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CHINA'S MANUFACTURING INDUSTRY IN AN INTERNATIONAL PERSPECTIVE: A CHINA-GERMANY COMPARISON

Ren Ruoen & Bai Manying[1]

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ABSTRACT. This study is the first attempt to compare China's economic performance with that of a European country following the approach of International Comparison of Output and Productivity (ICOP) developed by the Groningen University. The estimation of China's manufacturing output and value-added obtained with this method shows that China's labor productivity in 1995 was about 7 percent of the German level when small rural entreprises are excluded from the Chinese data, and was 5 percent of the German level when they are included. This is slightly higher than the result of the 1995 comparison between China and the US (Ren, Szirmai and Bai, 2002). The relative productivity performance at branch level varied considerably, from 22 percent of the German level in leather products and footwear to 3.6 per cent in paper products.

JEL Classification: E31; J24; L60.
Keywords: China; Labour Productivity; Relative Price Level.

RÉSUMÉ. Cette étude est la première tentative faite pour comparer les performances économiques de la Chine à celle d'un pays européen, en s'appuyant sur la méthodologie de comparaison internationale de production et de productivité mise au point par l'Université de Groningen. L'estimation ainsi obtenue de la production et de la valeur ajoutée manufacturière de la Chine montre qu'en 1995 la productivité du travail dans ce pays représentait environ 7 % de la productivité allemande, si l'on exclut les données relatives aux petites entreprises chinoises du monde rural, et 5 % quand celles-ci sont incluses. Ce résultat est légèrement plus élevé que celui obtenu pour la comparaison faite entre la Chine et les États-Unis pour 1995 (Ren, Szirmai et Bai, 2002). Les résultats de la productivité relative au niveau des branches varient considérablement, de 22 % du niveau allemand dans le cas des produits du cuir et chaussures, à 3,6 % pour le papier.

Classification *JEL* : E31 ; J24 ; L60.
Mots-clefs : Chine ; productivité du travail ; niveau de prix relatifs.

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1. Corresponding author: REN Ruoen, Professor, School of Economics and Management, Beihang University, and Director, Center for Competitiveness and Risk Analysis (CCRA), Beijing (ruoen8324@sina.com).
BAI Manying, Associate professor, School of Economics and Management and Research fellow, Beihang University, Center for Competitiveness and Risk Analysis, Beijing.
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The method of International Comparison of Output and Productivity (ICOP), developed at the University of Groningen, is regarded as being useful to measure a country's competitiveness at the industry level, and also to carry out total factor productivity comparisons across countries, such as those undertaken within the KLEMS project[2].

In 1993, a research project was initiated for comparing sectoral performance in manufacturing between China and the US using this methodology. The ICOP approach requires deriving Unit Value Ratios (UVRs) from the production-side and using these UVRs to convert the value-added and production data from a local currency into a common valuation. We used this method to obtain the manufacturing GDP of both countries in a common price system, and then compared their relative labor productivity in manufacturing industry in 1985, and built time series of compared labor productivity from 1980 to 1992. This study was published in a preliminary version as a University of Groningen research memorandum (Szirmai and Ren, 1995). The revised version appeared as a chapter in *The Chinese Economy* (1998). The final version was published in *China Economic Review* (Szirmai and Ren, 2000). The findings were also incorporated in an OECD Development Centre publication (Ren, 1997).

The Chinese 1995 Industrial Census provided an opportunity to carry out new benchmark studies comparing manufacturing in China and in other countries. We thus completed a benchmark comparison between China and US manufacturing for 1995 (Ren, Szirmai and Bai, 2002).

The current paper reports the findings of a 1995 benchmark comparison between China and Germany in manufacturing using the ICOP approach, as recently refined at the University of Groningen (Timmer *et al.*, 2001). The results of the China/Germany comparison combined with other studies allow conclusions to be drawn concerning the pattern of China's international competitiveness (productivity level, relative prices) which can be compared with the international competitiveness revealed in its foreign trade.

The paper is structured as follows. It first presents a brief discussion of the method used in this study. Then it discusses the data issues and reports the results of the comparison in fifteen branches of manufacturing for 1995. The discussion about the implication of the comparison is presented in the concluding remarks.

Methodology for the 1995 benchmark comparison

The ICOP methodology has been discussed in details in many papers (see Maddison and van Ark, 1988; van Ark, 1993a, 1993b; van Ark, and Pilat, 1993; Maddison, 1998; Ren, 1997; Szirmai and Ren, 2000). Timmer *et al.*, (2001) has refined the basic approach used in the recent comparisons. Only a brief outline is presented here. More detail is to be found in APPENDIX 1.

2. The KLEMS project is an international research project aimed at measuring the contribution to economic growth of capital (K), labour (L), energy (E), intermediate materials (M), and services (S).

The approach basically relies on binary matches of products, which are considered to be similar in the two countries. For each country, we need information at the product level on the quantities and the values of output (or sales). These data are used to calculate unit values (UVs). For each match, unit value ratios (UVRs) are calculated. The aggregation of UVRs for manufacturing is done in three steps. First, all UVRs within an industry are weighted with their gross output value. This gives us industry UVRs. Next, all industry UVRs in a branch are weighted with their gross output value. This gives a branch UVRs. Finally, all branch UVRs are weighted by branch gross output value to derive UVRs for total manufacturing.

In the binary comparison we can use either German quantity weights or Chinese quantity weights. At each level of aggregation, we therefore have two sets of UVRs. Usually, the Fisher average of these two is used to convert one country's production and value-added into the currency of the other country, to allow for comparison of real level of productivity.

DATA SOURCES

An overview of the data[3]

German data

The basic data for Germany come from the Statistisches Bundesamt: a) Produzierendes Gewerbe. Fachserie 4. Reihe 4.3 ("Kostenstrukturdes Unternehmen im Verarbeitenden Gewerbe sowie im Bergbau und der Gewinnung von Steihen un Erden, 1995") which provides the data about the output and employment for the sample industries and branches of manufacturing, and b)"Produktion im produzierenden Gewerbe des In-und Auslands, 1995, which provides the data on the value, quantities and unit value for around 7000 products.

The Chinese 1995 Industrial Census

On the Chinese side, the basic data come from the *Chinese 1995 Industrial Census*. This Industrial Census includes quantity data for around 2000 products and ex-factory average prices data for about 1000 products. It also reports figures for output, value added, employment, at different industry levels.

A recent paper has provided a detailed analysis of the concepts, coverage and lack of consistency of the different time series for employment and output in China's manufacturing (Szirmai, Bai and Ren, 2001). These clarifications were made possible by using the wealth of information contained in the 1995 industrial census. These findings provided the adjusted data on output and employment used to implement the present bilateral comparison. The major data issues concern 1) the coverage of the data collected by the Census 2) the different concepts used for output and value added, and 3) employment data.

3. See also REFERENCES.

Coverage of the Census data

In the 1995 Census, production is reported according to different categories of firms. The most detailed information, corresponding to a large set of variables, is broken down by manufacturing sector only for "enterprises with independent accounting systems (IAS) at the township level and above". These include the great majority of state-owned enterprises (affiliates are excluded), urban collectives, all county and township collectives with independent accounting systems, as well as a large unspecified residual category which includes joint ventures, foreign owned enterprises, incorporated (share holding) enterprises and other enterprises. It excludes all other collectives such as village collectives and other rural collectives below township level, and all affiliates without independent accounting systems.

For enterprises which have no IAS, such as individual enterprises, private enterprises, village collectives, rural cooperatives, etc, information is scarce and incomplete, so that sectoral breakdown is not available.

The problems of coverage are getting worse over time, as China moves towards a market economy and as the ownership structure is changing. This is due to the fact that the importance of state-owned enterprises, which used to form the bulk of enterprises with IAS is declining. In 1978, independent accounting enterprises at the township level and above accounted for most of output and employment in the industrial sector, but every year this becomes less and less true. In 1985, the subset of enterprises for which detailed information was available, accounted for 87 percent of total gross output in industry. By 1995, this percentage had declined to 67 percent. Since then it has declined further. In terms of employment, the coverage declined from 68 percent in 1985 to 58 percent in 1995 (Industrial Census, 1985, 1995).

The coverage of employment in time series is even more limited than in the industrial Census. In recent Chinese statistical publications, the bulk of employment is left out of consideration, which makes it extremely difficult to study employment trends in industrial branches of manufacturing. For instance, in the published 1993-99 time series on employment, sectoral detail is only provided for 52.1 million out of a total of 147.4 million persons engaged in industry. For output, coverage is slightly better as firms with IAS tend to have higher productivity per worker than others. But these differences in coverage affect all productivity estimates.

For independent accounting enterprises at the township level and above, information is available for a wide range of variables including gross output (new concept, see below), gross output (old concept), gross value added, employment, sales tax, value added tax, total tax and several variables referring to financial dimensions (profit, wages, interest and so forth). This detailed information is not available for the enterprises below this administrative level.

Szirmai, Bai and Ren (2002) have demonstrated, that the independent accounting enterprises at the township level and above have the same coverage as the published time series for industrial output. Therefore the comparison of productivity at this level is important since it can be used to draw time series.

Definitions of output and value-added

Since 1993, the concept of gross output has changed and now includes a few new items: value of output produced with non-purchased intermediate inputs, revenue from processing of intermediate inputs produced for others and the value of semi-finished goods and goods in process. This makes the new concept somewhat higher in value than the old one. The most important difference however, is that value added tax – introduced in 1994 – is excluded from the old concept. This makes the new concept lower in value than the old one. As the Chinese statistical practice has followed the SNA guideline, value added data excludes intermediate inputs from the manufacturing or the services industries, no matter where they come from. Annex activities were excluded from the output produced by production units and reallocated to the relevant industry. The concept of value added used in the 1995 census (and the time series) includes sales and other taxes and excludes value added taxes. By deducting sales taxes from the published figures we can get value added at factor cost, and by adding the value added taxes, we obtain value added at market prices.

Employment data

In the 1995 Census there are three concepts of employment. The first is often referred to in Chinese statistical practice as the *Social Labour Force*. It includes all persons engaged in industry, including persons with a second job and self employed persons, persons working in village enterprises, private enterprises and sole proprietorships. The census estimate of the social labour force in industry is 147.4 million persons.

A much more restricted concept of employment is the so-called *staff and worker concept* (also referred to as *formal employment*). This concept refers to workers with a formal employment status at township level and above, and includes part-time workers. Since 1998, the staff and worker concept has been redefined in a more restrictive sense and renamed "*on-post staff and worker*". This third concept excludes people who have still some kind of contractual relationship with the enterprise but are no longer actually working. The total number of staff and workers in the census in 1995 is 85 million, representing 58 per cent of the social labour force.

The labour forces working in annex activities, distinct from the major production activity, are included in employment statistics. Hence, this portion of the employment was deducted to arrive at employment figures consistent with the output figures.

Data on output and employment

In this section we present the basic data on output and employment by branch of manufacturing in Germany and in China.

As mentioned above, Chinese data derived from the *1995 Industrial Census* does not provide exhaustive information. It reports detailed information for a subset of enterprises but no detailed information for the rest of enterprises. Hence, for benchmark comparison, we constructed two data sets.

For one data set, we used the Census data for IAS enterprises at the township level and above (excluding village entreprises). This data set has a rather limited coverage but it presents detailed information on this subset of enterprises. It has two advantages: first, the data both for output and employment are taken from a single source without any adjustment; second, the coverage of this data set is consistent with that of the published time series.

For the second data set, we used the Census data for enterprises at the village level and above, with more than 1 million sales. The only categories of firms which are excluded are the individual firms, the so-called affiliated enterprises and small enterprises with less than one million sales. As the Census does not report sectoral value-added data for this extensive coverage, we calculated the value-added by sector by applying the ratio of value-added to output derived from the 1995 Input-Output table. The approach can be justified by the similarity of output structure between the 1995 Industrial Census and the 1995 Input-Output table, according to Szirmai, Bai and Ren (2001). Moreover, the employment concept corresponds to the concept of the social labour force. In constructing this data set, we thus had to make few assumptions to allow for a large coverage. The present data concerns 85 per cent of gross output, 75.5 per cent of employment, which is close to a full coverage of China's industrial sector.

So we carry out two comparisons. In these two comparisons, the German data are the same, but the Chinese data are different, corresponding to the two different levels of coverage.

The first version for Chinese data provides information about enterprises with independent accounting systems at the township level and above (TABLE 1). As discussed above the new concept of gross output is neither at factor cost, nor at market prices. For purposes of international comparison, the output figures have to be adjusted to factor cost. For these enterprises, the Chinese 1995 Industrial Census provides full details on gross output, value added, total taxes, sales and other taxes and value added taxes (and a multitude of other variables). By deducting sales taxes we arrive at factor cost concepts.

The second set of basic Chinese data (TABLE 2) refers to the broader coverage of output and employment, as it includes all enterprises at the village level and above, with annual sales of more than one million yuan. Enterprises' affiliates outside the industrial sector are excluded. Less information is available for this wider coverage: only gross output and total taxes are given. First, in order to adjust gross output figures to factor cost, we applied the ratio of sales and other taxes to total taxes observed for enterprises at the township level and above to the total tax figures for the village level and above. This gave us an estimate of sales taxes. As total taxes for the village level and above are only 9 per cent higher than in the township level and above, this is a fairly safe assumption. A similar procedure was used to estimate value added taxes. The final step was to apply value added/gross output ratios (at factor cost) from the 1995 input-output table to get estimates of gross value added for enterprises at the village level and above.

TABLE 2 provides the widest coverage available for sectoral data derived from the 1995 Industrial Census. One would indeed expect labour productivity to be lower when smaller

Table 1 - Basic data on output and employment for China, 1995 (excluding the Chinese small firms*)

		Gross Value of Output at factor cost (mill. Yuan)	Gross Value Added at factor cost (mill. Yuan)	Gross Value Added in branch as % of total	Employment (persons)
1.	Food and Kindred Products	626,275	170,735	14.2	5,707,900
2.	Textiles Mill Products	460,400	89,845	7.5	8,271,400
3.	Wearing Apparel	147,015	34,729	2.9	2,618,800
4.	Leather Products and Footwear	97,441	20,147	1.7	1,375,500
5.	Wood Products	40,553	9,508	0.8	995,500
6.	Paper Products, Printing & Publishing	130,399	29,506	2.5	2,777,000
7.	Chemicals & Allied Products	559,099	141,038	11.7	6,076,100
8.	Petroleum & Coal Products	202,812	56,133	4.7	688,200
9.	Rubber and Plastic Products	174,753	36,343	3.0	2,473,800
10.	Non-Metallic Mineral Products	301,836	89,991	7.5	7,623,000
11.	Basic Metal Products	503,251	135,533	11.3	4,571,600
12.	Fabricated Metal products	165,072	38,394	3.2	2,709,100
13.	Machinery and Equipment	412,223	111,916	9.3	7,405,900
14.	Transport Equipment	330,328	80,512	6.7	3,704,700
15.	Office, Accounting and Computing machinery	35,056	9,209	0.8	101,100
16.	Electrical Machinery and Equipment	557,314	136,137	11.3	5,236,780
17.	Other Manufacturing Products	59,709	14,761	1.2	1,174,000
	Total Manufacturing:	4,803,536	1,204,437	100.0	63,510,380

* The coverage is the IAS enterprises at the township level and above.

Note: The other manufacturing product branch includes 1. Furniture manufacturing, 2. Cultural goods, sporting and athletic and recreation products, 3. Instruments, meters and other measuring equipments, 4. Cultural and office equipments. The printers, typewriter and other office equipments are included in Office, Accounting and Computing Machinery branch.

Sources: The gross value of output and value added are from p. 46-197 of *the Census*, while labor data are from p. 198-233 of *the Census*. The labor data refer to the average figures and service employment was excluded.

enterprises are included. But the difference in productivity is also due to the fact that the average value-added/output ratio for township enterprises and above (which is available in the census) is three per cent higher than the ratio derived from the 1995 Input-Output table applied in table 3 (26.7 percent versus 23.7 percent).

The data sets on China's manufacturing reported in the present comparison have slight differences compared to the similar coverage of data displayed in Szirmai, Bai, and Ren (2001, table 9 and table 10) because of two reasons. There are 17 branches in the China-Germany comparison, which follows the new classifications system while there were only 15 branches in Szirmai, Bai, and Ren (2001). The other reason is that the composition of the branch "other manufacturing" is different in the two studies.

The basic data on gross value of output, gross value added and employment for Germany are presented in TABLE 3.

Table 2 - Basic data on output and employment for China, 1995 (including the Chinese small firms*)

		Gross Value of Output at factor cost (mill. Yuan)	Gross Value Added at factor cost (mill. Yuan)	Gross Value Added in branch as % of total	Employment (persons)
1.	Food and Kindred Products	731,817	147,746	11.0	8,060,400
2.	Textiles Mill Products	555,730	93,184	7.0	10,140,000
3.	Wearing apparel	223,257	50,405	3.8	4,188,700
4.	Leather products and Footwear	140,777	18,750	1.4	2,365,600
5.	Wood products	70,053	18,032	1.3	1,621,600
6.	Paper Products, Printing & Publishing	199,510	39,111	2.9	4,023,100
7.	Chemicals & Allied Products	634,149	123,229	9.2	7,526,800
8.	Petroleum & Coal Products	204,732	59,963	4.5	9,491
9.	Rubber and Plastic products	250,812	49,697	3.7	3,849,900
10.	Non-Metallic Mineral Products	496,561	140,212	10.5	13,847,500
11.	Basic Metal Products	579,001	123,873	9.2	5,823,400
12.	Fabricated metal products	271,971	63,703	4.8	4,340,000
13.	Machinery and Equipment	540,770	111,145	8.3	10,247,200
14.	Transport equipment	369,806	91,532	6.8	4,793,200
15.	Office, Accounting and Computing machinery	43,443	11,577	0.9	202,101
16.	Electrical Machinery and Equipment	556,036	128,146	9.6	6,120,300
17.	Other manufacturing products	274,688	70,919	5.3	6,669,499
	Total Manufacturing:	6,143,114	1,341,225	100.0	94,768,400

* Data on enterprises at the village level and above with more than 1 million sales.

Notes: (a) Tea making reclassified from beverages to food manufacturing; (b) Other manufacturing includes the unallocated residual for total industry. It is assumed that this residual is primarily included in manufacturing; (c) For the census total, the adjustment to factor cost and market prices was done by deducting and adding the same absolute amount of taxes as for the total industry village level and above.

The small individual enterprises pay income tax. We assume they do not pay much in the way of sales tax and VAT. We used the same proportions of value added to gross output as for total industry at the village level and above.

Data Sources:

Col. 1: Number of enterprises from *Industrial Census*, 1995 p. 3 ff.

Col. 2: Gross value of output (new concept), *Industrial Census*, 1995 p. 3 ff. The new concept is net of value added tax, but gross of sales and other taxes.

Col. 3. GVO adjusted to factor cost by deducting estimates of sales and other taxes. These taxes are estimated using the proportions of sales and other taxes to total taxes at the township level and above (Census p. 46), where more detail on taxes is provided. For page 3 only total taxes are given.

Col. 4: Value added at factor cost calculated by applying gross value added/gross output ratios from the 1995 IO table, p. 82 ff. (33 x33 use matrix) where the 1995 IO table does not have sufficient detail, it is broken down using proportions from the 1997 IO table. In some cases, value added at factor cost calculated by applying gross value added/gross output ratios from the 1995 Census data, p. 46.

Col. 7: Employment (year end from *Industrial Census*, 1995, p. 3 ff.), deducting service staffs.

Deriving unit value ratios

In the ICOP methodology, as a first step, unit values are derived by dividing ex-factory output values by produced quantities for each product in each country. However, because of data limitations, this approach was not applied in a satisfactory way in the 1985 China-US comparison (Szirmai and Ren, 2000). For the present study and further research agenda, we had to construct a commodity list of Chinese products with their corresponding quantities, out-

Table 3 - Basic data on output and employment for Germany, 1995

		Gross Value of Output at factor cost (mill. Yuan)	Gross Value Added at factor cost (mill. Yuan)	Gross Value Added in branch as % of total	Employment (persons)
1.	Food and Kindred Products	250,237	50,906	7.9	563,935
2.	Textiles Mill Products	31,981	9,959	1.5	150,334
3.	Wearing apparel	22,526	6,123	1.0	102,923
4.	Leather products and Footwear	7,532	2,100	0.3	35,383
5.	Wood products	30,767	10,225	1.6	122,445
6.	Paper Products, Printing & Publishing	121,195	44,720	6.9	539,005
7.	Chemicals & Allied Products	225,774	73,211	11.3	553,305
8.	Petroleum & Coal Products	116,157	3,860	0.6	24,679
9.	Rubber and Plastic products	88,811	32,148	5.0	365,773
10.	Non-Metallic Mineral Products	74,059	29,008	4.5	284,002
11.	Basic Metal Products	106,158	31,598	4.9	299,347
12.	Fabricated metal products	115,254	46,192	7.1	546,678
13.	Machinery and Equipment	245,947	95,144	14.7	1,039,431
14.	Transport equipment	313,691	94,068	14.5	895,895
15.	Office, Accounting and Computing machinery	30,381	7,478	1.2	66,620
16.	Electrical Machinery and Equipment	255,053	91,405	14.1	1,009,334
17.	Other manufacturing products	51,375	18,641	2.9	249,661
	Total Manufacturing:	208,689,697	64,678,664	100.0	6,848,750

Source: Produzierendes Gewerbe. Fachserie 4. Reihe 4.3. Kostenstruktur der Unternehmen, 1995.

put values and unit values. In APPENDIX 2, we present a detailed description of how the Chinese unit values were derived.

The Chinese unit value list is used to derive unit value ratios at sample industry level. At this lowest level of aggregation we weigh unit value ratios with quantities from the commodity list. Then the sample industry unit value ratios (UVRs) were weighted using gross output at the township level and above to get branch UVRs. This gives a benchmark comparison for manufacturing industry at the township level and above, which is consistent with the Chinese time series. This comparison is the comparison with limited coverage.

As a next step we apply the branch UVRs to the larger coverage (at the village level and above). The standard ICOP approach implies that the UVRs are assumed to be representative and can be applied to larger aggregates. As Maddison and van Ark (1988) have shown, it is much safer to make this assumption for prices than for output quantities or value of output.

The results: relative levels of prices, production and productivity in China and Germany

Unit value ratios and relative price levels

According to the revised ICOP classification system, we selected 52 sample industries which were grouped into 17 branches of manufacturing. The sample industries on the German side correspond to the four digit industry codes. The Chinese 1995 Industrial Census still does

not use the classification by industry codes. However, it is possible to organize Chinese industries according to the codes used in the International Standard Industrial Classification (ISIC). In the current study all the 297 products or groups of products were classified into 52 sample industries belonging to 17 branches of manufacturing. The products which were matched in the China-Germany comparison account for 33% of China's gross value of output and 21.5% of Germany's output. Thanks to the efforts made in reorganizing the value, quantity, and price information provided in the 1995 Chinese census as well as additional information from other sources, the number of matchings made in the current study is much larger than the previous 1985 benchmark comparison between China and US, for which the matched products represented about 27% of the gross value of output in China and 17% of the gross value of output in Germany. TABLE A2.1 (APPENDIX 2) shows the coverage ratios of the present comparison at branch and sample industry.

TABLE 4 shows the UVRs at the branch level. The average UVR (yuan/DM) for manufacturing is 2.89; it can be identified to the exchange rate that makes the parity of industrial product prices between the two countries. This conversion rate is well below the nominal exchange rate (5.8) The comparison of the average UVRs to the nominal exchange rate reveals the Chinese level of industrial prices compared to the German ones. In this case, we find that Chinese prices stand at 49.7% of the German level. This indicates that the yuan nominal exchange rate undervalues the yuan compared to the parity derived from UVRs. This means that Chinese output converted into DM through the UVR will be much greater than through the nominal exchange rate. From TABLE 4, it becomes apparent that China's relative price level differs across branches. The lowest relative prices are found in traditional branches, such as apparel, leather and shoes.

To discuss the results of the comparison, we present successively the two estimations of gross output, value-added and labour productivity in manufacturing, corresponding to the two data set available for China. These two comparisons have their specific interest. On the one hand, the benchmark comparison using Chinese data on enterprises at the village level and above has the largest possible coverage (85% of output and 75% of employment) and the comparison of labor productivity at this level makes sense because the German data have a complete coverage. On the other hand, the benchmark comparison based on a narrower coverage (67% of output and 58% of employment) is useful as it is consistent with the coverage used in time series, which record the trends in China's industrial output and employment.

We will first present the estimations derived from the restricted coverage and then the estimations derived from the broader coverage.î

Benchmark Comparison based on Chinese Data for Firms at the Township Level and above

Comparison of output size and structure

Using the geometric average UVRs (TABLE 4) and the gross value of output at factor cost of China and Germany (from TABLES 1 and 3), we made an evaluation of China's manufacturing

Table 4 - Unit value ratios (UVR) and price levels by major manufacturing branch in China and Germany, 1995 (excluding the Chineses small firms*)

		UVR (Yuan/DM)			
		At Chinese Quantity Weights	At German Quantity Weights	Geometric Average	Relative Price Level China (Germany = 100)
1.	Food and Kindred Products	3.7	3.6	3.6	62.2
2.	Textiles Mill Products	1.9	2.5	2.2	37.0
3.	Wearing Apparel	1.0	1.0	1.0	17.6
4.	Leather Products and Footwear	1.2	1.0	1.1	19.1
5.	Wood Products	1.9	2.1	2.0	34.6
6.	Paper Products. Printing & Publishing	3.3	3.9	3.6	61.2
7.	Chemicals & Allied Products	2.0	3.6	2.7	46.0
8.	Petroleum & Coal Products	7.1	7.0	7.0	120.9
9.	Rubber and Plastic Products	1.8	2.9	2.3	39.4
10.	Non-Metallic Mineral Products	2.9	2.5	2.7	46.1
11.	Basic Metal Products	5.7	2.5	3.8	64.7
12.	Fabricated Metal Products	1.7	1.6	1.6	27.6
13.	Machinery and Equipment	0.9	3.0	1.6	27.9
14.	Transport Equipment	1.4	3.3	2.2	37.2
15.	Office, Accounting and Computing Machinery	1.6	4.4	2.7	45.7
16.	Electrical Machinery and Equipment	0.9	3.3	1.7	29.5
17.	Other Manufacturing Products	0.7	1.2	1.0	16.4
	Total Manufacturing:	2.6	3.3	2.9	49.7
	Official Exchange Rate		5.8		

* IAS enterprises at the township level and above, value data refer to IAS enterprises at the township level and above.

Sources: From p. 46 of *the Census*; price data refer to large and medium enterprises at the township level and above.

output and of Germany's manufacturing output at both Chinese and German prices (TABLE 5). When the geometric average of Chinese and German prices are applied, the Chinese manufacturing output is evaluated at almost 80 per cent of the German manufacturing output. This proportion is twice as large as that obtained from the comparison using the exchange rate.

The comparison highlights the large differences in the structures of output between the two countries, which reflect the contrasted industrial specialisation associated with their different levels of development. China's production of labour intensive products such as textile, clothing, leather and footwear is several times larger than the corresponding German production. By contrast, China's output of capital intensive products such as transport equipment, is less than half the German output.

Productivity level: output per employee

TABLE 6 allows for a comparison between labour productivity (output per employee) at the branch level between the two countries. Usually, the international comparisons of productivity focus on the per capita value added rather than per capita output, because the measure-

ment of gross value of output involves the problem of double accounting. However, in the current comparison we also present the measurement of productivity based on gross value of output, as the starting point of the construction of an internationally comparable database, which can be useful in other research works. Because all data for the Chinese side have a narrower coverage, the comparison provides an insight into China's relative manufacturing performance at a level which excludes the small enterprises. Even at this level, labour productivity is quite low in China compared to Germany. It stands on average at 8.6% of the labour productivity in German manufacturing industry. However there are wide differences across branches: In five sectors, Chinese productivity reaches more than one fourth of the German level (wearing apparel, leather and shoes, office machinery and computers, electrical machinery, and other manufacturing products). In all these branches (except for office machinery) China displays a relative specialisation compared to Germany (TABLE 5). This suggests that China's manufacturing industry is relatively specialised in branches where it has

Table 5 - Gross value of output by major manufacturing branch in China and Germany, 1995 (excluding the Chinese small firms*)

		At Chinese prices			At German prices			Geometric average
		China	Germany	China/ Germany	China	Germany	China/ Germany	China/ Germany
		In million Yuan		%	In million DM		%	%
1.	Food and Kindred Products	626,275	898,193	69.7	171,283	250,237	68.5	69.1
2.	Textiles Mill Products	460,400	78,990	582.9	244,117	31,981	763.3	667.0
3.	Wearing Apparel	147,015	23,338	630.0	144,647	22,526	642.1	636.0
4.	Leather Products and Footwear	97,441	7,837	1,243.3	81,769	7,532	1,085.7	1,161.8
5.	Wood Products	40,553	65,102	62.3	21,175	30,767	68.8	65.5
6.	Paper Products, Printing & Publishing	130,399	469,462	27.8	39,674	121,195	32.7	30.2
7.	Chemicals & Allied Products	559,099	809,930	69.0	279,478	225,774	123.8	92.4
8.	Petroleum & Coal Products	202,812	810,888	25.0	28,554	116,157	24.6	24.8
9.	Rubber and Plastic products	174,753	259,198	67.4	96,902	88,811	109.1	85.8
10.	Non-Metallic Mineral Products	301,836	182,944	165.0	103,569	74,059	139.9	151.9
11.	Basic Metal Products	503,251	266,500	188.8	88,904	106,158	83.8	125.8
12.	Fabricated Metal Products	165,072	180,729	91.3	100,073	115,254	86.8	89.1
13.	Machinery and Equipment	412,223	745,010	55.3	471,598	245,947	191.8	103.0
14.	Transport Equipment	330,328	1,020,887	32.4	229,474	313,691	73.2	48.7
15.	Office, Accounting and Computing Machinery	35,056	133,256	26.3	21,711	30,381	71.5	43.4
16.	Electrical Machinery and Equipment	557,314	849,001	65.6	626,883	255,053	245.8	127.0
17.	Other Manufacturing Products	59,709	63,460	94.1	81,297	51,375	158.2	122.0
	Total Manufacturing:	4,803,536	6,864,724	70.0	1,885,656	2,086,897	90.4	79.5

* IAS enterprises at the township level and above, value data refer to IAS enterprises at the township level and above.

the relatively highest level of productivity. All the five branches are also characterised by a strong presence of foreign firms, which is likely to explain their high productivity performance: according to estimations, foreign affiliates contributed to a large share of output in electronic and telecommunication equipment (63%), leather and shoes (50%), apparel (43%), and electrical equipment (27%) (Lemoine, 2000).

Comparison of manufacturing value-added

By applying UVRs to value-added by branches of manufacturing, we can go further in the comparison of industrial performance. The results presented in TABLE 7 show that in 1995, China's manufacturing value-added represented about two-thirds of the German level. This ratio is lower than that derived from output comparison, indicating that the share of value-added in China's industrial output is smaller than in Germany. The structure by branches of the manufacturing value-added confirms that China is strongly specialised in textile and clothing, and leather and shoes. China's value added in these branches represented between four and eight times the German level.

Table 6 - Gross value of output per person employed in China and Germany, 1995 (excluding the Chinese small firms*)

		At Chinese prices			At German prices			Geometric average
		China	Germany	China/ Germany	China	Germany	China/ Germany	China/ Germany
		In Yuan		%	In DM		%	%
1.	Food and Kindred Products	109,721	1,592,724	6.9	30,008	443,734	6.8	6.8
2.	Textiles Mill Products	55,662	525,427	10.6	29,513	212,734	13.9	12.1
3.	Wearing Apparel	56,138	226,749	24.8	55,234	218,860	25.2	25.0
4.	Leather Products and Footwear	70,840	221,497	32.0	59,447	212,861	27.9	29.9
5.	Wood Products	40,736	531,684	7.7	21,270	251,271	8.5	8.1
6.	Paper Products, Printing & Publishing	46,957	870,978	5.4	14,287	224,849	6.4	5.9
7.	Chemicals & Allied Products	92,016	1,463,804	6.3	45,996	408,047	11.3	8.4
8.	Petroleum & Coal Products	294,699	32,857,423	0.9	41,491	4,706,703	0.9	0.9
9.	Rubber and Plastic Products	70,642	708,630	10.0	39,171	242,802	16.1	12.7
10.	Non-Metallic Mineral Products	39,595	644,165	6.2	13,586	260,770	5.2	5.7
11.	Basic Metal Products	110,082	890,270	12.4	19,447	354,631	5.5	8.2
12.	Fabricated Metal Products	60,932	330,594	18.4	36,940	210,827	17.5	18.0
13.	Machinery and Equipment	55,661	716,748	7.8	63,679	236,617	26.9	14.5
14.	Transport Equipment	89,165	1,139,516	7.8	61,941	350,142	17.7	11.8
15.	Office, Accounting and Computing Machinery	346,746	2,000,238	17.3	214,747	456,030	47.1	28.6
16.	Electrical Machinery and Equipment	106,423	841,150	12.7	119,708	252,694	47.4	24.5
17.	Other Manufacturing Products	50,859	254,186	20.0	69,247	205,779	33.7	26.0
	Total Manufacturing:	75,634	1,002,332	7.6	29,691	304,712	9.7	8.6

* IAS enterprises at the township level and above.

Table 7 - Gross value added by major manufacturing branch, China and Germany, 1995 (excluding the Chinese small firms*)

		At Chinese prices			At German prices			Geometric average
		China	Germany	China/ Germany	China	Germany	China/ Germany	China/ Germany
		Million Yuan		%	Million DM		%	%
1.	Food and Kindred Products	170,735	182,719	93.4	46,695	50,906	91.7	92.6
2.	Textiles Mill Products	89,845	24,599	365.2	47,638	9,959	478.3	418.0
3.	Wearing Apparel	34,729	6,344	547.4	34,170	6,123	558.0	552.7
4.	Leather Products and Footwear	20,147	2,185	922.1	16,907	2,100	805.2	861.7
5.	Wood Products	9,508	21,636	44.0	4,965	10,225	48.6	46.2
6.	Paper Products, Printing & Publishing	29,506	173,228	17.0	8,977	44,720	20.1	18.5
7.	Chemicals & Allied Products	141,038	262,632	53.7	70,501	73,211	96.3	71.9
8.	Petroleum & Coal Products	56,133	26,948	208.3	7,903	3,860	204.7	206.5
9.	Rubber and Plastic Products	36,343	93,824	38.7	20,153	32,148	62.7	49.3
10.	Non-Metallic Mineral Products	89,991	71 658	125.6	30,879	29,008	106.5	115.6
11.	Basic Metal Products	135,533	79,324	170.9	23,943	31,598	75.8	113.8
12.	Fabricated Metal Products	38,394	72,433	53.0	23,276	46,192	50.4	51.7
13.	Machinery and Equipment	111,916	288,205	38.8	128,036	95,144	134.6	72.3
14.	Transport Equipment	80,512	306,139	26.3	55,930	94,068	59.5	39.5
15.	Office, Accounting and Computing Machinery	9,209	32,800	28.1	5,703	7,478	76.3	46.3
16.	Electrical Machinery and Equipment	136,137	304,261	44.7	153,131	91,405	167.5	86.6
17.	Other Manufacturing Products	14,761	23,026	64.1	20,098	18,641	107.8	83.1
	Total Manufacturing:	1,204,437	2,127,566	56.6	472,809	646,787	73.1	64.3

* IAS enterprises at the township level and above.

The comparisons between China and Germany in terms of value added per employee are presented in TABLE 8. For total manufacturing, if the data used are limited to the enterprises at the township and above, Chinese productivity reached 7 per cent of the German level. This should be regarded as a major finding from the current comparison. At the branch level, there is quite large variation in relative productivity performance. Highest labour productivity is found in office, accounting and computing machinery (30.5% of the German level), leather products and footwear (22.2%), wearing apparel (21.7%), other manufacturing products (17.7%) and electrical machinery and equipment (16.7%). Relatively low productivity is found in paper products, printing & publishing (3.6%), non-metallic mineral products (4.3%), and wood products (5.7%).

Ren, Szirmai and Bai (2002) provided a new benchmark comparison between China and the USA using the same framework. TABLE 9 was reproduced from that study, which was based on the Chinese basic data on the enterprises at the township level and above. Therefore, in

Table 8 - Gross value added per person employed in China and Germany, 1995 (excluding the Chinese small firms*)

	At Chinese prices			At German prices			Geometric average
	China	Germany	China/ Germany	China	Germany	China/ Germany	China/ Germany
	In Yuan		%	In DM		%	%
1. Food and Kindred Products	29,912	324,008	9.2	8,181	90,269	9.1	9.2
2. Textiles Mill Products	10,862	163,627	6.6	5,759	66,249	8.7	7.6
3. Wearing Apparel	13,261	61,637	21.5	13,048	59,493	21.9	21.7
4. Leather Products and Footwear	14,647	61,749	23.7	12,291	59,342	20.7	22.2
5. Wood Products	9,551	176,699	5.4	4,987	83,507	6.0	5.7
6. Paper Products, Printing & Publishing	10,625	321,386	3.3	3,233	82,968	3.9	3.6
7. Chemicals & Allied Products	23,212	474,661	4.9	11,603	132,315	8.8	6.6
8. Petroleum & Coal Products	81,565	1,091,924	7.5	11,483	156,414	7.3	7.4
9. Rubber and Plastic Products	14,691	256,510	5.7	8,146	87,890	9.3	7.3
10. Non-Metallic Mineral Products	11,805	252,314	4.7	4,051	102,142	4.0	4.3
11. Basic Metal Products	29,647	264,990	11.2	5,237	105,556	5.0	7.5
12. Fabricated Metal Products	14,172	132,497	10.7	8,592	84,496	10.2	10.4
13. Machinery and Equipment	15,112	277,272	5.5	17,288	91,535	18.9	10.2
14. Transport Equipment	21,732	341,713	6.4	15,097	104,999	14.4	9.6
15. Office, Accounting and Computing Machinery	91,088	492,350	18.5	56,413	112,250	50.3	30.5
16. Electrical Machinery and Equipment	25 996	301,448	8.6	29,241	90,560	32.3	16.7
17. Other Manufacturing products	12,573	92,229	13.6	17,119	74,665	22.9	17.7
Total Manufacturing:	18,964	310,650	6.1	7,445	94,439	7.9	6.9

* IAS enterprises at the township level and above.

terms of coverage, the results in TABLE 9 are comparable to those in TABLE 8. Aggregate value added per person employed in Chinese manufacturing is 5.2 per cent of the US level in 1995, while it is 6.9 per cent of the German level in the same year.

Comparison based on Chinese data for enterprises at the village level and above

We will now turn to the comparison based on data with the broadest coverage.

Comparison of output and output per employee

TABLE 10 shows the value of output comparison by manufacturing branches between China and Germany and TABLE 11 shows the comparisons in terms of output per employee in manufacturing branches.

Table 9 - Gross value added per person employed, in China and the USA, 1995 (excluding the Chinese small firms*)

	At Chinese prices			At USA Prices			Geometric average
	China	USA	China/ USA	China	USA	China/ USA	China/ USA
	In RMB		%	In $		%	%
1. Food and Kindred Products	19443	454950	4.3	3328	78015	4.3	4.3
2. Textiles Mill Products	9970	194634	5.1	2526	36978	6.8	5.9
3. Wearing apparel	12342	238148	5.2	3642	41594	8.8	6.7
4. Leather products and Footwear	12608	104976	12.0	5652	47125	12.0	12.0
5. Wood products	9031	160654	5.6	4004	43714	9.2	7.2
6. Paper Products, Printing & Publishing	12395	308119	4.0	2268	58810	3.9	3.9
7. Chemicals & Allied Products	18542	1127896	1.6	2612	144456	1.8	1.7
8. Petroleum & Coal Products	63179	1631582	3.9	7997	202622	3.9	3.9
9. Rubber and Plastic products	12818	326137	3.9	1877	46889	4.0	4.0
10. Non-Metallic Mineral Products	10698	97925	10.9	4547	58013	7.8	9.3
11. Basic Metal Products	28647	544314	5.3	5382	74634	7.2	6.2
12. Fabricated metal products	14678	380260	3.9	7171	59500	12.1	6.8
13. Machinery and Equipment	11700	155567	7.5	7792	63160	12.3	9.6
14. Transport equipment	19096	79961	23.9	19404	81249	23.9	23.9
15. Office, Accounting and Computing machinery	56061	632639	8.9	22629	95525	23.7	14.5
16. Electrical Machinery and Equipment	22562	254292	8.9	7565	75989	10.0	9.4
17. Other manufacturing products	10189	246035	4.1	2437	50836	4.8	4.5
Total Manufacturing:	15696	327839	4.8	3754	67739	5.5	5.2

* IAS enterprises at the township level and above.

When industrial activity of firms at the village level is included, China's industrial output is slightly larger than Germany's (102%). At the branch level, the activity of small firms appears to be especially important in wearing apparel, leather and shoes, wood and paper products. Taking their production into account thus raises China's relative specialisation in traditional labour intensive sectors, in comparison to Germany. In wearing apparel, Chinese production is thus almost ten times Germany's production level and in leather and shoes, it reaches more than 16 times Germany's level.

The level of output per employee in China is 7.4% the German level in this extensive coverage (against 8.6% in the restricted coverage). Much higher productivity performance is found in the same branches (apparel, leather and shoes, electrical machinery, etc.).

Comparison of value-added and value-added per employee

TABLE 12 presents the bilateral comparison of value added in manufacturing between China and Germany for 1995. China's total manufacturing value-added, even in this broad coverage, remains smaller than Germany's (standing at 71%). This indicates that the share of value-added in output is much smaller in China's industry than in Germany's industry, especially when small firms are taken into account. Value-added represents 20% of output in the

Table 10 - Gross value of output by major manufacturing branch in China and Germany, 1995 (including the Chinese small firms*)

		At Chinese prices			At German prices			Geometric average
		China	Germany	China/ Germany	China	Germany	China/ Germany	China/ Germany
		In million Yuan		%	In million DM		%	%
1.	Food and Kindred Products	731,817	898,193	81.5	200,148	250,237	80.0	80.7
2.	Textiles Mill Products	555,730	78,990	703.6	294,663	31,981	921.4	805.1
3.	Wearing Apparel	223,257	23,338	956.6	219,660	22,526	975.2	965.9
4.	Leather Products and Footwear	140,777	7,837	1,796.3	118,135	7,532	1,568.5	1,678.5
5.	Wood Products	70,053	65,102	107.6	36,578	30,767	118.9	113.1
6.	Paper Products, Printing & Publishing	199,510	469,462	42.5	60,702	121,195	50.1	46.1
7.	Chemicals & Allied Products	634,149	809,930	78.3	316,994	225,774	140.4	104.9
8.	Petroleum & Coal Products	204,732	810,888	25.3	28,824	116,157	24.8	25.0
9.	Rubber and Plastic Products	250,812	259,198	96.8	139,078	88,811	156.6	123.1
10.	Non-Metallic Mineral Products	496,561	182,944	271.4	170,384	74,059	230.1	249.9
11.	Basic Metal Products	579,001	266,500	217.3	102,286	106,158	96.4	144.7
12.	Fabricated Metal Products	271,971	180,729	150.5	164,880	115,254	143.1	146.7
13.	Machinery and Equipment	540,770	745,010	72.6	618,661	245,947	251.5	135.1
14.	Transport Equipment	369,806	1,020,887	36.2	256,898	313,691	81.9	54.5
15.	Office, Accounting and Computing Machinery	43,443	133,256	32.6	26,905	30,381	88.6	53.7
16.	Electrical Machinery and Equipment	556,036	849,001	65.5	625,446	255,053	245.2	126.7
17.	Other Manufacturing Products	274,688	63,460	432.9	374,000	51,375	728.0	561.3
	Total Manufacturing:	6,143,114	6,864,724	89.5	2,411,516	2,086,897	115.6	101.7

* Data on enterprises at the village level and above with sales greater than 1 million Yuan.

broadest coverage of China's manufacturing industry, 25% in the limited coverage, and represents 31% of Germany's industry.

The comparison of labor productivity based on value-added per employee is presented in TABLE 13. This should be regarded as another major result from the current study. The average level of productivity based on value-added in China is 5.2% of the German level in this broad coverage (against 6.9% in the restricted coverage). The highest labor productivity is found in wearing apparel (19.7% of Germany's level) and office machinery (19.2%). The lowest level of productivity is found in paper products (3.3% of Germany's level) and non-metallic mineral products (3.7%).

CONCLUDING REMARKS

This comparative study marks a new step forward in estimating China's manufacturing output and productivity in an international perspective. The findings of this study can be com-

Table 11 - Gross value of output per person employed in China and Germany, 1995 (including the Chinese small firms*)

		At Chinese prices			At German prices			Geometric average
		China	Germany	China/ Germany	China	Germany	China/ Germany	China/ Germany
		In Yuan		%	In DM		%	%
1.	Food and Kindred Products	90,792	1,592,724	5.7	24,831	443,734	5.6	5.7
2.	Textiles Mill Products	54,806	525,427	10.4	29,060	212,734	13.7	11.9
3.	Wearing Apparel	53,300	226,749	23.5	52,441	218,860	24.0	23.7
4.	Leather Products and Footwear	59,510	221,497	26.9	49,939	212,861	23.5	25.1
5.	Wood Products	43,200	531,684	8.1	22,557	251,271	9.0	8.5
6.	Paper Products, Printing & Publishing	49,591	870,978	5.7	15,088	224,849	6.7	6.2
7.	Chemicals & Allied Products	84,252	1,463,804	5.8	42,115	408,047	10.3	7.7
8.	Petroleum & Coal Products	215,711	32,857,423	0.7	30,370	4 706,703	0.7	0.7
9.	Rubber and Plastic Products	65,148	708,630	9.2	36,125	242,802	14.9	11.7
10.	Non-Metallic Mineral Products	35,859	644,165	5.6	12,304	260,770	4.7	5.1
11.	Basic Metal Products	99,427	890,270	11.2	17,565	354,631	5.0	7.4
12.	Fabricated Metal Products	62,666	330,594	19.0	37,991	210,827	18.0	18.5
13.	Machinery and Equipment	52,772	716,748	7.4	60,374	236,617	25.5	13.7
14.	Transport Equipment	77,152	1,139,516	6.8	53,596	350,142	15.3	10.2
15.	Office, Accounting and Computing machinery	214,955	2,000,238	10.8	133,126	456,030	29.2	17.7
16.	Electrical Machinery and Equipment	90,851	841,150	10.8	102,192	252,694	40.4	20.9
17.	Other Manufacturing Products	41,186	254,186	16.2	56,076	205,779	27.3	21.0
	Total Manufacturing:	64,822	1,002,332	6.5	25,446	304,712	8.4	7.4

* Data on enterprises at the village level and above with sales greater than 1 million Yuan.

pared with the results of the comparisons made between China and the US for 1985 and 1995, and they are generally consistent with those derived from these comparisons. The present study confirms the labour intensive nature of Chinese production. In 1995, Chinese labor productivity in manufacturing reached 6.9 percent of the German level when small firms were excluded from the Chinese data, and 5.2 percent of the German level when they were included. This is higher than the figures derived from the 1995 comparison with the US, which puts China's productivity between 5.2 percent (excluding small firms) and 4.7 percent (including them) of the US productivity level.

Also remarkable is the branch variation around the mean. The present study finds that the relative productivity performance at the branch level varies considerably. When small Chinese firms are excluded, the best performance is recorded in office and computing machinery, with productivity reaching 30 percent of the German level, and the worst performance is recorded in paper products, with productivity representing 3.6 per cent of the German level. The ranking is somewhat different when small Chinese firms are included.

Table 12 - Gross value added by major manufacturing branch in China and Germany, 1995 (including the Chinese small firms*)

	At Chinese prices			At German prices			Geometric average
	China	Germany	China/ Germany	China	Germany	China/ Germany	China/ Germany
	In Yuan		%	In DM		%	%
1. Food and Kindred Products	147,746	182,719	80.9	40,408	50,906	79.4	80.1
2. Textiles Mill Products	93,184	24,599	378.8	49,409	9,959	496.1	433.5
3. Wearing Apparel	50,405	6,344	794.5	49,593	6,123	809.9	802.2
4. Leather Products and Footwear	18,750	2,185	858.2	15,735	2,100	749.4	801.9
5. Wood Products	18,032	21,636	83.3	9,415	10,225	92.1	87.6
6. Paper Products, Printing & Publishing	39,111	173,228	22.6	11,900	44,720	26.6	24.5
7. Chemicals & Allied Products	123,229	262,632	46.9	61,599	73,211	84.1	62.8
8. Petroleum & Coal Products	59,963	26,948	222.5	8,442	3,860	218.7	220.6
9. Rubber and Plastic Products	49,697	93,824	53.0	27,557	32,148	85.7	67.4
10. Non-Metallic Mineral Products	140,212	71,658	195.7	48,111	29,008	165.9	180.1
11. Basic Metal Products	123,873	79,324	156.2	21,883	31,598	69.3	104.0
12. Fabricated Metal Products	63,703	72,433	88.0	38,619	46,192	83.6	85.8
13. Machinery and Equipment	111,145	288,205	38.6	127,154	95,144	133.6	71.8
14. Transport Equipment	91,532	306,139	29.9	63,586	94,068	67.6	45.0
15. Office, Accounting and Computing Machinery	11,577	32,800	35.3	7,170	7,478	95.9	58.2
16. Electrical Machinery and Equipment	128,146	304,261	42.1	144,142	91,405	157.7	81.5
17. Other Manufacturing Products	70,919	23,026	308.0	96,560	18,641	518.0	399.4
Total Manufacturing:	1,341,225	2,127,566	63.0	526,506	646,787	81.4	71.6

* Data on enterprises at the village level and above with sales greater than 1 million Yuan.

Labour productivity reaches 19.7 percent of the German level in wearing apparel and falls to 3.3 per cent in paper products.

The labour productivity comparison based on extensive coverage (at the village level and above) indicates a comparatively lower performance in China's manufacturing activity. Although this estimate implies several adjustments and assumptions, and is therefore subject to errors, it may be closer to the reality than the higher estimate based on the limited coverage.

Concerning China's competitiveness, a first conclusion that can be drawn from this study is that the conversion rate derived from the comparison of production prices (unit values) in manufacturing indicates that the nominal exchange rate strongly undervalued the yuan in 1995 and led the level of Chinese production prices to stand well below the German price level. A second observation is that the comparison of industrial output structures and relative labour productivity shows that China's manufacturing industry is specialised in branches in which it has a relatively high level of productivity (apparel, leather and shoes, electrical and

Table 13 - Gross value added per person employed, China and Germany, 1995 (including the Chinese small firms*)

	At Chinese prices			At German prices			Geometric average
	China	Germany	China/ Germany	China	Germany	China/ Germany	China/ Germany
	In Yuan		%	In DM		%	%
1. Food and Kindred Products	18,330	324,008	5.7	5,013	90,269	5.6	5.6
2. Textiles Mill Products	9,190	163,627	5.6	4,873	66,249	7.4	6.4
3. Wearing Apparel	12,034	61,637	19.5	11,840	59,493	19.9	19.7
4. Leather Products and Footwear	7,926	61,749	12.8	6,651	59,342	11.2	12.0
5. Wood Products	11,120	176,699	6.3	5,806	83,507	7.0	6.6
6. Paper Products, Printing & Publishing	9,722	321386	3.0	2,958	82,968	3.6	3.3
7. Chemicals & Allied Products	16,372	474661	3.5	8,184	132,315	6.2	4.6
8. Petroleum & Coal Products	63,179	1091924	5.8	8,895	156,414	5.7	5.7
9. Rubber and Plastic Products	12,909	256510	5.0	7,158	87,890	8.1	6.4
10. Non-Metallic Mineral Products	10,125	252,314	4.0	3,474	102,142	3.4	3.7
11. Basic Metal Products	21,272	264,990	8.0	3,758	105,556	3.6	5.4
12. Fabricated Metal Products	14,678	132,497	11.1	8,898	84,496	10.5	10.8
13. Machinery and Equipment	10,846	277,272	3.9	12,409	91,535	13.6	7.3
14. Transport Equipment	19,096	341,713	5.6	13,266	104,999	12.6	8.4
15. Office, Accounting and Computing Machinery	57,285	492,350	11.6	35,478	112,250	31.6	19.2
16. Electrical Machinery and Equipment	20,938	301,448	7.0	23,551	90,560	26.0	13.4
17. Other Manufacturing Products	10,633	92,229	11.5	14,478	74,665	19.4	15.0
Total Manufacturing:	14,153	310,650	4.6	5,556	94,439	5.9	5.2

* Data on enterprises at the village level and above with sales greater than 1 million Yuan.

electronic goods). A third observation is that these branches are also those in which China appears to be the most competitive internationally, as evidenced by its strong positions in world product markets (see Lemoine and Ünal-Kesenci in this issue). Finally, these branches are also characterised by a strong presence of foreign firms (see Yu and Démurger in this issue) which suggests that foreign direct investment plays an important part in the productivity performance of China's manufacturing industry[4].

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Appendix 1
ICOP Methods

This annex is derived from Timmer *et al.* (2001).

A major task in the ICOP approach to manufacturing is to derive industry-specific conversion factors on the basis of relative product prices. As a first step, unit values (*uv*) are derived by dividing ex-factory output values (*o*) by produced quantities (*q*) for each product i in each country

$$uv_i = \frac{o_i}{q_i} \tag{1}$$

In a bilateral comparison, broadly defined products with similar characteristics are matched, for each matched product, the ratio of the unit values in both countries is taken. This unit value ratio (UVR) is given by:

$$UVR_i^{xu} = \frac{uv_i^x}{uv_i^u} \tag{2}$$

with *x* representing the country being compared, and *u* being the base country.

Product UVRs are used to derive an aggregate UVR for manufacturing branches and total manufacturing in a stepwise weighting procedure. There are four levels which are being distinguished: products, industries, branches and total manufacturing. These levels correspond to the levels distinguished in the International Standard Industrial Classification (ISIC rev 3). ICOP industries consist of four-digit ISIC industries, and ICOP branches consist of two-digit divisions. The total manufacturing output is the sum of branch output, which is the sum of industries' output. The output value of an industry is the sum of output values of its products.

Two UVRs are derived at each level. A Laspeyres UVR is calculated by using base country weights and a Paasche UVR by using weights for the other country. The Laspeyres and Paasche indices are combined into a Fisher index when a single currency conversion factor is required. It is defined as the geometric average of the Laspeyres and the Paasche.

■ Aggregation Step One: Industry Level UVRs

The industry UVR (UVR_j) is given by the mean of the UVRs of the sampled products. Product UVRs are weighted by their output value, as more important products should have a bigger weight in the industry UVR:

$$UVR_j = \sum_{i=1}^{I_j} w_{ij} UVR_{ij} \tag{3}$$

with $i = 1,.., I_j$ representnig the matched products in industry j; $w_{ij} = o_{ij} / o_j^M$ representing the output share of the i^{th} commodity in industry j in total matched output; and $o_j^M = \sum_{i=1}^{I_j} o_{ij}$ representing the total matched value of output in industry j. In bilateral comparisons the weights of the base country (*u*) or the other country (*x*) can be used. The use of the base country value weights leads to the Laspeyres index. Substituting base country weights in (3) gives:

$$UVR_j^{xu(u)} = \sum_{i=1}^{I_j} w_{ij}^{u(u)} UVR_{ij} \tag{4}$$

with $w_{ij}^{u(u)} = o_{ij}^{u(u)} / o_j^{Mu(u)}$; $o_j^{Mu(u)} = \sum_{i=1}^{I_j} o_{ij}^{u(u)}$; and $o_{ij}^{u(u)} = uv_{ij}^{u} q_{ij}^{u}$, the output value of matched product *i* in country *u* at own prices. Using (1), (4) can be rewritten as:

$$UVR_j^{xu(u)} = \frac{\sum_{i=1}^{I_j} uv_{ij}^{x} q_{ij}^{u}}{\sum_{i=1}^{I_j} uv_{ij}^{u} q_{ij}^{u}} \tag{5}$$

with $UVR_j^{xu(u)}$ indicating the Laspeyres index which is the unit value ratio between country *u* and *x* weighted at base-country quantities indicated by the u between brackets. For the Paasche index, weights of the other country quantities valued at base country prices are used in formula (3). This gives:

$$UVR_j^{xu(x)} = \sum_{i=1}^{I_j} w_{ij}^{u(x)} UVR_{ij} \tag{6}$$

with $w_{ij}^{u(x)} = o_{ij}^{u(x)} / o_j^{Mu(x)}$; $o_j^{Mu(x)} = \sum_{i=1}^{I_j} o_{ij}^{u(x)}$; and $o_{ij}^{u(x)} = uv_{ij}^{u} q_{ij}^{x}$, the output value of matched product *i* in country *x* at *u* prices… Using (1), (6) can be rewritten as:

$$UVR_j^{xu(x)} = \frac{\sum_{i=1}^{I_j} uv_{ij}^{x} q_{ij}^{x}}{\sum_{i=1}^{I_j} uv_{ij}^{u} q_{ij}^{x}} \tag{7}$$

with $UVR_j^{xu(x)}$ indicating the Paasche index which is the unit value ratio between country *u* and *x* weighted at the quantities of the other country (*x*).

■ Aggregation Step Two: Branch Level UVRs

Branch UVRs (UVR_k) are calculated as a weighted average of industry UVRs. Use of weights from the base country and the industry UVRs at base country weights, gives the Laspeyres index for branch *k*.

$$UVR_k^{xu(u)} = \sum_{j=1}^{J_k} w_{jk}^{u(u)} UVR_{jk}^{xu(u)} \tag{8}$$

with $j = 1,.., J_k$ representing the number of industries in branch k in which a product match has been made and $w_{jk}^{u(u)}$ being the industry weight. UVRs of industries with bigger output should have a higher weight to reflect the structure of the economy.

To arrive at the Paasche index, the output weights of country *x* valued at base prices is substituted. This gives:

$$UVR_k^{xu(x)} = \sum_{j=1}^{J_k} w_{jk}^{u(x)} UVR_{jk}^{xu(x)} \quad (9)$$

■ **Aggregation Step Three: Total Manufacturing UVRs**

The total manufacturing UVR is a weighted average of the branch UVRs. Use of weights from the base country and the branch UVRs at base country weights, gives the Laspeyres index for total manufacturing ($UVR^{xu(u)}$).

$$UVR^{xu(u)} = \sum_{k=1}^{K} w_k^{u(u)} UVR_k^{xu(u)} \quad (10)$$

with $k = 1,.., K$ representing the number of branches and $w_k^{u(u)}$ representing the branch weight. For branch weights the total branch output is used.

To arrive at the Paasche index, the output weights of country x valued at base prices is substituted. This gives:

$$UVR^{xu(x)} = \sum_{k=1}^{K} w_k^{u(x)} UVR_k^{xu(x)} \quad (11)$$

Originally ICOP was based on ISIC rev 2, though some aggregated branches (3 digits) were taken such as basic and fabricated metals (which are separate branches in ISIC rev 2). Since then the industrial classifications have changed across the world. ISIC was revised in 1990 to rev 3. ICOP at the moment distinguishes 14 to 16 (depending on whether food is taken together with beverages and tobacco) branches in manufacturing (our previous comparison followed this classification). In the current comparison we adopted the proposed new ICOP branches including 17 branches as suggested in Timmer *et al.* (2001).

Appendix 2

The Approach to Construct a Chinese Unit Value List

In order to construct a commodity list of Chinese products with their corresponding quantities, output values and unit values for purposes of international comparisons, we have the following data sources:

■ **A long list of quantities from the Chinese 1995 Industrial Census (p. 234)**

The table heading is: "output of major industrial products of industrial enterprises and subsidiary units dealing with industrial production". We know that in principle the coverage of this list is intended to be for the total economy. However, based on the examination of data from the various sources, it is possible that output of the small private enterprises and sole proprietorships is not well covered. On the other hand, the subsidiaries (non independent accounting enterprises) are explicitly included.

The problem is that this list is not complete. The National Bureau of Statistics of China has a longer list of quantities, which has not been published because of doubts about the quality of the data. This means that using the quantities as weights may involve bias. Sometimes the quantities listed seem to be very modest for a large country such as China. The possible incompleteness of the quantity list is a potential source of bias in the weighting of the unit values from the matches.

■ Average prices for large & medium enterprises by quality from the Chinese 1995 Industrial Census (p. 314)

The table heading is: product quality of national large-size and medium-size independent accounting enterprises. Since IAS enterprises are generally limited to township and above levels, most probably the coverage of this data is identical to page 46 of the Chinese 1995 Industrial Census (independent accounting enterprises at the township level and above), but within that category it is limited to large and medium enterprises. That category of large and medium enterprises accounts for 56 per cent of gross output and 62 per cent of value added. This source provides total quantities and total values, so that one can calculate unit values for 450 items. It also provides quantities and values of first, second and third quality products.

The average prices can be used directly in product matches. The unit values can be weighted by the quantities in the list. Once the unit values by sample industry have been derived, they can be applied at the township level and above. The branch unit values calculated at the township level and above can also be applied to higher levels of coverage.

■ Average prices and sales revenues from Chinese 1995 Industrial Census (p. 382)

The table heading is: "sales income and sales expenditure of national large-size and medium-size independent accounting enterprises". This table lists some 450 average prices and sales revenues for large-size and medium-size independent accounting enterprises. The coverage of this list is identical to previous sources. This table contains information about average prices, sales revenue and sales cost. We may safely assume the average prices refer to sales prices. Dividing sales revenue by average prices would result in an implicit sales quantity list, which could well be used as weights for the calculation of UVRs for the township level and above.

■ Ex factory prices from a government agency website

This is a data set of firm level ex factory prices from a government agency price website, starting from 1998. We have used the price index to put the price back to the 1995 benchmark. Because at present the data on detailed price indexes are not satisfactory, this price backward procedure is a very rough approximation.

For the current study, we reconciled the values, quantities and prices information from the different sources to compile a 1995 Chinese commodity listing. This list provided a unit value list for a large number of commodities. The coverage of the unit value list is identical to the coverage of the large and medium enterprises for the township level and above.

When we have the output values and average prices data, we can divide output values by average prices from large and medium coverage, to derive the quantities information. This procedure is definitely preferable to the procedure adopted in the 1985 China and US comparison. The rationale behind the approach is that average prices from large and medium coverage are applicable to the whole economy, which is a reasonable assumption often used in ICOP studies. This procedure avoids one of the important drawbacks of early procedure, namely that the coverage of the quantities and the values may not correspond.

Table A2.1 Coverage ratio: gross value of matched as % of total gross value of output in sample industries, China and Germany, 1995

Branch and Sample Industries within the Branch	China, 1995	Germany, 1995	Number of Matches
1. Food and Kindred Products	33.83	20.51	18
1. Forage and Grain Mill Products	18.65	37.67	**3**
2. Edible Vegetable Oil	11.62	18.54	**3**
3. Salt Industry	31.73	84.91	**1**
4. Sugar & Sugar Factories	47.97	68.16	**1**
5. Food Products	9.87	4.50	**2**
6. Milk	22.23	6.35	**1**
7. Beverages	41.32	58.34	**6**
8. Tobacco	93.03	23.56	**1**
2. Textiles Mill Products	39.81	42.38	23
9. Fibre Raw and Processed Industry	31.70	0.82	**1**
10. Textile, Printing and Dyeing Product	41.05	40.66	**19**
11. Knitting Industry	34.61	90.25	**3**
3. Wearing Apparel	**10.12**	**19.58**	**4**
12. Wearing Apparel	11.54	21.03	**4**
4. Leather Products and Footwear	**13.76**	**36.36**	**5**
13. Currying Leather	33.55	61.17	**2**
14. Leather Industry	12.19	33.14	**3**
5. Wood Products	**14.86**	**34.72**	**4**
15. Wood Products	11.54	81.86	**1**
16. Man Building Board Proceeding	29.82	81.93	**3**
6. Paper Products, Printing & Publishing	**43.54**	**11.54**	**6**
17. Paper Products, Printing & Publishing	79.40	62.60	**6**
7. Chemicals & Allied Products	15.79	8.00	**30**
18. Inorganic Chemicals	80.66	9.33	**5**
19. Fertilizer	11.34	44.19	**3**
20. Pesticides	2.02	59.92	**2**
21. Organic Chemicals	27.12	5.47	**11**
22. Chemical Fibers	23.63	36.55	**1**
23. Special Purpose Chemical Products	5.67	4.39	**3**
24. Daily Chemical Products	27.03	26.63	**5**
8. Petroleum & Coal Products	**63.42**	**13.80**	**13**
25. Petroleum Refineries	63.42	13.80	**13**

9. Rubber and Plastic Products	**68.05**	**39.39**	**13**
26. Rubber Products	37.45	22.01	**3**
27. Plastics	84.86	45.37	**10**
10. Non-Metallic Mineral Products	**18.49**	**13.90**	**19**
28. Cements	16.95	16.65	**2**
29. Glass and Glass Fibres products	66.87	25.82	**7**
30. Concrete Products and Fibrotile	4.37	4.42	**3**
31. Waterproof, Heat Preservation			
32. and Asbestos Products	**30.20**	**34.50**	**5**
33. Other Enduring Fire Materials	77.63	78.95	**2**
11. Basic Metal Products	**71.76**	**36.31**	**24**
34. Iron and Steel	170.61	0.05	**12**
35. Non-ferrous Metals	47.68	58.26	**12**
12. Fabricated Metal Products	**6.15**	**17.05**	**6**
36. Fabricated Metal Products	6.15	17.05	**6**
13. Machinery and Equipment	**18.35**	**17.17**	**70**
37. Industry Boiler	49.12	7.42	**9**
38. Metal Proceeding Industry	21.96	40.97	**26**
39. Common Machine Industry	6.61	10.92	**11**
40. Machine Industry for Other Purpose	6.32	15.74	**15**
41. Agriculture and Forest Machine Industry	54.80	76.52	**9**
14. Transport Equipment	**32.71**	**39.17**	**12**
42. Railway Industry	66.30	66.36	**4**
43. Road Transport Equipment	42.23	40.72	**5**
44. Ships	47.46	43.65	**3**
15. Office, Accounting and Computing Machinery	**20.91**	**33.68**	**6**
45. Office, Accounting and Computing Machinery	20.91	33.68	**6**
16. Electrical Machinery and Equipment	**23.92**	**14.81**	**39**
46. Electrical Machinery and Equipment Industry	13.78	10.01	**11**
47. Lights and Bulbs	20.28	47.95	**2**
48. Electrical Household Appliances	52.06	28.20	**5**
49. Electronics and Telecommunication	59.43	13.22	**4**
50. Communication Equipment	35.36	39.77	**2**
51. Measurement Instruments	11.77	9.94	**15**
17. Other Manufacturing Products	**3.17**	**1.99**	**5**
52. Other Manufacturing Products	3.17	**1.99**	**5**
Total Manufacturing:	**32.80**	**21.49**	**297**

Sources: Value: IAS enterprises at the township level and above, p. 46.
Price: l and m enterprises at the township level and above, p. 46.

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