CHINA’S GROWTH AND PRODUCTIVITY PERFORMANCE DEBATE REVISITED*
- Accounting for China’s Sources of Growth in 1949-2010 with A Newly Constructed Data Set

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ABSTRACT
Given that most of the existing studies on the sources of China’s growth are conducted in the same or very similar neoclassical growth accounting framework, the long and still inconclusive debate about China’s growth and productivity performance is logically and essentially caused by serious data and measurement problems. Based on my persistent efforts on China’s macro-measurement problems, this study presents a series of careful investigations in both input and output data problems in the Chinese statistics, especially those often ignored or mishandled in the previous studies, including a serious structural break in the official employment data, an abnormally high post-reform labor productivity growth in the non-market services (including the so-called “non-material” services in the old MPS statistics), a severe inconsistency between the official industrial statistics and national accounts in value added including an odd counter-cyclical movement of the industrial output by the below “designated-size” enterprises, and main conceptual and measurement problems in the official measure of fixed asset investment. These investigations have led to the construction of a new data set for the aggregate economy and its major sectors. Under the most reasonable scenario, my new estimates show that China’s annul TFP growth is -0.7 percent in the planning period and merely 1 percent in the reform period, substantially lower than the TFP estimates obtained using the unadjusted official GDP estimates and investment data and deflators, -0.2 and 4.2 percent, respectively.

Key words: Data and measurement problems in China’s production and employment accounts; estimation of physical and human capital stock; sources of growth in China.

JEL Classification: E10, E20, O47

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1. INTRODUCTION

The sources of China’s post-reform growth performance have been the subject of a heated debate. It draws particular attention whenever the China model of reform and development is questioned. The center of the debate is whether China’s growth during the reform period is attributed mainly to productivity growth or to factor accumulation. Although more and more studies have participated in the debate, it has remained inconclusive (Y. Wu, 2011). Using the estimated total factor productivity (TFP) for the Chinese economy in the literature, which is a productivity measure in the neoclassical growth accounting framework that is considered crucial for the quality and sustainability of an economy’s growth, we may approximately categorize the existing studies into two opposite groups, namely, an “optimistic camp” versus a “pessimistic camp”.

The “optimists” may be represented by the most recent studies by Perkins and Rawski (2008) and Bosworth and Collins (2008) both attributing over 40 percent of China’s post-reform growth to TFP, that is, 3.8 percent of annual TFP growth for the period 1978-2005 in the former and 3.6 percent for 1978-2004 in the latter.¹ The “pessimists” may be represented by Young’s study (2003) which only estimates China’s TFP growth at 1.4 percent per year for the period 1978-1998. Since Young only covers the non-agricultural economy, one may argue that his estimate for the TFP growth would have been even lower if agriculture were included, that is, at best TFP contributed no more than 15 percent of the growth in that period.² There are, however, estimates standing in between which includes an estimate of 2.4 percent of annual TFP growth for the period 1978-1999 in Wang and Yao (2002) and 2.5 percent for 1982-2000 in Cao et al. (2009).

There are also contradictory findings for more comparable but shorter periods. For example, for the reform period up to the mid-1990s (1978/79-94/95), China’s

¹ There are studies that obtain the estimates of annual TFP growth rate around 3 percent including the work by Ren and Sun (2005) which estimated an annual TFP growth at 3.2 percent for 1980-2000, Maddison’s revised estimate (2007a) of 3 percent for 1978-2003, and an estimate of about 3 percent by He and Kuijs (2007) (an approximate average of 3.3 for 1978-93 and 2.8 for 1993-2005), though the periods covered in these studies are less comparable.

² Kalirajan et al. (1996) found that TFP growth in Chinese agriculture was negative in 16 of China’s 29 provinces in 1984-87 after a positive growth in almost all provinces in 1978-84. Mao and Koo (1997) found that 17 out of China’s 29 provinces experienced a decline in “technical efficiency” in 1984-93 in agricultural production.
annual TFP growth rate is estimated at 3.8 and 3.9 percent in Borensztein and Ostry (1996) and in Hu and Khan (1997), and even as high as 4.2 percent in Fan et al. (1999). These results can be compared with a low estimate at 1.1 percent by Woo (1998). Maddison’s (1998a) earlier estimate of 2.2 percent stands in between.³

Other examples can be found for the next period between the mid-1990s to the early and mid 2000s. An optimistic estimate of the annual TFP growth rate for this period can be as high as 3.9 percent (1993-2004) in Bosworth and Collins (2008) and 2.8 percent (1993-2005) by He and Kuijs (2007), compared with a very pessimistic result of only 0.6 percent (1995-2001) by Zheng and Hu (2005) or even a negative value of -0.3 percent (1994-2000) by Cao et al. (2009).

Drawn on these very different findings, two conflicting views about the productivity performance of the Chinese economy have emerged in the debate. On one side, Bosworth and Collins (2008) concluded that their findings had set China “apart from the East Asian miracle of the 1970s and 1980s, which was more heavily based on investment in physical capital,” and that “China stands out for the sheer magnitude of its gains in total factor productivity” (p. 53). By contrast, Young (2003) concluded that the productivity performance of China’s nonagricultural sector during the reform period is, while respectable, not outstanding. [Here, to add Zheng & Hu (2005) and Cao et al. (2009).] This is in line with Krugman (1994)’s earlier comment that just as the case of other Asian economies China would face a limit on growth sooner or later since it depended on massive increase in inputs with only small improvement in productivity.

How much can we really learn from this debate with such conflicting empirical findings? If the findings by the “optimistic camp” can be accepted, how to explain the contrast between such a high TFP contribution to growth in post-reform China and the much poorer TFP performance in other East Asian economies which also pursued a similar export-oriented development supported by government policy, as found by Young (1992, 1994a, 1994b, 1995) and Kim and Lau (1994) among others. Some may argue that China’s central planning past may be able to explain the distinction between China and other Asian economies. However, it is never clear through what

³ In this literature review here I concentrate on the results using macro data and adopting the index number approach. But there are some studies that opt for the regression approach, e.g. one by Chow and Li (2002) which arrives at an estimate of 3 percent for 1978-98. A more comprehensive review can be referred to Y. Wu (2011).
mechanism the central planning legacy has found its way to benefit the TFP growth in the reform period.

Moreover, there is ample evidence suggesting that China’s economic growth has been to some extent subsidized or “externalized” in that the costs of labor, land, energy, capital and environment have been underpaid in the race of local governments for a faster catch up (Huang and Tao, 2010; Geng and N’Diaye, 2012). While it may not be difficult to understand that at micro level cost underpayment can exaggerate profit, hence encouraging overinvestment and more inefficient use of capital, it is hard to accept that such a negative externality may lead to a better TFP growth at the aggregate level. [More on government-selected industries?]

On the other hand, if the findings by the “pessimistic camp” are correct, whether we can jump to a conclusion that China is just another example of the “East Asian miracle” that relied mainly on perspiration (working hard) and gained little from inspiration (working smart) (Krugman, 1994). If so, then where have the new technology, new knowledge in management and marketing, and institutions that have been brought by foreign direct investment gone? [The rise of the TP component of TFP – unobservable in the standard growth accounting – has been substantially discounted by the decline of the TE component!]

These questions cannot be answered if we do not understand the true problem that has led to the clash of the findings of these studies. Apparently, the problem is unlikely related to the methodology used in these studies because most of the studies adopted the neoclassical growth accounting approach. Surely, the relevance of the neoclassical orthodoxy in the case of China is highly questionable for its institutional and behavioral assumptions (see Pack, 1993; Felipe, 1997), but it is a different issue. The only acceptable reason for these contradictory results is data or measurement problem. Indeed as I wrote elsewhere the official statistics suffer from many deficiencies from inconsistencies in definition, classification and coverage to the legacy of the material product system (MPS) in national accounting under central planning and from methodological problems to institutional hurdles that have caused data fabrication. Regrettably, despite over two decades of significant scholarly efforts in accounting for China’s growth and productivity performance, researchers still have

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to get back to the data fundamentals asking whether deficiencies in official statistics have caused significant biases and how to choose appropriate approaches to tackle the biases or how to justify reasons for ignoring them.

2. TAKING DATA PROBLEMS MORE SERIOUSLY

While getting back to the data fundamentals does not sound exciting, it is the only way to settle the debate especially when researchers use the same theoretical framework and methodology. Treating data problems more seriously certainly does not mean that the data issue is most important but it is scientifically and logically essential. It is surely not a surprise that growth accounting is highly data-driven and demanding, yet it is indeed a surprise if data problems are not seriously addressed in such studies. Researchers in this field should have remembered that there were dedicated economists from the 1950s to 1980s whose careful studies on data and measurement problems in accounting for the US economic growth have settled intense debates about the productivity performance of the US economy (see Jorgenson, 1990, for a comprehensive review of the contribution of the related studies).²

Some observations on important principles in dealing with data and measurement problems in those studies are worth mentioning here. First, a targeted data problem should be fully discussed not only with clear evidence but also with an understanding of the behaviors of agents involved in the data generating process. Second, any assumption that is adopted to solve a data problem should be compared with alternative scenarios and supported by sensitivity tests. Third, data work for any industry or sector of an economy should be considered in terms of accounting identity and intersectoral coherence in a SNA framework. Fourth, any adjustment that affects either level or growth rate in one time point must be empirically justified for a “flow-stock effect” over a longer period. Last but not least, all kinds of data work must be made transparent and unconditionally available for other researchers to repeat the same exercise.

Data problems have indeed been treated as a fundamental issue in some studies on accounting for China’s growth and productivity performance. Instead of taking official data for granted or simply filling data gaps by strong assumptions, researchers

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² Also see other articles on this topic in the same book edited by Ernst Berndt and Jack Triplett (1990).

There are, however, still unsolved data problems that have been an obstacle to a proper assessment of the Chinese economy. First, as discussed in Maddison and Wu (2008), there is a serious inconsistency between two official estimates of Chinese employment appearing in two different tables of the same statistical yearbooks for many years. It began in 1990 with an implausible 17-percent jump in one series compared with a 1.5-percent increase in another series with sectoral breakdowns. It may be caused by a clash between population census-based estimates and annual estimates through a long-established data reporting system as suggested in Yue (2005 and 2006). However, it requires an empirical investigation of the cause of the break and if the jump is reasonable, a solution to absorbing the additional employment at sectoral level, rather than simply smoothing it as in many studies.

Second, the Chinese official statistics show that the labor productivity of the so-called “non-material services” (including all non-market services, also known as “non-productive activities” under MPS) grew at an astonishing rate of 5.4 percent a year for the entire reform period and 6.4 for 1996-2010 that has never been observed in human history in normal situation. Labor productivity growth in such services is usually very slow if not stagnant because of their highly labor intensive nature. However, in adjusting for the likely overstatement of the real growth in this sector,

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6 As discussed in Maddison and Wu (2008, p. 34), in the China Statistical Yearbook 2006 (pp. 128 & 130), the three-sector total for 1990 (end-year) was 647.5 million whereas the actual total for the 16 sectors was 567.4 million—a discrepancy of 80.1 million. For 2002, the discrepancy had risen to 99.6 million. Instead of explaining it, the Yearbook disguised the discrepancy by showing the same “total” for the 16 sector breakdown as for the three-sector aggregate.

7 The calculation of the official real growth rate for these “non-material” services is based on national accounts data including nominal value added and constant price growth rates from various issues of China Statistical Yearbook (for example, see NBS, 2009, pp. 42-47). The same calculation provides an annual growth of 1.9 percent for the pre-reform period 1952-78, which is also higher than the experience of many other countries.
Maddison’s “zero labor productivity growth” assumption (1998 and 2007) has been hotly debated but remained inconclusive (Maddison 2006 and Holz, 2006a).

Third, it is evident that the Chinese official statistics on the industrial value added have exaggerated the real growth of industrial GDP as suggested by a series of studies including my physical output-based production index approach (Wu, 1997 and 2002) that was used in Maddison and Wu (2008) and by a more recent evidence that shows the sum of the value added by enterprises at and above the “designated size” already exceeding the total industrial GDP in the national accounts (Appendix A). Criticisms on my approach include the problem of assuming a constant input-output technology and a fixed ratio of gross value added to gross value of output, the typical problem of the Laspeyrsre index number that causes substitution bias (Wu, 2011; Wu and Yue, 2000), and the likely underestimation of quality improvement that may have produced a downward bias in my exercise approximating China’s real industrial growth (Holz, 2006a; Rawski, 2007).

This study attempts to improve the Chinese data for growth accounting from two sides. On the output side (the numerator), firstly, I test the sensitivity of Maddison’s estimates for the value added by “non-material/non-market services” under his zero-labor-productivity hypothesis using alternative assumptions as well as improving his estimates by incorporating annual movements; secondly, I substantially revise my earlier work on industrial output based on commodities by introducing multi weights and time-variant value added ratios. For agriculture, I adopt Maddison’s estimate (Maddison, 1998a and 2007).

On the input side (the denominator), firstly I examine and adjust the serious structural break in the official employment series at the broad sector level and adjust the break with alternative scenarios and then augment the results by a new human capital index; secondly, I construct a net capital stock series after examining problems in the initial stock, investment deflators and depreciation rates.

This paper is organized as follows. Section 3 explains why the official practices in estimating GDP may have introduced upward biases. Section 4 adjusts the serious break in 1990 in China’s employment statistics. Section 5 makes alternative GDP estimates for China’s “non-material/non-market services” compared with Maddison’s estimates under the “zero labor productivity growth” hypothesis. Section 6 estimates
average years of primary-equivalent schooling for China’s working-age and employed population as a proxy for measuring China’s human capital stock. Section 7 improves my commodity-based industrial production index in approximating China’s industrial value added. Section 8 provides alternative estimates of net capital stock for the Chinese economy. Section 9 reports and discusses alternative growth accounting results for the Chinese economy in 1952-2010. Section 10 concludes the paper.

3. Problems in the Official Estimates of China’s GDP Growth

Why may MPS exaggerate growth?

Since China’s statistical practice is still influenced by “many central planning legacies” (Xu, 2002a) and there are “gaps” between the adopted SNA standard and practice (Xu, 2009), it is necessary to understand the key differences between MPS and SNA and their implications in measuring the real GDP level and growth rate in a more rigorous way. Before progressing further, it should be noted that our approach is a value-added one, which constructs output from the production-side of the national accounts. Besides, for simplicity our discussions and mathematical expressions below are in real terms.

By the MPS standard of industrial classification, there are five material sectors in Chinese statistics including agriculture, industry, construction, transportation and telecommunication, and commerce, of which construction, transportation and telecommunication, and commerce are the so-call “material services”. Such grouping was common in the practice of all former centrally planned economies. However, it should be noted that the material service sectors only cover the services that are used for production or producer services. Consumer services, e.g. passenger transportation, are excluded because they are considered “unproductive” in the Marxian orthodoxy.

Perhaps contrary to the common theoretical perception, the MPS does not completely ignore the contribution by “non-material services”. In calculating NMP (net material product), the “non-material services” that are used (and hence paid) by the material sectors are kept together with the newly added value by “material production”, such as banking or financial services, research and development, and legal and business consulting services. However, the rest of the “non-material
services”, such as residential services and most of government services, is ignored in the national accounting practice under the MPS.\(^8\)

As shown by the formula below, the gross value of output of “non-material services” \(C^{ns}_t\) consists of two components: the gross value of the “non-material services” used (paid) by the material sectors, \(C^{ns1}_t\), and the gross value of the rest of “non-material services” used by consumers that are excluded from the MPS, \(C^{ns2}_t\):

\[
(1)\quad C^{ns}_t = C^{ns1}_t + C^{ns2}_t.
\]

Now, let the value of material inputs be \(C^{m}_t\), the value of depreciation of fixed capital be \(D^{m}_t\), \(^9\) and (net) value added from the material production be \(V^{m}_t\). We can define GMP (gross material product) for the total economy as:

\[
(2)\quad \text{GMP}_t = C^{m}_t + V^{m}_t + D^{m}_t + C^{ns1}_t
\]

and then derive the standard measure of NMP by subtracting \(C^{m}_t\) and \(D^{m}_t\) from Eq. 2, which equals the sum of the net value added \((V^{m}_t)\) and the payments to the “non-material services” \((C^{ns1}_t)\), that is:

\[
(3)\quad \text{NMP}_t = \text{GMP}_t - (C^{m}_t + D^{m}_t) = C^{ns1}_t + V^{m}_t
\]

Apparently, neither GMP nor NMP is compatible with the SNA concept of gross value added or GVA (GDP), which includes net value added and depreciation of all productive activities (as defined by SNA) as shown in Eq. 4 below:

\[
(4)\quad \text{GVA}_t = (V^{m*}_t + D^{m*}_t) + (V^{ns1*}_t + D^{ns1*}_t) + (V^{ns2*}_t + D^{ns2*}_t).
\]

The three components on the right hand side of Eq. 4 are: 1) gross valued added by the material sectors under MPS plus the missing “material services” for consumers

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\(^8\) Taking the national accounts statistics for 1991 in nominal terms as an example (the earliest data available with details of 2-digit services), if assuming 100% of the value added by scientific research services, 70% of the value added by financial services, and 20% of the value added by all other “non-material services” are used for producers, there would be above 60% of “non-material services” for consumers that were ignored under the MPS (NBS, 2001, Table 3-5).

\(^9\) Strictly speaking, depreciation is one component of the gross domestic income equation rather than part of the gross domestic product equation. However, in our discussion here it can be considered part of the value added because some output is made to compensate for the consumed capital in the current period.
\((V^m_t + D^m_t)\), 2) gross value added by the “non-material services” paid by the material sectors under the MPS \((V^m_{\text{ns1}} + D^m_{\text{ns1}})\), and 3) gross value added by the rest of “non-material services” that is missing under the MPS \((V^m_{\text{ns2}} + D^m_{\text{ns2}})\).

Clearly, GMP has a serious double counting problem because it includes the intermediate inputs of all the material sectors \((C^m_t)\). However, both GMP and NMP ignore the contribution by a major part of the “non-material services” \((V^m_{\text{ns2}} + D^m_{\text{ns2}})\) as well as the “material services” for consumers \((=(V^m_t + D^m_t) - (V^m_t + D^m_t))\). Besides, NMP also has a double counting problem because it includes the gross value of output rather than the gross value added of the “non-material services” consumed by the material sectors (note that \(\frac{C^m_{\text{ns1}}}{V^m_{\text{ns1}} + D^m_{\text{ns1}}}>1\)). Finally, NMP ignores capital consumption.

The differences between MPS and SNA imply that, firstly, in measuring the real GDP growth, GMP (as well as NMP but to a less extent) tends to exaggerate the real GDP growth if the growth of intermediate inputs is faster than that of the value added. In other words, using our notations, if \(C^m\) grows faster than \(V^m\), holding the growth of \(D^m\) constant, the GDP/GMP ratio will decline over time and, consequently, GMP will have a higher growth rate than GDP. Scholarly work has shown that this is indeed the case for typical centrally planned economies (e.g. see the case of the Soviet Union by Maddison, 1998b). Wu and Yue (2000) and Wu (2011) have also shown that the Chinese economy has experienced a declining value added ratio over time.

Secondly, if the excluded “non-material services” tends to grow at a slower pace compared with the rest of the economy, especially manufacturing, which is a widely observed phenomenon at the earlier stages of economic development in general and in centrally planned economy in particular whose industrial policy tends to sacrifice services, the real growth rate will also be exaggerated.

**Criticisms on the Chinese official GDP estimates**

Prior to 1992, China’s statistical authorities used the Soviet MPS which involved double counting and excluded a large part of service activities, therefore inevitably overstated growth. There were also serious deficiencies in the basic reporting system. Research has suggested that official estimates have underestimated GDP level while
overestimating GDP growth. As various studies have suggested, the underestimation of GDP level resulted from the undercoverage effect due to the nature of MPS (see the previous section) and the price distortion effect attributed to government industrial policy under central planning, whereas the overestimation of GDP growth was because of underestimation of price changes while overreporting output (see Keidel, 1992; Rawski, 1993; World Bank, 1994; Woo, 1996; Maddison, 1998a; Wu, 1997, 2000 and 2002).

As discussed in Wu (2000, pp. 479-480), China’s long practice of the Soviet-type “comparable price” approach underestimates inflation because it requires enterprises to report their output at some “constant prices” provided in a price manual specifying 2000 items that was set ten years ago, which tended to create “substitution bias”, worse when China experienced radical price reforms. The approach also tended to ignore the new products subsequently emerged after the benchmark years. Since new products could be over-priced in the absence of reference products, this created leeway for enterprises to exaggerate their real output by categorizing more products as new products and specifying their market prices to be the same as or close to their “constant prices” that were not provided in the price manual. (See Appendix B for further elaboration of the price problem.)

Institutionally, heavy government intervention in business decision making and the administratively managed data reporting system induced distorted incentives for firms and local officials to exaggerate their growth performance. Reports at the basic level reach NBS through several levels of aggregation in the administrative hierarchy. This transmission train provides opportunities for officials at different levels to adjust

10 China’s statistical authorities applied the “comparable price” approach mainly to the traditional “material sectors” such as agriculture, industry and “material services” such as transportation and post-telecommunication. There have been five sets of “constant prices” that were used for constructing the real output at “comparable prices”, namely, 1952, 1957, 1970, 1980 and 1990 “constant prices” (see SSB, 1997, p. 73; Xu and Gu, 1997, pp. 5-12). Traditionally, only state enterprises and collective enterprises at or above the township level (re-defined as “designated size” after 1998) were required to make regular report on their output at both “comparable” and current prices. The “1990 constant prices” were used till 2002. Afterwards, the prices of the previous year constant-price output were used as the constant prices for the current year’s output, but this new approach has not been explicitly explained by NBS.

11 In a market system, commodities whose prices increase more rapidly turn to be substituted by commodities whose prices increase less rapidly or decline. If prices are fixed over a period that is long enough to experience significant price changes, the constant price measure will turn to exaggerate growth after the benchmark year. In the Chinese case, prices have changed or been corrected by the market-oriented reforms especially since the 1990s, yet the official “1990 constant prices” (as part of the long-practiced “comparable price system” developed under MPS) were in use till 2002.
their reports to reflect favorably on their management. NBS conducts crosschecks, but they are inevitably limited in scope.

These problems justify using available *volume movements* to gauge the real growth since it can bypass the official problematic price measures as well as the upward bias due to the institutional problem. There have been a number of important studies attempting to make alternative estimates using various approaches, such as physical output index (Wu, 2002a), alternative price indices (Jefferson *et al.*, 1996; Ren, 1997; Woo, 1998; Young, 2003), and energy consumption approximation (Adams and Chen, 1996; Rawski, 2001). Despite different results, all studies appear to be supportive to the upward bias hypothesis for the official data. Rawski (2001) concentrated on the performance in the 1990s and was very critical of the official measure for 1997-98 which reflected “government objectives rather than economic outcomes”. In fact, estimates for 1997-98 by Wu (2011) and Maddison and Wu (2008) indeed show negative growth. Shiau (2004) re-estimated growth using the expenditure approach and found significantly slower growth than the official measure for 1978-2000. Keidel (2001)’s work from the expenditure side for the period 1979-2000 also suggests substantial annual divergence from the official measure by industry of origin.

4. A NEW ESTIMATION OF CHINESE EMPLOYMENT

China’s official data on employment not only have conceptual problems (see Wu, 2002b) but also suffer from structural breaks. In particular, the official total number of employment jumped from 553.3 million in 1989 to 647.5 million in 1990, suggesting an astonishing 17 percent or 94.2 million increase in one year (Table A3)! This new total is available with three-sector breakdowns (primary, secondary and tertiary) linking to the same breakdowns prior to 1990, but not with estimates at industry level. However, the existing industry level estimates, which follow the pre-1990 tradition, fall short of the new estimate of total employment in 1990 by 80.1 million. The post-1990 data series is then built on this new level of total employment, hence creating a continuous gap with the underlying trend based on the pre-1990 data series. When the traditional industry level estimation was discontinued in 2002, the gap rose to 99.6 million (NBS, 2009, Table 4-5). Two decades have passed since the gap first emerged, yet there has been neither explanation nor adjustment for it by the statistical authority.
In this section I adjust the 1990 employment data break by investigating the nature of the break and the fundamental forces that might affect the demand and supply of labor at the time of the break. Meanwhile, I also integrate the adjustment with a new effort to re-estimate the missing military personnel in “non-material services” prior to 1990 – a factor that played an important role in Maddison’s value added estimates for these services (Maddison, 1998a and 2007).

An Adjustment to the 1990 Break

A quick look at the 1990 structural break against the background of labor supply and macroeconomic situation gives an impression that the break is rather artificial. On the one hand, the change of working-age population around that time was stable, i.e. without any significant deviation from the trend. On the other hand, it was impossible for the demand for labor to have a faster-than-normal increase in the middle of a serious growth slowdown – by the official statistics (Table A6) the growth of GDP dropped sharply from 10.5 percent in 1988 to 3.3 percent in 1989 and stayed at around a similar rate (3.2) in 1990, which was the slowest growth since the reform.

As discussed in Yue (2005), the gap is caused by inappropriately linking the results of the 1990 Population Census to the annual estimates that are based on a regular employment registration and reporting system established in the early planning time. The population census discovered a large number employed who had been missed by the regular reporting system, yet the NBS was not able to integrate the results with the annual estimates at industry level. Nonetheless, without any good reason to ignore the census results, between 1990 and 2002 the NBS continued its census-based estimation for total employment supported by annual population sample surveys and published the results parallel to annual industry level estimates in a way that disguised the huge underlying inconsistency between the reported totals and the implicit sum of industries.

If this 80.1 million of additional workforce discovered in the 1990 Census did not appear suddenly in 1990, which is a reasonable assumption, a logical inquiry should ask whether the gap had always existed in the economy but never covered by the labor statistical system or it began from a certain period when policy or institutional changes allowed some new types of employment to emerge but not picked up by the registration system. A proper investigation should be conducted on two grounds:
checking earlier or pre-1990 population censuses or sample surveys to see if a similar gap existed in the earlier period and examining changes in employment policy that created outside system employment.

China only conducted three population censuses before the 1990 Census, in 1953, 1964 and 1982 respectively. Unfortunately, the available data from the 1953 and 1964 censuses do not contain employment information. However, the 1982 Population Census reports China’s total number of employment as 521.5 millions, or 68.6 millions more than the annual estimate of 452.9 millions for that year. Additional information from the 1987 one-percent population sample survey gives an estimate of 584.6 millions or 56.7 millions more than the annual estimate of 527.8 millions (see Tables A2 and A3). It is clearer now that the structural break started at least in 1982 rather than in 1990.

My next question is when this additional employment began to emerge. There has been ample studies suggesting that the government began to relax its employment regulation in the early 1970s to make room for the development of rural enterprises (then named as commune and brigade factories) and to allow “outside of plan” hiring in cities (Wu, 1994). However, new jobs were created in an informal way and many of the new workers were temporal and seasonal in nature and could be engaged in multiple jobs, hence they were insufficiently covered by the labor planning and reporting system. Therefore, it is reasonable to assume that the discrepancy began in the early 1970s.

In my alternative adjustment scenarios, the above two effects are separately or jointly considered. Before proceeding further, the official employment estimates have to be revised by taking into account the results from the 1982 Population Census and the 1987 Population Sample Survey (one percent). I use the total numbers of employment for 1982 and 1987 (sample survey results are multiplied by 100) as the control totals for the two years and use the annual movements between the benchmarks of 1982, 1987 and 1990 to construct a series of control totals between the benchmarks. Consequently, and not surprisingly, the break is pushed back to 1982 and results in 19.3 percent jump in 1982. The revised estimates are reported in Table A2.
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I then propose three scenarios for adjusting the 1982 employment data break.

Scenario 1: The adjustment under this scenario follows a simple smoothing procedure to tackle the problem. It assumes that the employment growth in 1982 follows a linear trend between 1981 and 1983, or 2.9 percent (i.e. an average of 1981 and 1983 growth rates of 3.2 and 2.7 percent, respectively) instead of 19.3 percent (Table 1). This lifts up the level of employment over the period from 1981 way back to 1949, yet maintaining the original official growth rates for all the rest years. As a result, the total employment is raised by 69.3 million to 506.6 million in 1981 and by 28.7 million to 209.5 million in 1949. The additional employment is then allocated into the existing sectors based on the original sectoral shares. This scenario does not consider any policy change effect and assumes that all the employment data prior to 1982 are underestimated to the same extent as suggested by the 1982 Census.

Scenario 2: This scenario assumes that the gap identified by the 1982 census began only from the early 1970s when the government began to relax its planning control over employment especially in rural areas. In the adjustment, the growth rate between 1981 and 1982 is first set as 2.9 percent, the same as in Scenario 1, to raise the level of employment in 1981. Then, a new trend between 1970 and 1982 can be established. I incorporate annual deviations from the original trend over the same period to derive a new series of employment. The so-added number of employment for each year in 1971-81, which is for example 69.3 million for 1981 and 4.8 million for 1971, is allocated to each sector based on the existing sectoral structure.

Scenario 3: For the level adjustment this scenario is the same as in Scenario 2. However, instead of allocating the additional employment to each sector according to the existing structure of the economy, this approach assumes that more of the additional employment is engaged in labor-intensive non-farming activities. Based on

---

12 The adjustment is made at sector level, including four sectors, namely, agriculture, industry, construction and services. Only the 1982 Census provides sectoral and industry level employment data. However, the number of agricultural employment in the 1982 Census (384.2 million) looks too high – almost the same as that of the 1990 Census (389.1). Its share in the total employment is 74 percent, which is much higher than that suggested by the regular statistical report system (68 percent). This is unreasonable given that the Census is supposed to pick up more non-agricultural employment that is not covered by the reporting system. I then reduce the agricultural employment by 10 percent and reallocate the difference to other sectors by the existing weights. The results look plausible with agriculture accounting for 66.3 percent, industry 18 percent, construction 2.2 percent, and services 13.5 percent.
this assumption, the amount of the additional employment that is allocated to the farm sector is assumed to be only 60 percent of its existing share in the total employment and the rest of the additional employment is allocated to the industrial and the “material services” sectors. The “non-material services” are excluded in this adjustment simply because the additional laborers are least-educated hence unlikely to engage in financial, governmental, healthcare and education services.\textsuperscript{13} Results based on this scenario are reported in Table A2.

<table>
<thead>
<tr>
<th>Year</th>
<th>Working-age Population</th>
<th>NBS Original</th>
<th>NBS Revised</th>
<th>Scenario 1 Results</th>
<th>Scenario 2/3 Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>1949-50</td>
<td>5.6</td>
<td>5.6</td>
<td>5.6</td>
<td>5.1</td>
<td>5.1</td>
</tr>
<tr>
<td>1969-70</td>
<td>3.0</td>
<td>3.6</td>
<td>3.6</td>
<td>3.9</td>
<td>3.9</td>
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<tr>
<td>1970-71</td>
<td>2.8</td>
<td>3.5</td>
<td>3.5</td>
<td>3.5</td>
<td>4.2</td>
</tr>
<tr>
<td>1971-72</td>
<td>2.5</td>
<td>0.7</td>
<td>0.7</td>
<td>2.0</td>
<td>3.4</td>
</tr>
<tr>
<td>1980-81</td>
<td>2.9</td>
<td>3.2</td>
<td>3.2</td>
<td>3.2</td>
<td>4.5</td>
</tr>
<tr>
<td>1981-82</td>
<td>3.1</td>
<td>3.6</td>
<td>3.9</td>
<td>3.1</td>
<td>3.8</td>
</tr>
<tr>
<td>1982-83</td>
<td>3.2</td>
<td>2.5</td>
<td>2.7</td>
<td>2.8</td>
<td>2.8</td>
</tr>
<tr>
<td>1988-89</td>
<td>2.0</td>
<td>1.8</td>
<td>3.5</td>
<td>3.5</td>
<td>3.5</td>
</tr>
<tr>
<td>1989-90</td>
<td>1.8</td>
<td>17.0</td>
<td>3.3</td>
<td>3.4</td>
<td>3.4</td>
</tr>
<tr>
<td>1990-91</td>
<td>1.5</td>
<td>1.1</td>
<td>1.1</td>
<td>2.2</td>
<td>2.2</td>
</tr>
</tbody>
</table>

Sources: Data for working-age population and official employment are from NBS (2009). See the text for the distinction between the two NBS series and explanation for the three scenarios. Official statistics refer to end-year numbers whereas the adjusted data are mid-year estimates. For a comparison with the NBS estimates the adjusted data do not include military personnel. The complete adjusted (including military personnel) and official employment estimates are reported in Tables A2 and A3, respectively.

Table 1 shows my alternative adjustments to the official employment statistics for the benchmarks and their adjacent years. All the estimates refer to the aggregate economy. The annual growth rate of the working-age population for these time points is also included to show the potential labor supply. The “NBS revised estimates” show the effect of my 1982 Census-based adjustment that shifts the break backward from 1989-90 to 1981-82. The results of the three scenarios are shown from 1981-82.

\textsuperscript{13} Strictly speaking, the census-discovered additional employment should be adjusted by part-time hours and these hours should be allocated to the most labor-intensive manufacturing industries and services based on industry level information, which is being conducted in an on-going research project. However, ignoring this fact here will not change the current results as we only consider the aggregate economy and its broad sectors.
backward (Note that Scenarios 2 and 3 are the same at the aggregate level). Scenarios 2 and 3 have significantly raised the annual growth rate in the period 1970-81 as shown by the growth rate of the benchmark years, but they look plausible considering the changes of the working-age population.

Adjustment to “Non-material Services”

My adjustment to the “non-material service” employment is motivated by Maddison’s earlier work (1998a) that added military personnel back to the “non-material service” employment that was a standard practice in constructing national labor accounts. More importantly, as Maddison argued, the exclusion of military personnel may have significantly lowered the service output estimation especially for the earlier period when the military employment was large after the civil war and engaged in many economic activities. However, due to limited information Maddison simply assumed the size of the military personnel was a constant of 3 million for the period 1952-1996 (Maddison, 1998a, pp. 168-9). In his later work, based on scattered information he assumed that military personnel were officially included since 1993 (Maddison 2007, p. 170).

My new work is based on more careful and detailed information gathering (documented in detail in Appendix C, Table A1). It begins with the reconciling two employment series with one categorizing total employment under “material” and “non-material” and the other under primary, secondary and tertiary. The “material” and “non-material” categorization for employment is in line with the official output statistics under MPS. Although the practice stopped after 1993, the available data are enough for our examination because the focus is the pre-1990 period. This reconciliation ensures the compatibility of the two employment series, and hence maintaining the consistency of the employment in “non-material services” where military personnel belong to.

My new evidence shows that, first, the official practice of excluding military personnel was ended in 1990 and, second, the size of military personnel prior to 1990 was not a constant of 3 million over time as Maddison assumed. In fact, China’s

14 Apart from defense service, military personnel also engaged in construction, transportation, farming and government services in the early period of the People’s Republic. Assuming that they only engaged in “non-material (and non-market) services” may exaggerate the input and output of these services, but it will not affect the aggregate analysis.
armed forces were numbered at about 5.5 million in 1949. After four rounds of demobilization between 1950 and 1956, the number was reduced to 2.4 million by the end of 1958. It, however, rose again from the mid 1960s to the mid 1970s responding to the boarder tensions and conflicts with the Soviet Union and India, respectively. By the end of 1975, the number picked at 6.8 million. There were two new rounds of demobilization were conducted in the post-Mao period initiated by Deng who aimed at maintaining smaller but more modernized armed forces at around 3 million from the end of the 1980s (Appendix C).

My adjustment has both level and rate effects in terms of employment and any employment-based income statistics. Clearly, in terms of the level of employment, the effect of adding the newly estimated military personnel to the existing “non-material services” employment is much stronger for the earlier period than for the later period. After the adjustment, the military personnel accounted for 67 percent of the “non-material service” employment in 1949, 27 percent in 1975 and only 5 percent in 1989. This has consequently changed the growth rate of employment. Compared with Maddison’s estimate of 6.3 percent annual growth in the “non-material service” employment in 1952-1962, my estimate is only 4.5 percent. This implies that any employment-based level estimation for that period, such as using labor compensation to estimate value added, will be substantially raised but the related growth rate will be considerably reduced.

5. **A Measure of Human Capital**

A standard measure of the contribution of human capital to growth requires data on labor composition by major human capital attributes (demographic, educational and industrial-occupational characteristics) and exactly matching compensation data for weighting and deriving a measure of quality-homogenous labor input (Jorgenson, Gollop and Fraumeni, 1987). It not only relies on population census or well-designed population sample survey data, but also requires compensation data from labor market surveys that must be reconciled in a national accounts framework. By this standard the available Chinese data are rather limited and in poor quality (Young, 2003; Wu and Yue, 2010), and mainly for the reform period. Besides, labor compensation under central planning was suppressed and distorted. Therefore, this study follows a school of researchers to use education attainment data to construct a proxy for human capital stock in China because such data are relatively easy to obtain for the entire period and
are in real volume measure by nature, thus satisfying a long-run comparison. Besides, we may argue that since the level of so-measured human capital stock can reflect the ability of learning at work, it is able to capture changes of industrial and occupational knowledge through on-the-job training and work experience.

There are two types of education data available in the annual Chinese statistics, i.e. numbers enrolled and numbers graduated per annum by the level of education. Because of limited information on annual drop-outs and repeat rates as well as the breakdown of the education system due to political reasons (the decade-long Cultural Revolution, 1966-1976, as an extreme case), which affect the average schooling cycle of each education level, I therefore prefer the use of the graduation data to the use of the enrollment data.

The method that I use to estimate human capital stock is the perpetual inventory method (PIM) that is usually used to estimate physical capital stock (see Section 8). Here, the number of annual graduation is considered as the current year flow of human capital investment, which after a proper “depreciation” is added to an existing stock up to the last period. In the estimation, different levels of schooling have to be made “homogenous”. In the case of lacking employment data by human capital attributes and their market costs, a popular approach to the problem is to convert the number of annual graduates at different education levels into a primary schooling-equivalent measure by somewhat arbitrarily assigned education level-specific “impact factors” (Maddison, 1998a). However, it is more appropriate to consider the impact of education based on the literature on the “returns to education” in China (see reviews by Zhang et al, 2005 and Meng, 2012). Following the work by Zhang et al (2005) and Meng and Kidd (1997), incorporated with wage index, I have constructed a time series of marginal conversion parameters for each level of education. [Here should make a comparison with Maddison in appendix; and discuss the Cultural Revolution effect on the quality of the reported education attainment] To derive a homogenous flow, the number of graduates at each education level is first multiplied by its standard years of schooling (see the note to Table 2), then multiplied by its marginal conversion parameter (impact factor), and finally converted to a primary schooling-equivalent value. Since this approach only takes the current level of education into account rather than the complete history of a person’s schooling, it can avoid double counting.
To set up the initial stock, I first compare two assumptions for the average schooling of the working-age population in 1950, i.e. 1.7 years by Maddison (1998a) and 0.9 years by Wang and Yao (2002). Maddison used the enrollment data, which might exaggerate the actual annual increase in educated human capital. Wang and Yao used the graduation data. However, to estimate the initial stock for China, Wang and Yao applied the Indian schooling structure in 1960 from Barro and Lee (1997 and 2000), which may underestimate the average years of schooling in China where there was no Indian type of caste system that obstructed mass education.

Based on the size of China’s working-age population in 1950, which was 298 million (Table 2), the implied initial level of China’s primary school-equivalent human capital stock was 507 million years of schooling by Maddison’s assumption and 268 million years by Wang and Yao’s assumption. If assuming that China’s modern school education\(^\text{15}\) in the first half of the twentieth century (1900-1950) had grown at a rate that was 20 percent slower than that of 1950-57 (2.3 percent), which is plausible given frequent wars and destructive interruptions, the average schooling of China’s working-age population in 1900 would be 0.91 years by Maddison’s assumption and 0.49 years by Wang and Yao’s assumption. I then have a rough assumption based on some earlier estimates (Liu and Yeh, 1965; Perkins, 1975; Rawski, 1989; Yuan, Fukao and Wu, 2010) that at the turn of the twentieth century, there were about 8 to 10 percent of the working-age population engaged in the urban or modern economies (especially in manufacturing, mining, utilities, transportation, government and other related services that required certain level of education) and possessed all the human capital stock based on the modern school education. This implies that on average each employed person could have finished 9.1 (in the case of 10 percent of the working-age population engaged in the urban or modern sector) to 11.4 years (in the case of 8 percent engaged) of the primary schooling-equivalent education by Maddison’s assumption and 4.9 to 6.1 years by Wang and Yao’s assumption. It is more reasonable to follow Maddison, which means that on average each person engaged in the urban or modern sector could have just completed his/her last year of the junior secondary level or achieved his/her first year of the senior secondary level.

\(^{15}\) The beginning of the modern school system in China can be dated back to 1862 when the first government-run foreign language school, Tungwen (Tongwen) College, was set up in Beijing (Biggerstaff, 1961).
Based on this assessment, I therefore conduct the PIM exercise with an initial human capital stock of 500 million primary schooling-equivalent years. Besides, I also assume the education-based human capital stock depreciates by a constant rate of 1 percent per year (following a geometric declining function), which means that about 20 percent of the knowledge will be lost or become obsolete 25 years after graduated from the high school. (See Table A4-1 and A4-2 for the full results.)

Table 2 presents the level of human capital investment and net stock based on education attainment and the average schooling of the working-age and the employed population for the entire period with a ten-year interval. It is slower than those estimated by Maddison (1998a) and Wang and Yao (2002). Referring to the same reference years as in Maddison and in Wang and Yao (not shown in Table 2), between 1950 and 1973 my results suggest that the average years of schooling increased from 1.68 to 2.40 per person or grew by 1.6 percent per annum compared with 0.91 to 2.51 years per person or grew by 4.9 percent per annum in Wang and Yao (2002) and 1.60 to 4.09 years or grew by 4.2 percent per annum in Maddison (1998a). For 1992, my

<table>
<thead>
<tr>
<th>Year</th>
<th>Annual flow of education “investment” (^1)</th>
<th>Stock of educated human capital</th>
<th>Working-age population (16-64)</th>
<th>Average schooling per person of working-age population</th>
<th>Number of employment</th>
<th>Average schooling per employed person (^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(ml. years of primary-equivalent) (^1)</td>
<td>(ml. years of primary-equivalent) (^1)</td>
<td>(ml.)</td>
<td>(year)</td>
<td>(ml.)</td>
<td>(year)</td>
</tr>
<tr>
<td>Initial value</td>
<td>500</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1950</td>
<td>6</td>
<td>501</td>
<td>298</td>
<td>1.68</td>
<td>191</td>
<td>2.63</td>
</tr>
<tr>
<td>1960</td>
<td>51</td>
<td>722</td>
<td>377</td>
<td>1.91</td>
<td>263</td>
<td>2.75</td>
</tr>
<tr>
<td>1970</td>
<td>37</td>
<td>1,106</td>
<td>460</td>
<td>2.40</td>
<td>344</td>
<td>3.22</td>
</tr>
<tr>
<td>1980</td>
<td>153</td>
<td>1,996</td>
<td>589</td>
<td>3.39</td>
<td>453</td>
<td>4.11</td>
</tr>
<tr>
<td>1990</td>
<td>165</td>
<td>3,402</td>
<td>763</td>
<td>4.46</td>
<td>643</td>
<td>5.29</td>
</tr>
<tr>
<td>2000</td>
<td>228</td>
<td>4,862</td>
<td>889</td>
<td>5.47</td>
<td>717</td>
<td>6.78</td>
</tr>
<tr>
<td>2010</td>
<td>322</td>
<td>7,095</td>
<td>999</td>
<td>7.10</td>
<td>781</td>
<td>9.08</td>
</tr>
</tbody>
</table>

Sources: The basic data for annual graduation at different levels are from NBS (2010 and earlier volumes).

Notes: Years of schooling are converted to a primary school-equivalent measure based on “returns to education” (see text). China’s standard years of schooling are 6 for the primary level, 3 for the junior secondary level, 3 for the senior secondary level, 4 for the tertiary level (including polytechnic institutions), 3 for vocational schools and 10 for special schools. The conversion is made by time variant marginal parameters to the next level of education with the primary level as 1.
estimates show that the average years of schooling increased to 4.67, compared with 8.50 years per person in Maddison and 5.29 years in Wang and Yao. This means that in the period 1973-92, my results suggest an annual growth of 3.6 percent, whereas it is 4.1 percent by Maddison and 4.5 percent by Wang and Yao. In other words, other things being equal, my results will imply a faster TFP growth.

To compensate for the missing information on human capital through on-the-job training and work experience, I further assume that all education-based human capital is used by the workforce as shown in the last column of Table 2. This is not unreasonable if we assume that an educated working-age person is more likely to be employed especially in the case of China. Since the effect of any type of withdrawal from the workforce is already taken into account, here I do not have to account for age cohort-specific mortality rate. The so-measured “primary-schooling equivalent” years per employed person is then used to augment the measured (heterogeneous) numbers employed (Section 3) which is used as a proxy for the labor input in China in my growth accounting analysis.

6. Estimation of the Value-added by “Non-material” Services

Based on the labor intensive nature of “non-material services” and evidence of no or very slow labor productivity growth in the OECD countries (van Ark, 1996, pp. 109-115), Maddison argued that the official estimate of gross value added (GDP) for this sector was implausible because it implied an abnormally high labor productivity growth in such service activities. He showed that the official estimate of GDP growth by “non-material” services was 11 percent per annum for the reform period 1978-2003 (Maddison, 2007a, Table C.6). Together with the relevant official employment data, this means that this sector’s labor productivity growth would be at 4.2 percent per annum, which appears too high to be true. It is likely due to insufficient measure of price changes for the output of such services in official statistics.

Based on the experience of economic history, Maddison used a “zero labor productivity change” assumption in his estimation for China’s “non-material” service value added, which means that the value added would grow along with the growth of the employment in this sector. He arrived at an annual value added growth of 5.5 percent in 1978-2003, just a half of the official estimate of 11 percent (10.9 for 1978-2008, Table 3). The impact of his adjustment on China’s total GDP growth is about
0.9 percentage points. Consequently, the TFP will be affected by this adjustment but only marginally, *ceteris paribus*.

In this study I have revised Maddison’s estimates using my new employment estimates for this sector as discussed in the earlier section. As shown in Table 3, my revision has a slightly downward effect on his original estimate. Both the original and revised Maddison estimates are presented in the table and are compared with the official estimates.

### Table 3

(Annual percentage change)

<table>
<thead>
<tr>
<th></th>
<th>Official</th>
<th>Maddison Original*</th>
<th>Maddison Revised</th>
<th>Alternative I**</th>
<th>Alternative II**</th>
</tr>
</thead>
<tbody>
<tr>
<td>1952-57</td>
<td>9.1</td>
<td>5.5</td>
<td>1.6</td>
<td>2.0</td>
<td>2.0</td>
</tr>
<tr>
<td>1958-65</td>
<td>6.8</td>
<td>4.4</td>
<td>5.1</td>
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</tr>
<tr>
<td>1966-71</td>
<td>1.9</td>
<td>1.2</td>
<td>2.0</td>
<td>0.7</td>
<td>0.7</td>
</tr>
<tr>
<td>1972-78</td>
<td>4.7</td>
<td>5.1</td>
<td>4.5</td>
<td>3.2</td>
<td>3.2</td>
</tr>
<tr>
<td>1952-78</td>
<td>5.6</td>
<td>4.1</td>
<td>3.6</td>
<td>3.4</td>
<td>3.4</td>
</tr>
<tr>
<td>1979-84</td>
<td>11.8</td>
<td>6.6</td>
<td>7.8</td>
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<td>1985-91</td>
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<td>5.5</td>
<td>3.7</td>
<td>3.3</td>
<td>3.3</td>
</tr>
<tr>
<td>1992-01</td>
<td>10.4</td>
<td>5.0</td>
<td>6.3</td>
<td>7.9</td>
<td>8.7</td>
</tr>
<tr>
<td>2002-09</td>
<td>11.2</td>
<td>4.0</td>
<td>3.2</td>
<td>4.3</td>
<td>5.6</td>
</tr>
<tr>
<td>1978-09</td>
<td>11.1</td>
<td>5.5</td>
<td>5.2</td>
<td>6.2</td>
<td>6.8</td>
</tr>
</tbody>
</table>

**Sources:** Official output and employment data used for the estimation are from *China Statistical Yearbook 2010* and earlier issues. Official output data prior to 1978 are from Maddison (2007). See Maddison (1998 and 2007) for his approach and original results. [need to be updated]

**Notes:** Revised Maddison estimates are based on the new employment estimates of “non-material” services in this study. See text for alternative assumptions. Annual growth rate is calculated as arithmetic average of log differences. *The period covered by the original Maddison results is 1952-2003. **The alternative adjustments cover the period from 1982 onwards because official data show the labor productivity of “non-material services” only started to rise in 1982.

Maddison’s “zero labor productivity” assumption has been challenged by some researchers (see Holz, 2006a) who argued that higher GDP growth for this sector is possible. My further investigation shows that Maddison’s rebuttal to Holz (Maddison, 2006) is justifiable at least for the pre-reform period. The official data as presented in Maddison (Table C.6, 2007a) show that there was virtually no labor productivity growth in this sector on average between the early 1950s and the early 1980s.

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16 This impact measure is obtained based on the average share of this “non-material” service sector in the nominal GDP for this period which is 16.8 percent.
However, there is some room to improve Maddison’s adjustment by incorporating annual labor productivity movements around the trend (i.e. deviation from the trend). This adjustment is introduced to the pre-reform period in my two alternative estimates in this study. For the reform period, which is redefined for my adjustment to begin in 1982 when the official estimates of labor productivity started to rise, I assume that it increased by one percent per annum throughout the period 1982-2008 (Alternative I, Table 3). To test the sensitivity of the estimate, I further raise the annual labor productivity growth to two percent from 1993 (Alternative II, Table 3) when China adopted the “socialist market economy” policy that deepened the reform and hence speeded up the restructuring of the economy. This assumption is strong if not outrageous because a faster growth of “non-material services” following the reform does not necessarily mean a faster increase in the labor productivity in those services. In fact, economic history shows that a transition towards services will lead to a decline rather than increase in productivity in general.

Compared with Maddison’s estimates, as demonstrated in I and II, Table 3, my alternative assumptions-based estimates arrive at greater volatility and slower output growth for the planning period, and also greater volatility but faster output growth for the reform period. The impact of my two estimates on the total GDP growth rate in the reform period (not shown in Table 3) is -0.85 percentage points by Alternative I and -0.77 percentage points by Alternative II, compared with -0.99 by Maddison’s original result (adjusted for annual changes). The full results are presented in Table A5 which can be compared with the official GDP estimates in Table A6.

7. AN ALTERNATIVE INDEX FOR CHINESE INDUSTRIAL OUTPUT

Methodological and conceptual deficiencies in the Chinese statistics, especially before China began its transition from MPS to SNA in 1993, and clashes between conceptually related official indicators motivated researchers over the past two decades to propose an upward-bias hypothesis about the official GDP growth estimates and a downward-bias hypothesis about the official GDP level estimates (Adams and Chen, 1996; Keidel, 1992 and 2001; Maddison, 1998a; Ren, 1997; Woo, 1998; Rawski, 1993 and 2001). Problems with growth estimates of the industrial sector play an important role (Wu, 1997 and 2002a; Woo, 1998).
As argued, the official statistics on the industrial growth contains two types of upward bias, methodological and institutional. Methodologically, the “price manual” approach used up to 2003 required firms to report their outputs at both the current prices and the base-year “constant prices” listed in the manual, called “comparable prices” (I use an abbreviation for the underlying price index as CPPI and the system as CPPS). The old manual was replaced by a new one for every 10 to 13 years. The official “real growth” estimates were calculated based on CPPI deflated outputs and costs (Wu, 2002a and 2011).

This created a typical Laspeyres index number problem (Wu, 2011) – the base year weights are fixed over a long period that inevitably lead to substitution bias which is well known as the Gerschenkron effect (Gerschenkron, 1951), especially when the economy experiences rapid structural changes such as China in the 1950s-1960s and since the reform. Besides, there are also problems in linking segmented weights using different CPPIs which exaggerates growth rate by nature (Wu, 2011) and missing or misrepresenting new products introduced between the benchmark manuals (Maddison, 1998).

Institutionally, assigning growth as a political task tends to inherently exaggerate the rate of growth because it provides leeway to various government offices (including statistical reporting system), local officials and state firm managers to make up their performances at their best interests. Besides, a fast-enough growth is also important to the central government as it is believed the key to reducing the (relative) pain of the losers in the reform as well as to tackling new problems (e.g. severe and still rising income inequality).

This upward-bias hypothesis has been supported by various empirical tests including my own work on the industrial sector (Wu, 1997, 2002a and 2011) using the physical output of major industrial products or product groups weighted by the input-output table value added weights. My earlier estimates for 1952-1995 (Wu, 1997) were incorporated in Maddison’s estimation of China’s post-war GDP growth (1998a). In 2002, I further improved the estimates by increasing the number of products and by introducing intra-industry value weights using detailed commodity price data from the National Bureau of Statistics (NBS). The results were adopted in Maddison (2007a) and Maddison and Wu (2008). The update suggests that the official estimate of China’s industrial GDP annual growth of 11.50 percent in 1978-2003 may have been
overestimated by 1.75 percentage points. For the pre-reform period 1952-78, the official annual growth estimate of 11.46 percent may have been exaggerated by 1.32 percentage points.

There are however potential problems in the commodity approach used in my earlier exercise that may introduce biases as discussed in Wu (2002a) and recapped in Maddison and Wu (2008). The first one is my strong assumption that the ratio of gross value added (GDP) to gross value of output (=GVA/GVO) or value added ratio in the 1987 input-output table remained unchanged. However, it follows that if the ratio has increased over time, growth would be underestimated; if it declined, growth would be exaggerated. Based on the earlier official estimates of net material product (NMP), Wu and Yue (2000) showed that for the industrial sector as a whole the ratio remained stable before the mid-1980s but declined afterwards (p.92, Table 2). More detailed information from various China’s input-output tables (IOTs) suggests that the ratio declined generally over the reform period. In 1987, the ratio was 0.32 if measured by the NMP approach as in Wu and Yue (2000) or 0.31 by the value added approach (Wu, 2002a, p. 193). It declined to 0.29 in 1995 (Wu, 2002a, p.193) and had remained at about this level until 2002 (28 in 2000, NBS, 2004, pp. 71-73; 30 in 2002, DNA, 2006, pp. 84-89). The ratio experienced a further decline along with a new wave of export-oriented growth following China’s WTO entry at the end of 2001. By 2007, it dropped to 0.23 according to China’s 2007 IOT. Therefore, my earlier estimates using the 1987 value added ratio are still likely to have exaggerated China’s real GDP growth for the post-reform period.

The second potential problem is the aforementioned substitution bias or the Gerschenkron effect. It suggests that if consumers are rational, changes in prices are negatively correlated with changes in quantities demanded. A quantity index based on prices after the base year would fall short of an index using the base-year prices. In other words, the fixed-weight quantity index will overstate growth rate for the years after the benchmark and understate the earlier growth performance before the benchmark. A very preliminary exercise in Wu and Yue (2000) has shown that if the benchmark were changed from 1987 to 1992 using the 1992 IOT weights while keeping all others unchanged, China’s industrial growth rate would be further lowered by about 1 percent per annum for the period 1978-97 but raised by 0.1 percent for the
period 1952-78. Apparently due to the price controls under central planning, the Gerschenkron effect appears to be evident only in the post-reform period.

In the present study, with an updated and substantially revised commodity series covering the entire period 1949-2009, three GVO series by industry (4 mining, 19 manufacturing and 1 utilities) using respective 1987, 1992 and 1997 IOT weights are first constructed. The results have revealed an expected clear Gerschenkron effect in most cases when shifting to more recent weights. Considering the industrial sector as a whole and using 1987 (the benchmark used in Wu, 2002a and Maddison and Wu, 2008) to separate two periods, the so-estimated annual GVO growth rate is reduced by 1.9 percentage points from 13.7 percent based on the 1987 IOT weights to 11.8 percent based on the 1992 IOT weights, and further reduced by 1.2 percentage points to 10.6 based on the 1997 IOT weights. For the period prior to 1987 when price control was heavy, shifting benchmarks gives little impact or no Gerschenkron effect.

**Figure 1**

**GROWTH OF CHINA’S INDUSTRIAL GROSS VALUE ADDED: OFFICIAL VERSUS ALTERNATIVE ESTIMATES, 1952-2010**

(Percent per annum)

Sources: In constructing the alternative industrial GVA index, commodity data are from DIS/NBS (2009) and DITS (2008 and earlier volumes), price data are from a Hitotsubashi University price database (IER, 1999), and the benchmark year (1987, 1992 and 1997) weights are from Chinese input-output tables. Chinese industrial GDP data are from NBS (2009 and earlier volumes).

Next, to derive GVA series by industry, I multiply each of the constructed GVO series by time-variant IOT value added ratios (GVA/GVO) obtained by interpolations
between benchmark IOTs starting with China’s first SNA-type 1987 IOT, and an extrapolation from 1987 back to 1949 based on NMP/GMP ratios constructed in Wu and Yue (2000). For the period after 1987, the results show an annual industrial GVA growth at 10.2 percent if based on the 1987 IOT weights, 9.2 percent if on the 1992 IOT weights and 8.1 percent if on the 1997 IOT weights, an expected similar downward Gerschenkron effect as in the case of GVO estimated.  

Finally, a single industrial GVA index is constructed by linking the three industrial GVA indices into one series. Figure 1 presents the annual growth of my alternative Chinese industrial GVA in comparison with that of NBS. The new exercise has further confirmed my previous findings (Wu, 2002a; Maddison and Wu, 2008) but with even slower yet more volatile industrial growth rates. It is indeed political economy-inspiring as one may argue from the institutional problem perspective that for almost all recessions or significant growth slowdowns my alternative estimates show a worse situation than that reported by the official statistics. More specifically, my results show that the industrial growth was indeed negative at the time when the Asian financial crisis hit China in 1998 (with about one-year lagging effect), which made the aggregate industrial GDP growth negative (-8.5 percent) as conjectured by some economists (e.g. Rawski, 2001), whereas the official estimate for that year is 8.9 percent. The new results have confirmed some earlier hypotheses among researchers that the overheating in 1995 was much more serious (23.3 percent) than the official data suggested (14 percent) and the effect of the government’s austerity program in 1996 by no means achieved a “soft landing” as claimed (-3.2 in my estimate compared with 12.5 percent in official estimate). For the recent global economic crisis in 2008, my estimate is 5.1 percent whereas the official estimate is 9.9 percent. The full results are reported in Table A5.

Table 4 compares my alternative estimates with the official estimates and shows the effect of the new adjustment on the total GDP growth rate. It shows that the impact of my adjustment is only -0.1 percentage points on the growth of the planning period but -1.7 percentage points on the growth of the reform period. However, my results show a slightly faster growth for the period 2001-10 by 0.4 percentage points.

17 For the pre-1987 period, although there is an expected positive Gerschenkron effect when shifting from 1987 to 1992 weights, its magnitude is trivial. However, it becomes unexpectedly negative when shifting from 1992 to 1997, which indicates likely misallocation of resources [to be discussed].
It is questionable because the official industrial growth is already very high. But, given the greater growth volatility as discovered with the commodity approach, this finding is likely indicative to some smoothing procedures in the official statistics since the 1990s as shown in Figure 1.

<table>
<thead>
<tr>
<th>Year</th>
<th>Official Estimates</th>
<th>Alternative Estimates</th>
<th>Official Estimates</th>
<th>After industry Adjusted</th>
<th>Effect of the Adjustment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1952-57</td>
<td>19.8</td>
<td>15.5</td>
<td>6.7</td>
<td>8.5</td>
<td>1.8</td>
</tr>
<tr>
<td>1958-65</td>
<td>9.0</td>
<td>0.7</td>
<td>2.4</td>
<td>1.2</td>
<td>-1.3</td>
</tr>
<tr>
<td>1966-71</td>
<td>11.8</td>
<td>8.3</td>
<td>5.3</td>
<td>5.3</td>
<td>0.0</td>
</tr>
<tr>
<td>1972-78</td>
<td>8.5</td>
<td>6.4</td>
<td>4.8</td>
<td>4.6</td>
<td>-0.2</td>
</tr>
<tr>
<td>1952-78</td>
<td>11.5</td>
<td>6.7</td>
<td>4.5</td>
<td>4.4</td>
<td>-0.1</td>
</tr>
<tr>
<td>1979-84</td>
<td>8.8</td>
<td>5.8</td>
<td>9.0</td>
<td>7.7</td>
<td>-1.3</td>
</tr>
<tr>
<td>1985-91</td>
<td>11.2</td>
<td>4.8</td>
<td>8.6</td>
<td>6.2</td>
<td>-2.4</td>
</tr>
<tr>
<td>1992-01</td>
<td>13.3</td>
<td>6.6</td>
<td>10.4</td>
<td>7.6</td>
<td>-2.8</td>
</tr>
<tr>
<td>2002-10</td>
<td>11.6</td>
<td>12.0</td>
<td>10.8</td>
<td>10.7</td>
<td>-0.1</td>
</tr>
<tr>
<td>1978-10</td>
<td>11.5</td>
<td>7.5</td>
<td>9.8</td>
<td>8.2</td>
<td>-1.7</td>
</tr>
</tbody>
</table>

Source: Table A5.
Note: *The official GDP estimates of other sectors are kept unchanged to see the effect of the adjustment for the industrial GDP.

One of the main criticisms to this commodity approach is that it may have missed the effect of quality change, that is, the real quality change may have been implicitly counted as a price effect (Holz, 2006a; Rawski, 2008). I agree that despite substantial efforts that have been made to ensure the quality compatibility of the commodities over time, there might be still problems that tend to underestimate quality change. However, an investigation by examining the gaps between official estimates and my alternative estimates (by subtracting the latter from the former with a polynomial trend to filter out most of the noises) does not support the critique as shown in Figure 2.

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18 It is indeed hard to maintain homogeneity of the commodities in the exercise. However, there are many products in the exercise that are homogenous in nature e.g. coal, iron ore, salt, basic metals and basic chemicals, and semi-conductors. Pressed steel products are measured by types rather than aggregate tonnage. Similar products including chemical fertilizers and refined oil products, product groups such as fabrics are measured using available intra-industry information taking into account the quantity and unit value of different fabrics. Different types of television set are also made “standardized”. Thus, it may be argued that changes of benchmarks in the present exercise have also captured some effect of quality changes.
One may reasonably expect that along with economic development the quality of industrial products should have been improving steadily rather than highly volatile as shown in Figure 2. If the gaps indeed indicate the missing quality changes, Chinese industry seemed to enjoy only one period of a continuous quality improvement that somehow began in the heydays of the Cultural Revolution (c.a. 1970) but ended in the late 1980s when the reform began to deepen. The following two decades of reform and integration with the world economy were accompanied by deterioration in product quality, which is difficult to accept.

To sum up, I would like to reemphasize that this exercise is not intended to provide “more accurate” annual estimates in GVA level and growth rate for Chinese industry. Rather, it is to examine, first, the long-run average growth rate that captures the underlying trend in Chinese industry and second, any abnormal volatility that deviates from the fundamentals and substantially change the level of industrial output, and hence affects the aggregate GDP. The advantage of this approach is that it can bypass the problematic price data. After all, the official approach for estimating real output under MPS until it abandoned CPPS in 2003 (together with the use of CPPI in the official deflation procedures) was essentially commodity-based and the “price manual” approach by nature also tends to underestimate quality change.

8. Estimation of China’s Aggregate Capital Stock
Since there are no official estimates for China’s aggregate capital stock, researchers have to construct it by themselves using available official statistics for the expenditure accounts. However, one has to be careful to avoid conceptual pitfalls in investment related statistics. Historically, there have been four different investment series in the official statistics. They are “total investment in fixed assets (TIFA)” and “newly increased fixed assets (NIFA)” in the investment statistics and “accumulation of national income (ANI)” and “gross fixed capital formation (GFCF)” in the national accounts statistics.

ANI is a MPS concept that began in the early 1950s but discontinued and replaced by GFCF in 1993 when China started to shift to the SNA in principle. However, studies before GFCF became available could only use the ANI statistics (Chow, 1993; He, 1992). Conceptually ANI is a net measure of investment in the “material sectors” of the economy in that it does not include the depreciation value of fixed assets. But, on the other hand, it is an incomplete and “dirty” indicator because it not only excludes investment in all “non-material activities” but also mixes up fixed asset investment, circulation funds and inventory. Therefore, it has no any theoretical underpinning if simply adding annual ANI to construct a “capital stock” series for the economy. Under the Chinese SNA, the Department of National Accounts (DNA) of NBS has adjusted the historical ANI series to reconstruct GFCF (DNA, 1997). The GFCF series has since been revised for twice (DNA, 2004 and 2007). Yet, GFCF is not problem-free, which will be discussed later.

TIFA also has a long history dated back to the beginning of the 1950s. It was designed to measure investment projects above certain size in value terms at current prices, available with breakdowns in investment type, asset type, ownership type, sector/industry and source of funding. The data collection for TIFA is conducted through the investment monitoring authorities at different levels of administration and published by DFAIS (Department of Fixed Asset Investment Statistics) of NBS.

Due to insufficient coverage and conceptual problems, TIFA should not be directly used as the investment variable in the perpetual inventory method equation as

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19 TIFA consists of three categories that distinguish fixed asset investment by nature, namely, “construction and installation”, “purchase of equipment”, and “other expenses” that are largely consumables to facilitate the above two activities (DFAIS, 1997, pp.444-445).
in many studies (Ho and Jorgenson, 2001; Young, 2003; Huang et al., 2002; Hu and Khan, 1997; Li et al, 1992). TIFA excludes all fixed asset investment project that is smaller than half million yuan and all intangible assets. More problematically, it includes the transaction of *existing* assets typically land which rocketed during the last decade, creating doubling counting problem. However, the coverage problem including land transaction-related double counting has largely been tackled in the construction of the national accounts. In this sense, GFCF is more qualified than TIFA.  

Besides, TIFA has a serious conceptual problem. It is by definition a measure of the *workload* in the construction and purchase of fixed assets in money terms (NBS, 2001, p.220; DFAIS, 1997, p.444). As correctly noted in Chow (1993, p.816), the work performed and recorded in TIFA may not eventually produce results that meet production standards for fixed assets in the current period. In fact, some of the work (investment projects) may take many years to become qualified for productive assets and some may never meet the standards, hence be completely wasted, which is a typical phenomenon observed in all centrally planned economies.

The nature of the problem shows a significant conceptual and practical difference between China’s national accounts and SNA. The SNA principle governing the time of recording and valuating fixed capital formation is “when the ownership of the fixed assets is transferred to the institutional unit that intends to use them in production” (CEC et al, 1993, p.223). Xu (1999, pp.62-63) notes that in the SNA a plant construction is counted as *inventory* if it cannot be sold to a buyer (investor) or cannot be used in production but it is included as *investment* in fixed assets in TIFA. The problem is aggravated in the case of a large project that needs several stages (years) to complete in which the investment “workload” is counted at each stage but the project

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20 In China, land belongs to the state or semi-state organizations (“collectives”) as in the case of farm land. There is no ownership transfer-based land transaction, but only the trade of “land use rights”. However, the government (both central and local) controls the primary release of the land use rights according to land size, location and market situation (unit price and timing). There have been increasing criticisms on the land-related government revenue and land-financed local public spending that has been considered largely responsible for China’s property bubbles ricking the financial system (Zhu, 2011).

21 Nonetheless, even the reported TIFA itself can be flawed regardless its conceptual problems. As observed at localities, TIFA statistics are manipulated by local officials in order to meet growth target: some non-investment spending are reported as fixed asset investment; some previously completed projects are repeatedly reported to exaggerate growth performance; and some planned future projects are reported as actual investment.
cannot be used for production before all stages are completed. This problem cannot be easily tackled in the construction of GFCF. In this sense, GFCF is also problematic.

By concept NIFA is designed to measure the completed fixed assets projects in value terms that are transferred to investors or users in the current period. As shown in the conceptualization for NIFA in Wu (2008), it is the current year completed and recorded result of TIFA initiated in the current and in all the previous years. NIFA appears to be a better indicator than TIFA but it is by no means flawless. Firstly, since NIFA is originated in TIFA, it has been affected by the same coverage and double counting problems as in TIFA. There is not a system that checks and removes the double-counted land value when a project is completed. Secondly, as required by the statistical authority, “to timely show the achievement in fixed asset investment, completed projects should be generally counted as currently in operation even if they are not yet quality-verified and passed” (DFAIS, 1997, p.448). Thus, even if NIFA does not exaggerate the actual fixed capital formation it will still have a different growth pattern from that of the true capital stock in the economy, which is difficult to predict. Lastly, NIFA has inherited a complicated price problem from TIFA. It is never clear whether the valuation in NIFA is at current prices or the prices recorded in TIFA that took place in previous years. However, since the workload approach is used in the valuation of TIFA, one may reasonably believe that the completed projects recorded in NIFA are also valued at multiple historical prices depending on when the projects were initiated.

Based on all these considerations, studies that relied on the official “transfer rate”\(^\text{22}\) (DFAIS, 1997, p.174), which is measured as NIFA divided by TIFA, to estimate the “real” GFCF have inevitably incorporated serious flaws (Wang and Fan, 2000; Holz, 2006b; Wang and Szirmai, 2012). Although NIFA and TIFA are connected in theory, they are conceptually incompatible. There is no regularity that makes NIFA predictable by TIFA because the average time used for a given amount of investment in fixed assets not only depends on the size and type of investment but also depends on the behavior of investors that is affected by ownership form, governing policy and institutional environment.

An Adjustment to GFCF

\(^{22}\) The official English translation of this ratio is recently changed to “Rate of fixed assets projects completed and put in use” (see for example NBS, 2009, p.206).
GFCF is now available as part of the national expenditure accounts starting in 1952 together with inventory, private and government consumption and net export (DNA, 2007). Nonetheless, the NBS adjustment procedures have not been made transparent enough. One can reasonably believe that the underlying problems are unlikely to be completely tackled.

In this study, I do not directly use the value of the official GFCF. Instead, I derive a new series of GFCF by using the share of the official GFCF in the gross domestic expenditure (GDE) accounts (Table 5) and my alternative GDP estimates. This is to ensure a “conceptual consistency” with my GDP adjustment. There is a downward effect of my adjustment on the investment growth by -0.5 percentage points for the pre-reform period and -2.3 percentage points for the post-reform period. However, one cannot simply interpret this downward effect on the investment growth as “offsetting” the potential exaggeration of the official GFCF level. This is because an exaggeration in level cannot be directly translated into an exaggeration in rate. But one thing is clear, that is, my adjustment here at least does not impose a downward effect on the TFP growth.

<table>
<thead>
<tr>
<th>Period</th>
<th>Share of Investment (%)</th>
<th>Growth of Investment (GFCF) (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Official</td>
</tr>
<tr>
<td>1952-57</td>
<td>17.1</td>
<td>19.1</td>
</tr>
<tr>
<td>1958-65</td>
<td>22.5</td>
<td>6.2</td>
</tr>
<tr>
<td>1966-71</td>
<td>21.3</td>
<td>10.1</td>
</tr>
<tr>
<td>1972-78</td>
<td>27.5</td>
<td>9.4</td>
</tr>
<tr>
<td>1952-78</td>
<td>22.5</td>
<td>10.5</td>
</tr>
<tr>
<td>1979-84</td>
<td>28.6</td>
<td>9.1</td>
</tr>
<tr>
<td>1985-91</td>
<td>29.0</td>
<td>7.6</td>
</tr>
<tr>
<td>1992-01</td>
<td>34.3</td>
<td>17.2</td>
</tr>
<tr>
<td>2002-09</td>
<td>40.4</td>
<td>14.4</td>
</tr>
<tr>
<td>1978-09</td>
<td>33.6</td>
<td>12.7</td>
</tr>
</tbody>
</table>

Source: The share of investment is calculated based on DNA (1997, 2004 and 2007). The alternative GDP (=GDE) estimates used in estimating the alternative GFCF are author’s estimates (Table A5).

The Initial Capital Stock
Despite many efforts have been made in estimating China’s aggregate capital stock, the estimation of its initial (post-war) stock has been left ambiguous. Existing studies have made or adopted very different estimates for the initial capital stock (usually referring to 1952) ranging greatly from less than 50 to over 250 billion yuan at 1952 prices which imply a capital-output ratio (K/Y) ranging from below 0.45 to over 2.22 if based on the official GDP for 1952. Some may argue that the initial stock in the early 1950s does not really matter if mainly interested in the reform period and in growth accounting (Young, 2003, p.1253). But it is however important if we are interested in examining changes in capital-labor ratio, capital-output ratio and the trend of return on capital in the Chinese economy especially in the long run.

Only a few of the studies have discussed how their estimates are made. Maddison (1998a, pp.64-65) relied on a hypothetical capital-output ratio of 0.9 for 1952 that was empirically justified by the lower bound of the international standard and pre-war estimates by Yeh (1968 and 1979). I use this as a reasonable starting point in the following discussion.

I first estimate the initial capital stock using an approach that is similar to Young (2003) as below:

\[ K_0 = \frac{I_0}{\bar{g} + \delta_0} \]  

where \( K_0 \) denotes the initial capital stock; \( \bar{g} \) is an average output (GDP) growth rate over a (stable) period; \( \delta_0 \) is a depreciation rate used for the initial stock estimation; \( I_0 \) is the investment taking place in the initial year. The net capital stock is then constructed by the standard perpetual inventory method:

\[ K_t = I_t + (1-\delta)K_{t-1} \]

To solve for \( K_0 \) of Equation 5, the national accounts GFCF in 1952 for \( I_0 \), two measures of the average GDP growth for the period 1952-56 are used for \( \bar{g} \) based on

NBS and my alternative estimates respectively, and $\delta_0$ is assumed to be 2 percent based on the information from the 1951 national asset census (explained below). Directly using the unadjusted NBS data including the national accounts implicit deflators, I obtain an initial capital stock of 82.6 billion in 1952 constant yuan. However, if using my alternative estimates for these variables and choosing a 5-percent depreciation rate, the results would be 68.5 billion in 1952 yuan (=171 billion 1990 yuan). I explain below why the estimate using the official data should be used as the initial level capital stock.

I evaluate the above estimates by some seldom used information from the 1951 National Asset Census verifying and evaluating China’s stock of fixed assets, only available for publication in 2000 as a collection of archived planning documents and papers by SETC (2000, Vol. 1, pp.1543-4). It shows that by the end of 1951, the total market replacement value of fixed assets was 128.3 billion in 1952 yuan. Taking off the accumulated depreciation value of 39.2 billion, the net stock would be 89.1 billion 1952 yuan. The census also gives an annual depreciation rate by sector based on which a weighted average of 1.94 percent can be calculated (I then decided to use 2 percent).\textsuperscript{24} My estimate of 82.6 billion using the NBS data comes out quite close to the census result of 89.1 billion. Additional information that can be used for crosschecking is the share of the industrial net capital stock in the total stock. The share is 11.6 percent (for 1951) by the census. If using my estimate for Chinese industry in 1952 (Wu, 2008b), including the residential housing owned by the industrial sector, this share would be 10.9 percent. I am thus convinced that this estimate of 82.6 billion 1952 yuan should be used as the initial stock. This by no means suggests that alternative depreciation rates should not be used in the construction of the capital stock based on this initial level of the stock.

\textit{Depreciation Rate}

Based on Equation 6 two sets of net capital stock series are constructed. They both use the same set of depreciation rates from my earlier work on industries, but use very different deflators. My depreciation rates ($\delta$) are based on my earlier work on

\textsuperscript{24} This depreciation rate seems too low given the impact of the wars in China in the first half of the twentieth century. However, it should be noted that this depreciation is based on survived assets. Given the severe shortage of capital, producers who managed to keep their production and survived should try hard to prolong asset life and reduce capital consumption.
industrial capital stock (Wu, 2008b). Following Hulten and Wykoff (1981), I assume $\delta = R/T$ where $T$ stands for asset lives that are based on official accounting regulations (State Council, 1985; Ministry of Finance, 1992) and $R$ is the declining balance rate of fixed assets using the empirical findings by Hulten and Wykoff (1981). The so-estimated depreciation rates are ranged from 5 to 7 percent across industries. The present study sets different annual depreciation rates at 5, 6 and 7 percent, respectively, to estimate alternative net capital stocks using the geometric depreciation function. Besides, taking into account an increasing market influence on firms’ depreciation decision that may have speeded up the depreciation process of fixed assets, I also introduce a multiple $\delta$ depreciation process in the present exercise assuming 5 percent for the pre-reform period, 6 percent for the early reform period 1978-92 and then 7 percent for the period from 1993 onwards. This alternative treatment does not satisfy the theory of economic depreciation; however, it is justifiable for reflecting the shifts of policy regime and hence changes in firms’ depreciation practice.

An Alternative Investment Deflator

The only difference between the two estimates of capital stock is the deflator. One uses the NBS expenditure accounts implicit investment deflator that is obtained with nominal investment and growth index of investment at constant price. The other exercise employs an alternative deflator based on my estimation. Two price indices are used in the estimation, namely, producer price index (PPI) for construction materials and PPI for machinery and equipment. The construction materials PPI is a weighted index of non-metallic materials and basic and fabricated metals and the machinery and equipment PPI is a weighted index of seven industries.\(^\text{25}\)

Table 5 presents the annual growth rate of the official and alternative estimates of China’s net capital stock by different depreciation scenarios (results for $\delta = 0.06$ are not shown). The full results are reported in Table A8. In general, the estimates using alternative deflator show a slower growth of net capital stock for the planning period but a faster growth for the reform period. The most significant difference between the two results is observed for 1991-2001 of the post reform period when the alternative

\(^{25}\) They include ordinary and special purpose machinery, transportation equipment, electrical and electronic equipment and office equipment. Machinery as consumer goods cannot be separated.
deflator-based estimates suggest a faster growth of about 4 percentage points in China’s net capital stock than what given by the national accounts implicit deflator for gross fixed capital formation.

**TABLE 5**

**Estimated Annual Growth of Net Capital Stock by Official and Alternative Deflators and by Different Depreciation Rates**

(Annual percentage change)

<table>
<thead>
<tr>
<th></th>
<th>By NBS Deflator</th>
<th></th>
<th>By Alternative Deflator</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( \delta=0.05 )</td>
<td>( \delta=0.07 )</td>
<td>Multiple ( \delta )</td>
<td>( \delta=0.05 )</td>
</tr>
<tr>
<td>1952-57</td>
<td>10.8</td>
<td>9.3</td>
<td>10.8</td>
<td>8.9</td>
</tr>
<tr>
<td>1957-65</td>
<td>9.6</td>
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<tr>
<td>1965-71</td>
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<tr>
<td>1971-78</td>
<td>9.0</td>
<td>9.0</td>
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<td>9.7</td>
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<td>1984-91</td>
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<td>9.0</td>
<td>8.8</td>
</tr>
<tr>
<td>1991-01</td>
<td></td>
<td>11.2</td>
<td>11.3</td>
<td>10.6</td>
</tr>
<tr>
<td>2001-08</td>
<td></td>
<td>12.8</td>
<td>13.0</td>
<td>12.9</td>
</tr>
<tr>
<td><strong>1978-08</strong></td>
<td><strong>10.5</strong></td>
<td><strong>10.6</strong></td>
<td><strong>10.1</strong></td>
<td><strong>12.3</strong></td>
</tr>
</tbody>
</table>

*Source: Table A7; [to be revised and updated]*

Table 6 presents the annual average of investment-capital stock ratio (I/K), capital intensity of output (K/Y) and “return to capital” (Y/K adjusted by the capital share of the total income) for both the planning and reform periods using alternative deflator. Figures 3 and 4 depict the annual series of these indicators compared with estimates using the NBS data.

**TABLE 6**

**Investment-Capital Ratio, Capital Intensity of Output and “Return to Capital”**

(Annual average)

<table>
<thead>
<tr>
<th></th>
<th>I/K</th>
<th>K/Y</th>
<th>“Return to Capital”</th>
<th>Y/K*( \delta )</th>
<th>Y/K*( \delta )</th>
<th>Y/K*( \delta )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1952-57</td>
<td>0.12</td>
<td>0.58</td>
<td>1.04</td>
<td>0.69</td>
<td>1.05</td>
<td></td>
</tr>
<tr>
<td>1957-65</td>
<td>0.12</td>
<td>0.91</td>
<td>0.68</td>
<td>0.46</td>
<td>0.68</td>
<td></td>
</tr>
<tr>
<td>1965-71</td>
<td>0.12</td>
<td>1.04</td>
<td>0.58</td>
<td>0.39</td>
<td>0.56</td>
<td></td>
</tr>
<tr>
<td>1971-78</td>
<td>0.13</td>
<td>1.31</td>
<td>0.46</td>
<td>0.31</td>
<td>0.41</td>
<td></td>
</tr>
<tr>
<td><strong>1952-78</strong></td>
<td><strong>0.12</strong></td>
<td><strong>0.97</strong></td>
<td><strong>0.68</strong></td>
<td><strong>0.45</strong></td>
<td><strong>0.67</strong></td>
<td></td>
</tr>
<tr>
<td>1978-84</td>
<td>0.13</td>
<td>1.57</td>
<td>0.38</td>
<td>0.25</td>
<td>0.31</td>
<td></td>
</tr>
<tr>
<td>1984-91</td>
<td>0.14</td>
<td>1.86</td>
<td>0.33</td>
<td>0.22</td>
<td>0.27</td>
<td></td>
</tr>
<tr>
<td>1991-01</td>
<td>0.19</td>
<td>2.94</td>
<td>0.22</td>
<td>0.14</td>
<td>0.18</td>
<td></td>
</tr>
<tr>
<td>2001-08</td>
<td>0.18</td>
<td>4.79</td>
<td>0.13</td>
<td>0.08</td>
<td>0.09</td>
<td></td>
</tr>
<tr>
<td><strong>1978-08</strong></td>
<td><strong>0.16</strong></td>
<td><strong>2.85</strong></td>
<td><strong>0.25</strong></td>
<td><strong>0.17</strong></td>
<td><strong>0.21</strong></td>
<td></td>
</tr>
</tbody>
</table>

*Sources: Tables A6 and A7; [to be revised and updated]*

*Notes: Y refers to the estimates based on my alternative assumption for labor productivity of the “non-material services” (see Alternative II, Table 2); I refers to GFCF using the alternative deflator; K refers to the estimates based on multiple depreciation rates; the*
The capital share of the national income is given as 0.6 following Chow (1993), 0.4 following Young (2000) and my time-variant estimates (φ) based on the Chinese input-output tables.

The change of the I/K ratio suggests that an increasing investment is required for a given unit of capital stock in order to compensate for the capital consumption or to maintain an effective capital stock to support the output growth. The period average of I/K in Table 6 looks fairly stable prior to the 1990s whereas it appears to be very volatile in Figure 3(A) with some huge shocks along with the shifts of policy regime and changes of macroeconomic situation. The K/Y ratio suggests that China evolved from a labor-intensive to a capital-intensive economy. It jumped from only 0.97 in the planning period to 2.85 in the reform period of which the sub-period 2001-08 saw the biggest increase (Table 6). As in the case of I/K, the K/Y ratio rose even more rapidly if based on my estimates (Figure 3(B)).

The estimated “return to capital” in Table 6 is gauged by applying three alternative capital shares of the national income (GDP), that is, 60 percent following Chow (1993) and Chow and Li (2001), 40 percent following Young (2003), and my time-variant estimates using information from the Chinese national accounts and input-output tables which show a decreasing capital share from 60 to 40 percent over time. As will be discussed in the next section, the estimated TFP is sensitive to the

**Figure 3**
INVESTMENT-CAPITAL STOCK RATIO AND CAPITAL INTENSITY OF OUTPUT 1952-2010

*Source: Revised estimates, not based on Table 6.*
choice of the factor shares. All the three estimates suggest a significant diminishing “return to capital” with the fastest decline of the estimate using the time variant national accounts (input-output table) income shares.

While the overall picture does not look encouraging, there are signs with interesting implications for further investigations (Figure 4). The central planning period experienced the most rapid decline in the return to capital in the history of the People’s Republic indicating a very high cost of the growth under central planning. The Cultural Revolution (1966-76) period was also very inefficient in terms of capital productivity. Beside, the central planning period saw greater volatilities in this ratio with unusual jumps in 1963-65 and 1969-70, apparently as a compensation for the unusual drops earlier – all can be explained by policy shocks. Yet, the economic reform has not reversed the general trend of the diminishing return to capital, but it indeed temporarily stopped the decline of the ratio in 1980-85 and 1990-95 likely due to positive policy and institutional effects. The decline of the ratio resumed since the mid 1990s and continued over the subsequent 15 years when China emerged as the “world factory”.

**FIGURE 4**

“RETURN TO CAPITAL” IN CHINA, 1952-2010

*Source: Revised estimates, not based on Table 6.*

9. **CHINA’S PRODUCTIVITY PERFORMANCE REVISITED**

Following the above discussion of the key data problems and the construction of alternative estimates for the variables required for the standard productivity analysis, this section provides TFP estimates using alternative data for the Chinese Economy.
As mentioned in the earlier discussion, to investigate whether it is the data problems that have caused the contradictory TFP estimates, the present study applies the same Solow model used in almost all growth accounting studies on the Chinese economy. Therefore, I also begin with an assumption of a linearly homogeneous Cobb-Douglas aggregate production function with a Hick’s neutral shift parameter:

\begin{equation}
Y = A(t)K^\alpha L^{1-\alpha}
\end{equation}

where \(Y\), \(K\), and \(L\) denote output, capital, and labor, respectively, \(\alpha\) denotes the output elasticity of capital, and the Hicksian \(A\), which is assumed to be a function of time \(t\), measures the shift in the production function at the given level of capital and labor. With total (logarithmic) differentiation and then a little mathematical rearrangement, we could get the Solow residual:

\begin{equation}
\frac{\dot{A}_t}{A_t} = \frac{\dot{Y}_t}{Y_t} - \frac{\partial Y_t}{\partial K_t} \frac{K_t}{Y_t} - \frac{\partial Y_t}{\partial L_t} \frac{L_t}{Y_t}
\end{equation}

Here comes the key link between the unobserved output elasticity of capital \((\alpha = \frac{\partial Y}{Y} / \frac{\partial K}{K})\) and labor \((1 - \alpha = \frac{\partial Y}{Y} / \frac{\partial L}{L})\) and the observable income shares of capital and labor, which hinges on Solow’s assumption that each input is paid its marginal product. As said, this is a theoretical as well as an empirical issue that will not be investigated in the present study.

However, while sticking to the Solow model one more important issue to discuss before we proceed further is how to determine the income shares of capital and labor. As a preliminary treatment, I opt for the direct use of the income shares from the input-output tables by simply taking the labor compensation as \(\alpha\) and capital compensation as \((1 - \alpha)\) for each year, which gives a set of time-variant estimates for \(\alpha\). There was a clear decline of \(\alpha\) from about 0.59 in 1952 to 0.45 in 1978 and further to 0.41 in 2008. To compare my results with the income shares of factors typically used in most of other studies, I choose a fixed \(\alpha = 0.6\) following Young (2000) and a fixed \(\alpha = 0.4\) as in Chow (1993).27

26 There is of course room to further improve the measure of labor compensation within the input-output framework. For example, taxes should be allocated to labor and capital by appropriate shares and more importantly labor share should be adjusted for self-employment (Gollin, 2002).

27 A new estimate by Chow and Li (2001) gives an even higher capital share as 0.63 suggesting that the labor share is only 0.37.
In Table 7, I report three sets of estimates based on the three different assumptions of labor share ($\alpha = 0.6$, $\alpha = 0.4$ and $\alpha = \text{time-variant IO shares}$); each set contains results using both the official data and my adjusted data. It is clear that the adjusted GDP growth rate has the most impact on the reform period. Let us take the results based on the input-output table income shares as an example. Compared with the results using the official data, the results using the adjusted data raise annual GDP growth by 0.5 percentage point for the central planning period but reduce annual GDP growth by 2 percentage points for the reform period. For the growth of capital stock, compared with the estimates using the national accounts implicit deflator, the estimates using my alternative deflator have trivial effect on the planning period but raise the growth by 0.9 percentage point per annum for the reform period. The impact of the adjusted labor is not significant for either period.
# Table 7

**ESTIMATES OF TFP FOR THE CHINESE ECONOMY USING OFFICIAL AND ADJUSTED DATA WITH ALTERNATIVE INCOME WEIGHTS**

(Percent change per annum)

<table>
<thead>
<tr>
<th>Data Used Based on Official Estimates&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Data Used Based on Adjusted Estimates&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>GDP</strong></td>
<td><strong>Labor</strong></td>
</tr>
<tr>
<td></td>
<td>Quantity</td>
</tr>
<tr>
<td><strong>Time Variant Input-Output Table Weights</strong></td>
<td><strong>Fixed Labor Income Share as 0.60 (Young, 2000)</strong></td>
</tr>
<tr>
<td>1952-57</td>
<td>6.7</td>
</tr>
<tr>
<td>1957-65</td>
<td>2.4</td>
</tr>
<tr>
<td>1965-71</td>
<td>5.3</td>
</tr>
<tr>
<td>1971-78</td>
<td>4.8</td>
</tr>
<tr>
<td>1952-78</td>
<td>4.5</td>
</tr>
<tr>
<td>1978-84</td>
<td>9.0</td>
</tr>
<tr>
<td>1984-91</td>
<td>8.6</td>
</tr>
<tr>
<td>1991-01</td>
<td>10.4</td>
</tr>
<tr>
<td>2001-10</td>
<td>10.8</td>
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<tr>
<td>1978-10</td>
<td>9.8</td>
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<td>1952-57</td>
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<td>10.4</td>
</tr>
<tr>
<td>2001-10</td>
<td>10.8</td>
</tr>
<tr>
<td>1978-10</td>
<td>9.8</td>
</tr>
</tbody>
</table>

*Source: Author’s calculation.*

*Notes:* 1) The official data include unadjusted GDP, unadjusted employment and estimated capital stock deflated by the national expenditure accounts implicit deflator. 2) The alternative data include adjusted GDP by the “Alternative II” approach (Table 3), adjusted employment of “Scenario 3” (Table 1), and the capital stock deflated by alternative deflator. 3) Multiple depreciation rates are used in the estimation of capital stock in both cases. 4) The results in the framed areas are corresponding to the framed areas in Tables A8 and A9.
Consequently, assuming the input-output table income shares, the estimated TFP growth will be substantially reduced from 3.3 to 0.3 percent per annum if shifting from the official data to the alternative data, of which about 70 percent of this downward adjustment (2.3 percentage points) is attributed to the GDP growth adjustment and the remaining 30 percent is mainly attributed to the investment deflator adjustment that affects the estimated capital stock. The estimated TFP is sensitive to the change of income share which can be examined by comparing different panels of the table. When the official data are used, the estimated TFP growth will be raised from 3.3 to 4.4 percent per annum with an assumed labor share of 60 percent, but it will be lowered to 2.9 percent if using an assumed labor share of 40 percent. In the case of the adjusted data, the estimated TFP growth rate will be raised from 0.3 to 1.6 percent per annum with an assumed labor share of 60 percent, but it will be lowered to -0.3 percent the labor share is reduced to 40 percent.

Obviously, none of these TFP values is unfamiliar in the existing literature as reviewed earlier. This confirms that the estimated TFP growth for the Chinese economy is very sensitive to how data are adjusted. If the data problems are indeed problematic as discussed, the lower bound rather than the upper bound TFP estimates should be closer to the truth. The results also suggest that data problems are much more severe in the reform period than in the planning period.

The change in the income shares of factors also has implications for the long-run performance of TFP level. Figure 5 presents alternative TFP level indices for China using my adjusted data with different income shares for labor compared with the estimates using the official data – all by the input-output table weights. It first shows that by any measure China’s TFP level declined significantly during the planning era. By 1978 the “best scenario” that assigns 60 percent of income to labor and uses the revised data only attains 87 percent of the 1952 level.

For the reform era, it is the estimation using the official data (with the input-output table weights) that gives the highest level of TFP by 2008 as 210 percent of the 1978 level (=100).28 However, if using the adjusted data and assigning 40 percent of income paid to labor, the level of TFP up to 2008 was only 91 percent of that in 1978.

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28 Accumulated TFP from the initial level of 100 in 1978 gives different TFP growth rates from what reported in Table 7 because in the latter it is measured as the arithmetic mean of annual changes in a given period.
This is changed to 161 if the labor share is raised to 60 percent. The time-variant input-output weights always bring forth an estimate of somewhere in between or 109 of the base year.

**FIGURE 5**

**ALTERNATIVE ESTIMATES OF TFP LEVEL FOR THE CHINESE ECONOMY**

(1978 = 100)

Source: Author’s calculation. See notes to Table 7, and Appendix Tables A8 and A9.

In any set of the estimates in Table 7, the growth of capital stock (representing the capital services though arguably) is seen as the most important driver of both China’s pre- and post-reform growth, and such an importance was increasing over time. The contribution by the quantity of employment declined significantly. As for the “quality of labor” with the growth of average schooling as a proxy, although it declined in general in the post-reform period compared with the pre-reform period, the trend was somehow reversed since the 1990s. In Appendix Table A8 and A9, sensitivity tests on TFP estimates for changes in GDP estimates and alternative depreciation rates are reported. They show that other things being equal, using Scenario 3 in the employment adjustment does not change the TFP estimate and using the multiple depreciation rates raises the TFP estimate by 0.2 percentage point. That is, choosing different delta within the range of my exercise does not change the result very much.

The estimated TFP performance does not suggest that there has been a stable improvement of productivity or efficiency over a long period. Figure 6 depicts the estimated TFP performance against the shift of policy regimes represented by periods adopting different policies, that is, the period implementing the Soviet-type central
planning in 1952-57, the Maoist “Great Leap Forward” campaign and its aftermath in 1958-65, the early chaotic period of the Cultural Revolution in 1966-71, an attempt to catch up the lost time in 1972-78, the early reform period in 1979-84 focusing on agriculture, the dual-track price reform in industry in 1985-91, the deepening state enterprise reform following Deng’s call for bolder reform that led to the official adoption of the “socialist market economy” in 1992, and the period following China’s WTO accession in 2001 (assuming the WTO effect began in 2002).

![Figure 6: Sources of Growth in the Chinese Economy](image)

It is clear from a quick glance at the figure that the growth of TFP was not closely associated with the growth of investment. One may therefore be convinced that policy and institutional shocks were the best candidate for the explanation of the changes of TFP growth over different periods. Interestingly, two significant positive TFP gains are observed when China shifted to the central planning in 1952-57 and when China began to depart from the central planning system in 1979-84. One-off incentive gains due to institutional change could be the main reason. However, all major political campaigns by ideological drive or political control during the pre-reform era, whether aiming at economic growth, resulted in severe negative TFP growth. The “modernization campaign” following China’s reestablishment of its formal ties with the West and Japan in 1972-73 brought about the most rapid growth in investment and employment under central planning, but it seemed to be extremely inefficient because
of wasteful investment together with deteriorating incentive problems. During the period 1972-78, 40 percent of growth vanished due to inefficiency (negative TFP growth by 2.5 percent).

On the other hand, perhaps contrary to what many may have believed, the earlier or pre-WTO reform measures between the mid 1980s and the beginning of 2000s were not TFP growth-promoting. The industrial reform began in 1985 which operated on the backbone of the central planning system brought about a shock reflected by a negative TFP growth in 1985-91. In the following period 1992-2001, the fastest ever physical investment made China enjoy the fastest economic growth in history. The efficiency of the economy slightly improved although the TFP growth still remained in the negative zone.

However, also shown in Figure 5, the only period that saw a significant positive TFP growth was the one following China’s WTO accession, though not as substantial as that estimated using the unadjusted official data (Table 7). It means that China could benefit from its comparative advantage in labor intensive manufacturing through a substantially enlarged market. China found itself in a very competitive position given that there had been a huge investment building up a huge production capacity, of which an increasing part had been underutilized (evidenced by China’s persistent deflation from 1998 to 2002). The WTO accession is productivity promoting not only because it allows China to benefit more from its comparative advantage but also because it speeds up the learning by doing process through deeper and wider international market exposure and further institutional reforms prompted by such an exposure.

10. CONCLUDING REMARKS

This study is obviously heavily data driven. It revisits the long-existing debate about China’s growth performance by seriously tackling the prevailing data problems that have been the major obstacles to a proper assessment of China’s growth performance.

First, it examines and adjusts the serious break in the official employment statistics in 1989-90. Second, it augments the numbers of employment by a human capital effect using estimated average years of schooling. Third, it tests the sensitivity of Maddison’s (1998a) “zero labor productivity growth” assumption in gauging the real growth of the so-called “non-material (including all non-market) services” by
proposing alternative assumptions using my new employment estimates for these services. Fourth, it further improves the author’s earlier physical output-based production index for the industrial sector (Wu, 2002a) by using multiple weights and time-variant value added ratios obtained from the Chinese input-output tables. The likely problem of “product quality” in such a physical measure is examined and rejected. Fifth, it provides a new set of estimates of capital stock for the aggregate economy using alternative deflators and depreciation rates, crosschecked by the author’s industry-level capital stock estimates (Wu, 2008b) and using also China’s first asset census in 1950-51. Base on these new data works, a range of TFP growth estimates have been obtained, compared and discussed.

Data tell the truth but they may also hide the truth. To make them truth-revealing one has to identify the problems which disguise the truth and then try to make proper adjustments accordingly. However, any data adjustment has to be transparent. The next is one’s knowledge about the economy and the institutions (and their deficiencies!) and the mechanism through which the data are produced by state agencies for the economy.

We have confined the current study to the well known neoclassical growth accounting framework that most of the earlier studies explicitly or implicitly adopted.\(^\text{29}\) As stated at the beginning of the paper, my purpose is to discover how data problems may affect the estimated TFP growth rather than exploring a new theoretical framework to gauge China’s TFP performance. For this purpose, I use the same approach to the existing literature accounting for China’s growth performance. The conclusion for the Chinese growth and productivity performance should be drawn by the reader.

Nevertheless, it is perfectly reasonable to argue that the neoclassical framework used in this study is questionable or unacceptable in terms of the discovery of the truth (Felipe, 1999). Emphasizing data problems does not mean that methodological problems are unimportant. Rather, methodological debate cannot be completely settled before major data problems are resolved.

\(^{29}\) Despite the long debate about the real meaning of TFP and its usefulness, we still think it is a indispensable tool that provides benchmarks for assessing growth and productivity performance of economies. Interested readers may see a criticism by Felipe (1999) in a review of productivity studies on the East Asian economies.
Given China’s increasing impact on the world economy because of its sheer size, rapid growth and unique institutional settings for promoting growth, a proper assessment of and explanation for China’s growth performance is an unavoidable challenge to the economics profession, not only in terms of empirical evidence based on more reliable data work and the empirical methodology, but also in terms of theory that better explains the China model of growth and catch up.

Below are my on-going studies with prioritized data work:

1) Construct sector-level capital stock following the approach used in this paper by seriously tackling inconsistency problems that may emerge from such an effort. This will include reconciliation with my industry-level capital stock estimation for the industrial sector in a separate project.

2) Estimate capital services by adopting the user cost approach in principle and adjusted due to limited available data.

3) Improve the input-output table-based income share estimation by adjusting for self-employed. This is related to my work on employment.

4) Improve the estimation of employment by converting numbers employed to hours worked by using all available labor market information as well as changes in institutional working hours per week. This will make the re-distribution of the discrepancy since 1982 more reasonable.

5) Improve the estimate of the human capital of the workforce by incorporating population census-based information on all other human capital attributes (age, gender, industry, occupation) in addition to education.
APPENDIX A
THE INCONSISTENCY BETWEEN NATIONAL INDUSTRIAL GDP AND VALUE ADDED BY INDUSTRY

Detailed industry statistics only available based on enterprises at and above the “designated size” through a regular (monthly, quarterly and annually) reporting system. Smaller “below size” enterprises are monitored by regularly conducted sample surveys. There is also workforce “outside the system”, which is only picked up by population censuses or annual 1% population surveys. The majority of the “outside the system” workers is recorded by a loose definition (i.e. “performing one hour wage-earning job in the week of the survey) and mainly seasonal, temporal, multi-jobs, thus not equivalent to an average of those “within the system” (i.e. above & below the “designated size”). A serious inconsistency is found in the current statistical system, that is, the sum of value added of the “above size” began to exceed total industrial GDP estimated by the national accounts from 2005 (Figure A1).

FIGURE A1
VALUE-ADDED AND EMPLOYMENT BY INDUSTRIAL ENTERPRISES AT/ABOVE THE “DESIGNATED SIZE” COMPARED WITH NATIONAL INDUSTRIAL GDP AND EMPLOYMENT

Sources: National accounts data are from various volumes of China Statistical Yearbook and the “above size” industrial employment, growth value of output and value added data are from various volumes of China Industrial Economy Statistical Yearbook.

The benchmark line (=1) gives the national totals for both gross value added and employment in the industrial sector. The so-called “above the designated size” criterion for firms to be included in the regular reporting system was introduced in
1998. The size is defined as total annual sales of five million yuan at market prices. Prior to 1998 the criterion was set at or above the township administrative level.

There appears to be the absence of a system that accommodates all categories of inputs and outputs that make up the national totals. In particular, there is not a coherent accounting balance between all industrial activities categorized as “at/above designated size”, “below size” and the rest (or “outside the system”). Official data show that the sum of the value added by “above size” enterprises was equal to the level of national industrial GDP in 2006 rendering 24 million employed of “below size” and 43 million employed “outside the system” producing nothing or simply disappeared! However, this sum exceeds the total industrial GDP in 2007 (by 6%) and in 2008 (by 10%)!

At an internal joint workshop between The Conference Board and NBS in May 2010, NBS acknowledged three factors that might be able to explain the problem: 1) Inconsistency in the enterprises covered by the “system” with a criterion of 5 million yuan sales – the number of enterprises rose from 160,000 in 1998 to 420,000 in 2008;\(^{30}\) 2) Double counting due to the so-called “headquarter effect”; 3) Data quality problem and data falsification. Mainly because of this problem of unaccounted-for labour, the Department of Industrial Statistics (DIS) of NBS that is responsible for handling the firm level data at/above designated size and producing estimates of gross output and value added for each industry at/above the size has stopped providing their value added estimates since 2008.

\(^{30}\) NBS has decided to raise the cut-off line from 5 to 20 million from 2010, which will substantially increase the size of the enterprises covered while reducing the number of enterprises covered. A new inconsistency problem will then be followed.
APPENDIX B
DIFFERENT OFFICIAL MEASURES OF PRICE CHANGES

One of the motivations behind this type of studies is that volume movements can better gauge the real growth since it can bypass official problematic price data or inflation measures as well as upward bias due to institutional problems in data reporting (exaggerating growth due to political reason). Despite the tremendous efforts made by NBS, problems in price measurement have not gone. Evidence has shown that the price problem has been further complicated by the recent adjustment of real growth rate following China’s first Economic Census for 2004. I found that the NBS post-census time series adjustment bypassed deflator problem and was made directly to the real output, which implicitly “adjusted” underlying prices (Wu, 2007). After replicating the adjustment procedures using the standard interpolation approach, it is also clear that the NBS post-census adjustment arbitrarily modified the results obtained by the standard interpolation approach and deliberately left the original debatable estimates for 1998 intact.31

FIGURE A2
ALTERNATIVE OFFICIAL PRICE INDICES FOR INDUSTRIAL OUTPUT

Sources & Notes: Basic data for calculating comparable price index (CPPI) are from China Industrial Economy Statistical Yearbook (DITS, various issues) and data for calculating the implicit GDP deflator are from China Statistical Yearbook (NBS, 2007, pp.57 & 59). PPI data are directly from China Statistical Yearbook (NBS, 2007, p.330). CPPI is calculated using the “comparable price”-

31 The problem of the post-census adjustment is more to do with services. However, we have reservations about the adjusted growth rate also because it is not clear whether the underreported services as discovered by the census only appeared after 1992. If the extent of underreporting was similar prior to 1992, no adjustment is needed, and if it was higher, which is not unlikely because one may reasonably assume that official statistical practices will improve over time, the growth rate should be downward rather than upward adjusted.
approach estimated industrial GVO and nominal GVO available at industry level. Such data were discontinued after 2003. Internal source confirmed that NBS stopped using this approach at least for this group of statistics. To compare with other indices presented here, we assume that CPPI in 2004-06 follows the changes of PPI in all industries, and the so-derived changes for industries are used to estimate changes over this period for the industry as a whole. The implicit GDP deflator is simply derived as the difference between nominal and real growth indices of industrial GDP. The nominal growth index is calculated using NBS nominal GDP data and the real industrial GDP index is directly from the NBS source.

To demonstrate the complexity of the price problem in the estimation of real industrial output, in Figure A2 I present three official price indices for the industry as a whole (including manufacturing, mining and utilities), namely, the comparable price index (CPPI) adopted under the MPS and used until 2003, producer price index (PPI) and an implicit GDP deflator for industry. A note to Figure 1 explains where our data are obtained and how the indices are constructed. It should be noted that both CPPI and PPI refer to the gross value of industrial output, whereas the (implicit) GDP deflator refers to the industrial gross value added. The annual fluctuations exhibit a similar pattern but to different degrees. The CPPI appears to be the least volatile index while the PPI is the most. The GDP deflator lies in between. Intuitively, it follows (may not be an appropriate word) that if the nominal output is given, the CPPI suggests the highest real growth, whereas PPI implies the slowest growth, leaving the GDP deflator again in the middle. It is never clear what deflation procedures that NBS adopts to estimate the real industrial value added. However, Panel B implies that the (underlying) value added ratio must be high enough and rapidly growing to compensate for the high and rising input prices (reflected by PPI). This is certainly not the case as discussed in Section 7.

APPENDIX C AND TABLES TO BE UPDATED…
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