An Analysis of Structural Change in China using Biproportional Methods

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Introduction

Since the beginning of the economic reforms, the Chinese economy has undergone a major economic and structural transformation. This takes the form of a change in the scale of the various sectors and industries and in the emergence of new industries, and this may be attributed to different causes: structural change can be due to technical change, to input substitution, to a change in consumers' tastes, to the growth of a market economy, or to a combination of all these elements.

With the help of the *Synthetic Biproportional Projector* (SBP), this article aims at studying and analyzing the nature of structural change that has occurred in Chinese industry since the beginning of the economic reforms with a particular emphasis on the manufacturing and services sectors. The chosen input&output (I&O) method best helps to isolate those industries that have been mostly responsible for the change in the industrial structure of the country as a whole. Some conclusive remarks will be proffered in the last paragraph. Beforehand, a concise review of the application of standard I&O methods to the case of the Chinese economy, and their limitations will be suggested.

1. The application of I&O methods to the case of China

Since the arrival of enterprise, regional, sectoral and national tables in the 1960s and 1970s, traditional I&O techniques have been used and applied in length and detail to the case of the Chinese economy with a view to describing and analyzing the transformation of the Chinese industrial fabric. Indeed, whereas the first input-output table ever compiled in China was the 1964 physical I&O table for the large enterprise Anshan Iron and Steel Corporation (Li Bingquan, 1991), the first input-output table describing the national economy as a whole came to birth in the year 1973 (Chen, 1991). Enterprise tables have extensively been used for enterprise planning

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purposes, in an economy where State Owned Enterprises were traditionally the backbone of the national industrial structure. Other tables constructed at the national level embrace specific sectors and industries; these include agriculture, energy, machinery, and electrical equipment (Hao, 1991; Li, Lin and Zhang, 1991)[2].

The interdependence existing between the various economic sectors and the expansionary potential that an industry has on any other one, have been highlighted by Heimler (1991), and by Bhalla and Yue (1990). Coady and Li (1993) discuss and analyze, albeit in a rather succinct manner, the change in I&O coefficients during the 1980s. In their analysis of China's energy use changes over the 1980s, Lin and Polenske (1995) show that China's energy savings between 1981 and 1987 were due essentially to production technology changes rather than to final demand changes. One of the essential merits of this later study is that, using a structural decomposition analysis, it allows for input substitution and technological changes and is thus superior to the traditional input-output model with its fixed technical coefficients. Finally, I&O tables and techniques, as an economic planning device, have been used at the provincial level (Polenske, 1991), as well as at the national level (Li and Li, 1991; Chen, 1991; Xia and Yang, 1991). I&O tables enabling to forecast the effects of a change in the circumstances of one industry upon other industries in the Chinese case, have been used by Li and Li (1991).

Recent contributions in Chinese include the work of Gu and Liu (1996) who analyze the change in the production structure and in the distribution structure by comparing the change in the technical coefficients relating to the 1987 and 1990 I&O tables. Gu, Zou and Li (1997) explain the change in the industrial structure by comparing the technical coefficients between two input-output tables, or by analyzing the change in the ratio of one sector's output over the total output. Finally, the use of a dynamic I&O model has enabled Zhong and Wang (1997) to discuss the relationship existing between the change in the industrial structure and in the economic growth rate.

Because the Chinese economy is moving gradually from a centrally-planned system to a market economy, the application of standard I&O analysis to the case of China has been and is still fraught with many limitations. Criticisms of standard I&O analysis as applied to the case of China have been proffered for example by Xu, Deng and Gruver (1991), and by Gu, Liu and Huang (1991). Using a mathematical model, Xu, Deng and Gruver (1991) discuss the limitations of the

[2] For a concise history of the birth of input-output tables in China, and for an overview of input-output research in

use of Leontiev matrices in transition economies. The coexistence of a planned economy and of a market economy leads to a dual price system, a planned price system and a market price system, which in turn necessitates the calculation of new/alternative input-output coefficients[3].

Time series analysis has been hampered by the lack of consistency in the collection of data[4]. Coady and Li (1993) highlight the problem of the time lag between the collection of data and the production of I&O tables, which implies that the table of technical coefficients in one time period may be based on data from a much earlier period. Finally, the problem of the measurement of the third sector (or 'non productive' sector) in the revamped national I&O tables (i.e. based for the first time on the UN System of National Accounts, SNA) is highlighted by Polenske (1991).

Therefore, any analysis of the change in the Chinese productive structure since the beginning of the economic reforms has to take these limitations into account.

2. Application of the Synthetic Biproportional Projector method (SBP) to the case of China

The objective of our study is to measure the changes in the Chinese industrial structure since the beginning of the economic reforms pertaining essentially to the manufacturing and services sectors (*i.e.* since 1985), and to explain the reasons for those changes. Most methods that have been used to analyze the changes in the Chinese national or regional industrial structure have relied on traditional I&O models based on technical coefficients, that are assumed to be fixed. In order to isolate the structural effect, or the change in the relative importance of the various industries, we must be able to capture the non proportional growth of the various industries between time period *n* and time period *n+1* as a result of overall economic growth. *Biproportional constrained matrix* methods which consist in finding, given a nonnegative coefficient matrix $L\langle q\rangle$, another matrix $\langle r\rangle\ (L\langle q\rangle)\ \langle s\rangle$, with *prescribed* row and column sums are used to that purpose (Bacharach, 1970). Using the *Synthetic Bi-proportional Projector* allows finding the exact value of a projected matrix, from an original matrix, fitted with the margins of a final one (De Mesnard, 1990a)[5].

China by Chinese and Western scholars see Polenske (1991) in Polenske and Chen, eds.

[3] Traditional I&O coefficients result in an overestimation or underestimation of the value of the intermediate demand. The introduction of market prices has been particularly slow in the industries controlled by the central government, such as Coal Mining. In July 1992, only 20 per cent of the coal produced by the Central Mining Administrations - representing still more than 40 per cent of the total output for the country as a whole - was being sold at market prices; by June 1993, this proportion increased to 80 per cent (Thomson, 1996).

[4] Some national I&O tables are in physical units only (table for 1973); others are in both physical and value terms (1981 and 1983); others are in value terms only (1987 table).

[5] For a discussion on the merits of the *SBP* over the *RAS* method, see De Mesnard (1990b)

We will use the *SPB* to explain the change in the structure of transactions between the various industries in China. The method will allow us to measure the extent of the change in the structure of input factors and distribution of every industry, and will ultimately enable us to determine which industries have been mostly responsible for overall structural change since the beginning of the industrial reform.

Let S be the source or original matrix in a given time period, and T the target or final matrix that can be observed in a later time period. The SBP method produces a projected matrix P from matrix S, fitted with the margins of T, *i.e.*:

$$P_{ij} = a_i \cdot b_j \cdot S_{ij} \quad \text{or} \quad P = A \cdot S \cdot B \qquad (1)$$

and
$$\sum_i P_{ij} = t_{.j} = \sum_i t_{ij}$$
$$\sum_j P_{ij} = t_{i.} = \sum_j t_{ij}$$

where A and B are two diagonal matrices,

$t_{.j}$ and $t_{i.}$ are the column and row sums (margins), respectively.

The core of the SBP method is to compare the changes between the projected matrix P and the target matrix T. In order to find P, it is necessary to obtain the A and B matrices. An iterative method shall be used:

starting with $a_i^0 = 1, (i = 1, \ldots, m)$

we can then calculate the values of A and B:

$$b_j^{n+1} = \frac{t_{.j}}{\sum_i S_{ij} \cdot a_i^n} \qquad (2)$$

$$a_i^{n+1} = \frac{t_{i.}}{\sum_j S_{ij} \cdot b_j^{n+1}} \qquad (3)$$

The iterative process stops when the margins of P approximate the margins of T.

As a result, since P and T have the same margins, the difference between the two transaction matrices will mirror structural change or the change in the industrial structure between the two time periods selected. The distance between two vectors or matrices is used to measure this difference:

$$\left\| D_j \right\| = \sqrt{\sum_{i=1}^{m} (P_{ij} - T_{ij})^2} \qquad (4)$$

where $\left\| D_j \right\|$ is the distance between the projected column and the target column of j-th vector.

We have used the 1987 and 1995 Input-Output tables to analyze the changes in the Chinese industrial structure since the beginning of the economic reforms pertaining to the manufacturing and services sector. The two tables were compiled by the SSB (State Statistics Bureau). The 1987 table was the first table compiled on the basis of the UN System of National Accounts (SNA). It is a 117x117 table and can be aggregated into a 33x33 table. The 1995 table, which is a 33x33 table, is the latest available I&O table for china. Consequently, the two 33x33 tables are chosen for our analysis. Every Input-Output table in China is based on current producer prices. In order to exclude the impact of the price factor and to make the two tables comparable, we had to deflate the 1995 table to 1987 prices. The price indices for the major industrial/sectoral categories as published in the Chinese Statistical Yearbook have been used to deflate the 1995 data to 1987 prices as follows:

$$X'_{ij} = X_{ij} \cdot P_i \quad \text{or} \quad X' = X \cdot P$$

where P is a diagonal matrix of the price indices. X' is the 1995 I-O table based on 1987 prices.

3. Application and results

The projection of the 1987 table onto the margins of the 1995 table is called a "prospective projection"; conversely, the projection of the 1995 table onto the margins of the 1987 table is called a "retrospective projection"[6]. According to formula (1), we can compute the absolute difference of each industry/product (column or line) between the two time periods. We can refine the analysis in taking the relative contribution of any industry - *i.e.* its share - to the overall change. These results are shown in table 1.

It should first be noted that the two projection paths give similar results. This is particularly the case for the top five industries. Commerce, Food, Chemicals, Agriculture and Construction have been the major contributors to overall change over the period under review. These industries have been responsible for more then 70 per cent of total structural change affecting the Chinese economy between 1987 and 1995. However, these industries are also the main industries in the Chinese economy in terms of total output (see Table in Appendix). Therefore, in order to exclude the "size effect", our analysis will rely on an indicator measuring the *relative intensity* of the change. The indicator of the relative intensity is given as:

$$RD_j = \frac{\sqrt{\sum_{i=1}^{m} (t_{ij} - p_{ij})^2}}{\left(\sqrt{\sum_{j=1}^{m} t_{ij}^2} + \sqrt{\sum_{j=1}^{m} p_{ij}^2} \right) \Big/ 2} \qquad (5)$$

where t_{ij} and p_{ij} are the elements of the target and projected matrices respectively, and RD_j is the relative intensity of j-th column. Because of the closeness of association existing between the prospective and retrospective paths, we have synthesized the results achieved from formula (5) in Tables 2 and 3 below.

[6] To use De Mesnard's terminology (1990a).

Table 1: Ranking of Industries Contributing to Overall Change (per cent)

	Prospective Path			Retrospective Path	
27	Commerce	24.74	6	Food	22.26
6	Food	17.88	27	Commerce	17.33
14	Chemicals	17.70	14	Chemicals	16.12
1	Agriculture	8.68	1	Agriculture	12.69
25	Construction	7.11	25	Construction	9.72
8	Clothing and leather	4.35	7	Textiles	2.66
10	Paper, cultural and educational articles	2.81	10	Paper, cultural and educational articles	2.40
16	Primary metals	2.24	16	Primary metals	2.39
7	Textiles	1.76	12	Petroleum refining	2.17
33	Public administration	1.67	26	Freight transport and communication	1.70
15	Building materials and other non-metallic mineral products	1.65	8	Clothing and leather	1.53
21	Electronics and communication equipment	1.29	31	Cultural, education health and scientific research institutions	1.48
17	Metal products	0.97	15	Building materials and other non-metallic mineral products	1.35
20	Electrical machinery and instruments	0.95	20	Electrical machinery and instruments	1.16
12	Petroleum refining	0.94	18	Machinery	1.08
18	Machinery	0.85	17	Metal products	0.86
30	Public utilities and services to household	0.72	21	Electronics and communication equipment	0.61
32	Finance and insurance	0.70	28	Restaurants	0.40
26	Freight transport and communication	0.69	11	Electricity, steam and hot water production and supply	0.39
31	Cultural, education health and scientific research institutions	0.68	30	Public utilities and services to household	0.32
11	Electricity, steam and hot water production and supply	0.30	29	Passenger transport	0.27
19	Transport equipment	0.28	33	Public administration	0.22
5	Other mining	0.26	9	Sawmills and manufacture of furniture	0.20
9	Sawmills and manufacture of furniture	0.26	24	Industries not elsewhere classified	0.14
28	Restaurants	0.18	19	Transport equipment	0.12
29	Passenger transport	0.11	2	Coal mining	0.12
3	Crude petroleum and natural gas production	0.09	5	Other mining	0.10
2	Coal mining	0.04	32	Finance and insurance	0.07
23	Maintenance and repair of machinery and equipment	0.04	3	Crude petroleum and natural gas production	0.06
24	Industries not elsewhere classified	0.03	23	Maintenance and repair of machinery and equipment	0.06
4	Metal ore mining	0.02	22	Instrument, meters and other measuring equipment	0.02
13	Coking, manufacture of gas coal products	0.02	13	Coking, manufacture of gas coal products	0.01
22	Instrument, meters and other measuring equipment	0.01	4	Metal ore mining	0.01

Source: Authors' calculations based on Chinese Input Output Tables, 1987 and 1995, State Statistics Bureau, China Statistics Press: Beijing.

Table 2: Ranking of industries according to their relative intensity (Column)

	Industry	Percentage
27	Commerce	8.05
32	Finance and insurance	6.83
29	Passenger transport	5.99
24	Industries not elsewhere classified	4.94
30	Public utilities and services to household	4.82
33	Public administration	4.68
5	Other mining	4.56
26	Freight transport and communication	3.96
12	Petroleum refining	3.50
3	Crude petroleum and natural gas production	3.42
22	Instruments, meters and other measuring equipment	3.25
2	Coal mining	3.20
23	Maintenance and repair of machinery and equipment	3.08
9	Sawmills and manufacture of furniture	3.02
11	Electricity, steam and hot water production and supply	2.90
15	Building materials and other non-metallic mineral products	2.78
10	Paper, cultural and educational articles	2.60
4	Metal ore mining	2.52
31	Cultural, education health and scientific research institutions	2.32
8	Clothing and leather	2.28
17	Metal products	2.20
13	Coking, manufacture of gas coal products	2.14
14	Chemicals	2.08
20	Electrical machinery and instruments	2.06
6	Food	2.01
28	Restaurants	1.82
16	Primary metals	1.66
25	Construction	1.66
1	Agriculture	1.59
21	Electronics and communication equipment	1.47
18	Machinery	0.92
19	Transport equipment	0.87
7	Textiles	0.82

Source: Authors' calculations based on Chinese Input Output Tables, 1987 and 1995, SSB, China Statistics Press: Beijing.

Table 3: Ranking of Products According to their Relative Intensity (Row)

	Industry	Percentage
26	Freight transport and communication	9.61
23	Maintenance and repair of machinery and equipment	7.19
13	Coking, manufacture of gas coal products	6.99
31	Cultural, education health and scientific research institutions	6.59
30	Public utilities and services to household	6.38
29	Passenger transport	5.62
24	Industries not elsewhere classified	5.13
27	Commerce	5.06
32	Finance and insurance	3.95
8	Clothing and leather	3.90
11	Electricity, steam and hot water production and supply	3.31
3	Crude petroleum and natural gas production	3.15
9	Sawmills and manufacture of furniture	2.92
5	Other mining	2.90
22	Instruments, meters and other measuring equipment	2.89
12	Petroleum refining	2.85
10	Paper, cultural and educational articles	2.82
4	Metal ore mining	2.20
14	Chemicals	2.19
2	Coal mining	2.07
6	Food	1.99
17	Metal products	1.70
21	Electronics and communication equipment	1.37
15	Building materials and other non-metallic mineral products	1.35
18	Machinery	1.17
20	Electrical machinery and instruments	1.13
19	Transport equipment	1.07
1	Agriculture	0.97
7	Textiles	0.79
16	Primary metals	0.73

Note: Three industries which have not been considered here correspond to the zero lines in the input-output tables (*i.e* .Construction (25), Restaurants (28) and Public administration (33)

Source: Authors' calculations based on Chinese Input Output Tables, 1987 and 1995, SSB, China Statistics Press: Beijing.

Table 2 gives the ranking of the various industries according to the magnitude of the change in the structure of their purchases. Three distinct groups of industries appear almost clearly in table 2. Various industries from the tertiary sector are clustered at the top of the table. This first group encompasses Commerce (retail and wholesale trade) (27), Finance and Insurance (32), Transport and Communication (29, and 26), Public Administration, Public Utilities & Services to Households (30), as well as the more heterogeneous group labeled as 'Industries not elsewhere classified (24). These industries explain more than a third of total structural change. The most high-tech industries,

i.e. Electrical Machinery (20), Electronics (21), Chemicals (14), Transport Equipment (19) tend to be classified at the bottom of the table, with the exception of Instruments (22). Clearly, this denotes the feeble integration of new high-tech industries, mostly owned by foreign investors, into the Chinese industrial structure, or the poor level of linkages in the economy. The development of the Electronics, Instruments and Electrical Equipment industries in a developing country starts typically with low-skilled, low value-added, assembly-type operations. The SEZs are merely used as assembly and re-export platforms by many Japanese and other foreign investors[7]. Finally, the industrial activities based on the exploitation of natural resources [Coal Mining (2); Electricity Production (11); Metal Ore Mining (4)], and the traditional industries [clothing (8); furniture (9)] are all classified mid-way through the table. Agriculture (1) and Textiles (7) are two other industrial activities that characterize a typical economy in the first stage of economic development. Their classification at the bottom of the table suggests that these two industries have been structurally stable.

Comparing table 1 with table 2 makes it clear that the industries contributing mostly to overall structural change have a low relative intensity with the exception of Commerce. We find that Food (6), Chemicals (14), Agriculture (1), and Construction (25) are very stable, in the sense that these industries did not modify substantially the structure of their purchases during 1987 and 1995. However, the structure of purchases by the firms belonging to Commerce (*i.e.* retail and wholesale trade) has changed the most. This is explained essentially by the fact that the central element in the economic reforms process in China has been the reform of the price system. At the end of 1992, more than 90 per cent of consumer goods prices were determined through the operation of the market, against less than 6 per cent in 1983[8]. Hence, the pricing reform went in parallel with the unprecedented development of the retail and wholesale industry. Many wholesale companies and retail outlets were established with an injection of foreign capital during this period (*e.g.* Lufthansa Center in Beijing). Moreover, and as documented by Tung (1997), urban areas in China have witnessed an important growth of private enterprises in the area of commerce (and other services) since the late 1980s. These new retail and wholesale firms have greatly facilitated the distribution of products manufactured in the new and expanding manufacturing businesses. As a result, the structure of the purchases of the Commerce industry has changed most.

[7] On the issue of poor linkages between foreign and indigenous electronics firms in the SEZs (Special Economic Zones) of China, see for example Luo (1997).

[8] These figures are from the *Book on Chinese Reform - Price Reform Volume*, 1997, Beijing.

Finance and Insurance is another industry that underwent an intensive restructuring during the period of time considered. Here again the reform of the banking system, which was given an impetus in the mid 1980s, is responsible for this change. As early as 1978, the finance market started to open gradually to outsiders; many foreign banks and insurance companies have set up branches in China, particularly in Shanghai which is becoming the leading financial center of mainland China. At the end of 1994, thirty foreign countries had established a financial and insurance representation in mainland China through 393 branches (China Development Report, 1995).

Table 3 shows the change in the structure of sales of products over the period considered. The sales of Freight Transport and Communication Services (26), of Maintenance Services (23), of Gas and Coal products (13), of Cultural and Educational services (31), of Public Utilities (30) of Passenger Transport Services (29) and of Commerce services have increased the most over the period under review. The change in the sales of these products and services explains more than 47 per cent of structural change. Here again, the table denotes the trend towards the 'tertiarization' of economic activities and the weak penetration of technology in the industrial structure of the country. Indeed, the sales of Electronic Products (21), Electrical Machinery & Instruments (20), and Chemicals (14) contributed only marginally to the change in the Chinese industrial structure between 1987 and 1995 (less than 8 per cent).

Conclusion

The choice of the *Synthetic Biproportional Projector* as a tool for the measurement and analysis of structural change in China since the mid 1980s allows us to determine the exact value of a new coefficient matrix, projected on the basis of a source matrix fitted with the margins of an observed final one. The distance between the new projected coefficient matrix and the target matrix allows us to measure the extent of structural change between the two periods under review. Our analysis has relied on the 1987 and 1995 national I&O tables, compiled by the SSB in China. The projection of the 1987 matrix onto the margins of the 1995 one (*i.e.* P(87/95)) gives similar results to the inverse projection (*i.e.* P(97/85)). Correcting for the 'size effect', or for the distortions introduced in the analysis by the change in the purchases and sales of large industries, leads us to the following results:

- a few industries and products are mostly responsible for the evolution of I&O coefficients over the period under review. Commerce, Finance, Passenger & Freight Transport, Public Utilities, Public Administration, Petroleum Refining, Petroleum and Natural Gas Production and Other Mining are industries that explain more than 50 per cent of overall structural change. Even fewer vertices account for more than half of the change in the structure of sales of products and services over the period considered. With the exception of Public Administration, the products and services explaining most of the relative intensity of the change correspond to the industries listed above. Another product with very important sales increases over the period is Maintenance and Repair of Machinery Services.

- structural change in China between 1987 and 1995 denotes a substantial shift from agriculture and manufacturing activities to tertiary production. Indeed, in spite of its still pivotal role in the PRC's economy (Table A in Appendix), the importance of Agriculture on overall structural change is marginal[9]. The period is characterized by an impressive growth of many domestic private businesses in Commerce, Public Utilities and Transport. The entry of domestic firms in these areas has been facilitated by low entry barriers, such as limited capital requirement and management expertise. Also, foreign MNEs (multinational enterprises) have provided a large impetus to Commerce and Finance & Insurance industries. The shift to tertiary production has been made possible by the price reform process (for Commerce) and also by the reform of the Banking and Insurance sector.

- in spite of burgeoning Electronics & Communication Equipment, Chemicals, and Electrical Machinery & Instruments industries in China, the high-tech sectors only play a minor role in Chinese structural change between 1987 and 1995. These three industries represent 12.6 per cent of total output in value terms in 1995 (Table A in appendix), and yet they explain only 5.6 per cent of structural change between 1987 and 1995 (less than 8 per cent for products). This mirrors the poor level of backward and forward linkages. This is a problem that the central government is currently trying to address with the targeting of high-tech industries as priority sectors for FDI and with the emphasis placed on technology transfer.

[9] These results concur with those of Li and Li (1991), when they predict lower than average growth rates for agriculture, petroleum and coal.

Appendix - Table A: Ranking of Industries by Total Output (10,000yuan - 1995)

	Industry	Rank
1	Agriculture	203410000
25	Construction	134019000
14	Chemicals	120853100
6	Food	107169300
27	Commerce	95353540
16	Primary metals	80103350
7	Textiles	79748260
18	Machinery	76775610
15	Building materials and other non-metallic mineral products	62209690
8	Clothing and leather	56882200
31	Cultural, education health and scientific research institutions	44708100
10	Paper, cultural and educational articles	43464330
30	Public utilities and services to household	43057800
26	Freight transport and communication	42837510
19	Transport equipment	40506990
20	Electrical machinery and instrument	39843400
21	Electronics and communication equipment	37644260
17	Metal products	34943450
33	Public administration	34014000
11	Electricity, steam and hot water production and supply	29338950
32	Finance and insurance	24584000
12	Petroleum refining	22513680
5	Other mining	18781020
9	Sawmills and manufacture of furniture	15820360
3	Crude petroleum and natural gas production	15036050
28	Restaurants	14660050
2	Coal mining	13315130
29	Passenger transport	9864910
4	Metal ore mining	7435442
23	Maintenance and repair of machinery and equipment	5045658
24	Industries not elsewhere classified	3997615
13	Coking, manufacture of gas coal products	3933099
22	Instruments, meters and other measuring equipment	3579386

Source: Input-Output Table, 1995, State Statistics Bureau, China Statistics Press: Beijing

Bibliography

Bacharach, Michael (1970), *Biproportional Matrices & Input-Output Change*. Cambridge: Cambridge University Press.

Bhalla, A., S., and Yue Ma (1990), 'Sectoral Interdependence in the Chinese Economy in a Comparative Perspective', Applied Economics, Vol.22, N.8, pp.1063-81, August.

Chen Xikang (1991), 'Application of National Input-Output Tables'. In Polenske and Chen Xikang, eds, *Chinese Economic Planning and Input-Output Analysis*, Oxford University Press: Oxford, pp. 27-44.

China Development Report (1995), State Statistics Bureau, China Statistics Press: Beijing.

Coady David and Li Jie (1993), 'Changes over time of Input-Output Coefficients for China', LSE Suntory-Toyota International Centre for Economics, London, Working Paper CP No.28, October.

De Mesnard, Louis (1990a), Biproportional Methods for Analysing Interindustry Dynamics: the Case of France, Economic Systems Research, Vol.2, No.3, pp.271-293.

De Mesnard, Louis (1990b), *Dynamique de la Structure Industrielle Française*, Paris: Economica.

Gu Haibin, Liu Qiyun, and Huang Dongpei (1991), 'The Application of Input-Output Analysis in China: Achievements, Problems and Strategies', Economic Systems Research, Vol.3, N.4, pp.430-32.

Gu Haibin and Liu Fen (1996), 'The Empirical Research of Input-output of Chinese Industrial Economy', Quantitative and Technical Economics Research, 2, (in Chinese).

Gu Haibin, Zou Ge and Li Fuqiang (1997), 'The Chinese Industrial Trend: The Comparative Analysis of China's Input-output Series Tables:1987-1990-1992', Quantitative and Technical Economics Research, 1, (in Chinese).

Hao Jinliang (1991), 'Application of an Energy Input-Output Table for Agriculture'. In Polenske and Chen Xikang, eds, *op. cit.*, OUP: Oxford, pp. 124-36.

Heimler Alberto (1991), 'Linkages and Vertical Integration in the Chinese Economy', Review of Economics and Statistics, Vol.73, N.2, pp.261-7, May.

Li Bingquan (1991), 'Application of the Input-Output Technique in Chinese Enterprises'. In: Polenske and Chen, eds, *op.cit.*, OUP: Oxford, pp. 257-72.

Li Poxi and Li Shantong (1991), 'Application of an Input-Output Table to Study China until the Year 2000, in: Polenske and Chen, eds, *Chinese Economic Planning and Input-Output Analysis*, Oxford University Press: Oxford, pp.45-68.

Li Yiyuan, Lin Desun and Zhang Lanhui (1991), 'Input-Output Analysis of the Machinery and Electronics Industry'. In: Polenske and Chen, eds, *op.cit.,* OUP: Oxford, pp. 137-46.

Lin Xiannuan and Polenske Karen, R. (1995), 'Input-Output Anatomy of China's Energy Use Changes in the 1980s', Economic Systems Research, Vol.7, N.1, pp.67-84.

Luo Qi (1997), 'Foreign Direct Investment and industrial restructuring in Xiamen', Issues & Studies, Vol.33, No.7, pp.62-76.

Polenske Karen (1991), 'Chinese Input-Output Research from a Western Perspective'. In Polenske and Chen, eds, *Chinese Economic Planning and Input-Output Analysis,* OUP: Oxford, pp.2-23.

Thomson Elspeth (1996), 'Reforming China's Coal Industry', The China Quarterly, No.147, Sept., pp.726-50.

Tung Ricky (1997) 'Possible Development of Mainland China's Private Enterprises', Issues and Studies, Vol.33, No.6, pp.1-16.

Xia Shaowei and Yang Linjun (1991), 'Dynamic Input-Output Model'. In Polenske and Chen, eds, *op.cit.,* OUP: Oxford, pp. 93-108.

Xu Dianqing, Deng Shengliang, and Gruver Gene (1991), 'The Application of the Leontief Input-Output Matrix in the Transition Process', Economic Systems Research, Vol.4, N.1, pp.35-47.

Zhong Xueyi and Wong Li (1997), 'Research on the Quantitative Relationship between the Changes in Industrial Structure and Economic Growth', Quantitative and Technical Economics Research, 5, (in Chinese).