVA in the CIP 1.0 database are constructed based on the following official sources:

1) China's annual national accounts that give the "control totals" in value added for the aggregate economy and its broad sectors, available in annual volume of *China Statistical Yearbook*, published by NBS.
2) China's Input-Output Tables (CIOTs), published every five years since 1987 by DNEA of NBS, which give the "control totals" in both gross output and value added, though they are not always completely reconcilable with the national accounts.
3) The industrial statistics for 2-digit level industrial enterprises at or above the "designated size" (see the discussion of "coverage"), available in annual volume of *China Industrial Economy Statistical Yearbook*, published by DITS of NBS.
4) Since the national accounts are often adjusted following censuses, especially, the 1992 *Tertiary Sector Census*, the 1985 and 1995 Industrial Censuses, and the 2004 and 2008 National Economic Censuses, we also go through these censuses to compare the results of post-census adjustment with those published before the census for checking and understanding various revisions.

Although the CIP Project does not attempt to challenge the given "control totals", it makes the various sources of national totals controlled by the (adjusted) national accounts. To achieve this, we first focus on adjusting inconsistencies in industrial classification over time and between national accounts, available only with broad sector breakdowns, and industrial statistics and input-output tables that are available with higher digit-level breakdowns. Besides, the annual industrial statistics can also compensate for the infrequent input-output tables. We rely on different levels of industry details and frequencies that are available in published official sources to derive intra-industry group structures. We then use such group structures to break down or sum up available industry level data to achieve a consistent classification that conforms to the CSIC/2002. Based on the so-reconstructed national and industry level control totals, and the five full-scale CIOTs, we use the EU/KLEMS SUTRAS (Supply-Use Table RAS) program (see Temurshoev and Timmer, 2010) to generate a time series of COITs that are consistent with the reconstructed national accounts (see Appendix of Wu, 2012b). The procedures for different sectors are described below.

The Industrial Sector[6)]

1) The value added of the "formal sector" at industry level is defined by the sum of all independent accounting units with "legal person" statues regardless their ownership type, administrative level and size. Since there is no information provided in the national accounts or input-output tables that can be used to define the quantitative relationship between the "formal sector" and the "national total" over time, industry data from aforementioned industrial censuses (1985 and 1995) and economic censuses (2004 and 2008) are used to define such a relationship for all the benchmark years, that provide anchors for the hypothetical relationship over time.
2) Following our earlier discussion of the coverage, enterprises within the "formal sector" implicitly fall in two categories: one that covers enterprises in the regular reporting and monitoring system, which covers enterprises at/above the "designated size" since 1998 (see discussion below), and the other that includes those outside the system. However, the first category has shown an unreasonable increasingly fast growth rate since the 2000s such that its value added became the same as the national industrial value added in 2006.[7)] Double counting at various levels, data fabrications and incomparable samples may explain the illogical result. With little information, we have to rely on a hypothetical quantitative relationship between this category and the national total over the period of 2000-04 assuming its steady growth over the period 2005-08.
3) Within the readily available first category, systematic SOE data at industry level are

used as the "hard core" for the entire period. The industry level non-SOE data for enterprises at/above the "township level" prior to 1998 and at/above the "designated size" since 1998 are used to define the boundary of the first category at industry level.

4) The second category of the "formal sector" is constructed by less systematic data for enterprises at the "village level" (below the rural township level) prior to 1998 and below the "designated size" since 1998. To obtain industry information, in addition to the data from China's 1985 and 1995 Industrial Censuses, we also make use of data from other sources such as rural village-level enterprise data by the Ministry of Agriculture.

5) At the end of the last procedure, we are in a position to logically derive the industry data of the "informal sector" by subtracting the industry data of the "formal sector" from the national "control totals" that are based on the input-output table-adjusted national accounts.

Applicable to most of the above steps, since before China shifted to the System of National Accounts (SNA) in 1992, there were no statistics on value added but net value of output or by the definition of the Material Product System (MPS), net material product (NMP) (see Wu, 2000), we have to adjust NMP to the concept of gross value added by adding back an estimated capital consumption component.

The Agricultural Sector

Although the official statistics for the agricultural sector are not problem-free, the current stage of the CIP Project in principle adopts the official farm output estimates as they are. This follows Maddison's pioneer work that examined farm produces at a high level of details for the best selected benchmarks supported by his production-side purchasing power parity (PPP) estimates with the US counterparts as a reference. He concluded that the official estimates largely reflected the fundamental volume movement and hence acceptable with some minor adjustment (Maddison, 1998 and 2007).

However, Maddison did not consider that at this stage of economic development there can only be a fuzzy line between the agricultural sector and the informal sector in non-agricultural activities. That is, there is a grey area that encloses a large number of seasonal, temporary, part-time and multi-employment workers shifting back and forth between farming and informal manufacturing, construction and services (see discussion below on employment data). While it may not be easy to measure the working hours used by farm workers engaged in both agricultural and non-agricultural activities, it may be even more difficult to distinguish and estimate the output of these activities. This inevitably affects the output estimates for both agricultural and non-agricultural sectors. However, due to lack of necessary information for a further investigation and adjustment to the official estimates we assume that the construction of the national accounts has already taken this problem into account.

Construction and Services

Having covered the output of the industrial and agricultural sectors, the rest is logically belonged to the so-called tertiary sector of the economy that includes construction and all services. First of all, we decide to adopt the official output estimates for the construction sector because all fixed asset investment projects that are valued at or more than 0.5 million yuan are subject to strict administrative approval and control (NBS, 2011, p. 208) and ultimately the national accounts has adjusted for those projects below the 0.5 million yuan cut-off line. After this decision the rest is given and defines the boundary of all services.

Since we assume that the national "control totals" for the service as a whole and its major sub-sectors are given, any adjustment is made only for ensuring conceptual and classification consistency and only affects industry level estimates within their given sub-sectoral "control totals". In the CIP data construction, industry-level adjustment is made based on the Chinese input-output tables that provide more detailed industry breakdowns than the national accounts.

However, this is not to say that official output statistics for services are free of problems. It is widely acknowledged that informal activities are very common in some services such as transportation (mainly road and inland waterway transport services), retail trade, hospitality and catering services, as well as domestic services. Since the concept of informal activities is not officially accepted, economic censuses cannot clearly distinguish their output and employment. One of the main difficulties here is that a large number of workers engaged in such activities do not have full time job for one industry within one year. We are still searching for more useful information from other national surveys with a hope to improve the CIP estimates in future.

When considering the problem of service output, we cannot bypass a debate initiated by Maddison (1998). Empirical studies with established evidence have suggested that the labor productivity of the so-called "non-material services" (a MPS concept that includes non-market services) grew very slowly in general and for some services such as education, health care, government and personal and home services it might not grow at all. However, the labor productivity of such services in China grew at a surprisingly fast rate of 6.1 percent a year in 1978-2008. Maddison proposed a "zero labor productivity growth" hypothesis for such services to gauge their real growth in the Chinese economy, which has been criticized by Holz (2006 and also see Maddison 2006). However, with clear empirical evidence I have shown that there was indeed zero labor-productivity growth in non-material/non-market services in the period 1952-83 (see Wu, 2011a), which makes the post-reform super-fast growth of these services doubtful.

In the CIP Project, instead of adjusting the official output estimates based on strong assumptions as in Maddison (1998 and 2007), Maddison and Wu (2008) and Wu (2011a), we assume that the implausibly fast labor productivity growth in these services is only caused by improper measure of employment and prices. With the official output estimates given in the national accounts, we do not expect to solve the problem but hope it will shed some light on the direction of further adjustment.

Intermediate Input

Based on the work at sector and industry level as discussed, it follows that in nominal terms, the intermediate input at industry level can be simply derived from the estimates of value added and gross output as defined by the input-output relationship given by the benchmark input-output tables and the time series of the national accounts that are adjusted by the input-output tables.

Gross Output and Value Added at 2005 Prices

To deflate the gross output and value added, the CIP Project relies on three sources of price data:

1) The national accounts from which an implicit price deflator for value added by broad sector which can be derived from the reported value added in nominal terms and the reported growth index in real terms;
2) The NBS producer price indices (PPIs) for 2-digit industries of mining, manufacturing, and utilities (e. g. NBS, *CSY*, 2010, Tables 9-11 and 9-12); and
3) Ex-factory commodity prices that are internally available from a joint research project between IER/Hitotsubashi and NBS.

Sources (1) and (2) are used to derive constant 2005-yuan value added for the industrial sector. We do not use the implicit value added deflator obtained in the national accounts for the industrial sector not only because it lacks of industry details but also because it provides a slower price change over time compared with that of PPI, which is in line with the discussion in the literature that official GDP estimates may have underestimated price changes (see Wu, 2000; Woo, 1998; Ren, 1997; Jefferson *et al.*, 1996). Besides, for the period prior to 2000s the national accounts implicit deflators are still strongly influenced by the traditional "comparable price index" (CPPI) under the MPS[8) (Wu, 2011b).

The nominal output of all the sectors in the rest of the economy, including agriculture, construction and services, are deflated by their national accounts implicit value added deflators. This treatment is not ideal because it assumes that the same deflators are applicable to both the gross output and intermediate input. The plausibility of this treatment can only be assessed when the CIP Project adopts the double deflation approach in the accounting for China's real output.

Outstanding Issues

There are three major outstanding issues that are yet to be tackled in the next round of the CIP Project.

The first one is to develop a consistent series of output measures for the "first category" of the "formal sector" in industry that covers enterprises in the regular reporting and monitoring system. The main problem here is that the enterprises that are covered by the reporting system have become increasingly incomparable over time. Apparently, enterprise level data are required to first identify comparable firms in the system and then make growth estimation based data from these firms. Estimates for national industrial gross output and value added should also be checked with proper weights of these firms at industry level in the industrial sector.

The next issue is the unusually fast growth of the labor productivity of the so-called "non-material (including non-market) services". Although we cannot rule out any possibility of data frication in this case, the very fast labor productivity growth could have been caused mainly by two factors: the underestimation of numbers employed and the underestimation of price changes in these services. The first concern should be taken into account in the measurement of employment (see the next section) and the second concern should be taken into account in the future data work on prices when more information is available.

The last outstanding issue is output price. Given the imperfection of the official statistics on nominal outputs and their prices, hence unknown direction of the underlying biases, one may have a good reason to stick to the use of the single deflation approach to nominal output, but it is not justifiable for using the value added deflators for agriculture, construction and all services. In fact, the value added deflators become even more dubious when they are implicitly derived from the national accounts. A new effort that is deemed necessary is to construct PPI for each service using available price information in published price surveys. Furthermore, there is also a need for constructing a "price reform parameter" to take into account the impact of the planning and market tracks at industry level alongside the dual-track price reforms from the mid-1980s to the end of the 1990s.

5. Measuring Numbers Employed and Hours Worked

Numbers Employed

In this section, we first introduce the main sources of the employment data used in the CIP data construction, we then highlight the major problems found in the data, and finally we describe the procedures aiming to tackle the problems.

Sources of the Data

The main sources of the employment data are described as follows:

1) Industrial statistics for 2-digit level industrial enterprises at/above the "designated size" i.e. the first-category enterprises of the "formal sector" that are monitored in an annual reporting system, available in regular issues of *China Industrial Economy Statistical Yearbook*, published by DITS of NBS. This source provides a narrow coverage of an industry but at the highest level of industry details and also available by ownership type.
2) Labor statistics for 16 sectors of the economy, available in regular issues of *China Labor Statistical Yearbook*, published by DPES of NBS. This source provides the widest coverage but at lower level of industry details, also available by ownership type. Conceptually, it fully covers the "formal sector" of the economy. It also publishes total numbers employed for three broad sectors, primary, secondary and tertiary.
3) Economic census data for industrial and service activities that usually cover 3/4-digit level industries, available by ownership type. This group includes the 1985 and 1995 Industrial Censuses, the 1992 Tertiary Sector Census, and the 2004 and 2008 National Economic Censuses.
4) Population census and sample data on the employment status of the entire population published by the national census authorities, including the 1982, 1990 and 2000 Population Censuses and the 1987, 1995 and 2005 One-Hundredth Population Sample Surveys. However, only the 2005 One-Hundredth Population Sample Survey provides detailed employment data by industry and ownership, as well as data on migrant labor.

Major Problems

1) Following China's 1990 Population Census, there was a huge structural break in the

official labor statistics, showing that the total number of China's employment suddenly increased by 17 percent or 94.2 million in 1990. While the subsequent growth of the total employment has since based on this new level, the official employment estimates for major sectors have maintained their original trajectory, hence creating a big and increasing discrepancy between the aggregate number of employment and the sum of sectoral employments (Maddison and Wu, 2008; Wu, 2011a).

2) As a long tradition of the central planning system, industrial employment statistics also counted employees of an enterprise, typically a medium or large-sized state firm, who provided auxiliary services in the enterprise's education units, medical clinics, childcare centers, commercial outlets, and political organisations as long as they did not have independent accounting status. A change to separate these service units through commercialization began in the mid-1990s following the SOE reform but there has been no consistency adjustment in the official statistics (Wu and Yue, 2000).

3) In the Chinese labour statistics the quantity of employment has never been measured in its natural unit, i.e. hours worked, although institutional working hours were never the same across industries under the central planning system (Zhu, 1999). Since the reform, while there have been several reductions in the institutional working hours, there have also been increases in working hours in practice in labor intensive manufacturing industries especially after China's WTO entry. Nevertheless, these changes in working hours have not been considered in the literature (e.g. Bosworth and Collins, 2008; Hu and Khan, 1997; Chow, 1993).

<u>Data Construction Procedures</u>

In the CIP Project, we aim to construct China's labor accounts that can exactly match the national production accounts. The first task is to construct the numbers employed at industry level, which involves the following major steps:

1) Following what described in Wu (2011a), this step carefully investigates the relationship between the annual or regular employment statistics, constructed through the statistical reporting and monitoring system, and the employment data from the population census and sample survey for 1982 (census), 1987 (1% sample survey) and 1990 (census). It shows that the 1990 structural break could have appeared in 1982 if the 1982 census results of total employment were used for the national total without altering the annual employment estimates.

2) As Wu (2011a) argued, this is mainly an administrative error in the statistical system that did not take into account the result of a significant policy change in employment.[9] In this step, the adjustment for the 1990 structural break first follows a trend-deviation approach (Wu, 2007) that introduces a new trend between 1970 and 1990, with data for 1982 and 1987 as two fixed mid-points or "anchors", and then makes annual estimates based on both the new trend and the deviations from the original trend.

3) This step is to allocate the additional numbers of employment, as the result of the above adjustment, into the major sectors of the economy. To this end, we certainly need proper sectoral weights. One important consideration here is that this part of the employment in China contains most of migrant workers engaged in labor intensive manufacturing and services, and laborers working for small family businesses or simply self-employed; many of them are temporal, seasonal and multi-job workers. Based on this consideration and lacking necessary information, the additional laborers are allocated to agriculture, industry, construction and services but excluding the so-called "non-material/non-market services" (mainly banking, business services, government services etc.) using the existing sectoral weights (Wu, 2011a).

4) We now need to further allocate the additional laborers at sector level to industries. Note that at this stage of the CIP Project, we are only able to do this for the industrial sector largely due to data constraint. The additional laborers in the

non-industrial sectors are allocated according to intra-sectoral structure. The data work for the industrial sector in Wu and Yue (2010) serves as the basis for allocating the additional workers at industry level. The allocation uses the weights calculated based on the employment structure of industries engaging small enterprises (village-level or below the "designated size") and informal activities.

5) The results of the last step laid an important foundation for the allocation of the additional employment in the rest of the economy. To this end, we first identify and adjust for inconsistencies by reconciling all the available information for the formal activities at industry level in agriculture, construction and services. Due to insufficient information, we have difficulties to clearly determine the line between the "formal" and "informal" activities for many industries, and we do not have much information on ownership type that helps a lot in the case of the industrial sector. For this reason, we have some reservation on the quality of the results for the non-industrial sectors, though they do not appear to be highly implausible for the non-industrial sectors as a whole.

Hours Worked

There have been no systematic official estimates of hours worked. Published data on hours worked focus on weekly average hours worked of the state industrial sector. They are based on occasional surveys and processed in a way that covers up useful information at detailed industry and ownership levels, apparently to disguise unfavourable results, and hence requiring some methodological innovation to detect the "truth". It is not certain if we can eventually work out something that is meaningful and plausible based the limited information. Thus, in the CIP 1.0 the number-hour conversion is inevitably mechanical, especially for non-industrial sectors.

The approach used here in principle follows Wu and Yue (2010). It first makes the institutional standard of weekly working hours as the baseline based on the official calendar and its changes over time, and it then applies anecdotal information-based assumptions to adjust non-baseline industries. We assume that the state sectors follow the baseline, which is highly plausible, whereas non-state industries, especially labor-intensive and export-oriented industries, and retail trade as well as personal and domestic (household) services are assumed to work for much more hours per week.

Outstanding Issues

1) To us, matching China's labor accounts with production accounts is still a big unfinished task. The most important work in the next step is to establish a set of more appropriate weights with empirical evidence to allocate the additional laborers that have emerged as the huge discrepancy between the official annual employment estimates and the population census/survey-based estimates.

2) Our numbers-to-hours conversion is inevitable arbitrary. Considering the rigidity of the labor system before the urban and SOE reform, this problem mainly affects the estimates for the period after the mid 1990s. The main task is to search for more proper information on hours worked that is able to match the information on industry, occupation, employment status, and more ideally income. In particular, in the next round of the CIP Project we are exploring the possibility of making use of the survey data from China Household Income Project (CHIP, 2002 and 2007), the 2005 1% Population Sample Survey and the Fixed Observation Points from the Economic Research Center of the Ministry of Agriculture.

3) The fact that at least large-sized industrial SOEs have employed a large number of auxiliary service personnel (as high as 15-20 percent of the industry total) and included them in their industrial employment statistics blurs the true picture of labor input and affects the industry-level productivity accounting. However, removing such service personnel is much easier than reallocating them into proper service industries they are belonged to because there is no detailed information for breaking down their services.

6. Growth of Labor Productivity, Sectoral Contribution and Labor Re-allocation Effect

Aggregate and Industry-Level Labor Pro-

Table 1. Annual Growth of Value Added Per Hour Worked by Industry, 1987-2008
(Percent, 2005 constant RMB yuan)

Code*	Industry	1987-91	1992-96	1997-01	2002-08	*1987-08*
TT	**Total Economy**	**1.8**	**7.8**	**5.7**	**9.2**	**6.6**
AtB	*Agriculture*	*0.6*	*6.7*	*2.2*	*5.1*	***3.9***
C+D+E	*Mining, Manufacturing, Utilities*	*2.3*	*8.0*	*8.5*	*6.2*	***6.4***
FtP	*All Services*	*3.0*	*5.1*	*4.7*	*9.9*	***6.2***
AtB	Agriculture	0.6	6.7	2.2	5.1	***3.9***
C	Mining and Quarrying	−1.8	0.7	9.4	−1.3	***1.6***
15t16	Food, Beverages & Tobacco	7.0	11.4	5.7	5.9	***7.4***
17t18	Textiles and Textile Products	−2.3	13.7	4.3	8.1	***6.5***
19	Leather and Footwear	4.6	21.4	−7.3	7.2	***6.7***
20	Wood and Products	2.0	25.2	5.1	5.4	***9.4***
21t22	Pulp, Paper, Printing	0.2	19.0	5.7	2.9	***6.9***
23	Coke, Petroleum & Nuclear Fuel	−4.5	−8.4	12.6	−6.0	***−1.9***
24	Chemicals and Products	−0.4	8.9	17.0	2.6	***7.0***
25	Rubber and Plastics	5.4	19.4	3.7	5.4	***8.3***
26	Other Non-Metallic Mineral	10.5	12.1	11.7	9.3	***10.8***
27t28	Basic & Fabricated Metal	−0.8	9.3	12.6	6.5	***7.2***
29	Machinery, Nec	2.6	15.0	16.2	5.4	***9.7***
30t33	Electrical & Optical Equipment	3.5	16.5	11.4	7.0	***9.6***
34t35	Transport Equipment	7.9	20.9	21.2	10.8	***15.1***
36t37	Manufacturing, Nec; Recycling	15.5	−7.4	14.8	13.6	***9.3***
E	Electricity, Gas & Water	1.4	−0.2	5.6	9.6	***4.8***
F	Construction	0.7	7.8	0.9	8.6	***5.1***
50t52	Wholesale & Retail	−3.8	2.0	4.9	11.2	***4.6***
H	Hotels and Restaurants	7.1	8.2	5.6	5.4	***6.4***
60	Inland Transport	4.8	9.6	6.5	11.3	***8.5***
61	Water Transport	9.4	−10.4	36.9	5.9	***10.1***
62	Air Transport	10.2	20.2	9.5	−6.4	***6.9***
63	Other Transport & Travel	6.8	5.9	−6.1	20.2	***8.0***
64	Post & Telecommunication	12.4	24.8	20.4	9.3	***16.3***
J	Financial Intermediation	4.1	5.9	2.8	9.1	***5.9***
70	Real Estate Activities	6.7	0.4	−0.2	7.8	***3.9***
71t74	Other Business services	7.2	13.8	12.2	12.5	***11.7***
L	Public Admin and Defense	3.3	14.2	10.7	9.6	***9.7***
M	Education	5.4	11.8	8.6	9.3	***9.0***
N	Health and Social Work	6.1	17.7	9.9	9.9	***11.0***
O	Other Social & Personal Service	2.5	−5.6	3.7	11.2	***3.8***
P	Households services					

Source) Author's calculation based on data from CIP 1.0.
Notes) *Codes are based on EU/KLEMS system.

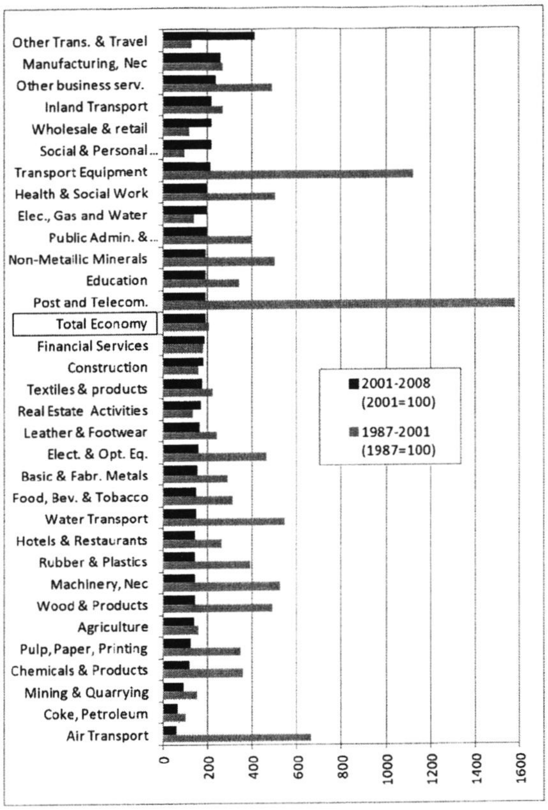
ductivity Change

The so-constructed data for gross value and value added, output prices, numbers employed and hours worked, and finally labor productivity by industry are provided in the CIP Database Round 1.0. Please refer to a set of appendix tables at the end of a related working paper (Wu, 2012b) for the growth rate of these basic indicators, plus value added ratio and average hours per person employed of the Chinese economy by industry.

After such a demanding, tedious and risk-taking (as pitfalls everywhere) exercise, an immediate question, perhaps a long awaited one, is whether the estimated results on China's industry-level labor productivity performance make sense. We are here ready for any critical challenge. What presented below is mainly to invite comment and suggestion based on the examination of the preliminary results.

We first examine the results on the growth of labor productivity by industry presented in Table 1. In this table we report results for four different sub-periods for capturing major policy regime shifts and business environment changes. The early industrial reform period is represented by the period 1987-91 that began with China's double-track reform-induced inflation and ended with the recessional aftermath of the Tiananmen turmoil (1989). The next period began with Deng's southern China trip in 1992 promoting bolder reform and ended with the government's self-imposed austerity. The following period 1997-2001 began with the Asian financial crisis (1997-98), followed by China's longest deflationary period post-reform, and ended up with China's WTO membership. The last period in the CIP 1.0 is from 2002 to 2008 that covered China's post-WTO period up to the collapse of the Lehman Brothers that

Figure 1. Labor Productivity Growth in China by Industry 1987-2001 versus 2001-2008, Ranked by the Value of 2001-08
(1987=100; 2001=100)



Source and Note) Author's estimation using CIP 1.0. Labor productivity is measured as value added per hour worked.

triggered the global financial and economic crisis.

Table 1 shows that the labor productivity of the total economy increased by nearly four folds by 2008 or growing by 6.6 percent per year. Among all sectors, "post and telecommunication service" experienced the fastest labor productivity growth, by about 30 folds from the initial level in 1987 or by 16.3 percent per annum. The second fastest labor productivity growing sector is the "manufacture of transportation equipment" growing by 24 folds over 1987 or by 15.1 percent per annum. However, that health care (11 percent), government service (9.7 percent) and business services (11.7 percent p.a.) also fall in what can be called the "super labor-productivity-growth club" raises a serious question about potential data problem in the measures of real output and employment. This is because, as discussed, these sectors do not show such a high labor productivity growth in the international experience. Rather, their labor productivity growth rate is typically very low or close to zero (Maddison, 2006). This finding may further support the suspicion (Maddison and Wu, 2008) about the reliability of the official estimates of the service value added, prices and employment for non-market services. By contrast, the labor productivity of mining merely grew by 1.6 percent per year and the labor productivity of petroleum and coking industry declined by 1.9 percent per year, likely suggesting inefficiency of the sectors and also a substantial resource constraint facing the economy.

For the total economy, the post-WTO period (2002-08) saw the fastest labor productivity growth by 9.2 percent per annum, which was followed by the deepening reform period (1992-96) with an annual labor productivity growth of 7.8 percent. The period with the Asian financial crisis and deflation (1997-2001) experienced a moderate labor productivity growth by 5.7 percent per annum, whereas labor productivity merely grew by 1.8 percent per annum in the early industrial reform period (1987-91). Besides, cross-industry labor productivity performances over the four periods show a clear decline of labor productivity variation across industries shown by a significant drop in the coefficient of variation from 1.124 in 1987-91 to 0.697 in 2002-08, suggesting increased market competition likely due to WTO-improved market institutions.

As shown in Figure 1, the results appear to be more meaningful if considering the institutional and political shocks in the earlier period compared with the much improved situation following the WTO entry. Prior to the WTO entry, the labor productivity performance across industries changed drastically between the periods. Deng's new reform period greatly stimulated the labor productivity growth of labor-intensive manufacturing (textiles, leather, paper and rubber and plastics), whereas the following the Asian financial crisis metals, machinery and chemicals substantially improved their performance. The rather unbalanced changes of the labor productivity performance across industries reflect the restructuring of the economy mainly caused by reform-induced corrections to the previous distortions which had an important bearing on the resource allocation in the Chinese economy. However, Figure 1 seems to suggest that the drastic restructuring period is over following China's WTO entry.

Contribution by Individual Industries and Resource Reallocation Effect

To see how industries' own labor productivity performance and reallocation of resources between industries as a result of productivity changes across industries affected the aggregate labor productivity changes, we can conduct an analysis using a method presented in Equation 4. With this method, the annual growth of labor productivity for the total economy can be decomposed into two components, a contribution from individual industries and an overall labor reallocation effect across all the industries. The key point here is that if labor is basically awarded by their marginal product, which should be "reflected" in the average labor productivity at industry level, it will shift to industries where the average labor productivity is higher, its growth rate is faster or both. Other things being equal, this approximate measure of the "labor reallocation effect" is considered to be able to boost the labor productivity of the total economy.

$$\begin{aligned}\Delta\ln y_t &= \textstyle\sum_i \bar{\omega}_{i,t}\,\Delta\ln y_{i,t} \\ &\quad + \left(\textstyle\sum_i \bar{\omega}_{i,t}\,\Delta\ln H_{i,t} - \Delta\ln \textstyle\sum_i H_{i,t}\right) \qquad (4) \\ &= \textstyle\sum_i \bar{\omega}_{i,t}\,\Delta\ln y_{i,t} + R_t\end{aligned}$$

where $\bar{\omega}_{i,t}\,\Delta\ln y_{i,t}$ stands for weighted the labor productivity growth of the ith industry at time t, $\bar{\omega}_{i,t}$ stands for the nominal income weight of the industry, and the difference between weighted growth of hours ($\sum_i \bar{\omega}_{i,t}\,\Delta\ln H_{i,t}$) and non-weighted growth of hours ($\Delta\ln \sum_i H_{i,t}$) is defined as the labor reallocation effect, R.

Table 2 presents the sectoral contribution to, and a labor reallocation effect on, the labor productivity growth of the total economy. It shows that for the entire period 1987-2008 there is about 10 percent of the annual 7.3 percent labor productivity growth that could be attributed to the labor reallocation effect.

It is also interesting to see how the contribution of the labor reallocation effect changed over the sub-periods that defined by major policy regime shifts. We expect that the changes may suggest how reforms and market forces affected labor reallocation across sectors that promoted or slowed down the growth of labor productivity. Obviously, the most significant contribution to labor productivity growth by labor reallocation is observed following China's WTO entry (2002-08), representing a gain from broader (international) market-based competition and restructuring of the economy. The period 1992-96 also experienced positive gain from labor reallocation largely due to market-oriented reforms to the state sector which caused a significant restructuring of the economy. On the other hand, following the Asian financial crisis in 1997-98 and a long deflationary macroeconomic environment China suffered a loss in labor reallocation in 1997-2001. It is likely caused by the sudden contraction of the pre-crisis fast growing sectors and inflexible labor market that is unable to reallocate labor to productive sectors.

Figure 2 shows a dynamic change of sectoral contribution to and labor reallocation effect on China's labor productivity growth. It also compares the results measured by numbers employed and hours worked. The comparison shows that the change of labor productivity becomes more volatile if we shift the measure from numbers to hours-based. This suggests that the adjustment of hours worked when market changes or policy adjusts is more flexible than the adjustment of numbers employed. If this is true, reforms aiming at removing labor market inflexibility may further raise labor productivity.

7. Assessing the Quality of the CIP 1.0 Data by an International Comparison

The quality of the CIP 1.0 data may be assessed in an international comparison among some economies at the same or similar stage of economic development. To me it is sensible to compare the Chinese economy with its East Asian counterparts. Conceptually, if the stage of development is given by per capita income level, labor participation rate and hours worked per employed person are important factors to assess whether China's labor productivity performance using the CIP 1.0 data is in line with the international experiences.

Let Y stand for the real income or GDP of an economy, N for the number of population, L for the number of employment and H for the number of hours worked in the same economy.

Table 2. Accounting for Sectoral Contribution to and Labor Re-allocation Effect on Labor Productivity Growth, 1987-2008

(Based on per hour worked in percent; percentage point in sectoral contribution)

		1987-91	1992-96	1997-01	2002-08	***1987-08***
	Total Economy					
TT	*Labor productivity growth*	*2.24*	*9.15*	*6.11*	*9.23*	*7.33*
TT	*- Sum of sectoral contribution*	*2.04*	*8.41*	*7.02*	*7.49*	*6.57*
TT	*- Labor re-allocation effect*	*0.20*	*0.74*	*−0.91*	*1.75*	*0.76*
	Sectoral contribution					
AtB	Agriculture	0.15	1.36	0.36	0.61	***0.71***
C	Mining and Quarrying	−0.07	0.03	0.36	−0.06	***0.06***
15t16	Food, Beverages & Tobacco	0.28	0.52	0.26	0.23	***0.31***
17t18	Textiles and Textile Products	−0.09	0.56	0.16	0.23	***0.24***
19	Leather and Footwear	0.02	0.14	−0.05	0.04	***0.04***
20	Wood and Products	0.01	0.17	0.04	0.04	***0.07***
21t22	Pulp, Paper, Printing	0.00	0.25	0.09	0.04	***0.09***
23	Coke, Petroleum & Nuclear Fuel	−0.06	−0.09	0.11	−0.06	***−0.02***
24	Chemicals and Products	−0.01	0.30	0.55	0.09	***0.24***
25	Rubber and Plastics	0.06	0.27	0.06	0.08	***0.12***
26	Other Non-Metallic Mineral	0.30	0.42	0.39	0.23	***0.32***
27t28	Basic & Fabricated Metal	−0.03	0.46	0.53	0.32	***0.33***
29	Machinery, Nec	0.10	0.53	0.51	0.17	***0.33***
30t33	Electrical & Optical Eq.	0.09	0.51	0.44	0.33	***0.36***
34t35	Transport Equipment	0.09	0.37	0.39	0.25	***0.27***
36t37	Manufacturing, Nec; Recycling	0.17	−0.05	0.09	0.09	***0.07***
E	Electricity, Gas & Water	0.03	0.00	0.14	0.30	***0.12***
F	Construction	0.03	0.47	0.05	0.48	***0.28***
50t52	Wholesale & Retail	−0.33	0.16	0.40	0.89	***0.38***
H	Hotels and Restaurants	0.12	0.17	0.12	0.12	***0.13***
60	Inland Transport	0.17	0.37	0.24	0.41	***0.31***
61	Water Transport	0.06	−0.04	0.27	0.07	***0.08***
62	Air Transport	0.02	0.07	0.04	−0.02	***0.02***
63	Other Transport & Travel	0.07	0.06	−0.05	0.15	***0.07***
64	Post & Telecom.	0.06	0.20	0.32	0.23	***0.23***
J	Financial Intermediation	0.20	0.28	0.12	0.35	***0.25***
70	Real Estate Activities	0.23	0.02	−0.01	0.36	***0.16***
71t74	Other Business services	0.13	0.28	0.34	0.45	***0.31***
L	Public Admin and Defense	0.06	0.31	0.33	0.36	***0.28***
M	Education	0.10	0.24	0.23	0.29	***0.22***
N	Health and Social Work	0.05	0.16	0.13	0.16	***0.13***
O	Other Social & Personal Ser	0.03	−0.07	0.07	0.25	***0.06***
P	Households services					

Source) Author's estimation based on data from CIP 1.0.
Note) Labor productivity is measured as value-added per hour worked compared with that in Table A7 based on value-added per person employed. Sectoral contribution is nominal output weighted and reported in percentage point; labor productivity growth and re-allocation of labor for the total economy are in percent per annum (see Equation 4).

Here we assume that there is no unemployment for simplicity. Then, per capita income can be defined as, $\Psi_1 = Y/N$, output per employed person as $\Psi_2 = Y/L$ and output per hour worked as $\Psi_3 = Y/H$. Therefore, we have the following accounting identity:

$$Y_t \equiv \Psi_{1t}N_t \equiv \Psi_{2t}L_t \equiv \Psi_{3t}H_t. \tag{5}$$

If considering introducing two variables, labor participation rate, $\lambda = L/N$ (equal to employment rate as we have assumed there is no unemployment of labor) and the average hours worked per employed person, $\eta = H/L$, we can have the following relationship:

$$Y_t = \Psi_{1t}N_t = \Psi_{2t}(\lambda_t \cdot N_t) = \Psi_{3t}(\eta_t \cdot L_t). \tag{6}$$

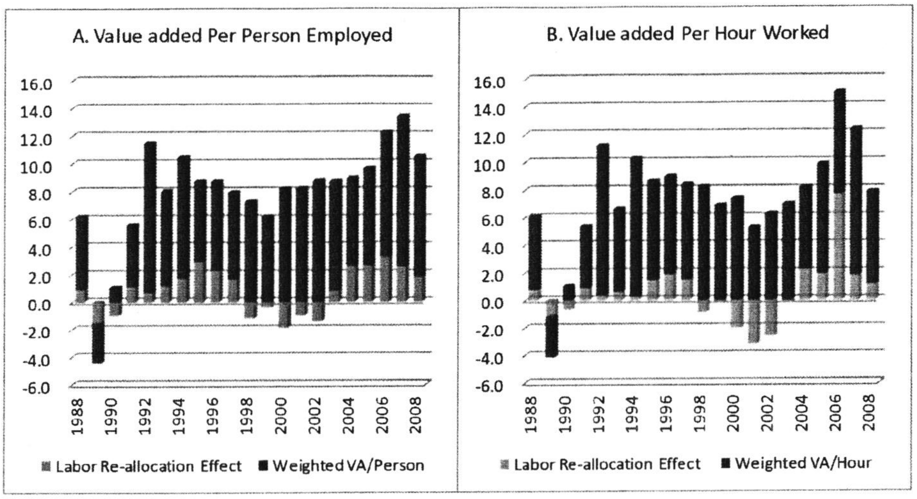
This implies that per capita income is a function of hourly output, labor participation rate, and average hours per employed person, i.e.

$$\Psi_{1t} = f(\Psi_{3t}, \lambda_t, \eta_t). \tag{7}$$

Following the above discussion, all the economies in the comparison have the same level of Ψ_{1t} or at the same stage of development. If we temporarily assume that all the economies use similar technology the labor productivity measured by the average output of per hour Ψ_{3t} should also be given. This is a strong assumption because although their stage of development is the same their resource endowments are different. We will revisit this assumption later. This assumption implies that labor participation rate is negative related to average hours per employed person, i.e.

$$\frac{\overline{\Psi}_{1t}}{\overline{\Psi}_{3t}}\lambda_t^{-1} = \eta_t. \tag{8}$$

Figure 2. Labor Productivity Growth and Re-allocation Effect, 1987-2008
(Percent)



Source) Author's estimation based on data from CIP 1.0.
Note) See Table 2.

Holding Equation 8, we can show that output per employed person can also be affected by the average hours worked per employed person and labor participation rate. Since $\Psi_{2t}(\lambda_t \cdot N_t) = \Psi_{3t}(\eta_t \cdot L_t) = \Psi_{3t}(\eta_t \cdot \lambda_t \cdot N_t)$, if the hourly output is given in an economy, output per employed person should be positively related with the average hours worked per employed person, i.e.

$$\Psi_{2t} = \overline{\Psi}_{3t} \cdot \eta_t. \tag{9}$$

From Equations 8 and 9, we know that output per employed person is negatively related with labor participation rate, i.e.

$$\Psi_{2t} = \overline{\Psi}_{3t} \cdot \eta_t = \left(\frac{\overline{\Psi}_{1t}}{\lambda_t \cdot \eta_t}\right)\eta_t = \frac{\overline{\Psi}_{1t}}{\lambda_t}. \tag{10}$$

Following this conceptual set up, using the data from the Total Economy Database (TED) produced by The Conference Board (TCB) (2012), which is essentially an update of the Maddison Database,[10] I pick up three East Asian economies for the comparison, i.e. Japan, South Korea and Taiwan. To define a similar stage of development in the four countries, China's per capita GDP should be used as the reference. However, the Chinese data in the TED are based on the Maddison database (see Maddison and Wu, 2008) that has adjusted the official GDP estimates. This is different from the CIP 1.0 which has adopted the official GDP estimates. Since our purpose here is to check if the results using the CIP 1.0 data are in line with other economies at the same stage of development, we use a (rough) GK PPP-adjusted official GDP estimates in this comparison rather than the China data in the TED. Note that even if we have a concern about the quality and reliability of the official estimates (Maddison and Wu, 2008; Wu, 2011a and 2011b), accepting the official GDP in defining the stage of development is the starting point of this checking exercise.

As shown in Table 3, since China's per capita PPP GDP was about GK\$2009 in 1992 and increased to about GK\$8586 in 2008, I set the starting point as (around) GK\$2000 and the ending point as (around) GK\$8500. To most closely match the stage of China, the similar stage of development for Japan was the period 1951-69 in which its per capita PPP GDP increased from GK\$2126 to GK\$8874, for South Korea it was the period 1969-90 in which its per capita PPP GDP rose from GK\$2040 to GK\$8704, and for Taiwan it was the period 1967-87 in which its per capita PPP GDP rose from GK\$2070 to GK\$8598.

Based on this comparable development stage setting, if labor productivity is measured as per employed person, South Korea and Taiwan were very close and much higher than that of Japan and China which was located at the bottom. At the beginning of this stage, the labor productivity of South Korea and Taiwan was GK\$6931 and GK\$7048, respectively, com-

Table 3. China's Labor Productivity in Comparison with Other Asian Economies at Similar Level of Per Capita GDP
(Measured in 1990 PPP GDP$)

China (1992-2008)			Japan (1951-1969)			South Korea (1969-1990)			Taiwan (1967-87)		
GDP per capita	GDP per person employed	GDP per hour worked	GDP per capita	GDP per person employed	GDP per hour worked	GDP per capita	GDP per person employed	GDP per hour worked	GDP per capita	GDP per person employed	GDP per hour worked
2,009	2,836	2.03	2,126	4,719	2.27	2,040	6,931	2.75	2,070	7,048	2.53
2,262	3,069	2.26	2,336	5,187	2.50	2,167	7,266	3.01	2,186	7,334	2.63
2,530	3,486	2.53	2,474	5,493	2.65	2,332	7,711	3.11	2,334	7,500	2.69
2,777	3,935	2.78	2,582	5,732	2.76	2,456	7,930	3.12	2,537	8,353	2.99
3,021	4,401	3.02	2,771	6,151	2.96	2,824	8,795	3.40	2,804	8,796	3.15
3,265	4,823	3.27	2,948	6,064	2.84	3,015	9,159	3.48	3,113	9,544	3.42
3,488	5,237	3.53	3,136	6,340	2.94	3,162	9,541	3.60	3,448	10,003	3.67
3,721	5,655	3.79	3,289	6,682	3.06	3,476	10,044	3.67	3,422	9,826	3.73
4,003	6,038	4.03	3,554	7,230	3.28	3,775	10,735	3.97	3,522	10,245	3.89
4,298	6,425	4.11	3,986	7,992	3.60	4,064	11,217	4.10	3,918	11,360	4.31
4,653	6,888	4.28	4,426	8,831	3.97	4,294	11,849	4.36	4,236	11,867	4.49
5,099	7,378	4.59	4,777	9,497	4.31	4,114	11,463	4.24	4,717	12,937	4.87
5,589	7,963	4.97	5,129	10,214	4.65	4,302	11,879	4.42	4,998	13,557	5.10
6,180	8,700	5.50	5,668	11,258	5.11	4,557	12,464	4.45	5,260	14,291	5.54
6,927	9,517	6.25	5,934	11,725	5.37	5,007	13,776	4.96	5,489	14,887	5.98
7,876	10,506	7.01	6,506	12,712	5.80	5,375	15,051	5.46	5,590	15,102	6.04
8,586	11,766	7.43	7,152	13,854	6.28	5,670	15,457	5.60	5,979	15,777	6.34
			7,983	15,382	6.96	6,263	16,648	6.17	6,521	16,881	6.78
			8,874	17,171	7.82	6,916	17,601	6.35	6,762	17,431	7.13
						7,621	18,988	6.81	7,477	18,693	7.59
						8,027	19,405	7.10	8,598	20,939	8.50
						8,704	20,633	7.68			

Source) *The Conference Board Total Economy Database 1950-2010* (http://www.conference-board.org/data/economydatabase/).
Note) The Conference Board PPP GDP is measured using the Geary-Khamis approach. Matching labor productivity level to that of China is highlighted.

pared with GK$4719 in the case of Japan and GK$2836 in the case of China. At the end of this stage, it increased to GK$20633 in the case of South Korea and to GK$20939 in the case of Taiwan, compared with GK$17171 achieved by Japan and GK$11766 by China.

However, if labor productivity is measured as per hour, China does not appear to be as a big outlier as it is measured as per employed person. China began with a level of GK$2.03, closer to that of Japan (GK$2.27) though still 20-25 percent lower than that of Taiwan (GK$2.53) and South Korea (GK$2.75), and ended with a level of GK$7.43, much closer to GK$7.82 and GK$7.68 in the case of Japan and South Korea, though 13 percent lower than GK$8.50 in the case of Taiwan.

Following the earlier conceptual discussion (see Equations 8 to 10), the position of China in the comparison suggests a higher labor participation rate or fewer hours worked per person or both compared with other economies. At the beginning of this stage, China's labor participation rate was 57 percent (equal to employment rate as assumed), which was much higher than 45 percent in the case of Japan and almost doubled that of both South Korea and Taiwan, i. e. 29 percent. By the end of this stage, China's labor participation rate maintained at similar high level of 59 percent, which was 13, 38 and 42 percent higher than that of Japan, South Korea and Taiwan, respectively.

On the other side of the coin, at the beginning of this stage, China's average hours per employed person was 1747 a year (CIP 1.0), which was only 85 percent of the level of Japan, 69 percent of the level of South Korea and 63 percent of the level of Taiwan. Compared with other economies, China had a much larger share of employment in agriculture with a serious labor underemployment problem due to a higher degree of labor surplus. By the end of this stage, China's average hours increased to 1982 a year, still 90 percent of the level of Japan (2196) and 75-80 percent of that of South Korea (2688) and Taiwan (2462). Here, it seems logical to conclude that if we can accept the so-constructed CIP 1.0 data for China, the Chinese appear to work less but with higher labor productivity than their East Asian neighbors. Can this be true?

Labor participation rate is subject to traditional and social conditions or constraints. If assuming such constraints will affect the choice of technology, i.e. choosing more labor or capital-intensive technology, but not affect the economic growth, we can explore the effect of the application of China's labor participation rate to other economies holding their level of per capita GDP constant. This exercise has given us some very interesting results in terms of output per employed person. At the beginning of this stage of development, the output per employment person in Japan (GK$3762 in 1951), South Korea (GK$3611 in 1969) and Taiwan (GK$3664 in 1967) could have been very close to that of China (GK$3710, an average of 1994-95). At or closer to the end of this stage, compared with China's GK$11766 in 2008, Japan could have been GK$12276 in 1967, South Korea could have been GK$11815 in 1987 and Taiwan could have been GK$11552 in 1985. No one appears to be an outlier.

Continuing this exercise, if we assume that none of the economies will change their average working hours per person a year — it is unreasonable to assume that the choice of a more labor-intensive technology will come with an adoption of fewer annual working hours, this turns out to a much higher hourly output in China than in other economies. At the end of this stage of development, using the three-year average labor productivity per hour worked, China was GK$6.9 (an average of 2006-08), which was 11 percent higher than that of Japan (GK$6.2), 36 percent higher than that of South Korea (GK$5.1) and 30 percent higher than that of Taiwan (GK$5.3). It should be however more logical if Japan was the productivity leader, followed by South Korea and Taiwan.

This exercise may suggest that either China's average number of hours worked per person has been underestimated or China's output per hour worked in real terms has been exaggerated or perhaps both by the CIP 1.0.

8. Ending Remarks

This paper describes the contents, the sources of raw data and detailed procedures for the construction of the first version of the Chinese Industrial Productivity (CIP) Database, i.e. the CIP Round 1.0, which contains indicators of output, prices, employment and labor productivity for 32 industries in line with the (re-grouped) EU/KLEMS standard of industrial classification for the period 1987-2008 and a set of reconstructed five Chinese Input-Output Tables (1987, 1992, 1997, 2002 and 2007) using the Supply-Use Table RAS (SUTRAS) approach adopted in WIOD-EU/KLEMS. It also discusses outstanding methodological and data problems, especially in measuring prices and hours worked. It aims to invite constructive comments and suggestions from the research community in order to further improve the database.

Using the constructed data this paper also provides a preliminary measure of labor productivity at industry level and analyzes industry contribution to and labor reallocation effect on the aggregate labor productivity performance of the Chinese economy. Policy

Table A1. Value Added/Gross Output Ratios of the Chinese Economy, 1987-2008
(Percent)

		1987-91	1992-96	1997-01	2002-08
TT	**Total Economy**	**42.3**	**38.7**	**38.4**	**35.1**
AtB	*Agriculture*	*66.3*	*62.5*	*59.1*	*58.4*
C+D+E	*Mining, Manufacturing, Utilities*	*30.9*	*28.5*	*29.1*	*25.3*
FtP	*Construction and Services*	*48.4*	*46.4*	*46.1*	*46.3*
AtB	Agriculture	66.3	62.5	59.1	58.4
C	Mining and Quarrying	55.4	49.5	54.1	51.6
15t16	Food, Beverages & Tobacco	26.0	26.5	29.0	27.0
17t18	Textiles and Textile Products	23.3	24.1	28.4	22.7
19	Leather and Footwear	23.5	21.3	21.7	20.3
20	Wood and Products	28.2	27.6	29.4	24.7
21t22	Pulp, Paper, Printing	30.1	28.9	32.7	28.3
23	Coke, Petroleum & Nuclear Fuel	32.7	25.0	19.9	17.5
24	Chemicals and Products	31.0	28.4	27.7	23.5
25	Rubber and Plastics	27.1	24.9	25.0	21.5
26	Other Non-Metallic Mineral	37.6	33.4	32.1	29.7
27t28	Basic & Fabricated Metal	29.5	24.6	22.5	21.6
29	Machinery, Nec	31.7	30.6	31.6	25.1
30t33	Electrical & Optical Eq.	27.8	25.2	23.5	19.2
34t35	Transport Equipment	28.2	26.5	26.2	22.1
36t37	Manufacturing, Nec; Recycling	28.4	29.2	38.0	38.5
E	Electricity, Gas & Water	52.9	46.5	45.4	35.9
F	Construction	29.1	29.2	26.5	23.3
50t52	Wholesale & Retail	48.1	47.4	52.2	57.5
H	Hotels and Restaurants	32.9	41.0	41.6	38.8
60	Inland Transport	58.7	57.3	58.5	59.4
61	Water Transport	59.8	44.8	36.2	42.7
62	Air Transport	44.4	40.9	39.4	29.9
63	Other Transport & Travel	62.5	53.4	42.5	39.0
64	Post & Telecom.	72.1	63.9	56.3	57.3
J	Financial Intermediation	68.2	55.5	62.2	66.8
70	Real Estate Activities	71.3	75.5	74.8	78.8
71t74	Other Business services	44.8	45.0	41.6	42.8
L	Public Admin and Defence	54.9	46.7	47.3	53.1
M	Education	63.8	63.9	56.8	58.2
N	Health and Social Work	40.3	38.7	39.0	40.3
O	Other Social & Personal Ser	56.5	48.3	46.2	45.3
P	Households services				

Source) Author's calculation based on data from CIP 1.0.

implications from the results are discussed against the background of policy regime shifts.

These results are put in an assessment in an international comparison exercise. After taking into account much higher labor participation rate in China compared with other economies, China's labor productivity performance measured by hourly output still appears to be an outlier. This may suggest that either China's average number of hours worked per person has been underestimated or China's output per hour worked in real terms has been exaggerated by the CIP 1.0. If this is true, our defined stage of economic development for all the economies in the comparison has to be revised. This assessment helps us set up our top priority in the next round of the CIP project that includes the construction of PPI for services and the use of double deflation approarch in the input-output tables to obtain alternative estimates of the real value added, and the collection of more information on hours worked at industry level to develop a more appropriate number-to-hour conversion approach for the next round of the CIP data work.

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Acknowledgment

* This paper is a revised version of a RIETI Discussion Paper that introduces the first version of the CIP Database (http://www.rieti.go.jp/en/database/CIP2011/index.html). I am indebted to Hiroshi Sato for his constructive discussion of the paper and Keiko Ito and Gaaitzen de Vries for their efforts in the reconstruction of the Chinese input-output tables. Comments and suggestions from participants at the IER and RIETI Seminars and from Kyoji Fukao, Tomohiko Inui, Keiko Ito, Gaaitzen de Vries, Tangjun Yuan and Xinxin Ma at the CIP project meetings are also gratefully acknowledged. I also thank Reiko Ashizawa, Lena Maruyama, Jiming Wang and Guang Zhang for their help in data collection and processing.

The CIP project has also benefited from scholarly exchanges with the EU/KLEMS Project based in the Groningen Growth and Development Center (GGDC) at the University of Groningen, the World KLEMS Project at Harvard University, and The Conference Board China Center. I am responsible for all errors and omissions.

Notes

1) Note that in 2007 the "designated size of 5 million yuan" was changed from the annual sales of *all* production or business to the annual sales by major activities only. Since 2011, the value of annual sales by *major* activities has been increased from 5 to 20 million yuan (NBS, 2011), creating further difficulties in maintaining data consistency.

2) The official industrial statistics show that in 2006 the sum of the value added by the enterprises at/above "designated size" was equal to China's industrial GDP which leaves 24 million employed by the below "designated size" enterprises and 43 million employed outside the reporting system producing nothing. It is even more illogical that the same source of the official statistics show that in 2007 and 2008 the value added produced by the "designated size" enterprises exceeded the national industrial GDP by 6 percent and 10%, respectively (see Wu, 2011a).

3) For many analyses it is useful to subdivide total intermediate inputs into three groups: energy, materials and services (*E, M, S*), which is beyond the scope of the current stage the CIP Project.

4) For the industry-level data construction of the industrial sector and the standard and alternative growth accounting exercises using the data see Wu (2012a), Corrado and Wu (2012) and Milana and Wu (2012).

5) Also see Wu (2000) for a comprehensive review.

6) Refer to Wu (2012a) for details.

7) This serious inconsistency is illogical because it has left the rest of the enterprises in the "formal sector" as well as those in the "informal sector" producing nothing in 2006 and a significantly negative output afterwards. It appears that there are serious coordination problems in work between the industrial statistics (DITS) and the national accounts (DNEA). The latter has apparently made adjustments for the inconsistency in its annual estimates but without giving any explanation. As an outsider, all we can hear from NBS is that "any post-release adjustment is normal". However, in 2008 DITS stopped providing value added estimates for the "above size" enterprises and rather surprisingly, the "value added" indicator disappeared from the report of the 2008 National Economic Census.

8) The NBS practice of CPPI stopped after 2002 with CPPI's last or 1990 benchmarked index for the period 1990-2002 (see Wu 2011b).

9) This structural break is caused by the fact that the official annual employment estimates did not take into account the activities emerged outside the labor planning and administration system as the result of a significant policy change in the early 1970s that encouraged small, collective enterprises to employ surplus labor especially in rural areas. Such a policy was substantially enhanced alongside the economic reform first in agriculture in 1978 and then in industry in 1984 (Wu, 1994; 2011a).

10) http://www.ggdc.nl/maddison.

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