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HOW FAST HAS CHINESE INDUSTRY GROWN?—MEASURING THE REAL OUTPUT OF CHINESE INDUSTRY, 1949–97

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The motivation of this study is to test the widely accepted but never tested hypothesis that Chinese official statistics on growth rates may contain serious upward biases. By adopting a Laspeyres quantity index approach to the recently available official physical output data at commodity level, we have constructed an independent output index for Chinese industry, and produced a unique data set for the value added of 17 major industrial branches at 1987 prices for the period 1949–97. This study has, for the first time, systematically tested this hypothesis with supportive results. It implies that any growth accounting study using the official growth rates may have exaggerated the productivity performance of Chinese industry.

I. INTRODUCTION

China's economic reform, which started in 1978, has driven a rapid transition of the economy from a central planning system toward a market-oriented system integrating with the world economy. The sheer size and rapid growth of the economy have attracted great attention from economists and politicians around the world. However, researchers have generally believed that the official growth rate estimates contain serious upward biases (Rawski, 1980; Perkins, 1988; Keidel, 1992; Woo, 1996; Ren, 1997; Maddison, 1998). Undoubtedly, if the official estimates have exaggerated China's growth rate, they will significantly affect the accuracy of the assessment of China's productivity performance in the past and hence growth potential in the future.

As argued in some studies (e.g. Woo, 1996; Maddison, 1998), the upward biases are largely the consequence of two effects: the Soviet-style "comparable price" approach in constructing output deflators that tends to inadequately deflate nominal output value, and the existing data reporting system, established in the central planning period, that tends to produce statistics skewed toward the government's economic targets.

There are also other difficulties in studying China's growth performance in the long run. For example, all historical statistics are compiled according to the concepts of the Marxian material product system (MPS) that are fundamentally

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different from those under the system of national accounts (SNA), and the available data are often inconsistent from period to period and inadequate for cross-checks and alternative assessments. In fact, during the 1960s and 1970s, the Chinese authorities released no systematic statistics at all. Scholarly activities by Western economists in the 1960s were largely based on the official statistics published in the 1950s. But such work gradually petered out in the 1970s.[1] Research on China's economic performance during the 1970s became cruder as widely scattered sources had to be used, including the speeches of government leaders, editorials in official newspapers and unpublished data through all possible channels.[2]

Since the beginning of economic reform in 1978, the Chinese State Statistical Bureau (SSB) has made tremendous efforts to recompile historical data, meanwhile shifting its statistical work from MPS to SNA. However, a recent study by SSB and the Institute of Economic Research (IER) at Hitotsubashi University (SSB–IER, 1997) has shown that it is difficult to get rid of the strong influence of MPS when attempting to reconstruct China's post-war GDP based on the net material product (NMP) data.[3]

One way to alleviate the MPS influence is to construct an output index based on physical output that is independent of the value of output, which is perhaps the most systematic and comprehensive method of checking the plausibility and consistency of the official data. Western economists used to apply such an approach to the former centrally planned economies. Liu and Yeh (1965) and Chao (1965) also employ this approach to assess the Chinese industrial GDP in the 1950s. The findings from the two studies support the upward-bias hypothesis for the official estimates of industrial GDP growth.

Compared with what was available in the 1950s, there are now more official data that allow a much longer and more reliable time series estimation, but there has hitherto been no attempt to continue the work started by Liu-Yeh and Chao three decades ago. This study attempts to bridge the gap by constructing an output index for China's 17 industry branches for the period 1949–97, primarily based on the official data on quantities and the 1987 producer prices of major industrial products as well as China's 1987 input-output table.

This paper is organized into seven parts. Section II discusses the upward-bias hypotheses for the official growth rate estimates. Section III explains the methodology used in this study. Section IV provides sources of data and discusses data problems. Section V reports the results of the estimation and compares them with the official estimates. Section VI discusses possible biases of the results by taking into account changes in prices, value-added ratio and product quality. Section VII concludes this study.

[1]For example, see Hollister (1959), Li (1959), Eckstein (1961), Liu and Yeh (1965), Chao (1965), Field (1980) and Perkins (1975, 1980).

[2]It should also be noted that during the 1970s, the U.S. CIA carried out some work (by Michael Field) attempting to reconstruct the real output of Chinese industry. But the method was rather crude, the data were much poorer than before and the work stopped after the 1980s. See, for example, JEC (1972, pp. 46–7).

[3]See the SSB-IER estimates cited in Table 1 and relevant discussion in Wu (2000). See Wu (1993) for an empirical study on the GDP–NMP relationship.

II. The Upward-Bias Hypotheses for China's GDP Growth[4]

Two major hypotheses have been put forward to explain why China's GDP growth rates might have been exaggerated. The first one is based on the *underdeflation effect* due to China's practice of the Soviet-style "comparable price" system adopted in the early 1950s in constructing constant price series GDP (Perkins, 1988; Keidel, 1992; Rawski, 1993; Woo, 1996; Maddison, 1998). Under this system the GDP deflator is assembled from several sets of administrative "constant prices" that are, different from Western usage, based on the average prices of "representative products" in a benchmark year, usually with a ten-year interval. Currently there are five "constant prices" with benchmark years of 1952, 1957, 1970, 1980 and 1990, respectively. Enterprises are required to report their output in both current and constant prices according to the price manuals which specify prices for (currently) 2000 items in the benchmark year (currently 1990).

This system tends to understate inflation and thus exaggerate real growth for the following reasons. Firstly, the ten-year interval is long enough to introduce substitution biases, known as Gerschenkron effect (Gerschenkron, 1951), which would exaggerate the growth of the commodities with more rapidly growing prices and underestimate the growth of the commodities with less rapidly growing or falling prices over each interval, especially after the 1980 benchmark when the economy became increasingly market-oriented. Secondly, as some researchers (Maddison, 1998) believe, there could also be some coverage biases towards (low) state listed prices and insufficient coverage of the (high) prices of other market-oriented transactions.[5] Thirdly, enterprises tend to report new products at current prices rather than at "constant prices" as it is very complicated to turn new products, which did not exist in the benchmark year and thus are not included in the price manuals, into something equivalent in the benchmark year. Lastly, enterprises, especially small-sized, non-state enterprises, many of which might not have started their business in the benchmark year, tend to report the same figures at both "constant prices" and current prices for convenience or just out of ignorance.[6]

Even some SSB statisticians have questioned the reliability of China's industrial growth rate based on this "comparable-price" approach. A study carried out by the Industrial Division of the SSB Hunan Province Branch (1989) constructed an independent industrial index for Hunan for the period 1983–87 and found that the so-estimated annual growth rate (9.2 percent) was systematically lower than that based on the "comparable price approach" (13.5 percent).

The second upward-bias hypothesis for China's GDP growth is based on the *institutional effect*. During the central planning period, since achieving high

[4]Part of the discussion in this section is based on Wu (2000).

[5]There is no detailed information about how the "representative products" were chosen and how their average prices were computed in the compilation of the official "constant prices."

[6]According to my personal interviews with SSB statisticians on several occasions in 1998–99, most rural enterprises, especially those at or below the village level, only report their output at current prices. The reported output figures are adjusted afterwards to "constant prices" by the upper level statistical offices based on the "real" growth rate of small-sized SOEs that report their output at both current and "constant prices." However, this treatment is *ad hoc* and leaves room for further adjustment, very likely to serve special policy purposes.

growth was always a political task, growth rates could be exaggerated, especially when the leadership promoted an expansionary policy. Even after extensive reforms the Chinese government still sets high growth targets and intervenes in various aspects of the management of state-owned enterprises (SOEs) in order to achieve these targets. In China, growth statistics are important not only for propaganda drives, but also for performance assessment of enterprises, sectors and regions. As argued by Maddison (1998), this system by its nature leads to underestimated inflation and exaggerated output. Despite penalties for falsification, there are substantial possibilities for exaggerating the volume of output when new products are incorporated into the reporting system at the "comparable prices," which are not easy to detect. Woo (1996) points out that enterprises had strong incentives to gratify their supervising bureaux by overreporting output growth since high-growth performance could be interpreted as evidence of superior management ability of the upper management level. Rawski (1993) also observes that local governments had strong incentives to exaggerate actual growth because they would be rewarded with special privileges if the economies under their governing had surpassed certain threshold levels of industrial output set by the government.

We argue that a properly constructed output index using the physical output of commodities could to a large extent overcome these problems and hence reduce the upward biases contained in the official output index. Firstly, its physical nature can easily bypass the substitution biases introduced by the official "constant price" approach.[7] Secondly, compared with output value, it was more difficult for firms and local officials to exaggerate physical output. It is well known that quantity control is the basic mechanism of a central planning system, which requires meeting physical output targets and distributing output to producers and consumers as planned. It is, therefore, crucial to the system to have reliable information on what is available. There are vast official documents showing that in the old days good efforts were made repeatedly by the central planners, often through numerous planning meetings, to make sure that a certain quantity of a particular input material would be available for the next year's production.[8] Quality of input materials was also a big concern. It is evident that production plans were adjusted after identifying hand-made (low quality or useless) coke, iron, steel and cement from the total output of these products.[9]

III. Methodology

In this paper we construct a new series on Chinese real industrial GDP which is an alternative to the official one. The methodology used in this study is based

[7]However, since commodities in quantities have to be weighted by their prices we are not completely free from substitution biases, or the Gerschenkron effect. We will come back to this problem in Section VI when the results are discussed.

[8]This is well documented in the recently published series *Fifty Years of Chinese Industry* by the State Economic and Trade Commission (SETC, 2000, especially in Volumes 1 to 5).

[9]See, for example, SETC (2000, Vol. 3, pp. 567 and 617). In this study, we do not attempt to adjust the output of these products for the amount made by hand because there is no detailed information on whether they were completely useless.

on a Laspeyres quantity index approach. We choose the year 1987 as the benchmark year, mainly because this is the earliest year covered by China's first SNA-type input-output table. There are three major steps involved in aggregating the commodity level quantity data to arrive at the standard branch level. The first step is to obtain 1987-based quantity indices at the commodity level that exactly match the industry classification of China's 1987 input-output table.

The second step is to estimate a time series of gross value added (GVA) at 1987 prices at industry level using both the GVA data from the 1987 input-output table and the estimated quantity indices. Here we have to assume that the ratio of GVA to gross value of output (GVO) remains constant over time, which implies that: (1) technology remains the same over time—essentially as given by the 1987 input-output table; and (2) the 1987 price weights are held constant over the entire period of study. These are strong assumptions, but there is no better alternative. We will discuss possible biases introduced by these assumptions in Section VI. Note that this second step makes industries additive.

The last step is to aggregate the estimated GVA series at industry level into 15 manufacturing branches plus mining and utilities, which is in line with the industrial classification of the International Comparison of Output and Productivity (ICOP) program at Groningen University. This allows us to calculate output index for each branch as well as for the industrial sector as a whole.

A simple mathematical expression for the method used is given as follows. Let q_{ij} be the quantity of the i-th commodity ($i=1, 2, \ldots, n$) of the j-th industry ($j=1, 2, \ldots, m$) and w_{ij} be the weight for this commodity. The physical output index for the j-th industry based on 1987 price weights, $Q_{j,t}^{\text{Index 87}}$, is defined by the following formula

$$(1) \qquad Q_{j,t}^{\text{Index 87}} = \frac{\sum_{i=1}^{n} w_{ij,87} \cdot q_{ij,t}}{\sum_{i=1}^{n} w_{ij,87} \cdot q_{ij,87}}.$$

Equation (1) is in line with the approach of Laspeyres index, i.e. a fixed base-period weight index. As clearly shown in this equation, to compute the industry's output index, quantities of commodities within each industry have to be aggregated by proper weights, which is called "*intra*-industry aggregation." The weights used to obtain the quantity index should be the producer prices in the base year (i.e. 1987) ($w_{ij,87} = p_{ij,87}$) or the unit values for the same year that can be derived directly from the quantity and gross value of output of a commodity.

However, for those commodities without any information on prices, two alternative approaches may be used. Firstly, assuming that n commodities within the j-th industry have the same or similar prices in the base year, and the quantity unit of measurement for these commodities is the same and constant over time, equation (1) can be simplified to:

$$(1a) \qquad Q_{j,t}^{\text{Index 87}} = \frac{\sum_{i=1}^{n} w_{ij,87} \cdot q_{ij,t}}{\sum_{i=1}^{n} w_{ij,87} \cdot q_{ij,87}} = \frac{\sum_{i=1}^{n} q_{ij,t}}{\sum_{i=1}^{n} q_{ij,87}},$$

which is simply the ratio of the sum of n commodities in quantity in period t to that in 1987. Secondly, if the unit-invariance rule is violated, an unweighted geometric mean is used to deal with this problem, that is,

$$Q_{j,t}^{\text{Index } 87} = \left[\prod_{i=1}^{n} \left(\frac{q_{ij,t}}{q_{ij,87}} \right) \right]^{1/n}. \tag{1b}$$

Fortunately, because of the unique producer price data set available to this study, there are only a few cases in which equation (1b) is applied. In most cases, equation (1) is followed with price weights. More details about this will be provided in the data section.

After completing the construction of the quantity index at industry level, we can move on to construct a time series of gross value added (GVA) at 1987 prices for the *j*-th industry by the following equation:

$$\text{GVA}_{j,t} = \text{GVA}_{j,87} \times \text{Q}_{j,t}^{\text{Index } 87} = \text{GVA}_{j,87} \times \frac{\sum_{i=1}^{n} w_{ij,87} \cdot q_{ij,t}}{\sum_{i=1}^{n} w_{ij,87} \cdot q_{ij,87}}. \tag{2}$$

Equation (2) implies that the *j*-th industry-level GVA at constant prices is estimated by multiplying the 1987 benchmark GVA with the quantity index for the same industry that is constructed by the *available* commodities. Since in most cases individual industries cannot be *fully identified* by the available commodities, this approach actually assumes that the unidentified output value moves along the same trend as that of the identified.[10] Finally, so-estimated GVAs of individual industries are summed up to obtain the branch-level GVA.

IV. Data Sources and Problems

In order to construct a relatively independent output index for each individual industrial branch, this study intends to use "raw data" that are not influenced by official output index. Basically, we need three types of data for this work. At commodity or commodity group level, we need time series data on physical output. At industry level, we need value added data for the benchmark year (1987). We also need price data for the benchmark year for intra-industry aggregation. The sources and problems of these data are discussed below.

Data on Physical Output

Data on the physical output of major industrial products/product groups are the key data of this study, which are obtained from various volumes of the *China Industrial Economic Statistical Yearbook* (CIES) published by the Department of Industry and Transportation Statistics (DITS) of SSB. Products included in this Yearbook are therefore called "CIES items" and coded in their original order in this study. As shown in Table A1, they include almost all major producer and consumer goods. It should be noted that these products are also the important output indicators used by relevant industrial ministries in China, a tradition of the Soviet-type, quantity-focused planning system.

[10]This issue will be discussed again in the following sections. See also Table 1 for the coverage ratio of each branch.

The number of CIES items has remained basically stable over time. It increased only when an important new product was added. There are 195 items reported in the 1994 Yearbook that covers the period 1949–93.[11] Most of them are updated to 1997 in the 1998 Yearbook. However, not every CIES item can be directly used in constructing the output index. Some items are incomplete or in broken series. In the processing of the CIES data, items that contain limited gaps are fixed by their own trend or the trend of their closely related items, and items that suffer from too many missing data which are difficult to fill are dropped (Table A1).

There are some CIES items whose series are seriously broken but could be repaired by information available from other publications. There are three official sources that are independent of the state statistical system and we have found useful. The first one is *Fifty Years of Chinese Industry*, a nine-volume series that contains previously unpublished documents on industrial planning, policy and production since 1949, complied by the State Economic and Trade Commission (SETC) (2000). The second one is *China Today*, a series of studies on the post-1949 development of individual industries and sectors of the Chinese economy and society by specially established editorial boards. In this study, for example, *China Today*: *Petrochemical Industry* by the Editorial Board of CTPI (1987) and *China Today*: *Shipbuilding Industry* by the Editorial Board of CTSI (1992) are heavily consulted. However, the two sources do not provide systematic historical data. The third source is the regularly published yearbooks by individual industrial ministries through their own publishers since the mid-1980s, of which, for example, *China Machinery Industry Yearbook* (Editorial Board of CMIY, 1996, 1997 and 1998) and *China Electronic Industry Yearbook* (Editorial Board of CEIY, various years) are more heavily used in this study. Data from this source are more systematic and often supported by more details, but in much shorter series than CIES items.

Based on the information disclosed in these publications, we have substantially improved the following incomplete or problematic items. Firstly, there are no systematic official statistics for gasoline (CIES53), kerosene (54) and diesel (55) before 1972, even though it is evident that China carried on producing these petroleum products after 1949.[12] This big gap is filled by the data on ten discontinuous time points for the period 1949–71 found in *Fifty Years of Chinese Industry* and *China Today: Petrochemical Industry* and the interpolations between these points.

Secondly, the CIES item civil steel ships (125) gives a broken series that covers only the period 1973–94, although China did produce civil steel ships in other years of the period 1949–97. We use the information found in *Fifty Years*

[11] After microcomputer is added as discussed later, the total number of commodities that are used will be 196 (Table 1).

[12] In fact, development of China's modern petroleum and petrochemical industries was evident in its embryo form at the beginning of the 20th century, but its pace was very slow in its first half-century development. By 1952 China refined about half a million tons of petroleum a year, which was almost its existing full capacity. The development has since hastened due to huge new investment, which could be reflected by official data on the increase in the production of petroleum-petrochemical equipment (108).

of Chinese Industry, *China Today*: *Shipbuilding Industry*, and various volumes of the *China Machinery Industry Yearbook* to complete this series.

Thirdly, starting from the 1990s, the CIES items semi-conductors (138) and integrated circuits (139) demonstrate very different trends from those suggested by the data reported in various volumes of the *China Electronic Industry Yearbook* (CEIY). The biggest problem is that the CIES output figures are even greater than the CEIY-reported capacity of Chinese electronic industry for producing these products in 1994–95.[13] The two CIES items are, therefore, revised by replacing the figures for the 1990s by the CEIY data.

Lastly, we rely on various volumes of the *China Electronic Industry Yearbook* to construct a series for the production of microcomputers that is not included in the original list of CIES items. We also use the information from the third source to check the plausibility of CIES items for the policy-driven expansion period 1993–95 when many CIES items appeared to experience an extraordinarily fast growth. However, most of them are confirmed by the relevant industrial ministries' yearbooks, except for the CIES items metallurgical equipment (107), petroleum-petrochemical equipment (108) and transformers (128) whose figures are much greater than those published in the *China Machinery Industry Yearbook* (CMIY). These items are, therefore, revised by the CMIY data for this period. After this data processing, 163 items are finally selected and 161 items are used in constructing the physical output index for the industrial sector (Table 1).

Data on Commodity Prices

The price data that we use to aggregate CIES items up to their industry level are the 1987 ex-factory prices in *The Post-War Chinese Industrial Price Database*, compiled by the Institute of Economic Research at Hitotsubashi University (IER, 1999), based on unpublished annual official price surveys in China. The IER Database contains about 2000 prices for industrial products. However, since these prices are for individual commodities but not commodity groups, they cannot directly match most CIES items. We need average prices for this purpose. An output-weighted average price is calculated to match a particular CIES item from the individual prices in the IER Database whenever the output information on relevant commodities is available. Otherwise, a non-weighted average price is used. In total, 527 prices are involved in working out the average prices for 118 CIES items. No proper price information can be found or calculated for the remaining 45 CIES items using the price information in the IER Database. Of these 45 CIES items, one item is already in value and 31 items are matched with the prices published in the *Price Yearbook of China* (Editorial Board of PYC, 1989) leaving only 13 items without prices. Different treatments to these items are explained as follows.

[13]According to the CIES figures, China produced 16,702 million units of semi-conductors (138) in 1994 and 17,735 in 1995, which were greater than the figures reported in CIEY of 10,458 and 12,386, as well as the industry's capacity of 12,391 and 16,979, respectively. Besides, the CIES figure on integrated circuits (139) for 1995 is 5,517 million, which is 11 times the level of the previous year and 5.7 times the industry's capacity. This is even more unacceptable compared with the case of semi-conductors (for details, see Editorial Board of CEIY, 1995, p. 37; 1996, pp. 36 and 52; DITS, 1998, p. 49).

The CIES item lacework (49) is the only item that is in value at its current prices. We deflate it to its 1987 price based on two price indices, the official producer price index for the clothing industry for the period after 1987 and the official retail price index for rural China for the period prior to 1987 (see Table A1 for details).

There are 31 CIES items that we find are difficult to obtain reasonable average prices using the prices in the IER Database.[14] For any of these items, even if the lowest price among the available relevant prices is chosen as a proxy, it will still end up with an output value that is too high to be accommodated by the total output value of the industry that the item belongs to. It could be due to exaggerated physical output or biased price samples or both. Since there is no information that allows any investigation into the reliability of these CIES items, we could only assume that the problem is mainly due to the biases in the price samples in the IER Database. This problem is finally solved using the information found in the *Price Yearbook of China* (PYC) (Editorial Board of PYC, 1989). More reasonable (lower) prices for these items are worked out with their average prices in 1988 and changes over 1987–88 reported in PYC (see Table A1 for details).

The remaining 13 items are reported in weight (tons) or power or amperes in the CIES yearbooks but all their relevant products are priced in units in the IER Database, including, for example, mining machinery (104), textile equipment (106) and transformers (128). Since it is impossible to price these items according to their weights or power, we use the geometric average approach (equation 1b) to conduct the intra-industry aggregation whenever such items are involved.

Data on Gross Value Added of Industries

The required gross value added (GVA) data at industry level for inter-industry aggregation are obtained from the 1987 *Input–Output Table of China* (DNEB and ONIOS, 1991), which is China's first SNA-type input-output table in history. Accordingly, individual industry in this study is defined following the classification of this input-output table and termed as CIOT (China Input-Output Table) industry. There are 83 CIOT industries included in the (Chinese style) industrial sector of the 1987 input-output table. After removing logging and maintenance of machinery that should not be included in the industrial sector by the international standard, 81 CIOT industries should be included in the industrial sector as the standard classification. In Table 1, the 81 CIOT industries are further grouped into 17 manufacturing, mining and utility branches, the level at which our analysis is conducted.

After a proper matching of the 161 selected CIES items with the CIOT industries, 60 CIOT industries are identified by these CIES items. Except for the 13 CIES items that could not be properly priced as discussed above, this matching shows an overall CIES coverage ratio of 57 percent in terms of the gross value of output (GVO) for the industrial sector as given in the input-output table (Table

[14]Most of these items share a common feature, that is, there are too many varieties in one item. Examples include steel products (92), plastic products (82), textile products (20, 21, 27, 29) and fertilizers (63).

TABLE 1

NUMBER OF CIOT INDUSTRIES AND CIES ITEMS AVAILABLE AND USED, AND 1987 CIOT GVA AND GVO AND COVERAGE RATIO BY BRANCH

	Number of 1987 CIOT Industries	1987 CIOT Gross Value Added (GVA)	1987 CIOT Gross Value of Output (GVO)	Number of CIES items Available	Number of CIES Items Used	Number of CIES-Item Identified CIOT Industries	CIES-Item Valued at 1987 Prices*	CIES Coverage Ratio (GVO = 1)
1. Food manufacturing	7	18,549	124,116	5	5	5	40,002	0.32
2. Beverages manufacturing	2	10,625	31,664	2	2	1	20,145	0.64
3. Tobacco manufacturing	1	19,405	28,918	1	1	1	28,623	0.99
4. Textile manufacturing	6	42,592	166,207	17	16	5	129,285	0.78
5. Wearing apparel manufacturing	1	9,124	31,037	2	2	1	30,818	0.99
6. Leather products, footwear manufacturing	1	4,523	15,539	2	2	1	14,934	0.96
7. Wood products, furniture, fixtures manufacturing	2	6,864	21,557	3	3	2	19,320	0.90
8. Paper, printing and publishing	2	14,271	44,329	4	3	1	27,591	0.62
9. Chemicals, petroleum and coal manufacturing	12	62,227	177,293	36	32	11	100,584	0.57
10. Rubber, plastic products manufacturing	4	13,735	46,805	3	3	3	23,770	0.51
11. Non-metallic mineral products	7	32,796	80,025	4	4	3	28,425	0.36
12. Basic and fabricated metal products manufacturing	4	50,825	157,056	29	20	2	94,731	0.60
13. Machinery, transport equipment manufacturing	12	61,183	179,976	38	29	9	56,743	0.32
14. Electrical-electronic equip manufacturing	6	28,587	98,487	23	22	6	54,663	0.56
15. Other manufacturing	4	14,769	40,441	10	7	1	2,473	0.06
Total manufacturing	71	390,072	1,243,451	179	151	52	672,108	0.54
Mining	8	46,420	71,725	10	9	7	59,773	0.83
Utilities	2	24,450	42,351	4	1	1	38,298	0.90
Total industry (western style)	81	460,943	1,357,527	193	161	60	770,179	0.57
Logging (forest—western style)	1	6,448	9,688	3	2	1	7,188	0.74
Maintenance (service—western style)	1	5,463	14,085	0	0	0	0	0.00
Total industry (Chinese style)	83	472,854	1,381,301	196	163	61	777,367	0.56

Source: Data on CIES items are from DITS (1995, 1998) and on CIOT industries from DNEB and ONIOS (1991). See Section IV for details.

Note: *Based on the quantity and price information provided in Table A1. Selected CIES items without price are not taken into account in the calculation of the value coverage.

1).[15] If we simply assume that each of the excluded 13 CIES items in this calculation should have at least contributed to the total industrial GVO as equally as other items on average, the CIES coverage ratio should have been around 62 percent. This is a fairly high coverage ratio given the nature of the matching.

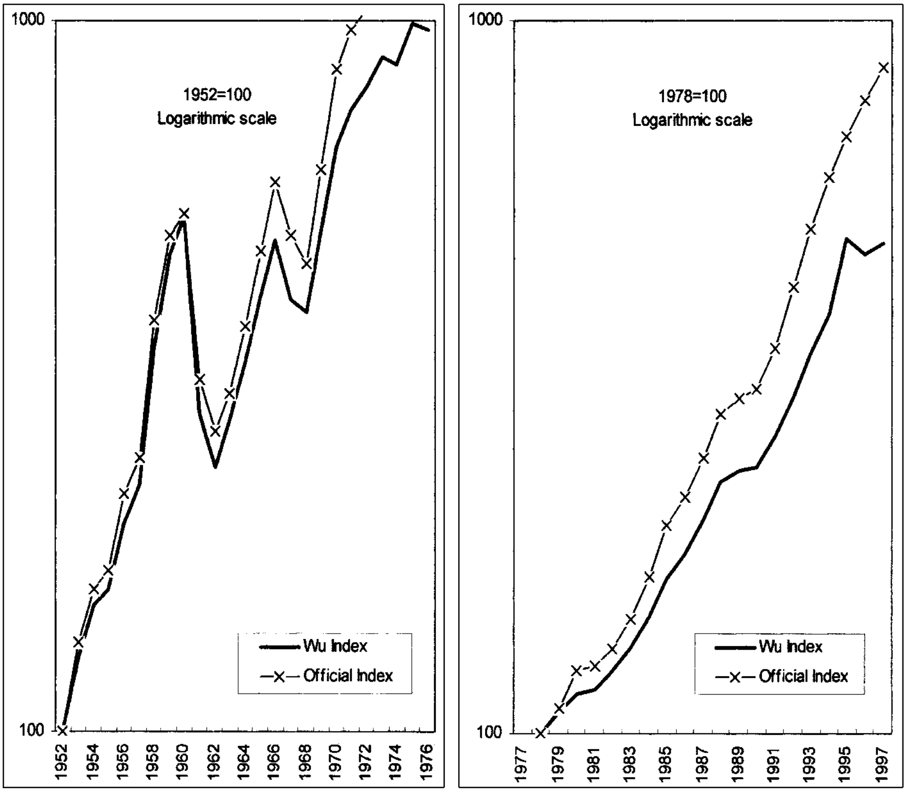
V. Results

Following the methodology discussed in Section III, the *intra*-industry aggregation of the commodities (CIES items) for every CIES-identified CIOT industry is conducted using the average producer prices discussed in Section IV. This exercise produces a physical output index for each of such CIOT industries. The CIOT industry-level gross value added (GVA) time series is then obtained by incorporating the 1987 GVA from the *Input-Output Table of China 1987* with the estimated physical output index of each CIOT industry. The industry-level GVA results are further aggregated into 15 manufacturing branches, plus mining and utilities branches. Within a branch, those CIOT industries that cannot be identified by the selected CIES items are assumed to have moved along the same trend as that of the CIES-identified industries, so that a complete output series for each branch and hence the whole industrial sector can be constructed. The full results are reported in Table A2.

Figure 1 depicts both the official output index and the index constructed in this study. As it demonstrates, our estimates for the industrial sector as a whole clearly suggest a slower growth trend than that of the official (SSB) estimates. The difference in the annual compound growth rate is about 1.2 percentage points for the pre-reform period (Mao's era) and 3.3 percentage points for the post-reform period (Deng's era) as reported in Table 2. The results appear to strongly support the hypothesis that the official output index contains serious upward biases. This could be observed for each sub-period in Table 2, whether the results are compared with the SSB net material product (NMP) series or with the recent SSB and IER joint estimates of GDP series.

It should also be noted that the official index indicates a slightly faster annual growth (by 0.5 percentage points) in the post-reform period than in the pre-reform period (12.0 compared to 11.5 percent), while our estimates show an opposite pattern with a bigger gap between the two periods (8.7 compared to 10.3). The new pattern appears to be more reasonable than the official one because the reform has shifted China from an industry-focused development, which sacrificed the development of other sectors of the economy, to a more balanced market-driven development. As a result of this shift, the industrial sector, especially heavy manufacturing that dominated the growth in the past, should not be expected to grow as fast as in the central planning period. As Table 2 shows, the annual growth of heavy manufacturing declined from 13.9 to 9.4 percent over the pre-

[15] The overall "CIES coverage ratio" is calculated by dividing the total output value of the selected CIES items (multiplying quantity with price for each item and summing up the results of all items) by the sum of the GVO of individual CIOT industries.



Source: "Wu Index" is based on the author's estimates reported in Table A2. "Official index" is based on SSB (1998, p. 57).

Figure 1. Index of Gross Value Added (GVA) of Chinese Industry: Official versus Wu's Estimates, 1952–78 versus 1978–97

and post-reform periods, while the annual growth of light manufacturing increased from 6.6 to 9.3 percent.[16]

The growth pattern of individual branches over different sub-periods also appears plausible as presented in Table 2. Both the post-revolution recovery (1949–52) and the Soviet-style first Five-Year Plan (1953–57) periods saw much more rapid growth of heavy industries compared with light industries. This pattern was presumably forced to change after the failure of the Maoist feverish Great Leap Forward (1958–59). As reflected by our results, compared with the earlier stages, the growth of heavy and light industries tended to be more "balanced" through the mid-1960s to the 1970s. A significant shift of the growth pattern could be seen at the early stage of the reform (1978–87) when for the first time since 1949, light industries grew faster than heavy industries, which is more in line with China's comparative

[16]Strictly speaking, light and heavy manufacturing branches should be defined on the basis of their capital intensity rather than on the basis of the products they produce. The definition that Table 2 adopts is more or less the Chinese official tradition as there are no matching capital data.

TABLE 2

ANNUAL COMPOUND GROWTH RATE OF GROSS VALUE ADDED (GVA) IN CHINESE INDUSTRY BY BRANCH, SELECTED PERIODS IN 1949–97 (IN PERCENTAGE)

	1949–52	1952–57	1957–65	1965–70	1970–78	1978–87	1987–97	1952–78	1978–97	1952–97
1. Food manufacturing	30.75	9.20	5.43	0.72	9.32	14.25	5.63	6.40	9.63	7.75
2. Beverages manufacturing	25.99	22.58	3.37	5.86	9.03	15.95	6.54	9.08	10.90	9.84
3. Tobacco manufacturing	18.32	10.97	0.87	10.37	5.28	10.41	1.60	5.92	5.68	5.82
4. Textile manufacturing	26.11	9.27	4.30	9.27	3.32	7.84	5.67	5.88	6.70	6.22
5. Wearing apparel manufacturing	26.47	5.74	1.34	–0.11	7.66	14.61	18.91	3.81	16.85	9.13
6. Leather products, footwear manufacturing	8.83	20.14	–3.81	19.79	7.75	11.24	18.59	8.44	15.05	11.18
7. Wood products, furniture, fixtures manufacturing	21.46	15.31	6.69	2.01	3.28	2.78	11.55	6.30	7.31	6.72
8. Paper, printing and publishing	49.58	19.84	8.40	6.94	7.83	11.30	9.14	10.04	10.16	10.09
9. Chemicals, petroleum and coal manufacturing	41.13	22.35	14.63	10.20	9.55	6.94	9.05	13.60	8.05	11.22
10. Rubber, plastic products manufacturing	28.89	16.59	11.70	10.79	8.69	11.18	14.96	11.51	13.16	12.20
11. Non-metallic mineral products	35.22	23.49	3.78	5.16	10.07	10.42	10.32	9.55	10.37	9.89
12. Basic and fabricated metal products manufacturing	150.35	46.42	13.19	9.37	8.23	5.44	4.32	16.54	4.85	11.45
13. Machinery, transport equipment manufacturing	68.90	40.09	8.38	19.27	9.18	8.83	11.11	16.24	10.02	13.57
14. Electrical equipment manufacturing	61.00	35.72	7.69	25.59	9.55	12.67	16.48	16.58	14.66	15.77
15. Other manufacturing	34.43	9.37	8.40	6.21	11.67	8.07	11.86	9.15	10.05	9.53
Total manufacturing**	29.97	17.39	7.42	9.86	7.91	8.76	9.88	9.90	9.35	9.66
Heavy manufacturing**	47.48	30.27	10.53	11.97	9.13	8.20	10.48	13.92	9.39	11.98
Light manufacturing	25.43	11.00	4.40	6.96	5.77	9.83	8.74	6.56	9.26	7.69
Mining	27.47	17.07	9.50	11.42	11.41	3.19	3.93	11.88	3.58	8.30
Utilities	19.29	21.46	16.96	11.39	10.45	7.63	8.61	14.67	8.14	11.87
Total industry (this study)	29.45	17.44	7.95	10.12	8.51	7.99	9.33	10.31	8.69	9.62
Total industry (SSB: NMP data)	n.a.	19.58	8.67	12.56	8.68	10.40	13.45	11.46	11.99	11.76
Total industry (SSB-IER: GDP)*	n.a.	19.84	8.98	11.62	8.96	10.40	13.45	11.46	11.99	11.76

Source: Results from this study are from Table A2. Official results are based on SSB (1998, p. 57) and SSB-IER (1997, Table A10).

Note: *The SSB-IER estimates are only available up to 1995. They are extrapolated to 1997 according to the SSB trend as the two series have the same trend for the post-1978 period. **Heavy manufacturing includes Branches 9–14 and light manufacturing includes Branches 1–8 and 15.

advantage. However, contrary to expectation, heavy industries remained important in Chinese industrial growth even after the reform. As Table 2 shows, the growth momentum of light manufacturing could not be maintained at the later stage of the reform (1987–97) while the growth of heavy manufacturing accelerated. While a close examination of the determinants of such a pattern is beyond this study, it is reasonable to expect that the current development should be healthier than that in the central planning era because the market is now playing an increasingly important role in the economic decision making in China.

VI. Possible Biases of the Results

The Laspeyres quantity index approach used in this study has the following assumptions: (1) the 1987 price weights are representative of the entire period in question; (2) the GVA–GVO ratio, or value-added ratio, remains constant over the same period; and (3) there is no quality change during the same period. Therefore, the most important question about the reliability of the new index is what are the possible biases that may have been introduced by these assumptions.

Firstly, the new index may contain substitution biases due to the Gerschenkron effect introduced by the fixed weights (Gerschenkron, 1951). The direction of biases depends on the correlation between changes in prices and changes in quantities of commodities. Consider the case where the correlation is negative, implying that consumers are rational. In this case, commodities whose prices rise less rapidly or fall will be substituted for those whose prices rise more rapidly. Therefore, the quantity index based on prices in an earlier year is higher than that which is based on a later year because the former gives a larger weight than the latter to those commodities whose prices grow more rapidly. In other words, the benchmark fixed-weight quantity index will overstate growth rate for the years after the benchmark year and understate growth rate for the years before that year. However, this should not be simply applied to the Chinese case. China's 1987 price structure is supposed to be less distorted than that in the early years when the central planning system dominated. If it is reasonable to argue that in a centrally planned economy the Gerschenkron effect might not hold because prices were controlled and consumers had few choices, it then suffices to argue that the new index may have some upward biases for the years after 1987, but it may not contain significant downward biases for the years prior to 1987.

Secondly, other things being equal, if the value-added ratio declines over time, this approach will overestimate China's industrial growth. Research on the centrally planned economies has found that their value-added ratios in the late 1980s were significantly lower than their counterparts in the West. In Table 3, we cite the previous studies on the ratio of gross material product (or GMP—a "gross value added" concept in MPS) to GVO in industry for some centrally planned economies in comparison with the same ratio of the U.S. and Germany. Note both the U.S. and German figures are converted to make them compatible with those of the centrally planned economies. The explanation for the low ratios of the centrally planned economies is that they made wasteful use of raw materials and other intermediate inputs because the price system did not encourage efficiency. For example, inputs of steel and energy were characteristically higher

TABLE 3

Ratios of Industrial Gross Material Product (GMP) to Gross Value of Output (GVO), Six Counntries in 1987/89

Country (year)	Currency	GVO (million)	GMP (million)	GMP/ GVO	Source
China (1987)					DNEB and ONIOS
industry	Yuan	1,381,300	506,183	0.368	(1991)
USSR (1987)					
manufacturing	Rubles	708,687	225,351	0.318	Kouwenhoven (1996)
Czechoslovakia (1989)					
manufacturing	Kcs	833,285	290,940	0.350	van Ark (1996)
East Germany (1987)					
manufacturing	OM	467,418	160,017	0.342	van Ark (1996)
USA (1987)					
manufacturing	US dollar	2,475,901	1,165,747	0.472	Kouwenhoven (1996)
West Germany (1989)					
manufacturing	DM	1,469,432	710,484	0.485	van Ark (1996)

in these countries than in the West (van Ark, 1996). Apart from the waste of inputs, these countries also tended to accumulate large amounts of unmarketable inventories.

It is reasonable to expect that this practice of wasteful use of intermediaries will decline along with market-oriented reforms and hence the value-added ratio will go up. However, conflicting evidence is found in the Chinese case. A scrutiny of China's 1990 and 1992 input-output tables reveals a significant decline in the value-added ratio for the industrial sector as a whole between 1987 and 1992, down from about 0.344 in 1987 to 0.305 in 1990, and further to 0.283 in 1992. However, this decline might have stopped after the early 1990s along with China's intensified marketization. This could be observed in the 1995 input-output table which shows that the ratio slightly increased to 0.287 in 1995.[17] This means that if this declining value-added ratio was characteristic of most of the period before the early 1990s, our use of the fixed 1987 weights would still have overstated China's industrial growth for that period.

Thirdly, other things being equal, if product quality improves over time, this approach will underestimate Chinese industrial growth. Ignoring the new products that might have appeared after 1987 will have a similar effect. There is no information that allows a test of the quality improvement and the new product effects on our estimates. However, since the process of quality improvement and introduction of new products under central planning was likely to be slow, the results may contain insignificant downward biases for that period. As for the reform period, although the downward biases in our estimates are likely to increase, they may have been to a large extent offset by the upward biases that are introduced by the declining value-added ratio as discussed above.

VII. Concluding Remarks

By adopting a Laspeyres quantity index approach, this study constructs an output index for each individual industrial branch using time series data on major

[17]The value-added ratio is measured as the ratio of GVA to GVO using data from DNEB and ONIOS (1991, pp. 146–62; 1993, p. 16) and DNEA (1996, pp. 187–201; 1997, p. 53).

industrial products, 1987 price data for these products and the gross value added data from China's 1987 input-output table, and produces a unique data set for the value added of 17 Chinese major industrial branches at 1987 prices for the period 1949–97.

In this study we have, for the first time, systematically tested the upward-bias hypothesis that the Chinese official growth index overstates China's real industrial growth performance. Our estimates demonstrate a significant downward correction effect upon the official growth rate. Therefore, they strongly support the upward-bias hypothesis. It implies that any growth accounting study using the official output index may have exaggerated the productivity performance of Chinese industry. Our results show that the extent to which the official index may have overestimated the real growth performance varies over different periods and across different industrial branches.

We believe that the new estimates are an important improvement over the official ones for the following reasons. Firstly, the physical output data are independent of the official output value data that suffer from the problematic "comparable price" approach. Secondly, compared with output value, physical output was less likely to be overreported because accurate quantity control was crucial in carrying out physical output-focused national plans under the central planning. After the reform the gradual phasing out of the central planning gives state firms and local officials no incentives to focus on physical output. Thirdly, compared with the official "constant prices" that are based on the years when state prices dominated, the 1987 producer prices that are used in this study are less distorted and hence, have more economic rationale as they better reflect opportunity costs and marginal utility.

Some biases remain in our estimates. The Laspeyres index approach used in this study inevitably produces substitution biases because it is subject to the fairly strong assumptions that the 1987 price weights and the relationship between input and output prices remained unchanged. This, combined with the evident declining value-added ratios over time and even after the reform, suggests that our results may still exaggerate China's industrial output performance. However, the likely downward biases due to our assumption that there was no quality improvement over time may, as argued above, to a large extent offset this exaggeration.

The net effect of these remaining biases is yet an empirical question that certainly deserves further investigation when more information becomes available. Research priority should also be assigned to a couple of new benchmark estimations at the same level of details focusing on the years after 1987, ideally with more new products added onto the list of products, which should be linked with this study's results.

Appendix

TABLE A1

List of 196 CIES Items (Commodity Groups) for Selected Years of 1952–97 and 1987 Ex-factory Prices (in Yuan)

CIES Item		1952	1978	1987	1997	Price[a]
1. Food manufacturing						
13 Edible oil (million tons)[f]	*	0.980	1.770	4.780	8.940	3,342
14 Sugar (million tons)[f]	*	0.450	2.270	5.060	7.030	1,140[d]
15 Dairy products (million tons)[b,f]	*	0.004	0.047	0.272	0.565	7,426
16 Canned food (million tons)[b,f]	*	0.013	0.488	1.615	2.546	4,222
19 Animal feed (million tons)[f]	*			18.890	48.380	499
2. Beverages						
17a Beer (million tons)	*		0.400	5.400	18.890	803
17b Other alcoholic drinks (million tons)[b]	*	0.230	2.070	6.550	9.450	2,414
3. Tobacco products manufacturing						
18 Cigarettes (million cases)[f]	*	2.650	11.820	28.810	33.770	994
4. Textile mill products						
20a Pure cotton yarns (million tons)	*	0.656	1.898	3.117	2.840	5,142[d]
20b Other yarns (million tons)	*		0.484	1.251	2.758	10,387
21a Pure cotton fabrics (million meters)	*	3,830	8,150	10,765	11,885	1.15[d]
21b Other fabrics (million meters)	*		2,880	6,545	12,995	2.31
22 Printed fabrics (million meters)[b]	*	1,920	6,500	8,310	14,140	2.97
23 Knitted goods (million tons)[c]	*	0.055	0.407	0.878	0.807	8,319
24 Towels (millions)[b]	*	224	986	2,042	3,381	1.02
25 Socks (million pairs)[b]	*	359	810	1,179	2,908	1.52
26 Bed sheets (millions)[b]	*	4	47	155	113	15.01
27a Pure knitting wool (million tons)	*	0.002	0.010	0.036	0.088	41,359[d]
27b Other knitting wool (million tons)	*		0.028	0.168	0.400	16,039
28 Wool fabrics (million meters)	*	4	89	265	388	30
29 Pure wool products (million meters)			17.14	87.98	159.07	
30 Wool blankets (millions)	*	0.720	6.250	30.190	32.830	50
31 Gunnysacks (millions)[f]	*	67	290	859	435	2.05
32 Silk (million tons)	*	0.006	0.030	0.052	0.083	81,177
33 Silk products (million meters)	*	65	611	1,602	6,522	9.40
5. Wearing apparel						
34 Garments (million pieces)[c]	*	243	673	2,300	13,692	12.13
35 Shoes with cotton uppers (million pairs)[b]	*	102	185	621	1,644	4.72
6. Leather and fur products						
36 Leather hides (million pieces)[b]	*	3.30	26.63	56.68	100.09	106
37 Leather shoes (million pairs)[b]	*	12.00	100.53	309.10	2,473.43	28.93
7. Wood products, furniture and fixtures						
38 Sawmill products (million cubic meters)	*	4.70	11.06	14.72	20.12	344[d]
39 Plywood (million cubic meters)	*	0.028	0.252	0.776	7.584	1,463[d]
40 Furniture (million pieces)[b,f]	*	13.64	122.74	144.85	438.94	91
8. Paper products, printing and publishing						
41a Newsprint (million tons)	*	0.061	0.339	0.366	0.730	2,012
41b Other printing paper (million tons)	*		0.444	0.754	0.524	2,423
41c Paper and paper board (million tons)	*	0.309	3.607	10.290	26.076	2,432
42 Printed items (million reams)						
9. Chemical, petroleum and coal products						
52 Refined petroleum (million tons)			70.69	97.18	166.97	
53 Gasoline (million tons)[e]	*	0.121	9.910	17.120	35.180	697[d]
54 Kerosene (million tons)[e]	*	0.071	3.560	4.155	5.770	498[d]
55 Diesel oil (million tons)[e]	*	0.077	18.257	23.382	49.245	442[d]
56a Machine-made coke (million tons)[f]	*	2.220	32.690	43.750	71.440	128[d]
56b Non machine-made coke (million tons)		0.670	14.210	14.200	65.870	64

TABLE A1—continued

CIES	Item		1952	1978	1987	1997	Price[a]
57	Sulphuric acid (million tons)	*	0.190	6.610	9.833	20.369	220
58	Concentrated nitric acid (million tons)	*	0.011	0.338	0.290	0.670	610
59	Hydrochloric acid (million tons)	*	0.014	1.115	2.270	4.092	201
60	Sodium carbonate (million tons)	*	0.192	1.329	2.363	7.258	511
61	Caustic soda (million tons)	*	0.079	1.640	2.739	5.744	806
62	Synthetic ammonia (million tons)	*	0.038	11.835	19.406	30.003	319
63	Chemical fertilizers (million tons)		0.039	8.693	16.722	28.21	
63a	Nitrogenous fertilizer (million tons)	*	0.039	7.639	13.423	20.750	1,148[d]
63b	Phosphate (million tons)	*		1.033	3.259	7.146	1,034[d]
63c	Potash (million tons)	*		0.021	0.040	0.315	660
64	Pesticides (million tons)[f]	*	0.002	0.533	0.161	0.527	7,767
65	Pure benzene (million tons)	*	0.008	0.320	0.494	1.358	1,023
66	Calcium carbide (million tons)	*	0.011	1.238	2.412	3.447	961
67	Methanol (million tons)	*		0.212	0.518	1.872	960
68	Ethylene (million tons)	*		0.380	0.937	3.586	1,101
69	Plastic (million tons)	*	0.002	0.679	1.526	6.858	3,856
70	Synthetic rubber (million tons)	*	0.000	0.102	0.219	0.642	4,760
71	Rosin (million tons)[f]	*	0.042	0.282	0.396	0.676	4,100
72	Glacial acetic acid (million tons)			0.105	0.234	0.598	
73	Paints (million tons)	*	0.027	0.344	0.829	1.704	4,895
74	Dyestuffs (million tons)	*	0.016	0.083	0.116	0.445	16,664
75a	Colour film (million meters)	*		109.600	181.980	25.090	5.10
75b	B & W film (million meters)	*		114.230	14.880	7.040	1.69
76	Fatty acid for soap (million tons)	*		0.059	0.045	0.009	1,783
77	Synthetic detergents (million tons)	*		0.324	1.192	2.799	2,640
78	Soaps (million tons)[b]	*	0.097	0.596	1.118	0.643	2,145
79	Matches (million cartons)	*	9.110	18.870	26.440	21.570	45
80	Pharmaceutical chemicals (million tons)[i]	*	0.000	0.041	0.181	0.443	
81a	Artificial fibers (million tons)	*		0.115	0.193	0.432	7,882
81b	Synthetic fibers (million tons)	*		0.169	0.982	4.285	10,183
10. Rubber and plastic products							
82	Plastic products (million tons)[f]	*	0.002	0.923	2.978	15.342	4,770[d]
83	Tyres (millions)[f]	*	0.420	9.360	23.330	95.990	186
84	Rubber boots (million pairs)[f]	*	61.69	381.57	779.99	1,247.09	6.69
11. Non-metallic mineral products							
85	Cement (million tons)[f]	*	2.86	65.24	186.25	511.74	115
86	Flat glass (million cases)	*	1.98	17.84	58.03	166.31	39
87	Thermos bottles (millions)[c]	*	8.56	108.03	196.26	255.96	2.19
88	Pottery for daily use (millions)[b,f]	*	621	3,470	4,730	11,560	0.92
12. Basic and fabricated metal products							
89	Pig iron (million tons)	*	1.930	34.790	55.030	115.110	362
90	Steel (million tons)		1.350	31.780	56.280	108.940	577
90a	Steel, open-hearth furnace (million tons)[i]	*	1.104	11.271	12.778	9.698	
90b	Steel, electric furnace (million tons)[i]	*	0.142	6.813	11.476	19.112	
90c	Steel, converter (million tons)[i]	*	0.097	13.64	31.956	79.869	
90d	Steel, oxygen converter (million tons)			10.617	30.855	64.58	
91	Alloy steel (million tons)		0.025	2.381	3.759	5.469	
92	Steel products (million tons)[b]		1.06	22.08	43.86	99.79	
92a	Heavy rails (million tons)	*	0.062	0.818	0.957	0.964	705[d]
92b	Light rails (million tons)	*	0.033	0.263	0.243	0.224	817[d]
92c	Ordinary large-size (million tons)	*	0.007	0.886	0.869	1.306	679[d]
92d	Ordinary medium-size (million tons)	*	0.212	2.049	3.232	4.228	761[d]
92e	Ordinary small-size (million tons)	*	0.429	4.641	10.785	25.305	848[d]
92f	High quality shapes (million tons)	*	0.078	2.891	4.483	5.859	1,228[d]
92g	Bearing steel (million tons)		0.001	0.261			
92h	Wire rods (million tons)	*	0.147	2.909	6.917	19.538	891[d]
92i	Medium-thick plates (million tons)	*	0.073	3.406	5.680	11.959	951[d]
92j	Thin steel plates (million tons)	*	0.017	1.327	3.938	13.081	1,068[d]

TABLE A1—continued

CIES Item		1952	1978	1987	1997	Price[a]
92k Silicon steel (million tons)	*		0.245	0.679	0.844	2,112[d]
92l Steel ribbon (million tons)	*	0.011	0.465	1.211	5.205	1,218[d]
92m Seamless steel tubes (million tons)	*		0.815	1.629	3.605	1,549[d]
92n Welded steel pipes (million tons)	*	0.037	0.867	2.448	5.665	1,043[d]
93 Alloy iron (million tons)[i]	*	0.017	0.939	1.846	4.044	
93a Electric furnace (million tons)		0.01	0.666	1.438		
93b Blast furnace (million tons)		0.007	0.273	0.394		
94 Enamelware for daily use (million tons)[i]	*	0.009	0.129	0.173	0.194	
94a Enamel basins (millions)		8.4	88.96	84.67		
94b Enamel mugs (millions)		16.24	114.77	84.19		
95 Aluminum products (million tons)[i]	*		0.057	0.106	0.158	
13. Machinery and transport equipment						
96 Internal combustion engine (million kw)[i]	*	0.029	20.741	43.358	206.419	
97 Metal cutting machine tools (millions)	*	0.014	0.183	0.172	0.187	26,513
97a Large size (thousands)		0.02	6.50	4.65	1.532	
97b High precision (thousands)			2.21	1.72	0.63	
98 Forging presses (millions)	*	0.001	0.038	0.076	0.074	42,431
99 Pumps (millions)[b]	*	0.014	1.331	3.320	10.166	3,164
99a Pumps for farm use (millions)			1.01	2.203	5.487	
100 Air blowers, for blasting (millions)[b]	*	0.008	0.201	0.446	1.216	7,442
101 Air compressors (millions)	*	0.001	0.026	0.045	0.401	36,195
102 Freezing equipment (million sets)			0.018			
103 Ball bearings (million sets)		1.18	179.32	411.36		
104 Mining equipment (million tons)[i]	*	0.002	0.243	0.297	0.532	
104a Excavators (millions)			0.001			
105 Machinery light manufacturing (million tons)		0.001	0.091	0.247		
106 Textile machinery (million tons)[b,i]	*	0.020	0.193	0.466	0.379	
107 Metallurgical equipment (million tons)[h,i]	*	0.000	0.068	0.088	0.173	
108 Petroleum industry equipment (million tons)[h,i]	*		0.083	0.207	0.215	
109 Chemical engineering equipment (million tons)	*	0.001	0.068	0.133	0.305	
110 Tractors, 14.7 kw and over (millions)	*		0.114	0.037	0.082	17,427
111 Small tractors (millions)	*		0.324	1.106	2.016	3,361
112 Tractor-attached farm tools (million tons)			0.371			
113 Combine harvesters (millions)	*		0.005	0.002	0.076	35,656
114 Machine-powered threshers (millions)	*		0.159	0.282	0.565	647
115 Rubber-tyred handcarts (millions)			10.3	10.37		
116 Film projectors (millions)	*	0.000	0.038	0.017	0.007	5,956
117 Sewing machines (millions)[b]	*	0.066	4.865	9.700	7.026	125
118 Bicycles (millions)	*	0.080	8.540	41.167	29.993	158
119a Watches (millions)	*		13.511	61.424	254.827	44
119b Clocks (millions)	*		0.597	0.170	40.219	35
120 Cameras (millions)	*		0.179	2.567	46.869	295
121a Steam engines (numbers)	*	20	267	365	0	430,000
121b Diesel engines (numbers)	*		234	402	873	1,419,080
121c Electric engines (numbers)	*		20	142	196	1,340,000
122 Passenger coaches (numbers)	*	6	784	1,791	2,535	223,870
123 Freight coaches (numbers)	*	5,800	17,000	21,600	31,200	48,651
14. Electrical machinery and equipment						
124a Trucks (millions)	*		0.096	0.298	0.574	26,689
124b Other automobiles (millions)	*		0.053	0.173	1.009	35,068
125 Steel ships (civilian) (million tons)[f,g]	*	0.022	0.861	2.518	3.845	468
126a Water turbogenerators (million kw)	*	0.006	1.446	1.777	3.269	80
126b Other electric generators (million kw)	*	0.006	4.838	9.411	24.051	71

TABLE A1—continued

CIES Item			1952	1978	1987	1997	Price[a]
127	Alternating current motors (million kw)	*	0.640	31.950	41.720	51.270	106
128	Transformers (million kva)[h,i]	*	1.170	48.620	92.970	161.340	
129	Refrigerators (millions)	*		0.028	4.013	10.444	1,049
130	Washing machines (millions)	*		0.000	9.902	12.545	460
131	Electric fans (millions)	*		1.378	36.607	81.714	131
132	Room air-conditioners (millions)	*		0.000	0.132	9.740	3,000
133	Vacuum cleaners (millions)	*		0.004	0.353	9.764	371
134	Electric irons (millions)	*		0.911	12.240	17.014	16
135	Electric cookers, cooking utensils (millions)	*		0.036	10.787	37.241	54
136	Light bulbs (millions)	*	26	759	1,683	6,034	0.32
137a	Electronkinescopes (millions)	*		0.550	11.150	26.990	167
137b	Other electron tubes (millions)	*	0.07	26.73	10.23	70.58	110
138	Semi-conductors (millions)[h]	*		442	1,379	12,550	6.13
139	Integrated circuits (millions)[h]	*		30	77	1,307	10
140	Electronic parts (millions)[c]	*	1.93	2,130	15,200	144,288	0.11
141	Radios (millions)	*	0.017	11.677	17.638	46.242	24
141a	Semi-conductor radios (millions)			11.154	17.638		
142a	Colour TV (million sets)	*		0.004	6.727	27.113	1,320[d]
142b	Black & white TV (million sets)	*		0.514	12.617	9.259	470[d]
143	Tape recorders (millions)	*		0.047	19.780	82.739	220
144	Industrial automation meters (millions)			4.8	14.07		
145	Large and special scales (millions)			0.098	0.232		
146	Personal computers (millions)[e,f]	*			0.047	1.299	15,008
15. Other manufacturing							
43	Ink pens (millions)[b]	*	39.75	134.45	216.57	279.45	0.89
44	Ballpoint pens (millions)[b]	*	0.41	252.38	339.21	815.35	0.31
45	Pencils (millions)	*	200	2,384	3,676	7,083	0.06
46	Basket, volley, soccer balls (millions)[b]	*	0.37	4.34	4.74	15.97	17
47	Ping-pong balls (millions)[b]	*	13.36	226.83	268.77	900.07	0.25
48	Lacquerware (million yuan)[b]			29.35	90.26	517.3	
49	Lacework (million yuan)[i]	*		611	1,123	3,890	
50	Carpets (million square meters)	*	0.15	1.80	13.28	94.65	51
Mining							
1	Raw coal (million tons)[f]	*	66.00	618.00	928.00	1,373.00	30
2	Washed coal for coking (million tons)[f]	*	2.77	53.97	72.30	130.70	52
3	Crude oil (million tons)[f]	*	0.44	104.05	134.14	160.74	116
4	Natural gas (million cubic meters)[f]	*	8	13,730	13,890	22,700	0.12
5	Raw iron ore (million tons)[f]	*	4.29	117.79	161.43	266.99	47
5a	Rich ore (million tons)		2.96	31.99	83.73		
6	Sulfur (vulcanized) ore (million tons)	*	0.21	6.87	10.87	25.83	59
7	Phosphate rock (million tons)	*	0.03	11.38	15.17	34.76	44
8	Asbestos (million tons)	*	0.01	0.14	0.14	0.44	1,817
9	Raw salt (million tons)[f]	*	4.95	19.53	17.64	30.83	90
Utilities							
51	Electric power (million kw/h)[f]	*	7,300	256,600	497,300	1,135,600	0.08
51a	Hydro power (million kw/h)		1,300	44,600	100,000	196,000	
51b	Thermal power (million kw/h)		6,000	212,000	397,300	924,100	
12	Tap water (million tons)					30,826	
Forestry (agriculture—western style)							
10	Timber (million tons)		12.33	51.62	64.08	63.95	
10a	Logs (million cubic meters)[b]	*	12.33	44.16	49.84	54.92	139[d]
11	Bamboo (millions)	*	12.14	112.05	137.02	449.21	3.27

Source: Data on CIES items are from DITS (1995 and 1998) and on prices are from IER (1999).
Notes:
*Selected CIES items in this study.

[a]Average ex-factory price per unit (i.e. number, ton, kw, kw/h, kva, meter, pair, set, etc.) in 1987 yuan. It is calculated based on the price data in the IER Database (IER, 1999) and quantity data from a relevant industry yearbook (as mentioned in the notes below) because no prices in the IER Database could directly match CIES items that are often in commodity groups rather than individual commodities.

[b]Contains missing data that are filled by interpolation following the item's own trend or the trend of closely related items.

[c]Contains missing data that are filled by information from various sources as follows: missing data in CIES23 and 34 are filled based on *China Textile Industry Yearbook* (Editorial Board of CTIY, 1999, pp. 349–51), CIES49 and 87 based on *China Light Industry Yearbook* (Editorial Board of CLIY, 1993, p. 58; 1995, p. 75), and CIES140 based on *China Electronic Industry Yearbook* (Editorial Board of CEIY, 1996, pp. 36–2; 1998, pp. 99–105).

[d]The price is estimated based on the information in *Price Yearbook of China 1989* (Editorial Board of PYC, 1989, pp. 348–50 and 414–15).

[e]The missing 1949–71 series is reconstructed by the interpolations between 10 discontinuous points in 1949-71 from two sources: *Fifty Years of Chinese Industry* (SETC, 2000) and *China Today*: *Petrochemical Industry* (Editorial Board of CTPI, 1987).

[f]The price is used to calculate value coverage ratio (Table 1), not to aggregate items as the item that it refers to is the only one that matches a particular CIOT industry.

[g]The missing 1950-72 series is constructed by the information from the following sources: *Fifty Years of Chinese Industry* (SETC, 2000), *China Today*: *Shipbuilding Industry* (Editorial Board of CTSI, 1992) and *China Machinery Industry Yearbook* (Editorial Board of CMIY, 1996, 1997 and 1998).

[h]Reported CIES data for the mid-1990s exceed the concerned industry's capacity. The series for that period is revised based on information from various sources as follows: CIES107, 108 and 128 based on *China Machinery Industry Yearbook* (Editorial Board of CMIY, 1998, p. vi-4; 1999, p. vi-3); CIES138 and 139 based on *China Electronic Industry Yearbook* (Editorial Board of CEIY, various issues).

[i]Selected without information on price. It follows the unit-free geometric approach in item aggregation as explained by equation (1b).

TABLE A2

Estimated Gross Value Added (GVA) in Chinese Industry by Branch, 1949–97
(million 1987 yuan)

	Food Products	Beverages	Tobacco Products	Textile Products	Wearing Apparel	Leather Products	Wood Products
1949	499	146	1,078	2,437	501	164	612
1950	671	184	1,246	3,259	667	178	717
1951	815	232	1,347	3,876	809	194	742
1952	1,116	293	1,785	4,888	1,013	211	1,097
1953	1,325	433	2,391	6,270	1,240	264	1,481
1954	1,379	522	2,512	7,023	1,384	356	1,784
1955	1,517	586	2,405	6,489	1,154	340	1,755
1956	1,606	687	2,634	8,154	1,528	419	2,272
1957	1,732	811	3,004	7,616	1,339	528	2,235
1958	2,293	1,286	3,199	10,459	1,713	585	3,597
1959	2,776	1,536	3,704	12,731	2,008	722	4,386
1960	1,814	1,528	3,024	9,775	1,449	791	4,554
1961	1,204	789	1,711	5,773	879	491	2,230
1962	1,247	921	1,643	5,179	983	374	2,077
1963	1,381	1,069	2,176	6,300	1,019	403	2,746
1964	2,105	1,167	2,782	8,349	1,211	380	3,329
1965	2,645	1,057	3,220	10,669	1,490	387	3,751
1966	2,910	1,120	3,637	12,435	1,700	550	3,855
1967	2,710	1,014	3,300	11,165	1,573	609	3,493
1968	2,572	1,120	3,509	10,989	1,265	626	2,896
1969	2,395	1,209	4,560	14,540	1,379	714	3,647
1970	2,741	1,405	5,274	16,621	1,482	954	4,143
1971	2,987	1,540	4,722	15,719	1,505	1,006	4,166
1972	3,375	1,765	5,018	15,136	1,901	1,094	4,386
1973	3,838	1,880	5,698	16,183	2,129	1,228	4,243
1974	4,278	2,160	5,873	15,474	2,204	1,193	4,087
1975	4,322	2,470	6,682	17,672	2,611	1,368	4,413
1976	4,224	2,444	6,614	16,913	2,788	1,415	4,195
1977	4,889	2,733	8,157	19,300	2,819	1,605	4,759
1978	5,593	2,805	7,961	21,584	2,674	1,733	5,363
1979	6,110	3,505	8,776	24,021	2,954	2,004	6,199
1980	6,660	4,099	10,238	27,254	3,785	2,707	6,909
1981	8,242	4,918	11,477	29,650	4,110	3,251	7,125
1982	9,444	5,282	12,696	30,932	4,017	2,844	7,873
1983	10,153	6,304	13,053	31,002	4,131	2,754	8,814
1984	11,852	7,148	14,360	31,699	4,581	2,947	9,503
1985	15,514	8,200	15,963	35,438	5,238	3,363	5,868
1986	18,224	9,030	17,485	38,955	10,448	3,948	5,881
1987	18,549	10,625	19,405	42,592	9,124	4,523	6,864
1988	22,587	11,701	20,853	46,509	11,443	4,716	7,508
1989	23,615	10,895	21,520	46,639	11,835	4,771	7,361
1990	20,000	11,765	22,213	45,847	12,471	5,485	7,139
1991	23,793	12,472	21,728	48,531	13,262	6,523	8,605
1992	27,214	13,641	22,126	54,195	16,506	8,614	8,948
1993	30,494	14,963	22,739	57,140	24,408	12,261	12,413
1994	29,199	16,412	23,116	60,207	29,765	16,250	18,338
1995	37,100	19,258	23,473	79,218	38,293	31,054	28,910
1996	33,804	19,456	22,914	65,759	47,936	24,055	21,302
1997	32,090	20,027	22,746	73,962	51,552	24,877	20,482

TABLE A2–continued

	Paper, Printing	Chemicals, Petroleum	Rubber, Plastic Products	Building Materials	Metals	Machinery, Transport Equipment
1949	135	439	146	507	38	119
1950	170	696	165	718	219	153
1951	290	904	271	995	360	295
1952	452	1,235	312	1,255	590	571
1953	522	1,461	380	1,615	948	853
1954	636	2,068	473	1,994	1,338	1,369
1955	710	2,356	479	2,476	2,005	1,506
1956	896	2,920	553	2,858	2,731	2,393
1957	1,118	3,385	671	3,604	3,972	3,080
1958	1,500	4,329	1,091	3,233	6,862	9,181
1959	2,097	5,741	1,074	3,940	13,066	11,991
1960	2,228	6,369	1,119	4,598	20,054	15,912
1961	1,354	4,051	796	3,157	8,949	4,840
1962	1,375	4,461	1,022	3,358	5,436	2,687
1963	1,571	5,786	1,215	3,821	6,779	3,052
1964	1,781	7,624	1,431	4,423	8,288	4,299
1965	2,131	10,089	1,627	4,847	10,706	5,863
1966	2,577	12,547	1,784	5,258	13,327	8,247
1967	2,419	10,836	1,549	4,032	8,945	5,094
1968	2,184	10,131	1,519	3,617	7,963	5,170
1969	2,677	13,609	2,090	4,846	9,835	8,349
1970	2,979	16,398	2,716	6,235	16,758	14,149
1971	3,256	18,526	2,870	7,350	20,594	17,763
1972	3,490	20,354	3,115	7,969	22,869	19,181
1973	3,873	22,466	3,516	8,384	25,266	22,029
1974	3,698	22,166	3,404	8,259	19,787	21,632
1975	4,225	24,817	4,051	9,979	21,981	24,659
1976	4,222	25,011	3,995	10,066	19,799	22,452
1977	4,670	28,679	4,507	11,788	23,932	24,626
1978	5,447	34,012	5,290	13,437	31,557	28,576
1979	6,122	37,204	5,926	14,440	33,517	29,378
1980	6,646	39,232	6,320	15,901	33,093	27,238
1981	6,713	40,005	5,583	16,637	30,663	25,546
1982	7,325	41,577	6,409	18,803	32,701	29,810
1983	8,226	43,866	8,054	20,632	37,038	34,458
1984	9,417	46,881	9,620	22,711	40,836	41,841
1985	11,364	52,310	11,505	26,065	43,241	51,849
1986	12,462	55,694	12,295	29,352	45,890	51,715
1987	14,271	62,227	13,735	32,796	50,825	61,183
1988	15,899	67,931	16,093	37,708	53,229	76,321
1989	16,682	66,689	17,127	38,577	55,564	72,113
1990	17,170	74,893	17,676	38,258	59,269	63,439
1991	18,508	82,021	21,066	44,393	60,265	73,707
1992	21,591	91,067	25,994	51,614	63,732	97,438
1993	23,916	100,385	32,130	60,567	69,754	112,477
1994	26,734	105,040	41,991	69,067	78,360	137,202
1995	35,202	131,228	45,400	80,470	87,359	209,615
1996	32,988	132,968	54,610	82,977	80,741	185,691
1997	34,220	147,978	55,386	87,576	77,546	175,386

TABLE A2–continued

	Electrical Machinery	Other Manufacturing	Total Manufacturing	Mining	Utilities	Total Industry
1949	43	310	7,174	912	211	8,297
1950	84	408	9,536	1,128	226	10,890
1951	108	565	11,804	1,516	280	13,599
1952	181	753	15,750	1,889	359	17,999
1953	259	1,067	20,508	1,916	452	22,877
1954	285	1,051	24,175	2,405	541	27,120
1955	292	821	24,892	3,099	605	28,596
1956	463	1,144	31,257	3,190	816	35,263
1957	834	1,178	35,106	4,155	949	40,211
1958	2,260	1,545	53,135	7,955	1,352	62,442
1959	3,760	2,227	71,760	10,717	2,080	84,557
1960	4,640	2,259	80,112	12,465	2,920	95,497
1961	2,156	1,301	39,683	8,409	2,360	50,451
1962	1,518	1,180	33,463	6,760	2,252	42,475
1963	1,387	1,340	40,047	6,930	2,409	49,385
1964	1,378	1,538	50,088	6,725	2,753	59,566
1965	1,508	2,247	62,236	8,587	3,324	74,146
1966	2,324	2,601	74,872	9,612	4,056	88,540
1967	1,789	2,281	60,810	8,433	3,805	73,049
1968	1,550	2,398	57,510	8,979	3,520	70,009
1969	2,794	2,907	75,554	10,730	4,622	90,906
1970	4,710	3,036	99,599	14,742	5,698	120,040
1971	5,500	3,053	110,555	17,672	6,804	135,032
1972	5,830	3,297	118,780	19,469	7,493	145,743
1973	6,384	4,493	131,610	20,494	8,201	160,305
1974	6,429	4,372	125,015	22,704	8,299	156,018
1975	7,172	5,046	141,466	26,670	9,627	177,762
1976	7,066	4,969	136,173	28,053	9,985	174,212
1977	7,784	5,648	155,896	31,252	10,984	198,131
1978	9,768	7,343	183,143	35,003	12,616	230,762
1979	10,725	8,634	199,516	34,803	13,865	248,184
1980	11,181	11,022	212,284	34,825	14,779	261,888
1981	11,409	12,092	217,422	33,860	15,207	266,488
1982	11,037	11,500	232,251	34,653	16,111	283,015
1983	13,366	8,736	250,587	36,455	17,277	304,319
1984	17,164	9,100	279,660	39,649	18,535	337,845
1985	23,848	8,765	318,529	41,842	20,192	380,563
1986	23,703	10,855	345,937	43,931	22,100	411,968
1987	28,587	14,769	390,072	46,420	24,450	460,943
1988	36,276	17,684	446,456	48,852	26,805	522,113
1989	37,896	27,341	458,623	51,552	28,752	538,927
1990	39,432	29,284	464,341	51,622	30,542	546,504
1991	46,853	34,460	516,186	53,056	33,310	602,552
1992	54,852	34,663	592,197	54,979	37,066	684,242
1993	76,733	42,714	693,092	56,253	41,274	790,619
1994	98,530	42,375	792,585	59,452	45,630	897,667
1995	123,826	55,098	1,025,504	65,472	49,510	1,140,485
1996	114,814	45,784	965,798	66,963	53,162	1,085,923
1997	131,437	45,313	1,000,577	68,257	55,832	1,124,666

Source: Author's estimates.

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