

China **E**conomy **P**apers ***1998/3***

**How rich is China and how fast has the
economy grown?
Statistical controversies**

Harry X. Wu

ASIA PACIFIC SCHOOL
ECONOMICS AND MANAGEMENT
THE AUSTRALIAN NATIONAL UNIVERSITY

Asia Pacific Press
<http://ncdsnet.anu.edu.au/online/>



© copyright 1998 NCDS Asia Pacific Press

China Economy Papers 1998

Published online by
NCDS Asia Pacific Press
Asia Pacific School of Economics and Management
The Australian National University
Canberra ACT 0200
email: publications@anu.edu.au
<http://ncdsnet.anu.edu.au>

The China Economy Papers are mainly research outcomes of projects coordinated by the China Economy Program at the Australian National University.

ISSN 1441 9866
ISBN 0 7315 2394 6

Harry Wu is a Lecturer in Economics at Department of Business Studies, Hong Kong Polytechnic University. He is also a former senior economist with East Asia Analytical Unit, Australian Department of Foreign Affairs and Trade, and a former research fellow with Chinese Economies Research Centre, University of Adelaide. Please send all correspondence to Department of Business Studies, the Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong, or contact on Tel: (852) 2766 7126, Fax: (852) 2765 0611; Email: buhxwu@polyu.edu.hk.

Acknowledgements

I am greatly indebted to Angus Maddison for his detailed comments and helpful advice. I would also like to thank Ross Garnaut for his great inspiration. This paper has also benefited from my discussions with Frances Perkins and comments from participants in the China Economy Program seminar at the Australian National University, 28 August 1997.

Abbreviations

CPEs	centrally planned economies
CPI	consumer price index
FPPPI	farm products purchasing price index
GDP	gross domestic product
G-K	Geary-Khamis (dollar)
GNP	gross national product
GVA	gross value added
GVO	gross value of output (MPS concept)
ICOP	International Comparison of Output and Productivity (project at University of Groningen, The Netherlands)
ICP	International Comparison Project (United Nations)
IPPI	industrial products producer price index
MER	market exchange rate
MPS	material product system
NMP	net material product (MPS concept)
NVA	net value added
NVO	net value of output (MPS concept)
OECD	Organisation of Economic Cooperation and Development
PPCs	purchasing power of currencies
PPP	purchasing power parity
PWT	Penn World Tables (reporting main results of ICP)
SNA	United Nations System of National Accounts
SOEs	state-owned enterprises
SSB	State Statistical Bureau (China)
TFP	total factor productivity
TVEs	township-village enterprises, also refers to all rural enterprises
UVRs	unit value ratios

How rich is China and how fast has the economy grown? Statistical controversies

Introduction

Correctly measuring a country's national income and its growth is essential to the understanding of various aspects of the country's economy both at present and in the future. The measurement issue is even more important for economies like China whose size-based economic-political power is always important to the world, but whose statistical system is less transparent and more non-standard because of the strong influence of the Marxian material product system (MPS) developed during the central planning period. Therefore, as the Chinese economy rapidly develops and integrates into the world economy there is a growing interest in a reliable and internationally comparable measure of China's real income or gross domestic product (GDP) and its growth performance.¹

The first controversial issue is how should China's per capita income level be measured on an internationally compatible basis? The debate began in the early 1990s with the question 'How rich is China?' raised by Garnaut and Ma (1992) based on their study on the relationship between China's food consumption and per capita GDP, and the GDP estimate for China by Summers and Heston (1991) based on the expenditure purchasing power parity (PPP) approach. These studies suggested that Chinese per capita GDP level measured by official exchange rates (around US\$400 in 1990) should be adjusted by a factor of about 3.0 to reflect the renminbi's real purchasing power (in the domestic market). This means that China could be much richer than previously believed. Despite more information from China and new estimation approaches used, however, later estimates varied greatly. For example, in their later study Summers and Heston (1993) estimated China's per capita GDP as 2,700 in 1990 in terms of 1990 Geary-Khamis dollars, blowing up the adjustment factor to nearly 7. This estimate suggests that the Chinese economy could be as large as the US economy in only about one decade if the current growth trends of the two economies persist.² This conclusion has shocked economists, politicians and multinationals around the world. By contrast, a number of recent studies has reduced this estimate by about 45 per cent to G-K\$1,500 (Tables 1 and 2), which evoked another question 'How poor is China?' (*Economist*, October 1996).

The second controversial issue is how fast has the Chinese economy grown particularly since economic reform began in 1978. While the official estimate of about 10 per cent annual growth rate for the reform period is almost taken for granted, some researchers insist that this could have been overestimated. China uses the comparable prices method to construct price indices and deflate GDP. This was used in the Soviet statistical system and is believed to have exaggerated GDP growth (Maddison forthcoming; Woo 1996; Perkins 1988). The estimated degree of overestimation varies considerably between 2 and 4 percentage points, which not only invalidates any official growth-rate-based estimate of China's total factor productivity (TFP) performance that partially relies on a reliable estimate of GDP growth, but also undermines any projection of China's future growth.

This paper reviews recent major studies on China's national accounts and growth performance, evaluates alternative estimates of China's national income and growth rates, and discusses their implications. Its main objective is to improve the understanding of these alternative estimates based on different approaches.

The paper is organised as follows. The next section takes a close look at the problems of China's national accounts and reviews the studies attempting to reconstruct China's GDP. The third section reviews the analyses designed to convert China's GDP into an international currency by two purchasing power parity conversion approaches and discusses the deficiencies of such conversions. The fourth deals with the issue of reassessing China's GDP growth rate, while the fifth discusses the implications of these new estimates. The last section gives some concluding remarks.

Reconstructing China's GDP

Problems with the Material Product System (MPS)

In the early 1950s, China adopted the MPS from the Soviet Union with the central planning system. The MPS artificially divided economic activities into 'material production' and 'nonmaterial production', and measured output in quasi-physical terms in line with the physical targets of national plans. Under the MPS, those services that are considered not directly linked to material production (for example, passenger transport, health services, education, etc.) are treated as consumption rather than production of national income. The distinction between MPS and the internationally adopted System of National Accounts in national income can be simply expressed as follows.

Let us start with the MPS concept of gross value of output, GVO. Given a time period, for each sector i , let the value of material input be C_i^m , the value of depreciation of fixed capital input be C_i^d and value added by 'material production' be V_i^m , then

$$(1) \quad GVO_i = C_i^m + C_i^d + V_i^m.$$

In Equation 1 only the component V_i^m is considered 'newly created value' in Marxian economics. In Chinese statistical terminology it is called net value of output or NVO, which is the same as NMP (net material product), commonly used for the national income measured in centrally planned economies. We can therefore define NMP as

$$(2) \quad NMP = V_i^m = GVO_i - (C_i^m + C_i^d).$$

The System of National Accounts concept of GDP in the following Equation 3 can be contrasted with Equation 2

$$(3) \quad GDP_i = V_i^m + V_i^n + C_i^d$$

where the term V_i^n indicates net value added by the so-called 'nonmaterial production' of sector i in Marxian economics. Clearly, GDP is not compatible at all with either GVO or NMP. In practice, GVO contains double counting and NMP seriously undercounts national income by ignoring the value of capital depreciation of all sectors ($\sum_i C_i^d$) and the value added from all 'nonmaterial' services ($\sum_i V_i^n$) that are considered 'nonproductive' in a Marxian system. However, at the sectoral level, the impact is different.

The service sector is most affected as most of the ignored output by 'nonproductive' services is the valued-added of the service sector.³

The introduction of a 'hybrid' national accounting system

Obviously, MPS is not a suitable national accounting system for a reforming Chinese economy. Towards the late 1980s, alongside market-oriented reforms and opening up to international trade and investment, China began to consider some changes to its national accounting system at least to help mutual understanding between China and the outside world. Since then China has taken a number of important steps to reform its national accounting system. In 1987 China's State Statistical Bureau started a project to establish China's first SNA-type input–output table. China's first-ever GDP estimates were released in 1988 with retrospective estimates of GDP back to 1978 (Wu 1993:63–4). From then onwards, aggregate GDP and gross value added by major sector have been measured and reported by the State Statistical Bureau, although it has made successive modifications to the previously released GDP estimates without proper explanations.

China's first SNA-type input–output table, *Input–Output Table of China 1987* was released in 1991 (DBNE and ONIOS 1991). The delay might be due to the coincidentally conducted second national industrial census referring to the 1985 calendar year. The State Statistical Bureau may have also cross checked with the census results after they became available. Two input–output tables were published thereafter, a reduced version input–output table for 1990 (DBNE and OIOS 1993) and a new input–output table for 1992 which took into account China's first national census on the tertiary sector for the same year.⁴ Successive modifications to GDP estimates might have been related to these processes of cross-checking (Wu 1993:6–9).

Although it is reasonable to believe that these practices have gradually improved the quality of China's national accounts, there are still serious shortcomings in the system. It should be noted that China has not in theory and practice been fully committed to SNA. The current version of input–output table is in fact a hybrid between MPS and SNA (World Bank 1994b; Ren 1997; Maddison forthcoming). Chinese Marxist statisticians and economists (DBNE and ONIOS 1991:3–12) claim that the new system is innovative in that it has the practical merits of both—it is able to satisfy Western economists and investors on one hand, and to link back to the prevailing MPS for Chinese accountants and economists on the other.

Problems yet to be solved

As the old system is to a large extent still in operation and the new SNA has been introduced as a system of conversion, many problems are expected to remain and contribute to GDP underreporting. Studies have suggested problems in China's current hybrid national accounting system, including shortcomings in statistical coverage, output valuation and data collection (World Bank 1992b, 1994b; Wu 1997; Ren 1997).

As suggested by Keidel (1992) and two major World Bank studies (1992b and 1994b), China's GDP has been underestimated because of inadequate GDP reporting coverage. Output of grain and vegetable production and rural industrial and service enterprises (township and village enterprises) are believed to be underreported, as are urban and rural housing expenditure. Other studies maintain that the output of defence industries are also probably underreported (Maddison forthcoming).

China's largely unreformed statistical data collection system contributes to GDP underreporting. This system depends heavily on complete administrative reporting rather than a modern system of random sampling. Grassroots reporting still follows the artificial distinction between MPS 'material' and 'nonmaterial' output categories and generally measures output in quasi-physical terms rather than in current value terms. To satisfy the SNA concept of GDP, GDP's 'nonmaterial' components are separately treated through *ad hoc* surveys and estimates, probably cause more distortions (World Bank 1992b). One study lists all major areas that need adjustment when converting Chinese output data into GDP, including own grain consumption, commercial real estate earnings, inventory growth, in-kind services, depreciation charges and government subsidies for SOE losses (World Bank 1994b).

Problems with output valuation also contribute to underestimation of China's GDP. The main reason for output undervaluation and misvaluation is China's price system. Keidel in his World Bank study argues that in spite of significant price reform, China's price system to some extent continues to result in higher prices for industrial goods and lower prices for rural commodities, placing an implicit tax on rural incomes and subsidising urban profits, wages and urban necessities, such as housing (World Bank 1994b).⁵

Reconstructing China's GDP according to the SNA principles

To measure China's national income on an internationally comparable basis, the first and most fundamental task is to reconstruct China's GDP according to SNA principles. This is also the most difficult and tedious stage because researchers have to rely on insufficient information to improve coverage, match economic activities, remove price distortions and adjust factor costs. There have been only a few studies in this area even after the great increase in statistics available since the 1990s.

In the 1960s and 1970s scholarly activity by western economists on China's national income was largely based on Chinese official statistics published in the 1950s.⁶ They were motivated by the then widely accepted assumption that China's official output index contained upward biases which made it unreliable for assessing China's performance under the communist government. The most important pioneer work in reconstructing China's national income and assessing economic performance was done by Liu and Yeh (1965 and 1973) and Chao (1965, 1968, 1970 and 1974). Liu and Yeh estimated China's national income by both industrial origin and end-use expenditure methods, while Chao based his estimation primarily on a physical output approach. Their results supported the hypothesis of upward-bias in official statistics.⁷ Such quantitative research work gradually petered out in the 1970s and 1980s because the Chinese authorities released no systematic statistical data at all during the 1960s and 1970s.⁸

The beginning of the 1990s saw a resurgence of the studies on China's national accounts following the start of SSB's regular publication of GDP and other macroeconomic data for China. Two studies by Wu (1993 and 1997) attempt to construct GDP time series for China covering the entire central planning period. Two different approaches were adopted in the two studies. In his first attempt, Wu (1993) developed an econometric method based on the relationship between the SNA concept of GDP and the MPS concept of NMP to estimate GDP by sector for 1952–77 using official data for 1978–90. In his second attempt, Wu (1997) reconstructed a GDP series for China's industrial sector at

branch level by estimating independent growth indices using official physical output data and China's 1987 Input–Output Table (SNA type). However, both studies implicitly assumed that the SSB's estimates of GDP were acceptable, leaving the problems of undercoverage and price distortions unsolved.

An extensive national account adjustment aimed at removing all price 'distortions' was first attempted by Keidel (1992; World Bank 1994b).⁹ His latest modified results have raised Chinese GDP for 1987 by 34 per cent (to 1,319 billion yuan) (World Bank 1994b). This is down from his earlier 55 per cent upward adjustment (Keidel 1992), but still so high that it is difficult to accept. The 34 per cent increase in yuan GDP adjusts for statistical shortcomings (scope adjustment plus a minor consistency adjustment, 13.6 per cent) and China's price system (valuation adjustment 18.3 per cent).¹⁰ Keidel reestimated profit rates in all sectors to reflect a more uniform rate of return to productive assets and land. He also reallocated the impact of subsidies.

Keidel's justification for these adjustments is based on identified statistical shortcomings in China reported by a World Bank statistical mission to China in 1990 (World Bank 1992b) and the common knowledge of price distortions in centrally planned economies and transition economies. However, such extensive price imputations are likely to produce further distortions given inadequate knowledge of such variables as the size of the capital stock by sector. As argued by Maddison (forthcoming), for a huge, very self-contained economy, which had only half emerged from central planning (especially in 1987), it is probably unrealistic to try to create a counterfactual estimate of what prices would be if it had been run in a market system. A fully fledged adoption of the Keidel level adjustments would make it difficult to use presently available purchasing power parity estimates which are based on converters relevant to the prevailing price system.

Maddison (forthcoming) also attempted to reconstruct China's GDP by adjusting sectoral coverage but used a more moderate approach than Keidel's. Maddison's benchmark year is also 1987. He mainly adjusted output of the agricultural and service sectors using the industry-of-origin approach. His main efforts were made in coverage adjustment rather than valuation adjustment. The combined effect of Maddison's adjustments raised his estimate for China's 1987 GDP by 10.2 per cent above the official figure. Based on the growth trend of each sector,¹¹ Maddison reconstructed a complete time series of GDP sector by sector for the period 1952–94.

Measuring Chinese GDP by two purchasing power parity approaches

The expenditure–purchasing power parity conversion of Chinese GDP

The prevailing international income comparison based on expenditure purchasing power parity converters was initiated by pioneering studies by Gilbert and Kravis (1954) and Gilbert and Associates (1958), and later developed in successive International Comparison Project phases by Kravis (1976, 1984), Kravis, Heston and Summers (1978, 1982), Summers and Heston (1988, 1991).¹²

Purchasing power parity in an expenditure framework can be defined as the number of currency units required to buy goods and services in the domestic market equivalent to what can be bought with one unit of the currency of a base country (Kravis, Heston and

Summers 1982). Note purchasing power parity is the commonly used term to refer to the parity computed for the fixed basket of products and services, even though theoretically this parity would be more appropriately labeled the purchasing power of currencies (Gilbert and Kravis 1954).

Conceptually, purchasing power parity methods represent a significant improvement over exchange-rate estimates because they adjust each country's GDP to a standard set of relative prices in the process of conversion to a common currency. The actual work of bilateral comparisons from the expenditure side includes two main steps. First, for each category within the Classification System of the International Comparison Project the analyst chooses a sample of items and matches their qualities and prices for the two countries being compared to calculate purchasing power parity for each item, and then aggregates the PPPs to the category level. Second, the analyst aggregates category-level PPPs to the sector level using the respective expenditure weights of the two countries being compared.¹³

The following formulas give the aggregated PPPs for sector j for countries a and b using respective weights:

$$(4) \quad PPP_j^a = \sum_{i=1}^n (P_{ij}^a / P_{ij}^b) \cdot w_{ij}^b;$$

$$(5) \quad PPP_j^b = \frac{1}{\sum_{i=1}^n (P_{ij}^b / P_{ij}^a) \cdot w_{ij}^a},$$

where P is the price for i category and w is the expenditure weight for i category of sector j .

The Fisher Index, that is, the geometric mean of the a country-weighted and b country-weighted PPPs, is then calculated for each sector j .¹⁴

Finally, the estimated national income in PPP terms, GDP_{ppp} , is derived by summing up all j sectors ($j=1, 2, \dots, m$)

$$(6) \quad GDP_{ppp} = \sum_{j=1}^m PPP_j \cdot GDP_j,$$

In practice, the expenditure PPP-based International Comparison Project is a highly sophisticated quality-matching, comparative pricing, weighting and aggregating exercise. It involves the collection of carefully specified price information for representative items of consumption, investment goods and government services.

The first expenditure-PPP exercise for China in comparison with the United States was conducted by Kravis (1981) using price and expenditure information for 1975 supplied by official sources in both countries according to the standard specifications of the International Comparison Project. However it was a 'reduced information' exercise because the amount of detail on prices and expenditure in China was significantly less than normally required by International Comparison Project standards. Although the study involved the highest levels of expertise available in this field, the results were unacceptably high compared with other estimates. It showed China's per capita GDP to be 10.4 per cent of that in the USA in 1975. As ICP comparisons are normally carried out at multilateral (Geary-Khamis) prices, Kravis made a rough estimate of what China's per capita product might have been on a Geary-Khamis (G-K) dollar basis.¹⁵ The end result was

a Chinese per capita GDP 12.3 per cent of that in the United States in 1975. If this result is updated to 1990 by official growth rates for 1975–90, it would have been \$4,264 in 1990 G-K dollars (Table 1; Maddison 1995:167–8).

China has not officially participated at any phase of the International Comparison Project. However, a significantly modified version of the Kravis estimates was used in the Penn World Tables of Summers and Heston (1993). Their estimates were based on official consumption deflators, together with a geometric average of PPPs they derived from Ren and Chen (1993).¹⁶ Their estimated PPP GDP per capita was G-K\$2,700 in 1990 (Table 1). Maddison (1995) argues that the Summers-Heston estimate is therefore a hybrid, and is not significantly different from what one would obtain by taking a simple geometric average of the Kravis and Ren-Chen estimates. On the basis of improved price indices and a revised estimation of growth, Summers and Heston recently (1996) substantially reduced their estimate for China to about G-K\$1,600 for 1990 (converted to 1990 prices, Table 1).

Table 1 Various estimates of China's per capita purchasing power parities, 1990 (\$US or \$international)

	Conversion approach	Per capita GDP (result year/price)	Per capita GDP (1990 prices)
Kravis (1981)	ICP	769 (1975/1975)	4,264
Summers & Heston (PWT 5.5) (1993)	ICP	2,700 (1990/1990)	2,700
Summers & Heston (PWT 5.6) (1995)	ICP	1,324 (1990/1985)	1,600
Ren-Chen (1994)	ICP	1,044 (1986/1986)	1,749
Ren (1997)	ICP	1,014 (1986/1986)	1,690
World Bank (1992)	ICP	1,950 (1990/1990)	1,950
World Bank (1996)	ICP	1,800 (1992/1992)	1,454
Maddison (1998)	ICOP	1,855 (1990/1990)	1,855
Ren (1997)	ICOP	886 (1986/1986)	1,484
Taylor (1991)	Mixed	788 (1986/1986)	1,135

Ren and Chen (1994) conducted an expenditure–PPP comparison between China and the United States for 1986, following a procedure similar to that of Kravis. They had much better Chinese price and expenditure information than Kravis, using over 200 items compared with 93 items. Their estimate of per capita PPP GDP for 1986 was \$1,044, applying an estimated Fisher converter of 0.8079 (Ren and Chen 1994:Table 6) to the yuan figure of 909 yuan. The spread between the results at US weights (\$1,818) and at Chinese weights (\$571) was large (three-fold), but not as wide as Kravis found for 1975 (four-fold). Maddison updated the Ren-Chen estimate of per capita GDP from 1986 to 1990 using official growth rate figures, yielding \$1,749 in 1990 G-K dollars (Table 1).

Ren's latest study (1997), which slightly revised the Ren-Chen results (1993) for 1986, implying a per capita GDP of \$1,690 for 1990 in 1990 Fisher dollars (Table 1).¹⁷ Ren's new study was based on more reliable information on difficult items like housing and government services (1997:38). Maddison (1998) adjusted the latest Ren estimates to a Geary-Khamis basis and also made a small upward adjustment to the official yuan figure for 1990.

Since the 1990s the World Bank has moved away from its previous preference for adjusted market exchange rate (MER) converters towards the ICP-type expenditure–PPP converters. For countries like China which have not participated in any phase of ICP, it has

adopted a regression method (regression approximation) to derive ICP-based GDP estimates, given as

$$(7) \quad \ln(GDP_{ppp}) = \ln(GDP_{Atlas}) + \ln(ENROL) + e$$

where GDP_{ppp} is ICP estimates of per capita GDP in international currency, GDP_{Atlas} is per capita GDP estimated by the *World Bank Atlas* method, $ENROL$ is secondary school enrolment (see for example World Bank 1995:244). GDP_{Atlas} and $ENROL$ are used as rough proxies of intercountry wage differentials for unskilled and skilled human capital, respectively. Following Isenman (1980), the rationale adopted here is that ICP and conventional estimates of GDP differ mainly because wage differences persist among nations due to constraints on the international mobility of labour.¹⁸

The World Bank began to report the ICP estimates for China in its 1993 issue of *World Development Report* based on this regression approach and other *ad hoc* estimates for China which also follow the ICP method. However, the World Bank estimates are very different from other ICP estimates, for example, those made by Summers and Heston. Table 2 of the World Bank report estimated per capita GDP at \$1,950 for 1990, whereas Summers and Heston gave a figure of \$2,700. (for example, for 1990, \$1,950 of *World Development Report* in Table 2 compared to \$2,700 of PWT 5.5 in Table 1). Although the report basically relies on Chinese official data, the estimates in Table 2 suggest some inconsistencies in the over-time growth pattern compared with the SSB official growth index and the growth index derived from the official CPI.

Table 2 Inconsistencies in China's per capita GDP estimates by *World Development Report*, 1990–1994

	Per capita GDP (current \$int)	Base country (USA) CPI	Per capita GDP (1990 \$int.)	Implied real growth index, WDR (previous year=100)	Real growth index (based on official CPI)*	Real growth index (by SSB)*
1990	1,950	100.0	1,950	--	--	--
1991	2,040	103.8	1,965	101.0	111.7	107.9
1992	1,910	106.9	1,787	91.1	113.8	113.0
1993	2,330	109.7	2,124	108.5	112.7	112.4
1994	2,510	112.2	2,237	115.5	107.7	111.5
1995	2,920	115.0	2,539	113.0	105.1	109.4

Note: *Adjusted to per capita GDP growth rates using population growth rate of 1.3 per cent for 1991, 1.2 per cent for 1992, and 1.1 per cent for annual growth of 1993–95 (SSB 1996:69)

Sources: World Bank (1992a, 1993, 1994a, 1995, 1996a, 1997), OECD (1997), SSB (1996) and Maddison (forthcoming).

The production-PPP conversion of Chinese GDP

The production approach to PPP GDP estimates has been developed by the International Comparison of Output of the University of Groningen since 1983 (Maddison and van Ark 1988; van Ark 1993), based on work by Rostas (1948), Paige and Bombach (1959) and Maddison (1970). It involves a comparison of real output (value added) in major sectors (agriculture, industry and services) and of branches within these three broad sectors, as

well as measures for GDP as a whole. It takes an integrated view of input and output quantities, producer prices and the values derived from them. Unlike the expenditure approach in ICP which uses special surveys, it employs information from production censuses, input–output tables, national accounts and, more recently, from individual firms. Its integrated statistics of quantity, unit value and values permit cross-checks not available to ICP. It also identifies variations in the coverage of national accounts and gives high priority to the measurement of output and productivity in services, issues not explored by ICP.

To some extent the production-PPP approach is superior to the expenditure-PPP approach because it could reveal many ‘disguised’ economic, especially service activities which are not closely and explicitly examined by the expenditure-PPP approach that values, for example, distribution services at the same margin in all countries.¹⁹

As pointed out by Maddison and van Ark (1994), the International Comparison of Output production approach is not a substitute for the ICP expenditure approach, but supplementary to it. The two approaches share the common features of PPPs and can be used to cross-check each other as they examine national income from different angles.

The key concept of the production-PPP approach is ‘unit value ratio’ (UVR) which is derived from the unit values of the same product or product group between countries being compared. The unit values are obtained by dividing the ex-factory sales value by the corresponding quantities obtained from each country’s production census or survey. These are the prices used in the ICOP project. The main advantage of using unit values instead of specification prices is that the quantities and unit values are consistent with the total value of output (van Ark 1993). Although the terms UVR and PPP are interchangeable, for output comparisons the former is preferable to the latter because it identifies more clearly the nature of prices used in the International Comparison of Output project.²⁰

There are two major steps in deriving production PPPs, as explained by van Ark (1993). First, the average PPP (UVR) for the industry j is obtained by weighting the unit value (P) of all matched items ($i=1,2,...m$) belonging to j by the corresponding quantity weights of one of the two countries compared, a and b

$$(8) \quad PPP_j^{ab(a)} = \frac{\sum_{i=1}^m (P_{ij}^a Q_{ij}^a)}{\sum_{i=1}^m (P_{ij}^b Q_{ij}^a)} \quad \text{and} \quad PPP_j^{ab(b)} = \frac{\sum_{i=1}^m (P_{ij}^a Q_{ij}^b)}{\sum_{i=1}^m (P_{ij}^b Q_{ij}^b)}.$$

Second, the aggregation of industry-level ($j=1,2,...n$) PPP to branch level (k) is made by taking the weighted average of sample industry PPPs using sample industry gross value added (GVA) as weights

$$(9) \quad PPP_k^{ab(a)} = \frac{\sum_{j=1}^n GVA_{jk}^a}{\sum_{j=1}^n [GVA_{jk}^a / PPP_{jk}^{ab(a)}]} \quad \text{and} \\ PPP_k^{ab(b)} = \frac{\sum_{j=1}^n [GVA_{jk}^b \cdot PPP_{jk}^{ab(b)}]}{\sum_{j=1}^n GVA_{jk}^b}.$$

In bilateral comparisons, two PPPs are derived at every level of aggregation, one at quantity weights of country *a* and the other at quantity weights of country *b*.²¹ As discussed previously the Fisher geometric average is then used to average the two PPPs.

Due to difficulties in obtaining necessary data especially on the unit value of inputs and outputs, fewer studies have attempted to convert China's GDP with the production-PPP approach than an expenditure-PPP approach. The earlier attempt by Taylor (1991) applied only a pseudo production approach.²² Taylor's estimates are based on gross-value-output and intermediate-input weights to derive overall PPPs. The difference in Taylor's study is that only China's gross output value was used as weight to derive sectoral PPP rather than the weights of both countries being compared (China and the United States) as suggested by the International Comparison of Output approach. As pointed out by Ren (1997), another important source of error in Taylor's study is the use of average PPPs of the industrial and agricultural sectors which include most tradable products, to generate PPPs for services which consist of mainly nontradable products. Taylor's estimate of per capita GDP is therefore very low, \$788 for 1986, updated by Maddison to \$1,135 for 1990 in 1990 G-K dollars (Maddison 1995: 168; Table 1).

Ren (1997) made a rough ICOP comparison between China and the United States based on Szirmai and Ren (1995) and Ren and Chen (1994). He could not apply a complete International Comparison of Output method due to inadequate information.²³ Ren's comparisons fell into four categories in terms of the methods used

- a standard ICOP method applied to agriculture, mining, manufacturing, utilities, transport and telecommunications
- reweighted expenditure PPPs for the distribution sector (wholesale and retail)
- quantity-indicator approach used to derive PPPs for the finance, insurance and real estate sectors
- expenditure PPPs used as proxy for production PPPs for construction, education, healthcare and government and other services.

Ren estimated that China's per capita GDP based on production PPPs was \$886 for 1986 (implying a total GDP of \$945 billion). If updated to 1990 following Maddison (1995), per capita GDP would have been G-K\$1,484 for 1990 in 1990 G-K dollars, compared with Ren's revised expenditure PPP of G-K\$1,699 in the same study (Table 1).

Ren (1997) argued that, although the ICP and ICOP approaches have different strengths and weaknesses, in the Chinese case preference might be given to the ICOP estimate over the ICP estimate for two reasons. First, Chinese data for manufactured goods from the industrial census used in his ICOP approach estimation are much better than the expenditure data for the final product used in his ICP approach estimation. To maximise reliability, the choice of method for any pair of countries must depend largely on relative quality of industry and final product data for manufacturing goods (Gilbert and Beckerman 1961). Second, the breakdown of GDP by industry of origin was based on China's 1987 input-output table and more reliable than the breakdown of GDP from the expenditure side based on his previous estimates with insufficient information.

Further research with the production PPP approach is necessary when more detailed census and input-output table data become available. As Maddison (1995) once pointed out, although China has moved towards a market system it still uses a mixture of controlled and market prices which makes international comparisons of growth and level

very difficult; there is therefore a strong case for augmenting the ICP type comparisons by the ICOP method.

Deficiencies of the PPP approaches in measuring China's GDP

Despite their obvious advantage over the MER-based income comparison technique, both expenditure-PPP and production-PPP methods have some shortcomings and problems particularly in practice. Unlike the simple and straightforward MER approach, the PPP methods rely heavily on individual item-level output, value and price data which are not always available in developing countries. Compared with the expenditure-PPP approach, the production-PPP approach relies on even more detailed statistics on products and services. For this reason there have been no complete PPP estimates for China using the standard ICOP approach.

Another common problem of the two PPP approaches is the conventional method of obtaining PPP converters. Each country in a PPP comparison has a different pattern of expenditure weights (ICP) or production weights (ICOP). Using PPP ratios to compare two economies such as China and the United States thus requires deciding which country's weights should be used to average individual sector PPP ratios. Conceptually, one should use yuan-based Chinese weights for calculating the cost of Chinese expenditures or products in dollars, and one should use dollar-based US weights for calculating the cost of US expenditures or products in yuan. However, the convention is that two sets of PPPs are calculated for China, one using Chinese weights (Paasche PPPs) and one using US weights (Laspeyres PPPs), respectively, and then a geometric mean (Fisher index) is used to average the two sets of PPPs. Therefore, US weights become part of the conversion of the Chinese GDP to dollars.

The purpose of a geometric mean of the two differently weighted PPPs is to come up with a neutral statistic to compare each currency's purchasing power. It is not surprising that the difference between the Paasche and Laspeyres PPPs varies between countries and across branches of the economy under investigation. However, 'the gap between the two measures is generally widest for comparisons between countries with very different income or productivity levels' (Maddison and van Ark 1994). In such case, a geometric mean of the two PPPs will certainly produce unrealistic averages. The World Bank (1994b) also argued that while geometric mean averaging may have a moderating effect on all developing countries' PPP estimates in dollars, it may do this to an unusual degree for China, either because of the large dispersion of the sample-item price ratios, or because Chinese and US final expenditure weights and production structures are so different.

Obviously, compared with countries like the United States, China has a very different economic structure, productivity and income level. The differences are not only due to the different stages of economic development but also price distortions inherited from the central planning period, even though most products have been freed from price controls since the reform. The World Bank (1994b) believes that by including US weights through the geometric mean technique, China's PPP dollar estimates have been significantly biased.

Another major challenge, facing all PPP comparisons but more crucial to PPP estimates for China, is how to overcome quality matching difficulties between countries like China and the United States. Quality matching problems exist in both the production-PPP and

expenditure-PPP exercises for China. Usually, the quality of products of a heterogeneous nature (such as machinery and vehicles) are more difficult to match than products of a homogenous nature (such as power cables, vitamin tablets and non-ferrous ingots). Exported products are understandably less problematic for quality matching than products not for export, as their quality is already 'measured' by the world market.

The World Bank (1994b) pointed out that in previous ICP (for example, Ren and Chen 1994) and non-ICP (for example, Taylor 1991) studies, most price data were from official price lists in China and the United States, although products on the US list were virtually certain to be of higher quality than products with the same name on the Chinese list. Calculating a PPP ratio from such prices without necessary adjustment for quality inevitably leads to upward-biased dollar PPP GDP estimates for China.

Studies like Chen-Ren's often followed an 'equivalence in use' rule in quality-matching exercise, which means that the matched items serve the same basic function, even though they are not of the same quality (Chen and Ren 1994:382). For example, for food this practice ignores the better quality of many foods in the US markets and the much greater degree of packaging and processing, and for furniture it ignores enormous price variation with quality and style between the two countries and the fact that furniture in the United States is generally of much higher quality than in China. These factors result in a higher dollar price than would otherwise be the case for an identical Chinese equivalent, thereby resulting in PPP ratios which exaggerate the PPP-based GDP estimates for China.

Most existing problems are practical rather than theoretical. Solving these problems relies on more reliable data from the expected ICP-type expenditure survey in China which is believed to be under preparation by the SSB. Meanwhile it is recommended that China should also establish standard GDP national accounts by expenditure.²⁴ As for the ICOP type of research, the newly completed first national census on the tertiary sector conducted in 1992 and the third national census on the industrial sector conducted in 1995 could significantly upgrade the current estimates once their electronic database become available. Another issue which is methodologically important is how to assure that these surveys are compatible with surveys in other countries. It will be useful if western researchers could be involved in China's statistical surveys at the stage of survey design and survey staff training. The national accounts and statistical departments of United Nations, the World Bank and OECD should facilitate such activities.

Reassessing China's GDP growth rate

China's unusual practices in growth measurement

When measuring GDP, China's statistical authority employs 'comparable price'-based output to calculate growth indices, it does not deflate GDP in current prices by a price index, such as a consumer price index. The term 'comparable prices' is taken from Soviet statistical practice based on MPS and does not have the same meaning as 'constant prices' in western statistical usage.

The SSB claims that the 'comparable prices' are assembled by five SSB administrative 'constant prices',²⁵ which are average prices of 'representative items' belonging to the same product category for a particular period (Li 1986:837-8). However, this method is

not transparent; there is no detailed information on how these representative products were chosen and how the average prices are computed over time.²⁶

Many researchers believe that the use of 'comparable prices' to construct the GDP deflator has understated inflation and overstated growth because they do not adequately reflect price increases (Maddison forthcoming; Woo 1996; Keidel 1992; Perkins 1988). Generally, this approach suffers from irregularities introduced by weights giving excessive weights to the price level of items covered by state listed prices and too little to the price level of items in transactions using negotiated and market prices. In addition, the practice of not writing off unsellable inventories also tends to inflate China's real growth (Ren 1997; Borensztein and Ostry 1996).

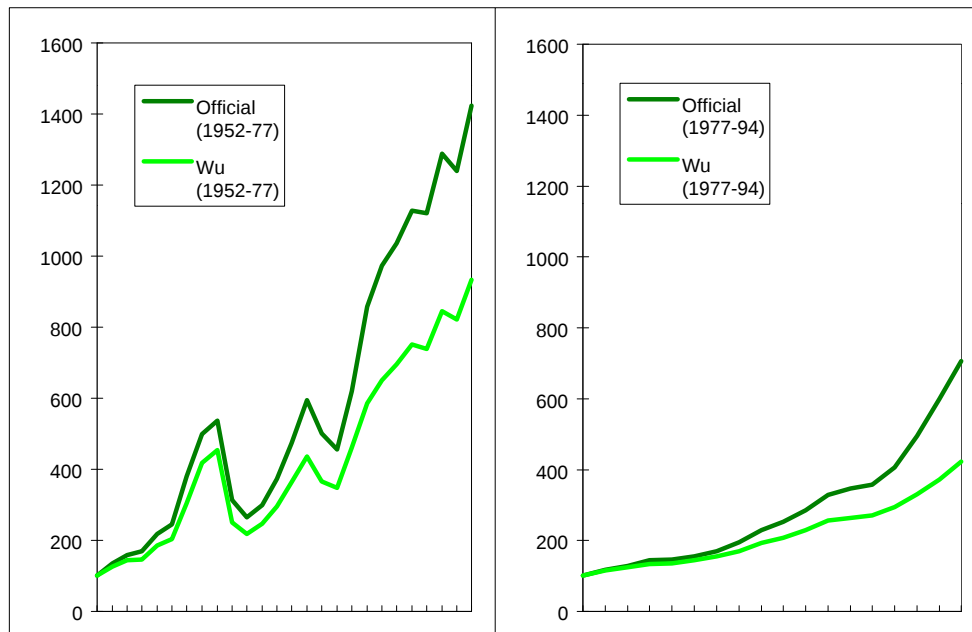
Woo (1996) gave three reasons to show why the base-year price reporting system tends to overstate growth particularly for nonstate enterprises. First, unlike SOEs, most collectively-owned enterprises and rural TVEs are much less clear about how to do the base-year computation, especially because in base-year 1980 (the 1980 prices were used until 1990) most of them did not exist. Because these enterprises are not closely supervised by the central ministries, they tend to report identical figures for output in current and base-year prices, either out of ignorance or convenience. Second, since high growth performance can be interpreted as evidence of superior management ability from the upper management level, all enterprises including SOEs have the incentive to oblige their supervising bureaux. Third, when a new product appears it involves an estimation of what its base-year price would have been given its 'quantity' attributes, for example, how many 286 computer chips are equivalent to one pentium chip in operational capacity. As a result of these complexities many enterprises report the value of new products in current prices as the value in base-year prices.

In fact, some Chinese official statisticians began to question the reliability of official growth indices early in the late 1980s. The expectation is that the official growth indices have overestimated growth. A study carried out by Industrial Division of SSB Hunan Branch (1989) established an independent industrial index for Hunan Province for the period 1983–87 showing that the annual real growth rate based on this industrial index (9.2 per cent)²⁷ was systematically lower than that based on the 'comparable-prices' approach (13.5 per cent). Unfortunately, this study has had no impact on SSB's practice in computing growth rates.

Constructing an independent GDP deflator using physical output data

It is difficult to construct an independent GDP deflator for China with limited alternative price information. Most ICP and ICOP studies with time series extensions have first focused on benchmark year estimation and extrapolated the benchmark year estimates to obtain time series estimates. Such extrapolation is often based on China's official GDP growth indices and inflation rates of the base country. Ren's extrapolation for his ICOP benchmark results produced a GDP growth rate of 7.3 per cent, compared with the official growth rate of 9.8 per cent for the period 1985–94 (see Ren I in Maddison forthcoming).²⁸

Figure 1 China's pre- and post-reform industrial growth trends: Wu versus official estimates (pre-reform 1952=100; post-reform 1977=100)



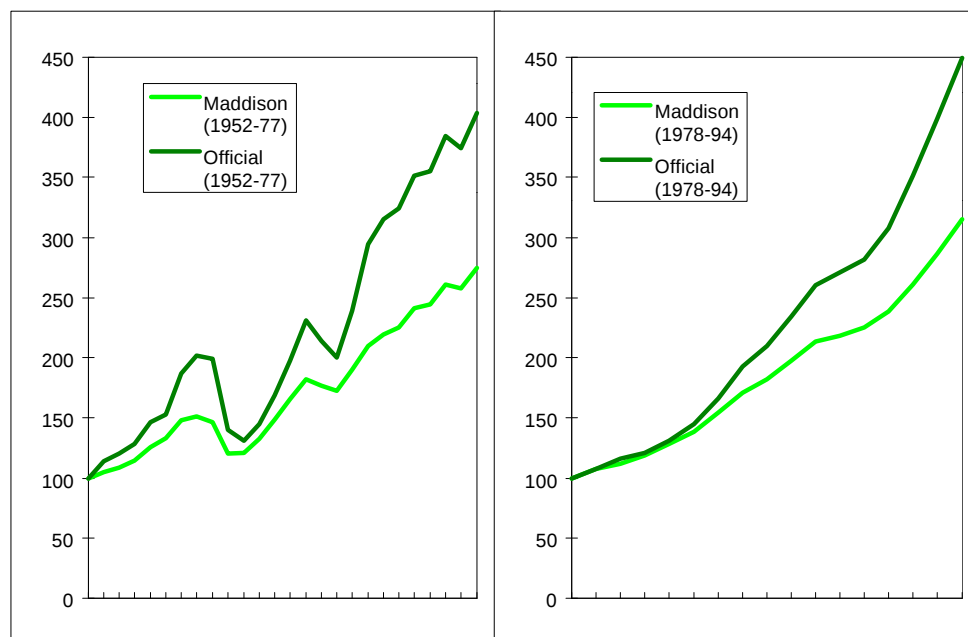
Source: Wu, Harry, 1997. *Reconstructing Chinese GDP According to the National Accounts Concept of Value Added: The Industrial Sector*, COPPAA (Comparative Output, Productivity and Purchasing Power in Australia and Asia) Working Paper Series 4, Centre for the Study of Australia-Asia Relations, Griffith University.

Constructing a physical output-based index, as attempted by Wu (1997), might be the only way to obtain an independent deflator, but is only possible for sectors with available time series data on physical output at product level. Based on the physical output of China's industry and the Chinese 1987 Input-Output Table, Wu constructed an independent industrial output index which implies that China's industrial sector²⁹ grew by 9.1 per cent per annum in the period 1952-94, compared to the SSB estimate of 11.6 per cent per annum. Wu's results also show that China's industrial sector grew slightly faster in the pre-reform period (9.3 per cent per annum) than in the post-reform period (8.9 per cent) (Figure 1). There still may be some unsolved measurement problems, for example, the inclusion of high-level unsellable products in China's output which was certainly worse in the pre-reform than in the post-reform period.

Other studies focusing on China's industrial sector have also supported the hypothesis that SSB figures have overstated China's industrial growth. For example, using factory-gate price indices and rebasing official output data on 1990 prices, Woo (1996) obtained an industrial growth of 8.7 per cent for the period 1978-93. Based on their ICOP-approach benchmark GDP level estimates and using similar industrial price indices, Szirmai and Ren arrived at an annual industrial growth of 7.4 per cent for the period 1980-92, a revision of their earlier results (Szirmai and Ren 1995). This is closer to Wu's estimate of 7.9 per cent

for the same period (Wu 1997),³⁰ but about one percentage point lower than Woo's estimate of 8.3 per cent for the same period. These estimates are all significantly lower than the SSB growth estimate of 10.9 per cent for the same period (SSB 1996:42).

**Figure 2 China's pre- and post-reform growth GDP trends:
Maddison versus official estimates (pre-reform 1952=100;
post-reform 1978=100)**



Source: Maddison, Angus, forthcoming. *Chinese Economic Performance in the Long Run*: Table C-4) and SSB (1993: 31, 34; 1996: 42)

Maddison (forthcoming) is the first researcher to reconstruct a GDP time series by sector for the period 1952–94.³¹ Wherever possible Maddison used a ‘volume movement’-based extrapolation from his benchmark estimates.³² His final result is obtained by incorporating his own estimates particularly for agriculture and services using the latest available statistical information, with Liu-Yeh’s (1965) and Wu’s (1997) results based on a method compatible to his approach. Maddison’s estimated annual growth rate for the pre-reform period 1952–78 is 4.4 per cent against the official 6 per cent, and for the post-reform period 1978–94, 7.4 per cent against the official 9.8 per cent (Figure 2). Maddison’s estimates are based on a defensible methodology and appear reasonably robust. They should be considered more reliable than official and other estimates and the best derived to date (Maddison forthcoming).

Using official price indices as alternatives

An alternative approach of reassessing official growth rate is the use of other available price information to get rid of the ‘comparable price’ effect. Ren applied three different official price indices, namely, farm and sideline products purchasing price index (FPPPI), industrial products producer price index (IPPPPI) and consumer price index (CPI), to the

primary, secondary and tertiary sectors, respectively, to derive sectoral GDP growth and hence total GDP growth at constant prices. He arrives at an annual GDP growth rate of only 6 per cent for the period 1985–94 (Ren II, Appendix Table 1), much lower than his 7.3 per cent ICOP estimate (Ren I, Appendix Table 1).

Although it has been generally accepted that the Chinese official growth deflators have overstated China's real growth, there has been no agreement about the degree of overstatement. It is therefore difficult to compare different growth rates. However, Ren's alternative estimate might have contained more problems than other estimates. First, two of his sectoral deflators, the FPPPI for the primary sector and the IPPPI for the secondary sector, are in fact state procurement price indices largely for intermediate products which were (and very likely still are) based on 'comparable prices'. This means his approach may still have been influenced by SSB's problematic 'comparable prices'. Second, his low growth estimate for the total economy is mainly attributed to his significantly lower growth estimate for the service sector (Appendix Table 1), which contradicts evidence of the rapid post-reform growth of previously suppressed services in China.

China in the East Asian context

Apart from Ren's alternative estimate (Ren II) which looks too low in the East Asian context, all non-official estimates of China's GDP growth rate, including Ren's ICOP estimate (Ren I), appear more in line with the growth of other East Asian economies compared with the official growth rate (Table 4).

Table 4 Total and per capita GDP growth, China compared with selected East and Southeast Asian economies, 1978–95
(per cent per annum)

	GDP growth	Per capita GDP growth
China (official)	9.9	8.5
China (Ren II, Appendix Table 1)	6.0	4.6
China (Maddison forthcoming)*	7.4	6.0
China (CPI, this study)	7.9	6.5
Hong Kong	6.7	5.0
Taiwan	7.5	6.2
Singapore	7.9	6.5
Republic of Korea	7.7	6.6
Malaysia	7.0	5.5
Thailand	8.1	6.5

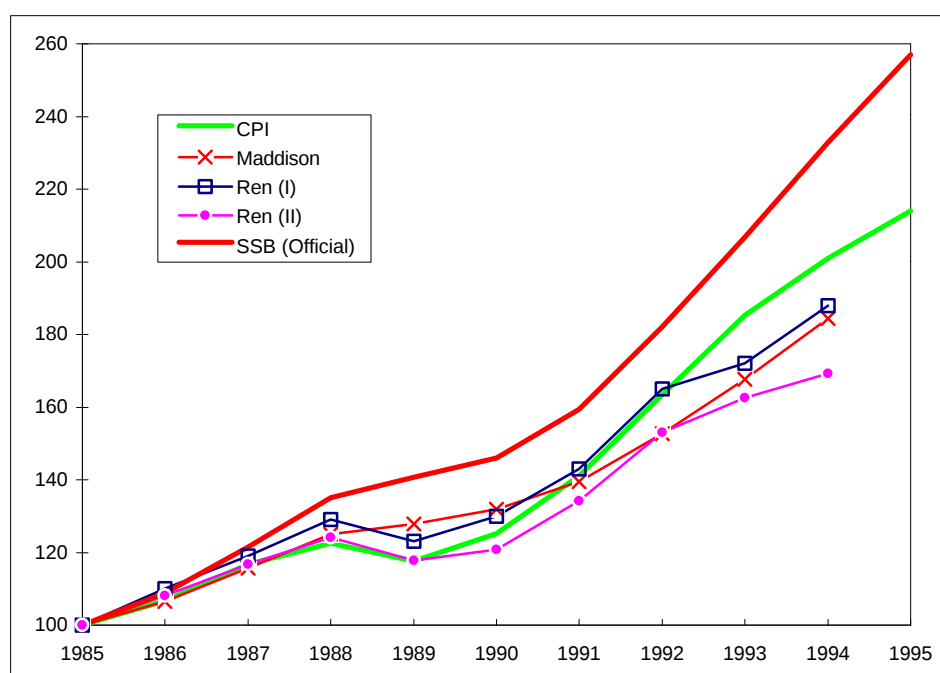
Source: Asian Development Bank, 1996. *Key Indicators of Developing Asian and Pacific Countries*, Economics and Development Resource Center, Asian Development Bank, Oxford University Press.

Note: *1978-94.

It may be argued that a more reasonable and perhaps the simplest approach to derive China's 'real' GDP growth rate is the use of China's official CPI as a single deflator, a standard approach that is widely used no appropriate GDP deflator is available. The results of this approach show an annual GDP growth rate of 7.9 per cent (1985–95), standing in the middle range of all estimates in Appendix Table 1, that is, between Ren's 6 per cent and SSB's 9.9 per cent. These different growth trends, including the CPI approach-based

estimate by this study are shown in Figure 3. Maddison's estimates show the least fluctuations among all estimates. Ren's two estimates and this study's estimate using the CPI follow similar fluctuations though at different degree, which suggest the influence of similar underlying price indices. It should be noted that the main difference between Maddison's and others' studies is that Maddison's estimates consist of Wu's physical output-based growth index for the industrial sector which is completely free from any price indices (Wu 1997).

Figure 3 China's GDP growth trend by various estimates, 1985–95 (1985=100)



Source: Appendix Table 1.

Important implications of the new estimates

After reviewing most recent studies designed to improve the measurement of Chinese national income levels and growth on an internationally comparable basis, a major concern remains: what do these new estimates imply and could change they the conventional views about the Chinese economy and its role in the world economy.

Living standard

The primary purpose of the PPP-based income comparison is to evaluate a nation's real standard of living by measuring the local purchasing power of the national currency on an internationally comparable basis. For low-income countries like China, the PPP-based per capita GDP is generally higher than the exchange rate-based per capita GDP measurement mainly because labour (adjusted for productivity) is cheaper in these countries than in high-income countries. Although new and different PPP-based GDP estimates may add

confusion to already controversial estimates, continuously improved data and estimation techniques are moving estimates closer to the reality. The result is that the Chinese per capita GDP level is probably no more than \$2,000 (in 1990 international dollars), much lower than what was previously widely believed.

The lower PPP-based GDP estimates for China imply lower living standards. For example, following recently accepted per capita ICP-PPP \$1,800 for 1992 (World Bank, East Asia and Pacific Region 1996), or about \$1,500 for 1990 in 1990 prices,³³ which is only about half of the estimate by Summers and Heston in the early 1990s (PWT 5.5), the World Bank has substantially altered its poverty assessment for China. The lower estimate of per capita income resulted in a near tripling of the World Bank's estimate of the percentage of China's population living under the international poverty line of US\$1 per day (in 1985 prices).³⁴ By this international yardstick, China's poverty incidence is now estimated to be 27 per cent in 1994 (compared to 7 per cent if old measurement is used), down only marginally from 32 per cent in 1987 (World Bank 1996b: Box 1.1).³⁵

Obviously, more reliable forecasts of future living standards depend on more reliable measurement of China's current national income and past growth. The new, lower estimates of China's income level and growth more accurately reflect the reality but have prolonged the interval necessary for China to catch up with industrial countries.

Total factor productivity (TFP) performance

Total factor productivity (TFP) growth measures the growth in output unrelated to the growth in inputs and hence is one measure of efficiency performance of an economy. As TFP growth is measured as a residual after subtracting the contribution of input growth to GDP growth, to the extent that China's GDP growth is overstated on account of insufficient deflation of output, China's TFP would be similarly overestimated, assuming that capital and labour are accurately measured. With given inputs, remeasured growth would alter the estimates for TFP performance, a lower GDP growth implies a poorer TFP performance.

Woo (1996) decomposed China's TFP growth into labour reallocation effect and net TFP effect, after correcting for overstatement of industrial output and inconsistent use of base years in calculating growth deflators. He calculated the labour reallocation effect to be about 1.1 percentage points and net TFP growth to be from 1.1 to 1.3 percentage points for the post-reform period (1979–93). Assuming his calculations for capital and labour inputs are accurate, even one percentage point adjustment to GDP growth measurement will significantly alter China's TFP estimate (Table 5).

Using Maddison's estimates to further correct GDP growth and allowing the residual to mainly explain resource reallocation effect, there may be little room left for efficiency growth in the post-reform Chinese economy.³⁶ This could possibly be close to the reality because the labour reallocation effect in China reflects the existence of large amount of labour employed in agriculture and the success of the post-1978 reforms in creating jobs in the industry and service sectors (Woo 1996). If this is acceptable, it implies that China's post-reform economic growth has largely been extensive in nature with little true technological progress. This result should alarm any optimistic prediction for China's future growth as any sustainable growth will only be dependent on efficiency improvement

rather than input growth, which requires a switch from an extensive to an intensive growth path.

Table 5 Woo's decomposed China's TFP performance, corrected for overstated growth and further adjusted by Maddison's growth rates (percentage points per annum)

Decomposition of GDP growth	1978–93	1984–93
Official GDP growth rate	9.3	9.7
Corrected for inconsistent use of base years	0.2	0.3
Corrected for overstatement of industrial output	0.5 ~ 0.7	0.9 ~ 1.2
'Corrected' GDP growth rate	8.4 ~ 8.6	8.2 ~ 8.5
Input growth rate	6.2	6.6
Capital accumulation	4.9	5.5
Labour force growth	1.3	1.1
Overall TFP growth rate	2.2 ~ 2.4	1.6 ~ 1.9
Labour reallocation effect	1.1	1.3
Net TFP growth	1.1 ~ 1.3	0.3 ~ 0.6
GDP growth remeasured by Maddison (forthcoming)	7.3	7.1
Derived overall TFP growth using Maddison (forthcoming)	1.1	0.5

Source: Woo, Wing Thye, 1996. Chinese economic growth: sources and prospects, paper presented at Economics Seminar, Research School of Pacific and Asian Studies, The Australian National University (unpublished) and Maddison, Angus, forthcoming *Chinese Economic Performance in the Long Run*.

Comparative productivity

The PPP-based international comparisons have also made international comparison of productivity possible and more accurate. Labour productivity is one important indicator for an economy's growth potential. Even though China's labour productivity per hour grew at an above-average rate of 3.7 per cent per year from 1973 to 1992, in 1992 it was still the second lowest rate among Asian and selected other economies (Table 6). While its labour productivity was higher than India's, it was only 33 per cent that of the Republic of Korea, 25 per cent of Taiwan's, 50 per cent of Russia's, 64 per cent of Thailand's, 83 per cent of Indonesia's and about 10 to 15 per cent of the labour productivity of the industrial economies of the United States, the United Kingdom, Japan and Australia. This labour productivity gap between China and industrial countries implies that China has huge growth potential if it continues to pursue appropriate economic policies.

Table 6 Labour productivity in China and selected economies, an ICP-PPP based estimation

	ICP-PPP GDP per hour worked (1990 international dollars)				Labour productivity growth (per cent per year)		
	1950	1973	1992	Rank by 1992	1950–73	1973–92	Rank by 1973–92
United States	12.66	23.45	29.10	1	2.72	1.03	10
United Kingdom	7.86	15.92	23.98	2	3.12	1.97	8
Australia	8.68	16.87	22.56	3	2.93	1.39	9
Japan	2.03	11.15	20.02	4	7.69	2.83	6
Taiwan (China)	1.17	4.13	11.06	5	5.64	4.80	2
Republic of Korea	1.28	3.22	8.48	6	4.09	4.72	3
USSR/Russia	3.07	6.59	5.66	7	3.38	-0.72	11
Thailand	0.74	1.68	4.34	8	3.63	5.12	1
Indonesia	1.02	1.86	3.35	9	2.65	3.15	5
China	0.82	1.31	2.79	10	2.06	3.67	4
India	0.60	0.94	1.58	11	1.97	2.50	7

Source: Estimates made with data derived from Maddison, Angus, 1995. *Monitoring the World Economy 1820–1992*, OECD Development Centre, Paris. Table J-5).

Compared with other economic sectors, manufacturing often plays a more important role in the process of a country's development and therefore productivity performance in manufacturing is crucial to a country's income growth. Although in absolute terms China's manufacturing labour productivity, measured by value added per employer, grew only by 5.5 per cent per annum between 1978 and 1994 (Wu 1997), Szirmai-Ren (1997) used international comparisons based on ICOP-PPP estimates and found that in relative terms China's manufacturing labour productivity stagnated during the reform period. They found that only 4 of 14 manufacturing branches (food and beverages, tobacco, wearing apparel, non-metallic mineral products) experienced positive labour productivity growth, 6 declined and 3 stagnated (Table 7).

Based on these findings, they argued strongly that China's post-reform manufacturing has featured 'rapid growth without catch-up' (Figure 4). Although this conclusion needs to be further justified through more refined measurement using more accurate information, it may be to some extent explained by the rapid post-reform growth of small rural-based, labour-intensive manufacturing enterprises and poorly performing SOEs.

Table 7 Production PPP-based comparative labour productivity by manufacturing branch, China and the United States, 1980–92 (USA=100)

	1980	1992	Annual growth 1980–92 (%)
Food products and beverages	6.2	8.2	+2.36
Tobacco products	8.2	26.3	+10.20
Textile mill products	12.4	7.0	-4.65
Wearing apparel	7.1	8.9	+1.90
Leather products and footwear	15.9	12.2	-2.18
Wood products, furniture and fixtures	4.9	4.3	-1.08
Paper products, printing and publishing	3.9	4.1	+0.42
Chemicals, petroleum & coal products	7.9	6.3	-1.87
Rubber and plastic products	7.6	5.7	-2.37
Building & non-metallic mineral products	7.4	8.7	+1.36
Basic and fabricated metal products	11.7	11.9	+0.14
Machinery & transport equipment	3.3	3.7	+0.96
Electrical machinery & equipment	9.6	10.4	+0.67
Other manufacturing	4.8	3.7	-2.15
Total manufacturing	6.3	6.2	-0.13

Source: Derived from Szirmai, A. and Ren, R., 1997. Rapid growth without catch-up: comparative performance in Chinese manufacturing, 1980–1992 (mimeo): Table 7.

While other economies experienced some degree of catch-up in terms of manufacturing labour productivity, with the Republic of Korea was the best performer, China's experience shows almost no catch-up during the period under discussion (Figure 5). In other words, the gap in manufacturing labour productivity between China and the US remained almost unchanged. However, a firmer conclusion about Chinese manufacturing performance relative to that of the United States requires further empirical evidences. Given the current difficulties in collecting Chinese information for this type of productivity study, it is too early to conclude that China has experienced a no-catch-up growth.

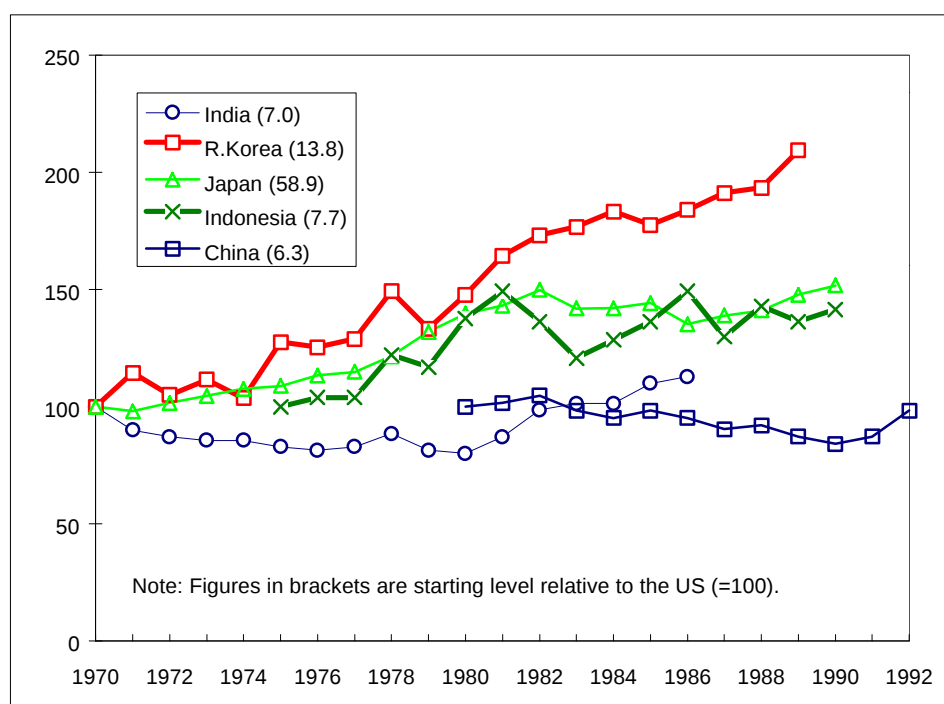
Degree of openness

The trade dependency ratio (trade divided by total GDP), is often used to represent the openness of an economy. The measurement of the GDP denominator is important. Obviously, the ratio will be substantially lowered if shifting from exchange rate-based to PPP-based GDP conversion to US dollars.³⁷

If measured on an official exchange rate basis, China's exports-to-GDP ratio was 21 per cent for 1995 (SSB 1996:579). By contrast, the same ratio for the United States was only 8 per cent (OECD 1997:62–6). However, researchers such as Lardy (1994) have pointed out that China's trade dependence ratio is too high because GDP was not properly measured.

Based on PPP estimates for the Chinese economy as a whole and compared with trade value, Ren (1997) estimated an ICOP PPP-based trade dependency ratio of about 6 per cent for 1994, using a numerator of half of the sum of exports and imports (1997:13). Ren argued that the conventional exchange rate-based trade dependency ratio of 23 per cent painted a unrealistic picture of a very open Chinese economy.

Figure 4 Growth index of manufacturing labour productivity on PPP basis, measured as individual country's relative position to the US



Source: Derived from Szirmai, A. and Ren, R., 1997. Rapid growth without catch-up: comparative performance in Chinese manufacturing, 1980–1992 (unpublished): Table 8.

Note: The relative productivity index transfers each country's starting level relative to the US level (given in brackets) into 100. Changes in the relative productivity is reflected by the changes from this base. This should not be mixed up with the US=100 which is used to define each country's position relative to the US. For example, if at the end of the period China's index is still not much different from 100, it means China's position relative to the US is still not much different from 6.3 (in brackets, also see Table 7).

However, this approach does not completely solve the problem. Conceptually, real trade value can only be measured at commercial exchange rate, which reflects the yuan's international purchasing power. It is certainly inconsistent with the PPP-measured GDP in the denominator. On the other hand, if the value of trade is measured by PPPs (that is, increasing the value of the yuan relative to the dollar based on PPPs), this will unrealistically overstate the value of the yuan in the international market and also make this ratio unmeaningful. More work is needed in this area before any consensus among researchers can be reached.

International versus domestic purchasing power

This review shows that even with the lowest PPP-conversion, Chinese GDP level (in international dollars) is inflated by 300 per cent from the MER-converted GDP level. This cannot, however, be interpreted as an increase in China's economic power in the world market, or in its power to purchase technology, machinery and weaponry from foreign

countries. The higher PPP-based GDP only means that the Chinese standard of living measured by the renminbi's domestic market purchasing power is higher than that indicated by its exchange rate in the world market, which gives a better indication of the renminbi's purchasing power in internationally comparable terms.

The more realistic PPP measurement of China's standard of living also has some commercial significance for foreign investors aiming at China's domestic market and employing domestic resources, especially human resources. Future increases in the international purchasing power of the renminbi will depend on increases in China's productivity and hence competitiveness in international trade. As productivity rises, incomes will rise and the gap between PPP and MER measures of income will decline, eventually resulting in a convergence of the renminbi's domestic and international purchasing power.

Concluding remarks

This paper examines most recent studies on China's national accounts, GDP level and growth and discusses some important implications suggested by these studies. It is not exaggerated to conclude that researchers in this field have made considerable progress during the short period since the early 1990s. Their estimates for China's both renminbi-measured GDP and PPP-based GDP, and China's real growth indices have filled some important gaps and provided alternative measures to official figures. Their findings, though still subject to further empirical support, have enabled deeper understanding of China's long-run economic growth from the beginning of the central planning period through the post-reform period. Yet a number of issues remain.

First, due to the deficiencies of China's national accounts, China's renminbi-measured GDP level may still be underestimated. The extent of the underestimation may be around 10 per cent of the official GDP figure.

Second, with more reliable information and refined approaches, studies on China's PPP-based GDP have tended to support the view that China's current official-exchange-rate-based per capita GDP level should be adjusted by a factor of 2, that is, the renminbi PPP-based exchange rate should be around 4 yuan against one international dollar (thus may be treated as one US dollar) compared with about the 1997 official exchange rate of 8.3 yuan per US dollar.

Third, most researchers have agreed that China's official 'comparable-price'-based growth index has overstated China's real income growth. Various methods used in these studies, including the application of China's official CPI data, have shown that the degree of overestimation of China's post-reform GDP growth is at least 2 percentage points.

Fourth, the lower and perhaps more reliable estimate for China's post-reform growth rate has left little room for TFP growth. This favours the view that China's post-reform economic development has almost entirely depended on factor inputs and resource reallocation and benefited little from productivity improvement. This may be further supported by the 'no-catch-up' findings for China's manufacturing sector. However, the puzzle is if we accept that China's post-reform development has been market driven and that resources have been reallocated towards the industries where China has strong comparative advantage, why has China's productivity performance been so poor? Before

jumping to any premature conclusion, perhaps this should be considered as a measurement problem rather than a theoretical problem. The best way to look into this puzzle is perhaps to separate enterprises under different ownerships or different levels from governments on government bodies that have different incentives in economic activities. However, this relatively more micro-level issue is out of the scope of studies on national accounts and growth accounting.

Endnotes

- ¹ To simplify our discussion we shall focus on GDP rather than GNP (gross national product) which includes net property income from abroad.
- ² This simple projection is based on the 1990 GDP level of 3,061 billion G-K dollars for China and 5,465 billion G-K dollars for the United States (Maddison 1995: Table C16), assuming the Chinese economy will grow at 9 per cent a year and the US economy will grow at 2.7 per cent a year according to their previous growth experiences.
- ³ See Wu (1993) for more detailed discussion on the difference of the two systems.
- ⁴ The summary results of the first national census on the tertiary sector have been systematically reported by National Census Office for the Tertiary Sector (NCOTS 1996).
- ⁵ This is confirmed by macroeconomic statistics. In the 1987 input–output table, the clearest statistical consequence of the price policy is very high industrial profits, very low or negative service profits and low rates of return relative to capital stock and land in rural areas (World Bank 1994b).
- ⁶ See, for example, Hollister (1959), Li C. (1959), Eckstein (1961), Liu and Yeh (1965, 1973), Chao (1965, 1968, 1970, 1974), Field (1980) and Perkins (1975, 1980).
- ⁷ For the industrial sector in 1952–7 period for example, both studies showed significantly slower annual growth than official estimates, 13.7 and 13.9 per cent (Chao 1965 and Liu-Yeh 1965, respectively) compared with official 19.5 per cent (see details from Wu 1997: Table 1).
- ⁸ During the 1970s, the US Central Intelligence Agency (CIA) carried out some work attempting to reconstruct Chinese industrial growth independently. But the method was rather crude as data were very poor at that time and the work stopped after 1982. The CIA measures for China were published by the Joint Economic Committee (JEC) of the US Congress in 1972, 1975, 1978 and 1982.
- ⁹ World Bank China Report 13580-CHA was prepared by Keidel in 1994 and provided an extension of Keidel's initial work in 1992.
- ¹⁰ The compounded total adjustment is 34.3 per cent ($1.343=1.136*1.183$) (World Bank 1994b: Table 2.7).
- ¹¹ Including indices estimated by Liu and Yeh (1965) and Wu (1997), and various official growth indices (Maddison 1998).
- ¹² See Kravis (1984) for a complete review of pre-World War II studies of PPPs.
- ¹³ Technically, the methods chosen for the bilateral comparisons should satisfy three requirements: characteristicity test, country-reversal test and factor-reversal test (Ren and Chen 1994).
- ¹⁴ This is also called 'ideal index number' because it meets the criteria set by Fisher as necessary conditions for an ideal index (Fisher 1922). It should be noted that the Fisher index is attractive only because it is a compromise solution. As Kravis, et al. (1978:220) once commented, 'It has little to recommend it, even though it is often favoured for this pragmatic reason'.
- ¹⁵ The 'Geary-Khamis dollar' is also known as 'international dollar'. The 'Geary-Khamis' method is the principal aggregation method of the ICP project. It was proposed by Geary (1958) and later pursued by Khamis (1970, 1972). It is based on the twin concept of 'purchasing power parities' of currencies and 'international (average) prices' of commodities.
- ¹⁶ The study by Ren and Chen in 1993 was an unpublished draft for the World Bank. It was later published by *Review of Income and Wealth* in 1994.
- ¹⁷ 'Fisher dollars' here refers to 'comparable dollars' derived from Fisher (geometric) average of China and USA weighted PPPs.
- ¹⁸ By fitting the regression model to the 1987 data from 81 participant countries in the ICP, the *World Development Report* obtained a result of adjusted R-squared 0.96 and RMSE (root mean squared error) 0.223 (World Bank 1995:244).

- ¹⁹ Distribution is one of such 'disguised' services, where ICP's 'potato-is-a-potato' rule infers that the distributive service content of various types of expenditure is the same in all countries (Kravis, Heston and Summers 1982:31).
- ²⁰ To be consistent throughout this study, production PPP is used here instead of UVR.
- ²¹ If the production structures are very different, as is often the case in a comparison of a low-income country with a high-income country, the PPPs may differ significantly, making the Fisher index unrealistic.
- ²² Taylor's study is also considered a mixture of both expenditure and production approaches, or an unconventional ICP approach using value-added weights (World Bank 1994b).
- ²³ Ren's data are mainly from official sources including industrial census data (ONIC 1987-88), industrial statistics (DITS 1993), input-output tables (DBNE and ONIOS 1991), price data USEST (various years) and other macroeconomic data (SSB various years).
- ²⁴ SSB began to calculate SNA expenditures and report highly aggregated data on GDP by expenditures in 1995 (see SSB 1995:36-8; 1996:46-8), shifting away from MPS expenditure statistics. There has been, however, no regular and detailed report on SNA standard national accounts by expenditures.
- ²⁵ Since the start of the material product system the SSB has used 1952, 1957, 1970, 1980 and 1990 constant prices (SSB 1996:59, explanatory notes).
- ²⁶ See Wu for more detailed discussion (1993: 69-70, footnote 17 and Appendix Table 2).
- ²⁷ This result is very close to Wu's 9.7 per cent for the nation's industrial sector for the same period (Wu 1997).
- ²⁸ By contrast, Ren's extrapolation results for his ICP benchmark estimates imply a growth rate of 8.4 per cent (Ren 1997: Table 5.3). This is not included in Maddison (forthcoming) because Ren argued that the ICOP estimates were preferable. However, Ren's results look rough as he did not have consistent growth estimates throughout his study with the same extrapolation approach. It seemed that Ren also provided constant-price growth rate estimates in his Table 5.1 but they were different from those in Table 5.3. If the estimates in Table 5.1 were in current prices, their differences from the constant-price estimates in Table 5.3 suggested very unrealistic underlying inflation rates. Ren gave no explanation of these inconsistencies.
- ²⁹ Here we use the western concept of 'the industrial sector' which includes mining, utilities and manufacturing. Unlike the Chinese classification, it does not include logging.
- ³⁰ Different estimates by Wu and Szirmai-Ren are not so surprising because they used different methods and data. However, there is a much larger gap in the estimates of manufacturing growth rates between Wu and Szirmai-Ren (1997), 8.5 against 7.6 per cent per annum respectively. In both studies manufacturing grew faster than the industry as a whole, but in Wu's study manufacturing grew even more rapidly. Because, by definition, the industry sector includes manufacturing plus mining and utilities, the findings simply suggest that mining and utilities grew more slowly than manufacturing. It is not certain whether Wu overstated or Szirmai and Ren understated the growth of mining and utilities. However, these two industries are among the few industries still subject to some price control because they are considered essential for industrial production and urban living. Since there are no particular price indices for the two industries, if overdeflated by an inappropriate deflator (as a proxy), their growth will certainly be underestimated and as will be the industrial sector as a whole.
- ³¹ His other benchmark year estimates for China include 1820, 1890, 1913 and 1933 in 1990 G-K dollars (Maddison 1995).
- ³² The 'volume movement' approach is used to remove the influence of real price movements that are not fully reflected by official deflators. For example, Maddison adopted Wu's estimate of industrial output time series based on physical output and he used employment trends for some services.
- ³³ If extrapolated back to 1990 using Maddison's growth rate (Maddison forthcoming) and converted to 1990 dollars, the level would be close to \$1,500.
- ³⁴ US\$1 a day (1985 prices) is an international poverty threshold set by the World Bank using PPP conversion rates (World Bank, East Asia and Pacific Region 1996: Box 3).
- ³⁵ Poverty incidence refers to the percentage of the population living below the poverty line. Note the altered estimate of poverty incidence for China is also a result of abandoning the official line of 60 cents a day and shifting from 'income' to 'consumption' criterion as consumption is considered a better and more reliable indicator of welfare than income because it measures more accurately and reflects households' ability to buffer their standard of living through saving and borrowing, despite income fluctuations (World Bank, East Asia and Pacific Region 1996).

- ³⁶ See Woo (1996) for more detailed discussion of decomposition of TFP growth into labour reallocation effect and net TFP growth that contains technological improvements.
- ³⁷ There is also no agreement among economists on what should be used as 'trade': exports, imports, sum of the total (exports and imports) or half of the total. The ratio of exports to total GDP is preferable as it reflects an economy's ability to pay for imports through exports to the world market.

References

- Asian Development Bank, 1996. *Key Indicators of Developing Asian and Pacific Countries*, Economics and Development Resource Center, Asian Development Bank, Oxford University Press.
- Borensztein, Eduardo and Ostry, Jonathan D., 1996. 'Accounting for China's growth performance', *American Economic Review*, 86(2):224–8.
- Chao, Kang, 1965. *The Rate and Pattern of Industrial Growth in Communist China*, University of Michigan, Ann Arbor.
- , 1968. *The Construction Industry in Communist China*, Aldine, Chicago.
- , 1970. *Agricultural Production in Communist China, 1949–65*, University of Wisconsin, Madison.
- , 1974. *Capital Formation in Mainland China, 1952–1965*, University of California, Berkeley.
- DBNE (Department of Balances of National Economy of the State Statistical Bureau) and ONIOS (Office of the National Input–Output Survey), 1991. *Input–Output Table of China 1987*, China Statistical Publishing House, Beijing.
- and ONIOS, 1993. *Input–Output Table of China 1990*, China Statistical Publishing House, Beijing.
- DITS, (Department of Industry and Transportation Statistics, SSB), 1995. *China Industrial Economic Statistical Yearbook 1994*, China Statistical Publishing House, Beijing.
- , 1996. *China Industrial Economic Statistical Yearbook 1995*. China Statistical Publishing House, Beijing.
- DNEA (Department of National Economic Accounting), 1996. *Input–Output Table of China, 1992*, China Statistical Publishing House, Beijing.
- Eckstein, A., 1961. *The National Economy of Communist China*, Free Press.
- Field, R.M., 1980. 'Real capital formation in The People's Republic of China, 1952–73', in A. Eckstein, A., *Quantitative Measures of China's Economic Output*, The University of Michigan Press, Ann Arbor:194–245.
- Fisher, J., 1922. *The Making of Index Numbers*, Houghton Mifflin, Boston.
- Garnaut, Ross and Ma, Guonan, 1992. *How Rich is China: evidence from the food economy*, Working Papers in Trade and Development, Economics Department, RSPAS, The Australian National University.
- Geary, R.C., 1958. 'A note on comparisons of exchange rates and purchasing power between countries', *Journal of the Royal Statistical Society*, 121:1.
- Gilbert, M. and Kravis, I.B., 1954. *An International Comparison of National Products and the Purchasing Power of Currencies*, OEEC, Paris.

- and Associates, 1958. *Comparative National Products and Price Levels*, OECD, Paris.
- and Beckerman, W., 1961. 'International comparisons of real product and productivity by final expenditures and by industry' in Kendrick (ed.), *Output, Input, and Productivity Measurement*, Studies in Income and Wealth 25, Princeton University Press, Princeton.
- Hollister, W.W., 1959. *China's Gross National Product and Social Accounts, 1950–1957*, Free Press, Glencoe.
- Industrial Division of SSB Hunan Branch, 1989. 'The issues on the calculation of industrial production index' (in Chinese), *Tongji Yanjiu (Journal of Statistical Studies)*.
- Isenman, Paul, 1980. 'Inter-country comparisons of "real" (PPP) incomes: Revised estimates and unresolved questions', *World Development*, 8:61–72.
- JEC (Joint Economic Committee of the US Congress), 1972. *People's Republic of China: an economic assessment*, US Congress, May, Washington, DC.
- , 1975. *China: A Reassessment of the Economy*, US Congress, July, Washington, DC..
- , 1978. *Chinese Economy Post Mao*, Vol.1, US Congress, November, Washington, DC.
- , 1982. *China under the Four "Modernizations"*, 2 vols., US Congress, August and December, Washington, DC.
- Keidel, A., 1992. *How Badly do China's National Accounts Underestimate China's GNP?* Rock Creek Research Inc. E-8042.
- Khamis, S.H., 1970. 'Properties and conditions for the existence of a new type of index number', *Sankhya*, Vol. 32.
- , 1972. 'A new system of index numbers for national and international purposes', *Journal of the Roral Statistical Society*, 135(1).
- Kravis, Irving B., 1976. 'A Survey of international comparisons of productivity', *The Economic Journal*, 86(March):1–44.
- , 1981. 'An approximation of the relative real per capita GDP of the People's Republic of China', *Journal of Comparative Economics*, 5:60–78.
- , 1984, 'Comparative Studies of National Incomes and Prices', *Journal of Economic Literature*, Vol. 12, March.
- , Heston Alan and Summers, Robert, 1978. *International Comparisons of Real Product and Purchasing Power*, The John Hopkins University Press, Baltimore.
- , 1982. *World Product and Income: international comparison of real gross product*, John Hopkins University Press, Baltimore.
- Lardy, Nicholas 1994. *China in the World Economy*, Institute for International Economies, Washington, DC.
- Li, Chengrui (ed.), 1986. *Tongji Gongzuo Shouce (The Handbook of Statistical Work)*, Chinese Finance and Economy Publishing House, Beijing.
- Li, Chon-ming, 1959, *Economic Development of Communist China*, Greenwood Press, Westport, Connecticut.
- Liu, Ta-Chung and Yeh, Kung-Chia, 1965. *The Economy of the Chinese Mainland: National Income and Economic Development, 1933–1959*, Princeton.

- , 1973. 'Chinese and other Asian economies: a quantitative evaluation', *American Economic Review*, May.
- Maddison, Angus and van Ark, Burt, 1970. *Economic Progress and Policy in Developing Countries*, Allen & Unwin, London.
- , 1988. *Comparisons of Real Output in Manufacturing*, Policy, Planning and Research Working Papers, International Economics Department, The World Bank, Washington, DC.
- , 1994. The international comparison of real product and productivity, Paper for the 23rd General Conference of the International Association for Research in Income and Wealth, August 21–27, St. Andrews, New Brunswick, Canada.
- , 1995. *Monitoring the World Economy 1820–1992*, OECD Development Centre, Paris.
- , forthcoming. *Chinese Economic Performance in the Long Run*.
- NCOTS (National Census Office for the Tertiary Sector, China), 1996. *The First Census on the Tertiary Industry in China: Summary Statistics*, China Statistical Publishing House, Beijing.
- OECD, 1997. *Main Economic Indicators*, Paris, January issue.
- ONIC (Office of National Industrial Census, the State Council), 1987–88. *Industrial Census 1985*, Vols. I-X (in Chinese), State Statistical Publishing House, Beijing.
- Paige, D. and Bombach, G., 1959. *A Comparison of National Output and Productivity of the United Kingdom and United States*, OEEC, Paris.
- Perkins, D.H., 1980. 'Issues in the estimation of China's national product', in A. Eckstein (ed.), *Quantitative Measures of China's Economic Output*, The University of Michigan Press, Ann Arbor:246–73.
- Perkins, D.H., ed., 1975. *China's Modern Economy in Historical Perspective*, Stanford University Press.
- , 1988. 'Reforming China's economic system', *Journal of Economic Literature*, 26:601–45.
- Ren, Ruoen, 1997. *China's Economic Performance in An International Perspective*, OECD Development Centre, Paris.
- Ren, Ruoen and Chen, Kai, 1993. An expenditure-based bilateral comparison of gross domestic product between China and the United States, The World Bank, Washington, DC (mimeo)
- , 1994. 'An expenditure-based bilateral comparison of gross domestic product between China and the United States', *Review of Income and Wealth*, Series 40(1):377–94.
- Rostas, L., 1948. *Comparative Productivity in British and American Industry*, NIESR, Cambridge.
- SSB (State Statistical Bureau of China) (various issues), *Statistical Yearbook of China*, China Statistical Publishing House, Beijing.

- Summers, R. and Heston, A., 1988. 'A new set of international comparisons of real product and price levels: estimates for 130 countries, 1950–85', *Review of Income and Wealth*, Series 34(1):1–25.
- , 1991. 'The Penn World Table (mark 5): an expanded set of international comparisons, 1950–1988', *Quarterly Journal of Economics*, 106(2):337–68.
- , 1993. The Penn World Tables 1993 Supplement (PWT 5.5) to PWT 5, diskette, NBER, Cambridge, Massachusetts.
- , 1995. The Penn World Tables (PWT 5.6), diskette, NBER, Cambridge, Massachusetts.
- Szirmai, Adam and Ren, Ruoen, 1995. *China's manufacturing performance in comparative perspective, 1980-1992*, Research Memorandum 581 (GD–20), Institute of Economic Research, Groningen Growth and Development Centre, University of Groningen.
- , 1997. Rapid growth without catch-up: comparative performance in Chinese manufacturing, 1980–1992 (mimeo).
- Taylor, J.R., 1991. *Dollar GNP estimates for China*, CIR Staff Paper, Center for International Research, US Bureau of the Census, Washington, DC.
- USEST (Urban Social Economic Survey Team, SSB), various years, *Price Statistical Yearbook*, China Statistical Publishing House, Beijing.
- van Ark, Bart, 1993. *International Comparisons of Output and Productivity: manufacturing productivity performance of ten countries from 1950 to 1990*, Groningen Growth and Development Centre Monograph Series 1, University of Groningen, Groningen.
- , 1996. 'Convergence and divergence in the European periphery: productivity in Eastern and Southern Europe in retrospect', in B. van Ark and N.F.R. Crafts (eds.), *Quantitative Aspects of Post-War European Economic Growth*, CEPR, Cambridge University Press:271–326.
- Woo, Wing Thye, 1996. Chinese economic growth: sources and prospects, paper presented at Economics Seminar, Research School of Pacific and Asian Studies, The Australian National University (unpublished).
- World Bank, 1991. *World Tables*, The World Bank, Washington, DC.
- , 1992a. *World Development Report*, Oxford University Press, New York.
- , 1992b. *China: Statistical System in Transition*, Report 9557-CHA, The World Bank, Washington, DC.
- , 1993. *World Development Report*, Oxford University Press, New York.
- , 1994a. *World Development Report*, Oxford University Press, New York.
- , 1994b. *China GNP per Capita*, Report 13580-CHA, The World Bank, Washington, DC.
- , 1995. *World Development Report*, Oxford University Press, New York.
- , 1996a. *World Development Report*, Oxford University Press, New York.
- , 1996b. *Poverty Reduction and the World Bank: progress and challenges in the 1990s*, The World Bank, Washington, D.C.

World Bank–East Asia & Pacific Region, 1996. *Poverty in China: what do the numbers say?* Background Note, The World Bank, Washington, DC.

——, 1997. *World Development Report*, Oxford University Press, New York.

Wu, Harry X., 1993. 'The real Chinese gross domestic product (GDP) for the pre-reform period 1952–77', *Review of Income and Wealth*, Series 39, 1:63–87.

——, 1996. Measuring China's industrial performance, 1952–1992, Groningen Growth and Development Centre, University of Groningen, mimeo.

——, 1997. *Reconstructing Chinese GDP According to the National Accounts Concept of Value Added: the industrial sector*, COPPAA (Comparative Output, Productivity and Purchasing Power in Australia and Asia) Working Paper Series 4, Centre for the Study of Australia-Asia Relations, Griffith University.

Appendix Table 1 **Various estimates of China's GDP growth by sector and total economy, and the implied per capita GDP growth, 1985–95** (growth index with previous year=100 and per-annum compound growth rate in per cent)

	Total GDP					Primary		Secondary		Tertiary	
	CPI	Maddison	Ren (I)	Ren (II)	SSB	Ren (II)	SSB	Ren (II)	SSB	Ren (II)	SSB
1986	107	107	110	108	109	102	103	112	110	108	112
1987	109	108	108	108	112	103	105	108	114	112	114
1988	105	108	108	106	111	97	102	109	115	111	113
1989	96	102	95	95	104	96	103	93	104	96	105
1990	106	103	106	102	104	122	107	102	103	89	102
1991	113	106	110	111	109	108	102	111	114	115	109
1992	116	109	115	114	114	106	105	120	121	112	112
1993	113	110	104	106	113	105	105	113	120	96	111
1994	108	110	109	104	113	98	104	108	118	102	110
1995	107	--	--	--	111	--	105	--	114	--	108
GDP growth rate (% p.a.):											
1985-1994/95	7.9	7.0	7.3	6.0	9.9	3.9	4.1	8.3	13.1	4.1	9.6
Implied per capita GDP growth (% p.a.):*											
1985-1994/95	6.5	5.6	9.4	4.6	8.4	--	--	--	--	--	--

Source: Derived from Maddison (1998: Table C-4), Ren (Ren (I), 1997: Table 5.3; Ren (II), 1997: Table 4.4), SSB (1996: 42, 69, 255).

Note: See text for the method used by each study. *The implied the per capita GDP growth is derived from 1.4-per cent annual population growth during the period.