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COMPARATIVE LABOUR PRODUCTIVITY IN THE CHINESE AND US MANUFACTURING: COULD STRUCTURAL CHANGES EXPLAIN THE GAP?

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ABSTRACT

Development policies and institutional arrangements in the former centrally-planned economies that are undergoing market oriented transition have made important roles in shaping industrial structures in these economies. Using the shift share approach to decompose the *intra*branch productivity and *inter*branch resource shift effects upon the aggregate labour productivity performance, this study examines the long-run effect of structural changes on the labour productivity growth and catch up with the world's productivity leader USA in the Chinese manufacturing. Its main findings show that the structural effect from the forced heavy industrialisation policy at the early stage of industrial development did make a positive contribution to the labour productivity growth, but it was not sustainable in the long run. Such a development was followed by a labour productivity stagnation. The "structural correction" effect are found following the market-oriented reform and the open door policy, which improved the labour productivity performance. Catch up in labour intensive industries are the main driving forces behind the labour productivity convergence with the USA.

1. INTRODUCTION

It has widely been observed that economic growth is usually accompanied by structural changes, especially at the early stages of industrialisation. Demand and supply side effects are able to explain such a correlation from different perspectives. On the demand side, largely attributed to Engel effects, income growth causes changes in the composition of domestic demand and hence production. On the supply side, the reallocation of labour and capital from the traditional to modern sectors, as explained in the classical models of "dual economic development" (Lewis, 1954; Fei and Ranis, 1964 and 1976), or from traditional to modern branches within a sector, can benefit growth, because it makes more productive use of resources.

Such a structural transformation is, however, by no means uniform across countries because it can heavily be influenced by the resource endowments and the initial structure of the economy, and more importantly, by the choice of development policies as well as institutional arrangements. In extreme cases, as argued by some researchers (Chenery, Robinson and Syrquin, 1986), large structural changes may have little or no effect on income growth. In a recent study by Timmer (1999) on the manufacturing performance of selected Asian economies, the "structural bonus" hypothesis is generally rejected in explaining the growth of labour productivity in these economies in both absolute and comparative terms.

The government development policies and institutional arrangements have strongly affected the economic structure in the former centrally planned economies such as that of China, both in the period of forced industrialisation under the central planning and in the period of economic transition towards a market system. It is interesting to find out whether, to what extent and in what direction the structural changes in such economies have affected productivity performance.

Using the author's newly established time series data on value added and labour input for major manufacturing branches for the period 1952-97, this study investigates the effect of structural changes upon labour productivity performance in the Chinese manufacturing in both absolute and comparative terms, with the latter using the US manufacturing as the reference.

The main findings of this study are summarised as follows: 1) China's forced heavy industrialisation in the 1950s brought about significant structural changes that contributed to an ever-fast growth of labour productivity in manufacturing. This was, however, not sustainable in the long run likely because such a development strategy was not in line with China's comparative advantage. The "structural bonus" to the labour productivity growth disappeared for most of the central planning period, even though structural changes still skewed towards heavy industries; 2) significant "corrections" to the structural distortions developed under the central planning appeared in the early stage of China's transition towards a market system and made an important contribution to the labour productivity growth; 3) industries where China has no comparative advantage were found largely responsible for the productivity gap between the Chinese and US manufacturing; and 4) labour intensive industries were the main driving force behind the productivity catch up after the market-oriented reform.

With the capital data for the Chinese manufacturing absent, we are, however, unable to investigate why the labour productivity level and growth are different across manufacturing branches between the two economies. We realise the deficiencies in our partial productivity analysis. But the deficiencies should not significantly discount the labour productivity approach especially for a *long-run* analysis because the growth in the long-run could not be driven by the growth of industries with low labour productivity.

This paper is structured as follows. The next section reviews the theoretical and empirical background to the problem. Section 3 presents the methodologies that are used in decomposing the labour productivity growth and the labour productivity gap with a benchmark economy into the *intra*branch and structural effects. Section 4 deals with data sources and problems. Section 5 discusses the results. The last section gives some concluding remarks.

2. THE THEORETICAL AND EMPIRICAL BACKGROUNDS TO THE ISSUE

It is easy to understand why in a market system structural changes can benefit growth. This is because without policy and institutional restrictions or barriers to resource mobility, resources will shift to the industries where they can get a better marginal return. In the classical models of "dual economic development" (Lewis, 1954; Fei and Ranis, 1964 and 1976), this is formulated and applied to an open, labour surplus, developing economy where labour shift from the rural traditional sector with low labour productivity to the urban modern sector with high labour productivity promotes industrialisation.

This can also be applied to manufacturing. During industrialisation the most dynamic sector is manufacturing. This is mainly because manufactured goods have relatively high income elasticity of demand, they are highly tradable and have greater potential gains from specialisation and economies of scale. Manufacturing growth is also one of the main sources of technological progress and hence driving the productivity growth of an economy. Therefore, as found in many studies the substantially rising share of manufacturing is almost a universal feature of structural transformation at the early stages of industrialisation (Kuznets, 1971; Chenery, Robinson and Syrquin, 1986).

Growth is expected to be unbalanced within the manufacturing sector particularly during the early industrial development. Typically, investment goods industries are the fastest growing industries, followed by heavy intermediate goods industries and then light industries that mainly produce consumer goods. This is largely due to the significant growth of the share of intermediate demand in total production during industrialisation (Nishimizu and Robinson, 1984). Therefore, the observed rapid output and productivity growth in manufacturing are benefited from structural changes within the manufacturing sector, that is, the resource shift from manufacturing industries with low and slow growing productivity to those with high and fast growing productivity.

Under the Soviet style central planning system adopted by China, the government chooses development policies with supporting institutional arrangements to serve its overriding goal (exogenously given) of a rapid heavy industrialisation. Resources are forcefully mobilised via administrative channels to heavy industries, which inevitably have a strong effect on the structure of manufacturing. At the initial stage of this type of development, the fast expansion of the heavy machinery and intermediate inputs manufacturing is likely to result in a rapid increase in aggregate manufacturing labour productivity. But sectoral and industrial interdependence imposes certain constraints, which if violated may retard growth. The crucial problem is, as aptly summarised by Kuznets (1961), how to extract agricultural surplus for the financing of capital formation necessary for industrialisation without at the same time harming the growth of agriculture, under conditions where no other capital resource is available.[1]

Compared with a market-driven industrial development the Soviet-style heavy industrialisation is more likely to suffer a severe imbalance problem. On one hand, it requires more surplus from agriculture, typically through price discrimination and institutional arrangements that harm farmers' work incentives. On the other hand, it suffers from worsening inefficiency problem not only because the investment is made not in line with the comparative advantage of the country, but also due to restrictions imposed on labour mobility. One may therefore postulate that the productivity gain from the initial heavy manufacturing development under the central planning may not be sustainable in the long run. Typically, after this stage labour productivity growth will stagnate and further structural changes will make little contribution to the productivity growth.

If this is the case, it is reasonable to argue that market-oriented reforms in centrally planned economies may have the following effects. At the early stage of the reform, the marketisation of economic activities and opening up to foreign trade and investment may have a significant correction effect upon the structure of manufacturing developed under the central planning. New investment, mainly made by the non-state sectors, will certainly concentrate on labour intensive, light manufactures where China has comparative advantage and hence large export potential. This "structural correction" will benefit both aggregate and per capita output growth. But its effect on the latter may be moderate because the labour-intensive nature of the development. The structural effect on manufacturing labour productivity growth is expected to decline as the structure of manufacturing matures or converges with that of industrialised economies.

A further question is whether structural changes through the central planning and transitional periods could explain the manufacturing labour productivity gap between China and the world's productivity leader USA. Comparative studies at manufacturing branch level with the USA using the industry-of-origin PPP approach[2] have found that the post-war Japanese, South Korean and Taiwanese economies all

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[1] For a good review of this problem see Johnston (1970) and Meier (1984).

experienced a significant catch-up (Pilat, 1994; Timmer and Szirmai, 1997). However, although the catch up was accompanied by a significant structural convergence to that of the USA, structural changes are found to be able to explain little of the catch up (Timmer, 1999). That is, *Intra*branch productivity improvement rather than *inter*branch resource shift (restructuring) plays the main role in the productivity catch up.

Compared with these economies, it is unquestionable that the post-war Chinese economy differs distinctly in both social and economic settings. It has experienced several radical institutional and policy shifts that have brought about significant structural effects. The question is whether such policy-induced structural changes, which will certainly affect China's social and technological capability for catch up (Abramovitz 1989), could explain China's manufacturing productivity gap with that of the USA.

Furthermore, if there is a catch up, what industries or industry branches are the main driving forces behind the catch up for China. In study on the Asian newly industrialised economies, Dollar and Wolff (1993) suggest that the catch up in labour-intensive industries is the main driving force behind the productivity convergence for all manufacturing, whereas Timmer (1999) argues that catch up in capital-intensive industries, rather than labour-intensive industries has been most important in this respect, because of the high share of heavy industries in manufacturing.

In the case of a transitional economy, it may be, however, argued that productivity improvement is unlikely to take place equally in all industries even if they are liberalised at the same time and to the same extent. So the "share effect" may not be a valid explanation. With deregulation and decentralisation measures following the reform, industries with comparative advantage and export potential will grow faster than those without such conditions. This means that compared with capital-intensive manufacturing, labour-intensive manufacturing may enjoy faster total output growth, though not as fast in per capita terms. Besides, difficulties often encountered in the reform of state-owned enterprises (SOEs) that traditionally concentrate on

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[2] Also known as the ICOP PPP approach developed by the International Comparison of Output and Productivity project at the University of Groningen. See Maddison and Ark for details (1988).

heavy industries under the central planning may discount the effect of market forces on the productivity growth of heavy industries.

Due to data problems there has been a lack of empirical study for China on the structural effect upon manufacturing labour productivity growth and catch up, especially in the long run. The only studies are by Szirmai and Ren (1995) and Timmer (1999). Szirmai and Ren estimate PPP for China's major manufacturing branches and find no aggregate labour productivity catch up with that of the USA in 1980-92. Using the PPP estimates by Szirmai-Ren, Timmer decomposes China's manufacturing labour productivity growth and difference with the USA into *intra*branch and structural effects. His result shows that in absolute terms China's labour productivity growth was mainly (95 per cent of the total change) due to *intra*branch effect and, in comparative terms, China's productivity gap with the USA stayed unchanged because the *intra*branch and structural effects, both insignificantly small (1 per cent), were completely cancelled off by each other. In Timmer's study, however, China is not given a special consideration as a transitional economy.

3. METHODOLOGY

This section presents the methodologies used in our empirical investigation into the relationship between structural changes and labour productivity growth and catch up in the Chinese manufacturing.

Firstly, we shall examine how different (similar) China's manufacturing structure is in comparison with that of the USA. This is important for the understanding of the structural difference between the two economies, and in some sense it can also suggest how "mature" the Chinese manufacturing is with that of the USA as the reference. Let *S* be the share in either output *Y* (gross value added) or employment *L*, subscripts *i* (*i*=1, 2, … *n*) and *t* (*t*=1, 2, … *m*) be manufacturing branch and time, respectively, and superscripts CN and US be China and the USA, the structural similarity index λ can be given as follows. The output (value added) structure similarity index with the USA in the current period *m* as the benchmark is defined as

$$\lambda_t^{Y(\text{CN,US})} = \frac{\sum_{i=1}^{n} S_{i,t}^{Y(\text{CN})} S_{i,m}^{Y(\text{US})}}{\left[\sum_{i=1}^{n} \left(S_{i,t}^{Y(\text{CN})}\right)^2 \sum_{i=1}^{n} \left(S_{i,t}^{Y(\text{US})}\right)^2\right]^{1/2}} \tag{1}$$

and the employment structure similarity index with the USA in the current period *m* as the benchmark is defined as

$$(2) \qquad \lambda_t^{L(\mathrm{CN,US})} = \frac{\sum_{i=1}^{n} S_{i,t}^{L(\mathrm{CN})} S_{i,m}^{L(\mathrm{US})}}{\left[\sum_{i=1}^{n} \left(S_{i,t}^{L(\mathrm{CN})}\right)^2 \sum_{i=1}^{n} \left(S_{i,t}^{L(\mathrm{US})}\right)^2\right]^{1/2}} \ .$$

The index varies between zero and one, and is close to one in case of greater similarity in the structures of the two economies. In extreme case, if China and the USA have the same production structure, the index will equal to one, and if the two countries have completely different structure or each country entirely specialises in a different industry or branch, the index will equal to zero.

Secondly, to investigate the structural effect on labour productivity growth we decompose the labour productivity change over a given period by following the shift-share method pioneered by Fabricant (1942) and used in recent studies like Timmer (1999). Let *Y* and *L* denote output and employment, respectively, *y* and *l* the labour productivity level and the branch share in total employment, respectively, and subscripts *i* (*i*=1, 2, … *n*) and *t* (*t*=0, 1, 2, …) manufacturing branch and time, respectively. Then aggregate labour productivity *y* at time *t* can be written as:

$$(3) \qquad y_t = \frac{Y_t}{L_t} = \sum_{i=1}^{n} \frac{Y_{i,t} L_{i,t}}{L_{i,t} L_t} = \sum_{i=1}^{n} y_{i,t} l_{i,t} \ .$$

Then the difference in aggregate labour productivity level at time 0 and *t* can be given as:

$$(4) \quad y_t - y_0 = \sum_{i=1}^{n} (y_{i,t} - y_{i,0}) l_{i,0} + \sum_{i=1}^{n} (l_{i,t} - l_{i,0}) y_{i,0} + \sum_{i=1}^{n} (l_{i,t} - l_{i,0})(y_{i,t} - y_{i,0}) \ .$$

Dividing both side of Equation 4 by y_0 it follows that aggregate productivity growth can be decomposed into the *intra*branch productivity growth effect (the first term on the right-hand side) and the effects of structural changes which consist of a static shift effect (the second term) and a dynamic shift effect (the third term). Whereas the static shift effect measures the amount of labour productivity growth caused by a shift of labour towards branches with a higher labour productivity level at the beginning of the period, the dynamic shift effect captures the amount of labour productivity growth due to a shift towards more dynamic branches, that is branches with higher labour productivity growth rates.

Thirdly, to investigate the effect of structural differences on labour productivity gaps we follow the approach used in Timmer (1999) that modifies the above shift-share method by Fabricant (1942). The labour productivity gap between China and the reference country USA can be examined in both interspacial and intertemporal perspectives. Using the symbols denoted previously, the labour productivity gap in an interspacial perspective could be defined as:

(5)
$$y^{(\mathrm{US})} - y^{(\mathrm{CN})} = \sum\nolimits_{i=1}^{n} (y_i^{(\mathrm{US})} - y_i^{(\mathrm{CN})}) \frac{1}{2} (l_i^{(\mathrm{CN})} + l_i^{(\mathrm{US})}) + \\ + \sum\nolimits_{i=1}^{n} (l_i^{(\mathrm{US})} - l_i^{(\mathrm{CN})}) \frac{1}{2} (y_i^{(\mathrm{CN})} + y_i^{(\mathrm{US})})$$

In Equation 5, the difference between China and the USA in labour productivity is decomposed into two parts, *intra*branch productivity differentials and static structural differentials, instead of three as in Equation 4. This is because in an interspacial context, the dynamic shift effect has no straightforward interpretation. Equation 5 follows the same principle as in Equation 4 except for a base-invariant treatment to each term on the right-hand side.[3]

If China and the USA have the same branch productivity, the first term of the right-hand side of the Equation 5 will be zero, so the differences in structures can explain the entire gap in labour productivity. If China and the USA do not differ in their employment structure, the second term will be zero and the total productivity differential is solely due to *intra*branch productivity differentials.

To examine structural effect on labour productivity catch up, that is, the changes in the labour productivity gap over time, we can modify Equation 5 by incorporating an intertemporal analysis as follows:

(6)
$$\frac{y_t^{(\mathrm{CN})}}{y_t^{(\mathrm{US})}} - \frac{y_0^{(\mathrm{CN})}}{y_0^{(\mathrm{US})}} = \frac{y_0^{(\mathrm{US})} - y_0^{(\mathrm{CN})}}{y_0^{(\mathrm{US})}} - \frac{y_t^{(\mathrm{US})} - y_t^{(\mathrm{CN})}}{y_t^{(\mathrm{US})}} \\ = \left(\frac{\alpha_0}{y_0^{(\mathrm{US})}} - \frac{\alpha_t}{y_t^{(\mathrm{US})}} \right) + \left(\frac{\beta_0}{y_0^{(\mathrm{US})}} - \frac{\beta_t}{y_t^{(\mathrm{US})}} \right),$$

3 That is, the second factor of each term on the right-hand side takes the average of the values of the two countries instead of the value of either country (Timmer, 1999, p.110).

where $\alpha = \sum_{i=1}^{n}(y_i^{(US)} - y_i^{(CN)})\frac{1}{2}(l_i^{(CN)} + l_i^{(US)})$ and

$$\beta = \sum_{i=1}^{n}(l_i^{(US)} - l_i^{(CN)})\frac{1}{2}(y_i^{(CN)} + y_i^{(US)}).$$

In Equation 6 α is the *intra*branch effect and β is the structural effect as given in Equation 5. The terms in the first brackets of the right-hand side give the *intra*branch productivity catch up effect and the terms in the second brackets give the changes in structural differences between China and the USA.

4. DATA

4.1 The Chinese Data

All data required in this study are not directly available from the Chinese official sources. Most of them are based on the estimates from the author's previous studies. Brief explanations are given below.

Manufacturing gross value added (GVA) Manufacturing GVA data for major branches for the period 1952-97 at the 1987 prices are estimated based on the Chinese 1987 Input-Output Table and an output index constructed using physical output data (Wu, 2000).

Manufacturing labour input The estimates are from Wu (forthcoming). To match the full-time equivalent employment concept used in the US statistics, this study uses the DITS (Department of Industrial and Transportation Statistics, SSB) indicator "staff and workers" of "independent accounting units" as a conceptual basis (DITS, 1994). Compared with other SSB employment indicators this DITS indicator is argued to be closer to the full-time equivalent concept. The DITS series is, however, only available for the period 1985-97. To estimate the 1952-84 series two major data works were conducted. First, with the help of DITS statisticians in Beijing and mainly using unpublished information, branch-level time series data for 'staff and workers' of state-owned enterprises (SOEs) were constructed. Second, also using unpublished SSB survey data the distribution of non-'staff and workers' employed across branches was first estimated for some benchmark years (1955, 1959, 1964, 1971 and 1978) and then interpolated for other years in between the benchmarks.[4]

[4] Details of the estimation and complete results are available from the author on request.

4.2 The US data

Manufacturing gross value added (GVA) The manufacturing GVA data for major branches for the period in question are the BEA (1998) annual chained 1992-dollar estimates of gross product originating by industry (GPO). There are two adjustments made to the BEA data. One is to estimate the 1987-dollar growth index to obtain a GVA series in 1987 dollar and another one is to adjust the 1972 SIC (Standard of Industrial Classification) to the 1987 SIC for the period 1952-86 (Wu, 1999).

Manufacturing labour input The 1952-97 branch-level employment data are the full-time equivalent employment data estimated by BEA (1998). The only adjustment made is the conversion of the 1972 SIC-based data to the 1987 SIC-based data for the period 1952-86, using the same approach as in adjusting the US GVA data (Wu, 1999).

4.3 PPP Conversions

The PPP estimates for China for the bilateral comparison in this study are from Wu (1999). The estimation follows the ICOP production-of-origin PPP approach (Ark, 1993; Maddison and Ark, 1993). To calculate the China/US PPPs for each branch, 66 product/product group matches in 39 sample industries were first made for 1987. The estimated PPPs for industries were then aggregated into 14 ICOP manufacturing branches. Both the Chinese- and US-weights based China/US PPPs are estimated, and the Fisher (geometric mean) PPPs are adopted in this study.

The average PPP for the Chinese manufacturing for 1987 is lower than the then prevailing official exchange rate, 3.11 versus 3.72 yuan per US dollar. Another set of PPP estimates are made by Szirmai and Ren (1995) for 1985, with a result of 1.45 versus the official exchange rate 2.90 per US dollar. The spread between the PPP and official rates is much smaller in Wu (1999) than that in Szirmai and Ren (1995). Wu's result may be more acceptable for the smaller spread. The reason is that although domestic currency overvaluation is used to facilitate import substitution policy in countries like China, it eventually has to reflect the 'real cost' of domestic production, especially after the economy opens up to foreign trade and investment, therefore, the gap between the PPPs and official exchange rates should not be too large. For the

Chinese case, the gap should reasonably become smaller after several rounds of the devaluation of renminbi by 1987 (Wu, 1998).

5. RESULTS AND DISCUSSION

5.1 Growth, Labour Productivity and Changes in Employment Structure

Our labour productivity performance analysis for the Chinese manufacturing begins with some observations of output growth, labour input and productivity growth, and employment structural changes. The results reported in Tables 1 to 4 are derived based on Equation 3 discussed previously. The periods in our discussion are selected according to major policy changes since China started the Soviet-style heavy industrialisation and central planning in the early 1950s, which allow comparisons of labour productivity performance in different policy regimes.

TABLE 1
Annual Compound Growth Rate of Gross Value-Added (GVA) in the Chinese Manufacturing by Major Branch, Selected Periods of 1952-97
(annual growth rates in percent)

Manufacturing Branch	1952-57	1957-65	1965-70	1970-78	1978-87	1987-97	1952-78	1978-97
Total manufacturing	15.80	6.07	9.09	7.93	8.22	10.31	9.04	9.32
Food products & beverages	11.80	5.02	2.02	9.33	14.89	6.68	7.02	10.50
Tobacco products	10.97	0.87	10.37	5.28	10.41	1.60	5.92	5.68
Textile products	8.46	2.27	7.80	3.27	6.84	6.34	4.80	6.58
Wearing apparel	5.74	2.29	-1.01	7.91	14.63	19.51	4.00	17.18
Leather products, footwear	20.14	-3.81	19.79	7.75	11.24	18.59	8.44	15.05
Wood products, furniture	12.04	4.49	-0.86	0.31	4.11	9.44	3.53	6.88
Paper, printing & publishing	19.72	8.36	6.85	7.78	11.20	9.13	9.98	10.10
Petroleum & coal products	10.85	10.85	10.85	11.16	4.44	7.31	10.95	5.94
Chemicals	24.09	12.83	8.29	9.42	7.91	9.67	12.94	8.83
Rubber, plastic products	17.34	13.42	12.50	9.96	12.02	15.98	12.90	14.09
Building materials, etc.	23.03	3.72	5.35	10.10	10.69	10.55	9.50	10.62
Basic & fabricated metals	32.19	11.26	8.35	7.73	6.63	7.20	13.29	6.93
Machinery, transport equip.	39.83	5.43	18.94	11.61	6.18	10.08	15.94	8.22
Electrical and electronic equip.	38.36	6.23	29.70	9.09	11.98	18.92	17.10	15.58
Other manufacturing	12.51	9.10	7.29	6.34	3.99	7.81	8.53	5.98

Source: Wu (2000).

Along with the implementation of the Soviet-style first five-year plan, China's manufacturing, as shown in Table 1, experienced the fastest output growth in 1952-57 when huge investment was made into heavy industries, most of which were new to China. The 15.8 per cent annual growth rate was never achieved again at other stages of the industrial development in China also because the development began with a very small industrial base. The slowest industrial growth of 6 per cent per annum was observed in 1957-65, a period experienced the launching and the failure of the Maoist feverish Great Leap Forward. The heavy-industry-focused strategy seemed to have slightly been adjusted during 1965-78 when some labour-intensive, light industries gained growth momentum. The average annual growth rate in 1965-78 was about 8.4 per cent (derived from Table 1), which is even a little faster than that of the first reform period 1978-87 (Table 1). Increase in industrial labour was associating with the output growth. In fact, as reported in Table 2, manufacturing employment in 1965-78 had the fastest growth since the 1950s (around 7 to 8 per cent compared with only about 2 per cent in 1952-65, Table 2).

TABLE 2
Annual Compound Growth Rate of Labour Employment in the Chinese Manufacturing by Major Branch, Selected Periods of 1952-97
(annual growth rates in percent)

Manufacturing Branch	1952-57	1957-65	1965-70	1970-78	1978-87	1987-97	1952-78	1978-97
Total manufacturing	1.93	2.32	8.28	7.07	5.33	0.48	4.82	2.75
Food products & beverages	13.92	1.66	3.29	5.17	7.55	1.02	5.32	4.06
Tobacco products	9.36	-4.15	4.02	6.29	10.13	1.49	3.10	5.50
Textile products	-0.16	0.59	4.14	4.43	10.60	-1.54	2.29	4.03
Wearing apparel	-7.33	-2.52	-0.06	-2.71	15.71	1.15	-3.06	7.80
Leather products, footwear	-1.91	-0.10	5.37	7.78	11.52	3.47	2.95	7.21
Wood products, furniture	-0.28	-3.23	-1.26	-12.00	11.50	-0.97	-5.11	4.75
Paper, printing & publishing	5.07	1.12	5.93	6.46	8.77	0.71	4.42	4.45
Petroleum & coal products	11.34	12.14	7.84	10.38	6.40	5.61	10.61	5.98
Chemicals	13.30	10.39	14.40	10.28	5.07	2.88	11.67	3.91
Rubber, plastic products	14.33	12.82	8.71	14.75	12.47	1.40	12.89	6.50
Building materials, etc.	9.81	3.88	12.14	13.85	2.00	0.03	9.60	0.96
Basic & fabricated metals	0.45	3.89	8.73	4.52	6.07	0.81	4.32	3.27
Machinery, transport equip.	12.20	9.26	13.50	10.90	1.71	-0.33	11.13	0.63
Electrical and electronic equip.	12.20	9.81	17.10	9.35	9.21	1.96	11.49	5.33
Other manufacturing	-3.65	0.82	11.56	2.23	-0.88	-0.99	2.35	-0.94

Source: Derived based on the data from Wu (2000; forthcoming).

Another possible reason for such a fast employment growth was the shift to more labour-intensive technologies in heavy industrial development under an ever-increasing employment pressure. This could be partially reflected by decline in labour productivity growth over the different periods under the central planning (1952-1978) as demonstrated in Table 3. The 13.6 per-cent annual productivity growth in 1952-57 dropped to 3.7 per cent in 1957-65, and then to below 1 per cent in 1965-78. However, compared with that of the 1950s, light industries had better productivity performance than heavy industries in general in the 1960s-1970s, reflecting more resources including capital and technology were shifted to light industries.

China's market-oriented reform and open-up policy began in 1978. The first stage of the reform (1978-87) brought about a slightly better growth performance than that of the 1970s (8.2 versus 7.9 per cent per annum, Table 1). During this period while the growth of manufacturing employment slowed down to 5.3 per cent from 7.1 per cent in 1970-78 (Table 2), the aggregate labour productivity in manufacturing more than tripled that of the period 1965-78 (2.8 versus 0.8 per cent per annum, Table 3).

TABLE 3
Annual Compound Growth Rate of Labour Productivity in the Chinese Manufacturing by Branch, Selected Periods of 1952-97
(annual growth rates in percent)

Manufacturing Branch	1952-57	1957-65	1965-70	1970-78	1978-87	1987-97	1952-78	1978-97
Total manufacturing	13.61	3.66	0.75	0.80	2.75	9.79	4.03	6.40
Food products & beverages	-1.86	3.30	-1.23	3.95	6.82	5.60	1.61	6.18
Tobacco products	1.48	5.24	6.11	-0.95	0.25	0.11	2.74	0.18
Textile products	8.63	1.67	3.52	-1.11	-3.39	8.00	2.45	2.45
Wearing apparel	14.10	4.93	-0.95	10.91	-0.94	18.16	7.27	8.69
Leather products, footwear	22.49	-3.71	13.69	-0.03	-0.25	14.61	5.33	7.32
Wood products, furniture	12.36	7.98	0.40	14.00	-6.62	10.50	9.10	2.03
Paper, printing & publishing	13.94	7.16	0.88	1.25	2.23	8.36	5.32	5.41
Petroleum & coal products	-0.44	-1.15	2.79	0.71	-1.84	1.61	0.31	-0.04
Chemicals	9.52	2.21	-5.34	-0.78	2.71	6.60	1.13	4.74
Rubber, plastic products	2.64	0.54	3.49	-4.18	-0.40	14.38	0.01	7.12
Building materials, etc.	12.04	-0.15	-6.05	-3.29	8.51	10.52	-0.09	9.57
Basic & fabricated metals	31.60	7.09	-0.35	3.07	0.52	6.34	8.60	3.54
Machinery, transport equip.	24.63	-3.50	4.80	0.64	4.40	10.45	4.33	7.54
Electrical and electronic equip.	23.31	-3.26	10.76	-0.23	2.54	16.63	5.03	9.73
Other manufacturing	16.77	8.21	-3.83	4.02	4.91	8.89	6.04	6.98

Source: Derived from Wu (forthcoming).
Note: Labour productivity is measured as gross value added (GVA) per labourer engaged.

Most importantly, the market-oriented reform began in 1978 brought about some significant "structural corrections" to the manufacturing sector especially in terms of employment, which should be observed at the early stage of economic transition from the centrally planned economy as discussed in Section 2. As clearly shown in Table 2, all light industries experienced a faster employment growth than the aggregate rate, many of them more than doubled the manufacturing average, such as textiles, wearing apparel, leather and footwear and wood products.

This effect could be more closely examined in Table 4, which gives annual changes in manufacturing employment structure in different periods in question. The distinction between the periods under the central planning (i.e. prior to 1978) and the first period of the reform (1978-87) is that almost all light industries reduced their shares in labour employment under the central planning, whereas they regained their shares after the reform. What happened to heavy industries was just opposite. Exceptions are rubber-plastics and electrical-electronic branches, both maintained growth trends in the long run. This is mainly because both contain some new industries that are more labour using than traditional heavy industries (i.e. plastic products since the 1960s and electronics since the 1980s).

TABLE 4
Annual Rate of Structural Change in Labour Employment in the Chinese Manufacturing by Major Branch, Selected Periods of 1952-97
(annual growth rates in percent)

Manufacturing Branch	1952-57	1957-65	1965-70	1970-78	1978-87	1987-97	1952-78	1978-97
Food products & beverages	11.76	-0.65	-4.60	-1.78	2.11	0.54	0.48	1.28
Tobacco products	7.29	-6.33	-3.93	-0.73	4.56	1.01	-1.64	2.68
Textile products	-2.05	-1.69	-3.82	-2.47	5.00	-2.01	-2.41	1.25
Wearing apparel	-9.09	-4.73	-7.70	-9.13	9.86	0.67	-7.51	4.92
Leather products, footwear	-3.77	-2.37	-2.69	0.66	5.88	2.97	-1.78	4.34
Wood products, furniture	-2.17	-5.42	-8.80	-17.82	5.86	-1.44	-9.47	1.95
Paper, printing & publishing	3.08	-1.17	-2.17	-0.57	3.27	0.23	-0.38	1.66
Petroleum & coal products	9.23	9.59	-0.41	3.09	1.02	5.11	5.52	3.15
Chemicals	11.16	7.88	5.65	3.00	-0.25	2.39	6.54	1.13
Rubber, plastic products	12.16	10.26	0.40	7.17	6.78	0.92	7.70	3.66
Building materials, etc.	7.72	1.52	3.57	6.33	-3.15	-0.45	4.56	-1.74
Basic & fabricated metals	-1.45	1.53	0.42	-2.38	0.71	0.33	-0.48	0.51
Machinery, transport equip.	10.07	6.77	4.82	3.57	-3.44	-0.81	6.02	-2.06
Electrical and electronic equip.	10.07	7.32	8.15	2.13	3.68	1.48	6.37	2.52
Other manufacturing	-5.47	-1.46	3.03	-4.52	-5.89	-1.46	-2.36	-3.59

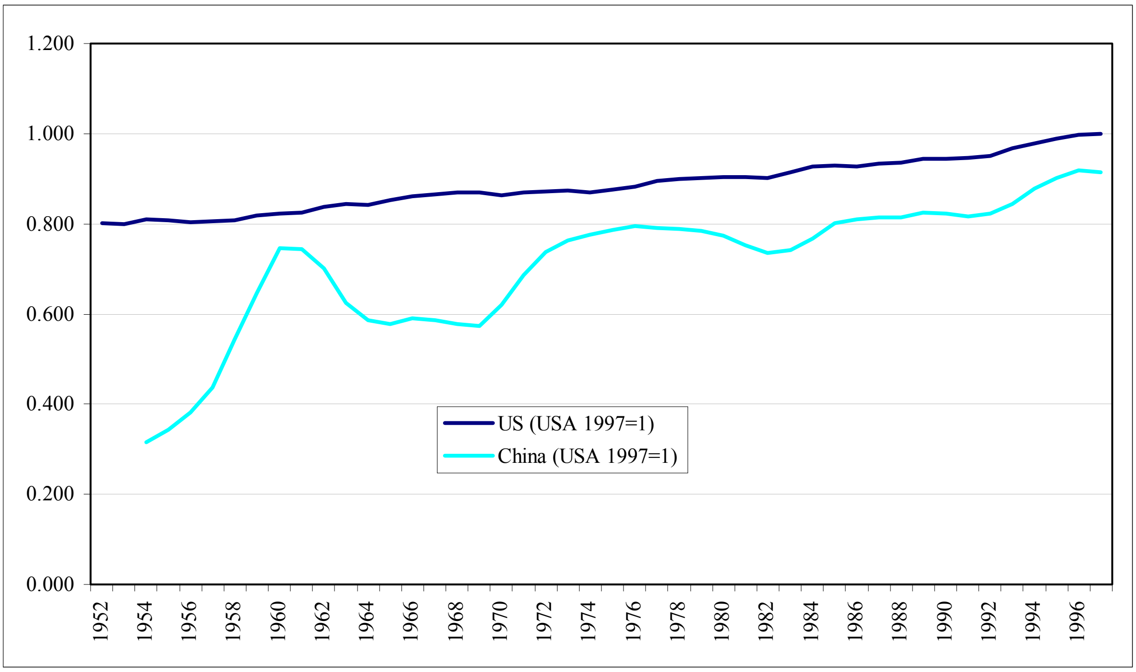
Source: Wu (2000; forthcoming).
Note: Labour productivity is measured as GVA per labourer engaged.

The labour shifts from heavy to light industries in 1978-87 is obviously growth promoting as supported by the above results. One may argue that the market-driven "structural corrections" were completed after about a decade of reform by the end of the 1980s with what could be observed in 1987-97: significant structural changes stopped (Table 4); both total output and productivity growth achieved record high rates since the 1960s (Tables 1 and 3); and importantly such an impressive growth provided little jobs (Table 2).

5.2 Structural Convergence

Using the US manufacturing structure in 1997 as a reference of a mature manufacturing structure in a fully developed economy, we calculated the output structure similarity index for both the Chinese and US manufacturing over the entire period 1952-97. The output data are value-added data in constant (1987) prices, so the structure could largely reflect some "technical relationship" among branches. The results are illustrated in Figure 1.

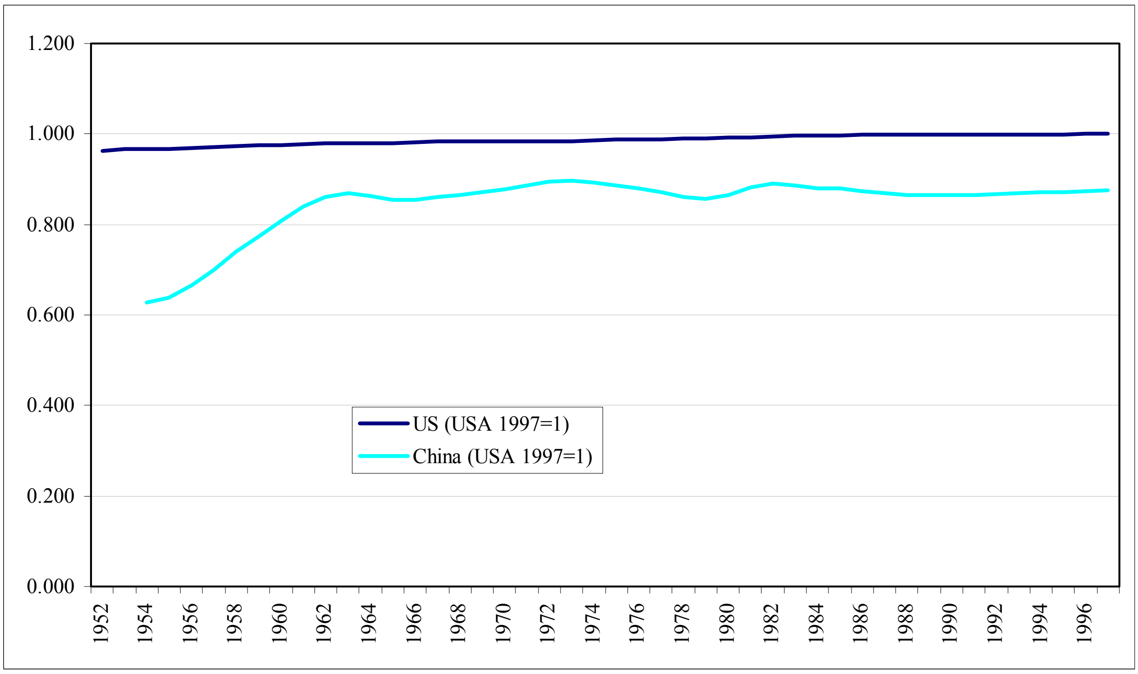
FIGURE 1
Output Structure Similarity Indices for the Chinese and US Manufacturing, 1954-97
(at 1987 prices, USA 1997=1)



Source: Calculations for the indices are based on Equation 1 (see text) using data from Wu (1999; 2000). Three-year moving averages are used for the Chinese data to smooth out short period fluctuations.

Clearly, as Figure 1 shows that although the Chinese manufacturing structure converged with that of the USA in the long run, there were radical fluctuations over different stages of industrial development that were under different policy regimes. The forced heavy industrialisation in the 1950s led to a dramatic structural convergence in this period. This was followed by an also dramatic reverse restructuring and then a structural stagnation in the 1960s, a period that suffered from the aftermath of the Great Leap Froward campaign and the chaotic and destructive years at the early stage of the Cultural Revolution. As the economy was back to the "normal" track in the early 1970s, the structural convergence reappeared. However, the "structural corrections" along with the reform began in the end of the 1970s again resulted in a reverse restructuring in favour of light industries. In fact, from the early 1960s till the end of the 1980s there was no clear convergence with the output structure of the US manufacturing. The fast convergence since the 1990s indicates that the "structural corrections" initiated by the reform may be over and China is likely back onto the converging path again.

FIGURE 2
Employment Structure Similarity Indices for the Chinese and US Manufacturing, 1954-97
(USA 1997=1)



Source: Calculations for the indices are based on Equation 2 (see text) using data from Wu (1999). Three-year moving averages are used for the Chinese data to smooth out short period fluctuations.

The same approach is used to calculate the employment structure similarity indices for China and the USA (Figure 2). The evolution of the employment structure in the Chinese manufacturing is very different from that of the output structure. A very important finding here is that after experiencing an equally dramatic structural convergence with that of the USA, there was no clear trend since the economy was forced to slow down its heavy industrialisation pace in the early 1960s. Meanwhile the US manufacturing employment structure, as a mature structure, remained as it was in 1997. Combined with the findings depicted in Figure 1, this structural stagnation in manufacturing employment explains, at least partially, why China experienced no labour productivity catch up in manufacturing since the 1960s for about three decades. The difficulties in continuously pursuing the Soviet-style heavy industrialisation after the 1960s, the increasing employment pressure and the strict controls over labour mobility to facilitate planning and maintain political stability were likely the main factors behind such a structural stagnation.

5.3 Structural Explanation of Labour Productivity Growth

A more precise measurement of the structural effect on the labour productivity growth in the Chinese manufacturing is made based on Equation 4 and reported in Table 5. The calculation is also made for different periods as used in the previous discussions. As we have postulated about the positive relationship between the gain in labour productivity and heavy industry-oriented structural changes, the 17 per cent of productivity increase during 1952-57 was found attributable to the structural effect, of which about 14 percentage points are the static structural effect and 3 the dynamic structural effect. While the gain from the static effect was even greater in 1957-65 (29 per cent), it was largely cancelled off by the loss in the dynamic effect (17 percentage points). This indicates that the continuous shift to heavy industries (Table 4) as the labour productivity growth in these industries declined (also see Table 3) made a negative contribution to the aggregate labour productivity growth.

Compared with the previous periods, the two periods 1965-70 and 1970-78 saw much slower productivity growth with only 3.8 and 6.6 per cent increase over 5 and 8 years, respectively (Table 5). In both periods, especially in 1970-78, the *intra*branch effect made the net contribution to the labour productivity growth, while the overall structural effect was negative. The loss in the dynamic structural effect completely overrode the gain in the static structural effect, indicating an inappropriate resource (labour and capital) allocation (and reallocation) among branches.

TABLE 5
Structural Changes and Labour Productivity Growth in the Chinese Manufacturing by Branch, Selected Periods of 1952-97
(In percentage)

Manufacturing Branch	1952-1957				1957-1965				1965-1970			
	Growth within period (%)	Intra-branch effect (%)	Static struct effect (%)	Dynamic struct effect (%)	Growth within period (%)	Intra-branch effect (%)	Static struct effect (%)	Dynamic struct effect (%)	Growth within period (%)	Intra-branch effect (%)	Static struct effect (%)	Dynamic struct effect (%)
Food products and beverages	4.17	-0.64	5.29	-0.47	1.38	1.77	-0.30	-0.09	-1.42	-0.33	-1.16	0.07
Tobacco products	4.68	0.67	3.73	0.28	-0.77	3.60	-2.91	-1.47	0.48	1.65	-0.87	-0.30
Textile products	12.51	17.63	-3.38	-1.73	-0.10	3.51	-3.16	-0.45	-0.40	3.49	-3.28	-0.62
Wearing apparel	0.96	4.46	-1.81	-1.69	-0.01	1.42	-0.97	-0.46	-0.82	-0.11	-0.75	0.03
Leather products, footwear	1.33	1.84	-0.18	-0.32	-0.49	-0.33	-0.22	0.06	0.38	0.52	-0.07	-0.07
Wood products, furniture, fixtures	5.81	7.59	-1.00	-0.79	1.49	6.90	-2.93	-2.48	-2.58	0.14	-2.67	-0.05
Paper, printing & publishing	2.83	2.11	0.38	0.35	1.58	2.00	-0.24	-0.18	-0.21	0.14	-0.33	-0.01
Petroleum & coal products	1.87	-0.08	1.99	-0.04	2.58	-0.25	3.11	-0.27	0.51	0.61	-0.08	-0.01
Chemicals	8.18	2.81	3.41	1.96	8.19	1.32	5.76	1.10	0.01	-2.72	3.58	-0.86
Rubber, plastic products	1.07	0.15	0.81	0.11	1.43	0.05	1.32	0.06	0.40	0.36	0.04	0.01
Building materials, etc.	9.62	4.72	2.78	2.13	0.95	-0.10	1.07	-0.01	-0.89	-1.87	1.34	-0.36
Basic & fabricated metal products	14.70	16.24	-0.39	-1.15	10.18	7.80	1.38	1.01	0.05	-0.27	0.33	-0.01
Machinery, transportation equipment	14.58	7.58	2.33	4.67	2.63	-2.40	6.69	-1.66	5.54	2.44	2.45	0.65
Electrical and electronic equipment	3.05	1.56	0.52	0.96	0.72	-0.48	1.56	-0.36	3.05	1.39	1.00	0.67
Other manufacturing	3.91	7.17	-1.50	-1.76	3.55	4.66	-0.59	-0.52	-0.30	-1.18	1.07	-0.19
Total manufacturing	89.27	73.81	12.96	2.51	33.31	29.47	9.57	-5.73	3.81	4.27	0.60	-1.05
	(100.00)	(82.68)	(14.51)	(2.81)	(100.00)	(88.48)	(28.72)	(-17.20)	(100.00)	(111.93)	(15.72)	(-27.64)

(To be continued.)

TABLE 5 (CONTINUED)

Structural Changes and Labour Productivity Growth in the Chinese Manufacturing by Branch, Selected Periods of 1952-97

(In percentage)

Manufacturing Branch	1970-1978				1978-1987				1987-1997			
	Growth within period (%)	Intra-branch effect (%)	Static struct effect (%)	Dynamic struct effect (%)	Growth within period (%)	Intra-branch effect (%)	Static struct effect (%)	Dynamic struct effect (%)	Growth within period (%)	Intra-branch effect (%)	Static struct effect (%)	Dynamic struct effect (%)
Food products and beverages	0.71	1.43	-0.53	-0.19	5.18	3.54	0.90	0.73	6.14	5.42	0.41	0.30
Tobacco products	-0.64	-0.37	-0.29	0.02	2.19	0.10	2.05	0.05	0.59	0.05	0.53	0.01
Textile products	-4.38	-1.49	-3.16	0.27	1.68	-3.27	6.76	-1.81	8.33	12.66	-2.00	-2.33
Wearing apparel	0.09	1.80	-0.75	-0.96	1.59	-0.11	1.86	-0.15	10.92	10.07	0.16	0.69
Leather products, footwear	0.05	0.00	0.05	0.00	0.57	-0.02	0.61	-0.01	4.92	3.38	0.39	1.15
Wood products, furniture, fixtures	-1.82	8.29	-3.55	-6.57	-0.25	-1.15	1.67	-0.77	2.37	3.02	-0.24	-0.41
Paper, printing & publishing	0.16	0.30	-0.13	-0.01	1.80	0.63	0.96	0.21	4.70	4.50	0.09	0.11
Petroleum & coal products	1.55	0.26	1.22	0.07	-0.41	-0.87	0.54	-0.08	3.80	0.71	2.64	0.46
Chemicals	2.07	-0.66	2.91	-0.18	2.97	3.31	-0.27	-0.07	16.62	10.63	3.16	2.83
Rubber, plastic products	0.53	-0.64	1.65	-0.48	1.91	-0.09	2.08	-0.07	11.27	9.98	0.34	0.96
Building materials, etc.	1.46	-1.38	3.71	-0.87	3.87	7.45	-1.72	-1.87	13.45	14.45	-0.37	-0.63
Basic & fabricated metal products	0.76	4.14	-2.65	-0.73	1.74	0.72	0.98	0.05	11.87	11.06	0.44	0.37
Machinery, transportation equipment	5.61	0.75	4.62	0.24	1.40	8.80	-5.03	-2.38	23.40	26.70	-1.22	-2.08
Electrical and electronic equipment	0.80	-0.09	0.91	-0.02	3.97	1.37	2.07	0.53	32.19	26.80	1.16	4.23
Other manufacturing	-0.33	2.26	-1.89	-0.70	-0.59	2.92	-2.28	-1.23	3.87	5.09	-0.52	-0.70
Total manufacturing	6.62	14.59	2.13	-10.10	27.63	23.32	11.18	-6.88	154.44	144.51	4.96	4.96
	(100.00)	(220.39)	(32.18)	(-152.57)	(100.00)	(84.43)	(40.47)	(-24.90)	(100.00)	(93.58)	(3.21)	(3.21)

(To be continued.)

TABLE 5 (CONTINUED)
Structural Changes and Labour Productivity Growth in the Chinese Manufacturing by Branch, Selected Periods of 1952-97
(In percentage)

Manufacturing Branch	1952-1978				1978-1997				1952-1997			
	Growth within period (%)	Intra-branch effect (%)	Static struct effect (%)	Dynamic struct effect (%)	Growth within period (%)	Intra-branch effect (%)	Static struct effect (%)	Dynamic struct effect (%)	Growth within period (%)	Intra-branch effect (%)	Static struct effect (%)	Dynamic struct effect (%)
Food products and beverages	5.08	3.65	0.95	0.49	13.01	9.27	1.20	2.54	41.42	26.51	3.15	11.76
Tobacco products	2.76	9.00	-3.09	-3.15	2.94	0.14	2.71	0.09	10.97	9.60	0.66	0.71
Textile products	-0.17	30.15	-16.15	-14.17	12.32	7.14	3.27	1.91	34.23	67.77	-11.29	-22.25
Wearing apparel	-0.88	24.87	-4.15	-21.61	15.53	5.40	2.08	8.05	42.48	139.75	-3.21	-94.05
Leather products, footwear	1.48	2.99	-0.39	-1.12	6.86	2.56	1.12	3.17	20.63	14.38	0.42	5.82
Wood products, furniture, fixtures	-2.64	82.84	-8.88	-76.60	2.78	1.16	1.11	0.52	5.13	125.85	-8.56	-112.16
Paper, printing & publishing	5.71	6.54	-0.22	-0.61	7.80	4.93	1.05	1.81	27.49	21.73	0.55	5.21
Petroleum & coal products	12.12	0.30	10.91	0.91	4.44	-0.04	4.52	-0.03	24.52	0.27	22.56	1.69
Chemicals	29.13	1.66	20.49	6.97	24.18	17.18	2.91	4.10	96.67	10.91	26.55	59.21
Rubber, plastic products	6.17	0.00	6.15	0.02	16.30	6.96	2.53	6.81	51.67	2.83	13.18	35.67
Building materials, etc.	13.01	-0.15	13.48	-0.32	21.03	32.07	-1.95	-9.09	71.75	27.96	7.91	35.88
Basic & fabricated metal products	36.08	41.57	-0.64	-4.85	16.88	13.96	1.51	1.42	83.23	85.71	-0.15	-2.33
Machinery, transportation equipment	48.22	7.59	13.50	27.13	31.26	55.48	-6.09	-18.13	135.52	41.46	7.86	86.20
Electrical and electronic equipment	14.20	2.18	3.36	8.66	45.05	26.06	3.25	15.73	140.03	16.80	5.90	117.32
Other manufacturing	9.02	22.04	-2.83	-10.19	4.35	14.14	-2.71	-7.07	21.17	95.44	-4.48	-69.80
Total manufacturing	179.28	235.24	32.49	-88.44	224.73	196.41	16.50	11.81	806.90	686.97	61.05	58.89
	(100.00)	(131.21)	(18.12)	(-49.33)	(100.00)	(87.40)	(7.34)	(5.26)	(100.00)	(85.14)	(7.57)	(7.30)

Source: Calculated based on Equation 4 using data from Wu (1999; 2000).

The market-oriented reform-induced "structural correction" hypothesis is further supported by the results for the period 1978-87 in Table 5. The net structural effect on labour productivity became positive (16 per cent), with a static effect of 41 per cent offset by a dynamic effect of 25 per cent. This means that the effect of the resource shift to some slow growing branches was overridden by the effect of the resource shift to the branches with higher labour productivity.

The period 1987-97 enjoyed a 154-per cent labour productivity growth, while the structural effect declined and could only explain about 6 per cent of the total productivity growth (Table 5). As discussed previously, during this period the Chinese manufacturing structure became more "mature" (Figures 1 and 2). More importantly, as reported in Table 5, there is a sign indicating that the market-oriented development in this period seemed to lead more "natural" or "healthier" structural changes, with resources shifting to branches with both high labour productivity level and growth rate, e.g. the electrical and electronic equipment industries, as well as chemicals, plastics, footwear and wearing apparel industries.

Table 5 also provides an overall comparison between the central planning period (1952-78) and the reform period (1978-97) in both the *intra*branch and structural effects upon labour productivity change. The total 179 per-cent growth in labour productivity in the Chinese manufacturing in the central planning period was entirely attributed to the *intra*branch effect (131 per cent offset by a negative structural effect of 31 per cent). In the reform period, 87 per cent of the 225 per-cent increase in China's manufacturing labour productivity was due to the *intra*branch effect and 13 was due to the structural effect. With the policy background discussed, our results for the reform period are more acceptable than the findings in Timmer (1999) which show no positive structural effect for 1980-92.

5.4 Structural Explanation of Labour Productivity Catch Up

In this part of the study, we did two calculations. Firstly, we measured the labour productivity gap between the Chinese and US manufacturing, and the *intra*branch and structural effects to explain the gap, following the approach expressed by Equation 5. Secondly, we measure China's labour productivity catch up with that of the USA and the *intra*branch and structural effects to explain the catch up, using Equation 6.

TABLE 6

Decomposition of China's Manufacturing Labour Productivity Difference with the USA, by Branch, Selected Years of 1952-97
(China-US difference in percentage, US total manufacturing =100)

Manufacturing Branch	1952			1957			1965			1970		
	Total effect $\alpha+\beta$	Intra branch effect α	Structure effect β	Total effect $\alpha+\beta$	Intra branch effect α	Structure effect β	Total effect $\alpha+\beta$	Intra branch effect α	Structure effect β	Total effect $\alpha+\beta$	Intra branch effect α	Structure effect β
Food products and beverages	9.85	7.32	2.53	10.10	9.96	0.14	8.81	8.79	0.02	9.17	8.29	0.88
Tobacco products	3.81	2.89	0.91	2.95	3.39	-0.44	2.80	2.22	0.58	2.93	2.21	0.72
Textile products	-3.25	0.03	-3.29	-4.79	-0.87	-3.92	-2.61	0.93	-3.54	-2.17	0.76	-2.93
Wearing apparel	3.22	4.37	-1.16	2.90	2.99	-0.09	2.81	2.21	0.59	2.76	1.88	0.89
Leather products, footwear	1.59	1.30	0.29	1.39	1.04	0.35	1.28	0.95	0.33	0.97	0.71	0.26
Wood products, furniture, fixtures	5.19	10.03	-4.84	4.72	9.34	-4.62	5.23	7.62	-2.39	4.98	5.57	-0.60
Paper, printing & publishing	10.81	7.77	3.04	11.56	8.47	3.10	11.34	7.84	3.50	11.61	7.68	3.93
Petroleum & coal products	1.56	0.45	1.11	1.58	0.57	1.01	1.59	1.08	0.51	1.67	1.13	0.55
Chemicals	4.14	2.70	1.44	5.16	3.86	1.30	6.10	6.01	0.09	7.44	8.18	-0.74
Rubber, plastic products	1.75	0.39	1.36	1.39	0.20	1.19	1.70	0.63	1.07	1.83	0.49	1.34
Building materials, etc.	3.68	4.76	-1.08	3.43	5.95	-2.53	3.39	6.28	-2.90	3.23	7.10	-3.88
Basic & fabricated metal products	22.24	19.63	2.62	21.75	18.08	3.67	18.03	16.10	1.93	16.80	15.22	1.58
Machinery, transportation equip.	22.41	14.31	8.10	21.67	15.38	6.30	21.80	19.69	2.11	19.52	20.04	-0.52
Electrical and electronic equip.	4.03	2.32	1.71	4.04	2.40	1.64	5.57	3.71	1.85	6.24	4.53	1.72
Other manufacturing	4.49	8.34	-3.84	4.45	6.69	-2.24	4.43	6.11	-1.68	5.12	7.64	-2.52
Total manufacturing gap*	95.51	86.60	8.91	92.31	87.44	4.87	92.25	90.17	2.08	92.09	91.41	0.68
(Share of α, β effects, %)	(100.00)	(90.67)	(9.33)	(100.00)	(94.73)	(5.27)	(100.00)	(97.74)	(2.26)	(100.00)	(99.26)	(0.74)

(To be continued.)

TABLE 6 (CONTINUED)

Decomposition of China's Manufacturing Labour Productivity Difference with the USA, by Branch, Selected Years of 1952-97
(China-US difference in percentage, US total manufacturing =100)

Manufacturing Branch	1978			1987			1997		
	Total effect $\alpha+\beta$	Intra branch effect α	Structure effect β	Total effect $\alpha+\beta$	Intra branch effect α	Structure effect β	Total effect $\alpha+\beta$	Intra branch effect α	Structure effect β
Food products and beverages	8.61	7.60	1.01	8.43	8.10	0.33	6.30	5.97	0.33
Tobacco products	2.63	2.36	0.27	0.63	1.14	-0.51	0.04	0.64	-0.60
Textile products	-0.29	1.76	-2.05	-0.27	3.66	-3.93	-1.22	2.14	-3.37
Wearing apparel	2.83	1.42	1.41	2.33	1.74	0.59	0.93	0.70	0.23
Leather products, footwear	0.79	0.68	0.12	0.37	0.62	-0.26	0.00	0.60	-0.60
Wood products, furniture, fixtures	5.01	3.03	1.98	5.28	3.59	1.69	3.41	2.16	1.25
Paper, printing & publishing	11.04	7.27	3.77	11.35	7.58	3.76	7.78	5.01	2.77
Petroleum & coal products	1.39	1.06	0.34	2.43	2.20	0.23	1.40	1.95	-0.55
Chemicals	8.41	10.56	-2.15	9.39	11.60	-2.21	8.13	11.66	-3.53
Rubber, plastic products	2.13	1.20	0.92	2.62	2.13	0.49	2.18	1.15	1.03
Building materials, etc.	2.86	9.29	-6.43	2.23	6.57	-4.34	1.50	5.19	-3.69
Basic & fabricated metal products	13.98	11.71	2.27	10.45	10.13	0.33	9.02	8.69	0.33
Machinery, transportation equip.	20.87	24.29	-3.42	22.68	21.90	0.78	23.74	21.85	1.88
Electrical and electronic equip.	7.44	5.74	1.70	9.35	7.83	1.52	21.57	19.60	1.97
Other manufacturing	5.63	6.26	-0.63	6.03	4.94	1.08	3.50	2.64	0.86
Total manufacturing gap*	93.33	94.22	-0.89	93.29	93.75	-0.45	88.27	89.94	-1.67
(Share of α, β effects, %)	(100.00)	(100.95)	-(0.95)	(100.00)	(100.49)	-(0.49)	(100.00)	(101.90)	-(1.90)

Source: Calculations are based on Equation 5 using data from Wu (1999; 2000).

Note: *Total manufacturing gap between US and China is defined as $\left(y_t^{(US)} - y_t^{(CN)}\right) / y_t^{(US)} \times 100$. A smaller value indicates a smaller gap between the two countries.

The China-US labour productivity gap declined by 8 percentage points from 96 in 1952 to 88 in 1997. However, most of the decline took place in the 1990s (Table 6) The findings for explaining the gap show that over the entire period in question the structural effect explanation was never more than 10 per cent of the gap and only valid for the selected years up to 1970 (Table 6).

The branches that were more responsible for the aggregate labour productivity gap were, almost identically over the time up to 1987, food, paper and printing, basic and fabricated metals and machinery. For all these branches China has no comparative advantage. Since the 1970s chemicals became important in explaining the productivity gap because of a decline in labour productivity in this branch, while metals became less important for the gap due to a rise in labour productivity.

By 1997 there were some findings that are worth noting: 1) food and paper branches for the first time became less important for the gap, 2) metals continued to improve its productivity - less responsible for the gap, 3) electric and electronic branch more than doubled its part in explaining the gap, and 4) machinery continued to be the most responsible branch for the gap. Items 3 and 4 are certainly not very good news for China, they are very much relied upon by China for technological advance, but they are accountable for about half of China's productivity gap with the USA.

These findings are further supported by incorporating an intertemporal analysis with the above interspacial analysis as expressed in Equation 6. As reported in Table 7, the productivity catch up was only seen in 1952-57 and 1987-97 during the entire period, with 3.2 and 5.0 percentage points of catch up, respectively, which is fairly disappointing compared with the manufacturing labour productivity performance in South Korea and Taiwan (Timmer, 1999, Table 7.7).

Different from what argued by Timmer (1999, p.113) that catch up in capital-intensive industries should play the most important role in the aggregate productivity catch up in the Asian economies, our estimates show that it was the catch up in labour-intensive industries that made the main contribution to the aggregate productivity convergence. In 1952-57, about 60 per cent of the catch up was accountable to light industries. In 1987-97, 73 per cent of the catch up was attributable to labour-intensive industries, mainly light industries (Table 7). These

TABLE 7
Branch Contribution to China's Aggregate Catch Up with Labour Productivity Level in the USA, Selected Periods of 1952-97
(In percentage points of catch up)

Manufacturing Branch	1952-57			1957-65			1965-70			1970-78		
	Total effect	Intra branch effect	Structure effect	Total effect	Intra branch effect	Structure effect	Total effect	Intra branch effect	Structure effect	Total effect	Intra branch effect	Structure effect
	$\alpha+\beta$	α	β	$\alpha+\beta$	α	β	$\alpha+\beta$	α	β	$\alpha+\beta$	α	β
Food products and beverages	-0.15	-2.13	1.98	-0.04	-0.03	0.00	-0.48	0.66	-1.14	0.20	0.27	-0.07
Tobacco products	0.72	-0.39	1.11	0.00	-0.04	0.04	-0.17	0.01	-0.18	0.12	-0.09	0.21
Textile products	1.24	0.74	0.50	0.07	0.06	0.01	-0.58	0.23	-0.80	-0.88	-0.48	-0.40
Wearing apparel	0.28	1.17	-0.89	0.00	-0.02	0.02	0.05	0.44	-0.39	-0.05	0.20	-0.25
Leather products, footwear	0.18	0.22	-0.05	0.00	0.00	0.00	0.41	0.32	0.09	0.08	0.01	0.07
Wood products, furniture, fixtures	0.42	0.63	-0.21	0.02	-0.05	0.07	0.33	2.70	-2.37	-0.05	1.17	-1.22
Paper, printing & publishing	-0.56	-0.53	-0.03	0.00	-0.02	0.02	-0.36	0.20	-0.57	0.19	0.14	0.05
Petroleum & coal products	-0.01	-0.10	0.09	0.00	0.02	-0.02	-0.11	-0.07	-0.04	0.12	0.02	0.09
Chemicals	-0.81	-0.94	0.13	0.04	0.08	-0.04	-1.77	-2.88	1.11	-0.51	-1.19	0.67
Rubber, plastic products	0.30	0.16	0.15	0.01	0.02	0.00	-0.17	0.19	-0.36	-0.16	-0.34	0.19
Building materials, etc.	0.23	-0.95	1.18	0.00	0.02	-0.01	0.21	-1.08	1.30	0.15	-1.09	1.24
Basic & fabricated metal products	0.54	1.39	-0.85	-0.12	-0.06	-0.06	1.62	1.16	0.46	1.22	1.56	-0.34
Machinery, transportation equip.	0.74	-0.80	1.54	0.02	0.16	-0.14	3.01	-0.48	3.48	-0.78	-2.16	1.38
Electrical and electronic equip.	0.02	-0.05	0.07	0.06	0.05	0.01	-0.90	-1.08	0.18	-0.61	-0.61	0.00
Other manufacturing	0.06	1.40	-1.34	0.00	-0.02	0.02	-0.92	-2.02	1.10	-0.28	0.60	-0.88
Total manufacturing catch up	3.20	-0.18	3.38	0.06	0.15	-0.09	0.16	-1.69	1.85	-1.24	-1.98	0.74

(To be continued.)

TABLE 7 (CONTINUED)

Branch Contribution to China's Aggregate Catch Up with Labour Productivity Level in the USA, Selected Periods of 1952-97

(In percentage points of catch up)

Manufacturing Branch	1978-87			1987-97			1952-78			1978-97		
	Total effect	Intra branch effect	Struc-ture effect	Total effect	Intra branch effect	Struc-ture effect	Total effect	Intra branch effect	Struc-ture effect	Total effect	Intra branch effect	Struc-ture effect
	$\alpha+\beta$	α	β	$\alpha+\beta$	α	β	$\alpha+\beta$	α	β	$\alpha+\beta$	α	β
Food products and beverages	0.07	-0.20	0.27	2.08	2.08	0.00	-5.85	2.82	-8.67	2.23	1.58	0.65
Tobacco products	0.80	0.49	0.31	0.58	0.49	0.09	-6.43	-2.75	-3.68	2.50	1.66	0.84
Textile products	-0.01	-0.76	0.75	0.92	1.47	-0.55	17.24	10.34	6.90	0.90	-0.37	1.26
Wearing apparel	0.20	-0.13	0.33	1.36	1.02	0.34	-1.81	-16.99	15.18	1.83	0.70	1.13
Leather products, footwear	0.17	0.02	0.15	0.35	0.02	0.33	-4.51	-3.53	-0.98	0.76	0.07	0.69
Wood products, furniture, fixtures	-0.11	-0.22	0.12	1.83	1.40	0.43	-0.23	-40.32	40.09	1.55	0.85	0.70
Paper, printing & publishing	-0.12	-0.12	0.00	3.48	2.51	0.97	3.09	-1.74	4.84	3.15	2.19	0.97
Petroleum & coal products	-0.41	-0.46	0.04	1.00	0.25	0.76	-0.75	3.73	-4.48	0.00	-0.85	0.85
Chemicals	-0.39	-0.41	0.02	1.23	-0.05	1.28	26.23	47.54	-21.30	0.28	-1.04	1.32
Rubber, plastic products	-0.20	-0.37	0.17	0.43	0.96	-0.53	2.56	4.95	-2.39	-0.04	0.06	-0.10
Building materials, etc.	0.26	1.09	-0.84	0.71	1.35	-0.64	-4.30	27.90	-32.20	1.31	3.96	-2.64
Basic & fabricated metal products	1.42	0.64	0.78	1.41	1.41	0.00	-45.99	-44.33	-1.66	4.80	2.93	1.87
Machinery, transportation equip.	-0.72	0.96	-1.68	-0.99	0.08	-1.07	-5.68	62.12	-67.79	-2.71	2.39	-5.11
Electrical and electronic equip.	-0.76	-0.84	0.07	-11.84	-11.40	-0.44	21.07	20.87	0.20	-13.56	-13.30	-0.26
Other manufacturing	-0.16	0.53	-0.69	2.46	2.24	0.22	7.53	-11.13	18.66	2.06	3.49	-1.43
Total manufacturing catch up*	0.04	0.21	-0.17	5.02	3.84	1.18	2.18	59.47	-57.29	5.06	4.31	0.75

Source: Calculations are based on Equation 6 using data from Wu (1999; 2000).

Note: * Total manufacturing labour productivity catch up over time *t* and 0 is measured as Equation 6; simply, if $y_t^{(CN)} / y_t^{(US)} - y_0^{(CN)} / y_0^{(US)} > 0$ it indicates a catch up, and if < 0, a fall.

findings support the argument by Dollar and Wolff for the Asian newly industrialised economies that "it is the rapid productivity convergence in labour-intensive industries that has been the main driving force behind productivity convergence for all manufacturing" (1993, p.170).

6. CONCLUDING REMARKS AND POLICY IMPLICATIONS

Using the shift-share approach we have estimated the *intra*branch productivity change and *inter*branch resource shift effects upon labour productivity growth and catch up in the Chinese manufacturing for both the central planning and reform periods. Some interesting findings with important policy implications are summarised and discussed as follows.

First, the radical structural changes in the 1950s , as a result of China's forced heavy industrialisation in the 1950s brought about an ever-fast labour productivity growth in manufacturing. This was, however, not sustainable in the long run likely because such a development strategy was not in line with China's comparative advantage. After the early heavy industrial development in the 1950s up to the end 1970s, although the structural changes still skewed in favour of the heavy industries, the growth of the labour productivity significantly slowed down, and the "structural bonus" to the productivity growth disappeared.

Second, the market-oriented reform and the policy of opening up to foreign trade and direct investment after 1978 first led to some significant "structural corrections" to the previous structural distortions developed under the central planning, which made an important contribution to the improvement of labour productivity. Such a structural correction effect died out when the manufacturing structural matured or converged to that of the USA.

Third, structural differences could explain the productivity gap between the Chinese and US manufacturing only for the early stages of the industrialisation when such differences were significant. Over the long run the *intra*branch productivity difference could mainly explain the gap and the industries where China has no comparative advantage were found largely responsible for the gap.

Fourth, even if heavy industries account for the larger proportion of the Chinese manufacturing, labour intensive, the labour productivity catch up in light-industries are found to be the driving force behind China's productivity convergence with that of the USA during the later stage of the reform.

Nevertheless, it should be noted that the structural effect, or the effect of *inter*banch resource shift, is found only when there are fast structural changes, but even in such cases, its contribution to the aggregate labour productivity growth is not more than 20 per cent, with the rest due to the *intra*branch productivity growth effect.

There are some important implications that could be drawn for development policies: 1) industrial policies that ignore the comparative advantage of the economy will not have sustainable productivity effect; 2) both the growth and labour productivity will gain from the "structural corrections" brought about by market-oriented reforms and opening up policies, even if such "correction" may look to be "down grading" the industrial structure; and 3) a free resource mobility policy will benefit the labour productivity growth through the structural effect.

Without the capital stock data for manufacturing branches, we are, however, unable to investigate why the labour productivity level and growth are different across manufacturing branches between the two economies. We realise the deficiencies in our partial productivity analysis, and the limitations of our findings. But the deficiencies should not significantly discount the labour productivity approach especially for a *long-run* analysis because the growth in the long-run could not be driven by the growth of industries with low labour productivity. Studies on the manufacturing capital stock and then the total resource reallocation effect based on total factor productivity (TFP) analysis for major Chinese manufacturing industries remain the top priorities.

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