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Chinese Manufacturing Performance from Multilateral Perspective: 1980-2004*

Abstract Based on our research work of 1998, we discuss Chinese manufacturing performance from multilateral perspective in 1980-2004 through performing the comparison of labour productivity between China and its trade partners so as to better understand the problems of RMB exchange rate. We talk about Chinese manufacturing competitiveness through the multilateral comparison of PPPs, relative price levels, labor productivity and ULCs, with the PPPs being standardized according to the base year 1997. All of the results are compared with those in the year 1987. The following findings are presented: in Chinese manufacturing, the various PPPs in the base year 1997 are approximately 3.7 yuan/international $. After the middle 1980s, the relative price turns the lowest in all the five investigation countries. Furthermore, it is still trending downward. ULC is declining albeit the fluctuations. In the 1980s, there is no "catch-up" rapid growth in labor productivity. However, after 1992, it has shown a distinct "catch-up", though with the low level.

Keywords Multilateral comparison, Manufacturing, International competitiveness

JEL Classification O470, O570, F140

Introduction

The aims of this study are two-fold. The first objective of the study is to update our early study (Ren [12]) in 1998, in which the purchasing power parities (PPPs) are estimated for 1987 benchmark year. Ren [12] is the first effort to explore the international competitiveness of Chinese manufacturing in a multilateral comparison framework for the year 1987.

The current study explores Chinese manufacturing performance from a multilateral perspective in 1980-2004 based on the PPPs derived for 1997 benchmark year. Relative price levels, labor productivity, unit labor cost (ULCs) and international prices derived in a multilateral comparison are used to investigate Chinese manufacturing competitiveness.

Generally speaking the factors determining international competitiveness include price factors and

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non-price factors. The relative price level between the countries which is equal to PPP divided by exchange rate is the very important factor to price international competitiveness. Furthermore, the price competitiveness depends on the cost competitiveness which covers unit raw material cost and unit factor cost consisting of unit capital cost and unit labor cost. With international trade and capital inflow in China increasing, prices are in the process of equalization. Therefore, in international comparison, unit raw material cost difference and unit capital cost difference are accidental in making price competitiveness. Otherwise, unit labor cost difference is primary. To non-price competitiveness, productivity is very important. And scientific progress and technological innovation at most represent high productivity. In this paper, only labor productivity is computed and others such as TFP (total factor productivity) will be studied further. Therefore, the second objective of this study is to offer .the measurements of international competitiveness involving the international comparisons of price levels, productivities and costs which can be used to explore the RMB exchange rate issues in a real exchange rate framework.

Comparisons of output and productivity levels across countries require the conversion of output and factor inputs expressed at local currencies into a common valuation. In contrast to the case for expenditure prices, there is no internationally coordinated survey for collecting information on output and input prices. Generally, there are three alternatives for deriving output price relatives and input price relatives: exchange rates, the expenditure purchasing power parities and unit value ratios. The advantages and disadvantages of the various alternatives are discussed in Ark and Timmer [1].

A conversion of Chinese national income into dollars using purchasing power parities calculated from the expenditure side puts Chinese GDP in 1985 a factor 3.2 higher than an exchange rate conversion [11]. However, the expenditure-based PPPs are less suitable for sectoral comparisons of real output and productivity. For sectoral output and productivity comparisons the industry of origin PPPs are in order. Szirmai and Ren [19] compared the labor productivity in manufacturing between China and US for 1985 and built the time series of comparative labor productivity from 1980 to 1992 based on the unit value ratios (UVRs). The 1995 Industrial Census of China provided a new opportunity to carry out another benchmark study on the comparison between China and the other countries in manufacturing. Bai and Ren [2] have completed another benchmark study on PPP estimates and labor productivity comparison in manufacturing between China and US for 1995 by ICOP approach, while Ren and Bai [13] have completed another benchmark study between China and Germany for 1995 in the same framework.

These studies are based on the bilateral comparison, which have no transitivity. In order to explore China's competitiveness in manufacturing, we may need to compare China with other countries, especially China's trade competitors in terms of relative price levels, productivities and unit labor costs.

The paper is structured as follows. Section 2 outlines the methodologies for multilateral comparison. Section 3 deals with the ICOP database. We make use of multilateral aggregation of price data below the branch level to get branch PPP between USA and Germany for 1995. Section 4 provides a summary of multilateral comparison results using PPPs from those calculations, and these results are used to discuss international competitiveness of Chinese manufacturing industries. Section 5 offers the concluding remarks.

Multilateral Comparison Method

The Multilateral Comparison Method below the Branch Level

The multilateral comparison method below the branch level had been described in detail by Rao and Timmer [10]. This study considered two methods for multilateralisation such as CPD method and

EKS method, and then the EKS method is generalized. Here, only a brief outline of the EKS method is introduced. This section discusses how to compute PPPs at the branch level. The method is used to measure branches PPPs between USA and Germany for the year 1997.

The EKS method is designed to construct transitive multilateral comparisons from a matrix of binary comparisons derived using a formula which does not satisfy the transitivity. The EKS method in its original form uses the binary Fisher PPPs (F_{jk}: j,k=1,..M) as the starting point. The formula for the EKS index is given by

$$EKS_{kj} = \prod_{l=1}^{M} [F_{kl} * F_{lj}]^{\frac{1}{M}} \qquad (1)$$

The formula defines the EKS index as an unweighted geometric average of the linked comparisons between countries j and k using each of the countries in the comparisons as a link.

For the EKS method in (1), a major problem is that it gives equal weights to all linked comparisons $F_{kl} * F_{lj}$, effectively assuming that they are of equal reliability. In Rao [9] and Rao and Timmer [10], they show that some link comparisons are intrinsically more reliable than others. It is desirable to take this information into account when constructing the EKS multilateral indices.

In order to generalize the EKS method to incorporate weights to various linked comparisons involved in equation (1), it is necessary to look at the EKS method from a different angle. Suppose we wish to derive a set of index numbers I_{jk} which are transitive and minimize the log-distance from the Fisher indices, then we

$$\text{minimize} \quad \sum_j \sum_k (\ln I_{jk} - \ln F_{jk})^2 \qquad \text{subject to} \quad I_{jk} = I_{jl} * I_{lk}$$

The above problem can be restated as one findings $\Pi_1, \Pi_2, \cdots \Pi_m$, which minimizes

$$\sum_j \sum_k (\Pi_k - \Pi_j - \ln F_{jk})^2$$

(2)

Where, $I_{jk} = \dfrac{e^{\hat{\Pi}_k}}{e^{\hat{\Pi}_j}}$, where $\wedge$ shows that these are solutions to the minimization problem. The EKS index is related to the solution above as:

$$EKS_{jk} = \frac{e^{\hat{\Pi}_k}}{e^{\hat{\Pi}_j}}$$

(3)

Considering further equation (2), it is evident that $\hat{\Pi}$'s are the ordinary least squares estimators of Π's (which are the best linear unbiased estimators) in the following model specification. Moreover, the model discriminates between different pairs of countries using some indicators of reliability.

$$\ln F_{jk} = \Pi_k - \Pi_j + u_{jk} \qquad \text{With} \quad E(u_{jk}) = 0 \quad and \quad v(u_{jk}) = \frac{\sigma^2}{w_{jk}}$$

(4)

Where w_{jk} is a measure of reliability. If w_{jk} is large we consider that particular Fisher index, F_{jk}, to be reliable. Weighted EKS indices can be obtained by applying generalized least squares or ordinary least squares to (4).

$$\sqrt{w_{jk}} \ln F_{jk} = \sqrt{w_{jk}} \Pi_j - \sqrt{w_{jk}} \Pi_k + u_{jk}^*$$

$$\text{With} \quad E(u_{jk}^*) = 0 \quad and \quad v(u_{jk}^*) = \sigma^2 \qquad \forall j,k = 1,\cdots,M, j \neq k \qquad (5)$$

In Rao and Timmer [10], they consider two sets of weights for aggregation below the branch level, such as weights based on number of matches and weights based on Hill's distance function. In this study, we adopt the former weight system. A comparison between two countries for a given branch is considered to be more reliable if it is based on more matches. Let n_{jk} be the number of common products between j and k and n* the total number of items in the branch, then the formula is specified:

$$w_{jk} = \frac{n_{jk}}{n^*} \qquad \forall j,k, j \neq k; \qquad w_{jk} = 0 \qquad j = k \tag{6}$$

The Multilateral Comparison Method above the Branch Level

Pilat and Rao [7] had pursued an approach to construct multilateral comparisons of output and productivity within the ICOP conceptual framework and the bilateral comparison resulting from the ICOP studies. The study considered two methods for multilateralisation, the Geary-Khamis(GK) and the generalized TT index, also known as the CCD index in the literature. These two aggregation methods were applied to the data from some of countries covered in ICOP project to give a multilateral comparison among these countries.

The GK method has been most widely used as the principal aggregation method for international comparisons of real expenditure and was first proposed by Geary [5] and later pursued by Khamis [6]. It is based on the two concepts of "purchasing power parities" of currencies and "international (average) prices "of commodities. The G-K method defines these unknown parities and international prices using the following system of interdependent equations, for each currency j (1, 2,...., M) and commodity i (1, 2,.....,N):

$$PPP_j = \frac{\sum_{i=1}^{N} P_{ij} Q_{ij}}{\sum_{i=1}^{N} P_i Q_{ij}}, \qquad P_i = \sum_{j=1}^{M} \frac{P_{ij}}{PPP_j} \left[\frac{Q_{ij}}{\sum_{j=1}^{M} Q_{ij}} \right] \tag{7}$$

where: Pi = international price of commodity i;

Pij= price of commodity i in country j;

Qij= quantity of commodity i in country j;

PPPj= overall PPP for country j;

The generalized TT index was proposed by Caves, Christensen, and Diewert [3, 4] for temporal and spatial comparisons of prices, output and productivity. This index is defined in two stages. The first stage involves the computation of the standard TT index for binary comparisons. The TT index for j with country k as base is given by:

$$TT_{kj}^{p} = \prod_{i=1}^{N} \left[\frac{P_{ij}}{P_{ik}} \right]^{\frac{v_{ik}+v_{ij}}{2}}$$

(8)

where v_{ij} represents the value share of i-th commodity in country j.

However, the TT index does not have transitivity. Caves, Christensen, and Diewert [4, 5] proposed to obtain a generalized TT index through the application of the EKS techniques. The generalized TT index is usually referred to as the CCD index.

The CCD index for two countries j and k is given by :

$$CCD_{kj} = TT_{kj}^{G} = \prod_{j=1}^{M} [TT_{ki} * TT_{ij}]^{\frac{1}{M}}$$

(9)

The CCD index in (9) provides a PPP between country j's currency and that of country k. The CCD index for a pair of countries (k,j) is a simple geometric average of all indirect comparisons between country j and k, through a bridge country l.

Similar to the EKS method, the CCD index is a unweighted average of all TT indices. Therefore, Selvanathan and Rao [15] firstly put forward to weighted CCD index. They made use of the stochastic approach to generalize the CCD index.

Suppose we wish to derive a set of index numbers I_{jk} which are transitive and minimize the log-distance from the TT binary indices, then we

$$\text{minimize} \quad \sum_{j}\sum_{k}(\ln I_{jk} - \ln TT_{jk})^2 \qquad \text{subject to} \quad I_{jk} = I_{jl} \cdot I_{lk}$$

According to the same procedure as the generalized EKS method, the following model is specified:

$$\ln TT_{kj} = \Pi_j - \Pi_k + u_{kj} \quad \text{With} \quad E(u_{jk}) = 0 \quad and \quad v(u_{jk}) = \frac{\sigma^2}{w_{jk}} \qquad (10)$$

Where w_{jk} is a measure of reliability. Weighted CCD indices can be obtained by applying generalized least squares or ordinary least squares to (10).

$$\sqrt{w_{jk}} \ln TT_{jk} = \sqrt{w_{jk}}\Pi_j - \sqrt{w_{jk}}\Pi_k + u_{jk}^*$$

$$\text{With} \quad E(u_{jk}^*) = 0 \quad and \quad v(u_{jk}^*) = \sigma^2 \qquad \forall j,k = 1,\cdots,M, j \neq k \qquad (11)$$

Rao，Selvanathan and Pilat [8] considered a measure of reliability of the CCD model and introduced a weighting scheme which is linked to economic distance. The gap in GDP per capita may reflect the economic distance between the two countries.

Applying least squares to (11) gives the following equations to be solved:

$$\begin{bmatrix} 2\sum_{j\neq 1}^{M} w_{1j} & -2w_{12} & \cdots & -2w_{1M} \\ -2w_{21} & 2\sum_{j\neq 2}^{M} w_{2j} & \cdots & -2w_{2M} \\ \vdots & \vdots & \cdots & \vdots \\ -2w_{M1} & -2w_{M2} & \cdots & 2\sum_{j\neq M}^{M} w_{Mj} \end{bmatrix} \begin{bmatrix} \hat{\Pi}_1 \\ \hat{\Pi}_2 \\ \vdots \\ \hat{\Pi}_M \end{bmatrix} = \begin{bmatrix} -2\sum_{j\neq 1}^{M} w_{1j} \ln TT_{1j} \\ -2\sum_{j\neq 2}^{M} w_{2j} \ln TT_{2j} \\ \vdots \\ -2\sum_{j\neq M}^{M} w_{Mj} \ln TT_{Mj} \end{bmatrix} \qquad (12)$$

The computing steps for the weighted EKS method in Rao and Timmer [10] can be applied to weighted CCD index numbers which take into account measures of reliability. The Fisher index is transferred to the TT index. The study uses these steps to complete the weighted CCD index.

The Data Sources

The multilateral comparison in this study involves the multilateral comparison of China with other countries covered in ICOP project at the third level of aggregation, the manufacturing branch, following the approach suggested by Pilat and Rao [7]. The reasons for this choice were given in the above mentioned reference. The other countries being the participating countries in the multilateral comparison were selected by the two criteria: ICOP studies provided the detailed comparisons for this country; and this country should be the major party in the world market and the major trade partner of China as well. In this stage, Japan, Germany, US, UK, and Korea are selected as the participants in this multilateral comparison because the similar industries of origin comparisons have been made for these countries. The data used in the current study contain PPPs from binary comparisons and Gross Value of Outputs (GVOs) of all branches in six countries.

The branch level PPPs from the binary comparisons in ICOP exercise are the price data for the multilateral methods. PPPs for Japan and UK for the 1997 bench year come from O'Mahony and van Ark CD-ROM[1], and Korean from Stuivenwold and Timmer [18]. The data sources for China are the recent studies in ICOP framework [2]. The base country of these binary comparisons is USA.

But there are no PPPs between Germany mark and USA dollar, and fortunately Ren and Bai [13] measure PPPs between Germany mark and China RMB yuan for the 1995 benchmark year. Therefore, we estimated branch PPPs between Germany mark and USA dollar based on the binary comparison between Germany mark and China RMB yuan, and the binary comparison between China RMB yuan and USA dollar by the generalized EKS method.

The branch GVOs is used in combination with the PPPs to derive quantity data implicitly. The branch GVOs in China come from 1997 Input-output table in China, the branch GVOs in USA come from 1997 industry census, and the branch GVOs in Germany come from OECD Structural Analysis database[2]. The data in the other three countries are from International Yearbook of Industrial Statistics [20].

The Results of Multilateral Comparison on International Competitiveness of Chinese Manufacturing Industries

PPPs of Multilateral Comparison in 1997

The multilateral procedures described above were applied to the data. For GK method, this study, according to formula (3) and (4), applies MATLAB software to arrive at the PPPs. For TT method, this study solve for PPPs by EXCEL, covering TT binary index, CCD index (or generalized TT index) and weighted CCD index. Rao，Selvanathan and Pilat [10] considered a measure of reliability of the CCD model and introduced a weighting scheme which is linked to economic distance. The gap in GDP per capita[3] may reflect the economic distance between the two countries. So the reciprocal of the gap was thought of as weight, and the formula is

$$w_{kj} = \frac{1}{\left|\ln E_j - \ln E_k\right|} \tag{13}$$

Where E_j represents GDP per capita in country j. This implies that the actual price differences exhibit more variation if the countries are at very different levels of development, and then weight is less. At last, weighted CCD procedure are applied to the weight matrix and TT binary index to arrive at weighted CCD index.

The empirical results are presented in the table 1 which shows the binary and multilateral PPPs for

[1] See http://www.ggdc.net/index-dseries.html#top。

[2] For the detail data, see http://www.oecd.org/document/15/0,2340,en_2825_495649_1895503_1_1_1_1,00.html。

[3] In Rao，Selvanathan and Pilat’s study（1995）, real per capita incomes are adopted.

1997 as well as the exchange rate.

Table 1 Binary and Multilateral PPPs in Manufacturing, 1997

	Binary PPPs (nat.cur./U.S.$)		Multilateral PPPs(nat.cur./int.$)			exchange rate
	Fisher	TT	G-K	CCD（Generalized TT）	weighted CCD	nat.cur./U.S.$
US	1	1	1	1	1	1
UK	0.70	0.72	0.65	0.72	0.73	0.611
Germany	1.36	1.44	1.36	1.46	1.43	1.734
Japan	153.60	153.44	152.28	154.53	153.75	120.991
Korean	882.30	893.24	905.05	896.43	894.54	951.289
China	4.42	3.80	3.66	3.75	3.74	8.290

Source: a. exchange rate comes from IMF, international financial statistics (http://ifs.apdi.net/imf/)

b. Fisher PPPs from table 1, other PPPs from computing.

In table 1, using US as the base country, the PPPs are far below the exchange rate between China and US, a little below against to exchange rate in Germany and Korean cases, and above compared to exchange rates between UK and US as well as between Japan and US. Reflecting the main feature of the model, weighted CCD indices are closer to the TT binary indices than the CCD index for all the developed countries (except UK). The findings is similar to Rao，Selvanathan and Pilat’s [10].

PPPs from 1979 to 2004

The PPPs in manufacturing in 1997 are separately extrapolated to other years (1980-2004) using deflators from both countries' data sources. The detailed deflators specified for each industry on Chinese side are the industrial producer price index (these in 1979-1999 from Ren, Szirmai, and Bai [14], 2000-2004 from industrial producer price indices in *China Statistical Yearbook, various issue* [16, 17]) while the detailed deflators specified for each industry on the other five countries’ side are the value added deflators (Sources see O'Mahony and van Ark (2003) CD-ROM). Finally, making using of the above data, the study adopts the results of GK method and TT index method to extrapolate PPPs for manufacturing in six countries in 1997 to the whole period of 1980-2004. PPPs for manufacturing in China are listed in the table 2:

Table 2 Multilateral PPPs for manufacturing in China, 1980-2004

year	GK-PPP	CCD-PPP	year	GK-PPP	CCD-PPP
1979	1.729	1.767	1992	2.366	2.418
1980	1.665	1.702	1993	2.864	2.927
1981	1.610	1.645	1994	3.360	3.433
1982	1.522	1.555	1995	3.788	3.871
1983	1.536	1.570	1996	3.770	3.852
1984	1.532	1.565	1997	3.660	3.740
1985	1.663	1.699	1998	3.358	3.432
1986	1.649	1.685	1999	3.189	3.259
1987	1.792	1.831	2000	3.260	3.331
1988	1.987	2.031	2001	3.122	3.191

1989	2.238	2.287	2002	3.074	3.141
1990	2.245	2.294	2003	3.067	3.134
1991	2.285	2.335	2004	3.065	3.132

Based on the table 2, the PPPs derived by GK method were used to analyze relative price levels, labor productivity and unit labor cost.

Relative Price Levels of Manufacturing Industries

One way to measure the competitiveness of one country's manufacturing sector is to show the differences in prices for similar products between countries. This measure of competitiveness is certainly more important for China than the comparative productivity levels. GK-PPPs are used to compute relative price levels, which equal to PPP divided by exchange rate. If the PPP of manufacturing of a country is below the exchange rate its relative price level will be lower than the country under comparison. This indicator implies that the country with lower relative price levels can compete on favorable positions with the country in question in the world market. The relative price levels in manufacturing are shown in table 3.

Table 3 Manufacturing Price Levels in Six Countries, 1980-2004 (USA=100)

	UK	Germany	Japan	Korean	China
1980	115.651	80.527		92.226	111.151
1981	104.041	64.037		91.255	94.445
1982	90.542	59.272		85.791	80.430
1983	82.755	58.545		86.669	77.747
1984	73.813	52.046		85.194	66.024
1985	74.531	51.391		81.734	56.615
1986	85.057	70.842		79.814	47.751
1987	99.629	87.480		89.128	48.135
1988	108.495	87.712		104.730	53.394
1989	100.837	78.058		111.657	59.447
1990	110.444	90.159	141.183	105.088	46.926
1991	106.966	86.306	147.189	108.487	42.932
1992	106.510	92.331	151.274	105.234	42.906
1993	91.334	86.180	165.949	107.218	49.713
1994	94.233	85.998	172.038	111.114	38.980
1995	100.619	97.389	177.600	122.159	45.360
1996	101.071	93.220	145.136	113.276	45.345
1997	106.412	78.429	125.861	95.139	44.151
1998	104.730	76.030	111.135	70.873	40.562
1999	100.020	72.421	120.922	73.654	38.525
2000	94.861	61.770	119.964	70.446	39.378
2001	89.963	59.436	100.570	59.091	37.722
2002	92.172	64.542	97.037	61.044	37.128
2003	102.303	76.038	101.206	62.481	37.040
2004	112.661	79.442	101.019	61.217	37.021

Shown in the table 3, in the early 1980s, relative price levels in Germany compared to US have been the lowest in all five countries while since the middle 1980s, relative price levels in China have been the lowest in all five countries. Furthermore, it has a downward tendency except two exceptions, because exchange rate in 1994 depreciated by a large scale, but PPP in 1994 rose a little. In the recent year, Chinese manufacturing showed improved price competitiveness but its downward tendency is very smooth.

Multilateral Comparison of Labor Productivity in Manufacturing

In Szirmai and Ren [19] an effort was made to derive a time series of labor productivity of Chinese manufacturing. The most important finding is the absence of significant change in aggregated Chinese relative labor productivity in manufacturing between 1980 and 1992.

GK-PPPs in the base year 1997 are taken as the currency converters and used to compute comparative labor productivity. Because the estimates derived by GK method are transitive and invariance with respect to the base country, it is legitimate to compare any pair of countries among the six countries in the multilateral comparison in 1997. Table 4 serves to put Chinese manufacturing productivity performance in an international perspective from 1980 to 2004:

Table 4 China Labor Productivity in Manufacturing, 1980-2004

year	China				
	USA=100	UK=100	Germany =100	Japan =100	Korea =100
1980	6.816	10.914	6.215		4.997
1981	6.483	10.549	6.346		6.059
1982	6.605	10.159	6.454		7.076
1983	6.252	9.659	6.409		7.897
1984	6.077	9.352	6.355		7.796
1985	6.246	9.570	6.521		8.816
1986	6.345	9.317	6.690		8.805
1987	5.993	8.929	6.932		9.536
1988	6.099	8.927	7.100		11.027
1989	5.973	8.485	6.615		11.691
1990	5.799	8.095	6.303	8.637	10.990
1991	6.176	8.206	6.537	8.897	13.841
1992	7.019	9.162	7.247	10.629	16.952
1993	9.498	11.935	10.033	14.927	24.768
1994	8.239	10.358	8.441	13.469	23.259
1995	6.939	9.007	7.132	10.805	21.125
1996	8.431	11.050	8.654	12.316	23.018
1997	9.362	12.453	9.296	13.460	22.897
1998	10.222	13.589	9.902	15.002	27.039
1999	12.218	16.117	12.288	17.753	18.449
2000	14.626	19.159	14.617	20.047	14.990
2001	19.078	23.524	18.101	24.800	17.938
2002	21.879	28.035	22.365	30.049	20.705
2003	25.557	33.417	27.007	36.316	24.530
2004	25.384	33.291	26.397	36.895	24.429

Sources: Data are from labor productivity studies for various countries. The data for China from 1980 to 1999 come from Ren, Szirmai and Bai [14]. For data from 2000 to 2004, the paper adopts method used in Ren, Szirmai and Bai [14] to estimate them. For other countries, the data from 1979 to 2001 come from O'Mahony and van Ark (2003) CD-ROM. And data for USA in 2002-2004 are from BEA（http://www.bea.doc.gov/bea/dn2/home/annual_industry.htm). Other data are from Annual National Accounts of OECD.

From the table 4, the findings obtained so far concluded that Chinese manufacturing in the 1980s and 1990s was characterized by extremely rapid growth of production, but no decrease in the productivity gap between the world productivity leader, the United States and China in the 1980s. And from 1992, productivity gap between US, UK, Germany and Japan has gradually declined. Especially in 21 century, “catch up” is more distinct. In 2004, compared with labor productivity in USA and Germany, the productivity in China has increased four times than the levels in 1980, arriving at 25% and 26%, respectively. Compared with UK, it has increases three times, reaching 33%. Compared with Japan, it has increased four times as much as the level in early 1990s, arriving at 37% .It shows that “no catch up” process has ended in the 1990s. But compared with Korean, Chinese manufacturing show “catch up” at the beginning of 1980, and until 1999, this tendency had ended because labor productivity in Korean has an extremely rapid growth in 1999 and 2000, especially in office, accounting and computing machinery, electrical machinery and instruments industry.

Unit Labor Cost

The estimates of branch PPPs and productivity levels in manufacturing provide a possibility to explore competitiveness in Chinese manufacturing from the cost perspective, namely unit labor costs (ULC). For comparing ULC, the labor costs per employee for six countries need to be collected. Japan is excluded from the comparisons of ULC because of no data for Japan,. The data for US, UK and Germany are from O'Mahony and van Ark (2003) CD-ROM. The data for Korean are from Stuivenwold and Timmer [18] while the data for China are from 1985 and 1995 Industrial Censuses, China Industrial Economy Statistics Yearbook, China Labor and Wage Statistics Yearbook, and China Statistics Yearbook. In this connection, the labor costs refer to total compensation, i.e. including wages and salaries before tax, employer's social security contributions, contributions to pensions, insurance and health, and other expenses related to employment.

Estimates of total compensation per employee and labor productivity for the benchmark years during 1980-2001 were used to estimate the ULCs in Chinese currency. These were converted to ULCs in US dollars by the following formula:

$$ULC^{X(U)} = \frac{(LCH^{X(X)}) / ER^{XU}}{(OH^{X(X)}) / PPP^{XU}} \quad (14)$$

where ER^{XU} is the exchange rate between country X and U, PPP^{XU} is the manufacturing PPP between country X and U, $LCH^{X(X)}$ are the labor costs per person in country X in prices of X, and $OH^{X(X)}$ is value added per person in country X in its own prices. ULCs of the other countries' manufacturing in US dollars were compared with ULCs in US manufacturing in Table 5.

Table 5 Relative Unit Labor Costs in Manufacturing as % of The United States, 1980-2001

year	US	UK	Germany	Korean	China
1980	100	116.396	76.311	9.888	34.914
1981	100	108.250	62.909	12.960	29.620
1982	100	91.549	57.214	14.161	25.070

1983	100	81.797	56.323	17.298	24.576
1984	100	73.931	51.265	18.358	23.761
1985	100	73.369	48.814	18.140	19.488
1986	100	82.081	66.332	18.995	17.295
1987	100	99.028	88.440	24.710	17.390
1988	100	108.391	90.167	36.478	19.888
1989	100	99.054	80.272	42.460	23.486
1990	100	111.646	92.820	42.762	19.827
1991	100	111.430	88.959	55.995	20.072
1992	100	110.570	98.107	61.846	19.571
1993	100	93.281	94.392	70.880	14.938
1994	100	94.942	94.733	84.410	14.088
1995	100	103.088	111.537	114.070	20.369
1996	100	103.181	107.046	111.638	18.583
1997	100	110.066	89.153	85.543	17.217
1998	100	111.230	83.935	62.906	18.023
1999	100	108.696		43.195	15.856
2000	100	99.491		32.368	13.922
2001	100	94.119			11.906

From the table 5, it is interesting to note that ULCs are declining from 1980 through 2001 between China and US, although there are some fluctuations. But Korea is in the opposite case. Other countries have no an obvious tendency. Compared with Korea, China has lower ULCs. Moreover, the table 5 shows that the gaps between the ULCs of Chinese and American manufacturing increased from 1980 to 1987 and then declined from 1987 to 1992. And then in 1993 and 1994, The RULC (relative ULC) of Chinese manufacturing reached the lowest level due to the big gaps in comparative labor productivity and overvalued exchange rate. After 1995, the gap between the ULCs of Chinese and American manufacturing had increased, because comparative labor productivity had increased and exchange rate had no change. The trends in comparative labor costs are determined not only by changes in labor costs, but also by changes in exchange rate as well as changes in comparative labor productivity.

Conclusions

This paper explores Chinese manufacturing performance from multilateral perspective in 1980-2004. The PPPs, relative price levels, labor productivity, ULCs and international prices in multilateral comparison are used to investigate Chinese manufacturing competitiveness. The PPPs are based on the base year 1997. Particularly, the weighted CCD index is applied to empirical analysis on multilateral comparison.

The PPPs and productivity measurements of Chinese manufacturing in a multilateral comparison were derived based on the PPPs from the ICOP type binary studies. These findings can be used to explore the trade performance of China with its main trade partners. The findings derived from this multilateral comparison can be summaries as follows:

Firstly, the various PPPs in the base year 1997 are computed, such as GK PPPs, TT binary PPPs, CCD PPPs and weighted CCD PPPs. The results are approximately 3.7 yuan/international $ and the weighted CCD indices are closer to the TT binary indices than the CCD index for all the developed countries (except UK). The paper extrapolates PPPs for manufacturing in six countries in the base year 1997 to 1980-2004.

Secondly, since the middle 1980s, relative price levels in China have been the lowest in all five countries. Furthermore, it has a downward tendency except two exceptions, because exchange rate in 1994 depreciated by a large scale, but PPP in 1994 rose a little. In the recent year, Chinese manufacturing showed improved price competitiveness but its downward tendency is very smooth.

Thirdly, China is characterized by very low labor productivity in manufacturing, characteristic of a labor surplus economy. Manufacturing in China has the lowest labor productivity in all six countries in 1997, only accounting for 9.139% in USA. Comparison with Korea gives the highest ratio, which is 22.138% It confirms our earlier findings (Szirmai and Ren [19]) that Chinese labor productivity is extremely low from an international comparative perspective. It should be emphasized that low labor productivity is the logical result of economically efficient labor intensive factor proportions in a labor surplus economy.

Fourthly, Chinese manufacturing in the 1980s and 1990s was characterized by extremely rapid growth of production, but the comparison of labor productivity between 1980 and 1990 has shown that no catch-up process occurred between China and the U.S. and Germany. And from 1992, productivity gap between US, UK, Germany and Japan has gradually declined. In 2004, compared with labor productivity in USA and Germany, the productivity in China has increased four times than the levels in 1980, arriving at 25% and 26%, respectively. Compared with UK, it has increases three times, reaching 33%. Compared with Japan, it has increased four times as much as the level in early 1990s, arriving at 37% .It shows that “no catch up” process has ended in the 1990s.

Finally, ULCs are declining from 1980 through 2001 between China and US, although there are some fluctuations. Moreover, compared with Korea, China has lowest ULCs.

The comparison of labor productivity is useful but only part of the story. An explanation of the huge gaps between China and other countries would certainly provide new insights on policies aiming to improve productivity levels. For this respect it would be very helpful to have estimates of the stock of capital in manufacturing sector by the perpetual inventory method. The total factor productivity between China and others countries in a KLEMS framework would be more useful for exploring China’s international competitiveness at industry level further.

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