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Industrial Productivity and the Cost of the Chinese Economy: An Analysis of Inflation Using 1987, 1992 and 1997 Input-Output Tables

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Abstract

Inflation has occurred repeatedly in China. It is still regarded as one of the big issues endangering stable and sustained economic growth. This paper analyzes the cost structure (inflation), total factor productivity (TFP), and their relationships by industry in China for the period 1987-1997, using 1987, 1992 and 1997 input-output tables. For this purpose, we estimate the capital stock by industry and the 1997 input output table at constant 1990 prices. We divide the whole ten-year period into two parts: 1987-1992 and 1992-1997. This division is made because China adopted policies for the socialist market economy in 1992, since when nearly all prices have been determined in the market. For the two periods, we compare and examine the cost structure of each industry, the relationship between productivity and inflation, and the contribution made to the improvement of the productivity (TFP) of the Chinese economy by adopting the market economy. We also discuss some implications for inflation since 2003, with reference to the government policy of macro-control.

KEYWORDS: input-output analysis, output price, input cost, TFP by industry, China, transition period

1. Introduction

China achieved great progress after implementing a policy of reform and opening up to the rest of the world, but has also encountered many problems. Inflation, which has occurred repeatedly, is one of the headaches accompanying economic growth. The objective of this paper is to analyze the problem of inflation from the viewpoint of productivity improvements, price increases, and the cost structure of industries. In particular, the paper aims to examine the relationship between price reforms and economic efficiency, together with the policy of macro-control by the government, based on the measurement of productivity (TFP) and cost structure by industry.

It is a common view that inflation in China was essentially due to the insufficient supply of goods. After implementation of the reform policy, China experienced high inflation on several occasions. Two instances of hyperinflation, in 1988 and 1994, made it clear that inflation was closely related to price reforms.

Until China initiated its reform policy in 1978, prices were set by the government and there was no market mechanism for adjusting prices. There were many cases of irrational price setting, which broadly fell into three categories: (1) price setting ignored the quality of goods; (2) the prices of energy, such as petroleum and coal, and some raw materials were set at low levels; (3) the purchase prices of

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agricultural products were set higher than the sale price, making it inevitable that the government would have to provide large subsides to fill the gaps. The market mechanism could not function under such an irrational system of prices, preventing the efficient allocation of resources and resulting in poor efficiency throughout the economy. The objective of price reform was to improve the efficiency of resource allocation and finally to improve the efficiency of the Chinese economy by establishing a rationalized price system.

Price reforms underwent many twists and turns in the process of China's transition to a market economy. Before 1984, reforms focused on adjusting the relative ratios of the prices of different products, with the government retaining price controls. From the latter part of the 1980s, the government began to loosen its control on prices, reducing the number of goods whose prices were to be determined by the government, while expanding the scope for "variable prices" and "free prices". To begin with, a system of "multiple prices" was adopted in 1985. In other words, except for a few important goods and services whose prices were determined by the government, major production materials and other goods and services had their prices determined by markets (market prices) or by markets with the guidance of the government (government guiding prices). Under this system of "multiple prices", steps to relax price controls were hastened. However, when the government showed a clear intention to conduct price reforms in the spring of 1988, consumers tended to buy goods even though they had no need of them at that time, as they expected inflation to follow. Because prices soared in the latter half of the year, the government had to impose price controls again. The government adopted policies that tightened its grip on the economy between 1989 and 1991, and the number of goods whose prices were adjusted in the markets increased steadily during this period. At the beginning of 1992, Deng Xiaoping visited Shanghai and Shenzhen and called for efforts to hasten reforms and economic development. The Communist Party of China (CPC) took the decision to establish a "socialist market economy" at the 14th secession congress of the CPC held in December 1992. As a result, the pace of economic reform increased and China began in earnest its transition to a market economy. Price adjustments effectively progressed after 1992. The system of supplying staple foods and edible oils to urban citizens was abolished in 1993. The market determined the prices of nearly all production materials and the system of "multiple prices" was practically abolished. The price adjustment regulations on postal services, telephones, house rent, water and electricity, transportation, medical care, education and nursery schooling were eased, enabling prices to soar again.

Price reforms are, by their very nature, accompanied by inflation, but they are a must if China is to shift to a market economy. See Nanbu (1995) for a detailed discussion on the relationship between price reforms and inflation until the mid-1990s.

China experienced five years of deflation from 1998 to 2002, but it began to face inflation again at the end of 2003. The prices of agricultural products and some raw materials started to increase at two-digit rates around the end of 2003, while the prices of energy and all raw materials increased by about 20% in 2004. Amongst others, the prices of mining and quarrying products rose continuously by more than

30% for two months. On the other hand, the prices of consumer durables such as electrical appliances and automobiles fell into a state of deflation. Early in 2005, the trend towards rising prices in the fields of agriculture and energy calmed down to some extent, but significant upward pressure on the prices of raw materials and real estate still exists. In urban areas, in particular, price increases are unavoidable in such areas as transportation, medical services, water, gas and heating.

Is the nature of the latest round of inflation (i.e. that taking place since 2003) the same as before? The policy of macro-control (i.e. fiscal and monetary policies aimed at the indirect control of the macroeconomic elements of the market economy) was implemented to combat inflation in 1994, resulting in a one-digit rate of inflation after 1996, as well as a government declaration of a successful soft landing. The government of China is again adopting a policy of macro-control against the current round of inflation. Is this policy still effective? Is a different policy or reform needed to prevent repeated inflation?

This paper mainly analyzes inflation in China from 1987 to 1997 through a quantitative investigation of the relationship between price reforms and economic efficiency from the point of view of cost-push inflation, referring also to the current round of inflation and the policy of macro-control to combat it. The period under study is divided into two parts —1987-1992 and 1992-1997— with the dividing line between the two periods being set as 1992, the year that Deng Xiaoping toured South China and China began to establish the "socialist market economy" system. The first five years represent a period in which the Chinese economy was mainly subject to government planning with a few adjustments by the market, while the second five years represent a period in which the Chinese economy was mainly adjusted by the market with a few controls on the part of the government.

This paper consists of five sections. Section 1 is an introduction. Section 2 provides an introduction to methods of estimating capital stocks, as well as explaining briefly how to analyze cost structure. Section 3 analyzes inflation in the light of cost-push or the cost structure of industries within the framework of input-output tables. Section 4 discusses the TFP and price rises in the light of economic reforms. The last section is a conclusion. Details of the methodology used are provided in the appendix.

2. Methodology

2.1 Estimation of capital stocks

For the purposes of analysis in this paper, it is essential to estimate the stocks of capital in each sector. It is not easy to obtain data on capital stocks for China, as well as for many other countries. It is especially difficult to estimate data on capital stocks in each sector. We mainly used the Young (1994) method to accomplish this in this paper[1] , but in order to figure out a reasonable estimate of capital stocks we also developed and applied some new adjustment methods.

According to Young (1994), the real capital stock at constant prices at the beginning of the period (K_0) can be estimated under the hypothesis of perpetual inventory (PI) by

$$K_0 = I_0 / (g+\delta)$$

where I_0 is the real investment in the benchmark year, "g" the average real growth rate of investments in the five years before the benchmark year, and "δ" the depreciation rate. The average growth rate of real investment in the five years before the benchmark year is supposed to be the average growth rate of the whole period (from the year infinitely before to the benchmark year) in this equation. The capital stocks at the beginning of each period after the benchmark year (K_t) are estimated by

$$K_{t+1} = I_t + (1-\delta) K_t \quad (t= \text{year})$$

When this estimation method is applied to China, the estimated data of real capital stocks in most sectors were either too big or too small[2]. The problem occurred because the average growth rate of real investments throughout the period is assumed to be the same as the average growth rate in the five years before the benchmark year. Of course, the two growth rates were not the same in practice except in the case of constant investment growth. The larger the fluctuation of the latter growth rate, the larger the difference between the two. In the case of China, total fixed investment fluctuated greatly due to changes throughout the economy. Fixed investment by industry also fluctuated significantly in many industries. If the Young method were applied directly, irrational results would be generated.

In order to avoid this problem, some devices have been added to the Young method. Firstly, the precondition that g is the average growth rate of real investment in the five years before the benchmark year is eased. In other words, we choose five years without significant change in investment by dropping abnormal years, thereby assuming the average growth rate of investment of these five years to be that of the whole period (from the year indefinitely before to the benchmark year). We attempt to choose five years in which investment growth rates fluctuate modestly around the average level. Secondly, allowing for short-term fluctuations in the investment level, the average amount of investment is applied to the equation above instead of the initial amount or the amount for a single year. The capital stock estimated in this way is supposed to be the capital stock in the middle of the period. The capital stocks in other years can be estimated from annual accumulation of investment. The data on fixed investment and depreciation rate by sector in the period 1987 to 1997 are obtained from the statistical materials listed in the references of this paper. Investment deflators are taken directly or processed from those of SSB-PRC and IER-HU (1997).

2.2 Analysis of cost structure by sector

A detailed explanation of the methodology of cost structure analysis is attached in the appendix[3] . This section gives only a brief essence of the framework. The discussion starts from the equilibrium relationship between the prices and costs in the input-output table (I-O table), i.e. the price of each sector is the sum of intermediate, labor and capital costs ($p_j=\sum p_i a_{ij}+w_j b_{Lj}+r_j b_{Kj}$)[4] , where "p" is the price; "w" is the wage rate; "r" is the profit rate; "a" is the intermediate input coefficient; "b_L" is the input ratio of labor; "b_K" is the input ratio of capital; and "i" and "j" represent a sector. From this equilibrium equation, the growth rate of prices between two years

($\Delta pj/pj$) can be measured by using the growth rate of wage rates ($\Delta wj/wj$), the growth rate of profit rates ($\triangle r_j/r_j$), the TFP growth rate ($\Delta T_j/T_j$), and the Leontief inverse coefficients $(I-A)^{-1}$:

$$\triangle p_j/\bar{p}_j=[(\bar{w}_j \cdot \bar{b}_{Lj}/\bar{p}_j)\cdot(\triangle w_j/\bar{w}_j) +(\bar{r}_j \cdot \bar{b}_{Kj}/\bar{p}_j)(\triangle r_j/\bar{r}_j)-\triangle T_j/\bar{T}_j]$$

[direct effects (own sector)]

$$+[(\bar{w}_j \cdot \bar{b}_{Lj}/\bar{p}_j)\cdot(\triangle w_j/\bar{w}_j)+(\bar{r}_j \cdot \bar{b}_{Kj}/\bar{p}_j)\cdot(\triangle r_j/\bar{r}_j)-\triangle T_j/\bar{T}_j]\cdot(\bar{c}_{jj}-1)$$

[indirect effects (own sector)]

$$+\sum_{h\neq j}^{n}(\bar{p}_h/\bar{p}_j)[(\bar{w}_j \cdot \bar{b}_{Lh}/\bar{p}_j)\cdot(\triangle w_j/\bar{w}_j)+(\bar{r}_j \cdot \bar{b}_{Kh}/\bar{p}_j)\cdot(\triangle r_j/\bar{r}_j)-\triangle T_h/\bar{T}_h]\bar{c}^{hj}$$

[indirect effects (other sectors)]

The bars over certain letters of the alphabet represent the average amount over two years. "Δ" represents the increased amount between the two time points, with the estimates for the periods 1987-1992 and 1992-1997 being calculated by multiplying by one-fifth to indicate annual averages. It is noted in the above equation that the growth rate of the wage rate and the growth rate of the profit rate are multiplied by the share of wages and the share of capital respectively.

The TFP growth rate is defined as the weighted sum of the reduction rates of intermediate input coefficients, labor input coefficients and capital input coefficients with their input shares as weights:

$$\triangle T_j/\bar{T}_j=-[\sum_{h=1}^{n}(\bar{p}_h \cdot \bar{a}_{hj}/\bar{p}_j)\cdot(\triangle a_{hj}/\bar{a}_{hj})+(\bar{w}_j \cdot \bar{b}_{Lj}/\bar{p}_j)\cdot(\triangle b_{Lj}/\bar{b}_{Lj})+(\bar{r}_j \cdot \bar{b}_{Kh}/\bar{p}_j)\ (\triangle b_{Kj}/\bar{b}_{Kj})]$$

According to the equation above, the reasons for price rises in each sector can be broken down into direct effects, consisting of increases in the wage rate, profit rate and productivity (in the opposite direction) in the sector, and indirect effects on this sector multiplied by the direct effects of this sector and the other sectors through the Leontief inverse matrix. Before the equation is applied to China, it is necessary to construct an input-output table for 1997 at constant prices and to estimate the amount of labor in each sector. In order to construct an input-output table at constant prices, the price deflators of the sectors were first of all measured, using the method created by Li Qiang and Xue Tiandong (1998) on the basis of the statistical data listed in the references. The I-O table for 1997 with 30 sectors at constant 1992 prices was then constructed. The estimate of the amount of labor was based on statistical data listed in the references.

Table 1 Changes in Prices (Cost Structures): 1987-1992 (% annual)

Code	Sectors	Change in prices	Direct effects							Indirect effects		
			Change in wage	Change in Capital	−ΔTFP				Total	Own	Others	Total
					Intermediate input	labor	Capital	Total				
01	Agriculture	8.2	5.7	0.6	0.9	-1.7	0.1	-0.7	5.6	1.2	1.5	2.7
02	Coal Mining	12.5	3.4	0.9	5.3	-1.2	0.1	4.2	8.5	0.4	3.6	4.0
03	Crude oil,gas	12.3	0.8	1.9	4.3	0.0	3.0	7.2	9.9	0.2	2.1	2.4
04	Metal ore	7.3	1.4	2.8	1.9	-1.2	-2.3	-1.6	2.6	0.3	4.4	4.7
05	Non-ferrous	6.1	3.6	-0.2	2.8	-2.8	-1.3	-1.3	2.1	0.1	3.9	4.0
06	Food mfg	7.3	0.5	0.8	-1.0	-0.3	0.5	-0.8	0.5	0.1	6.8	6.8
07	Textiles	6.3	0.6	0.4	-0.4	-0.4	-0.6	-1.4	-0.4	-0.3	7.0	6.7
08	Apparel	3.7	1.2	1.2	-1.6	-1.5	-2.2	-5.2	-2.8	-0.2	6.7	6.5
09	Furniture	2.2	0.5	1.6	-2.2	-1.3	-1.9	-5.4	-3.3	-0.6	6.1	5.5
10	Paper, printing	3.7	1.3	-0.1	-1.2	-1.2	-0.8	-3.2	-2.0	-0.5	6.3	5.7
11	Electr. Steam.	11.7	1.1	2.5	2.4	-0.4	1.0	3.0	6.6	0.3	4.8	5.1
12	Petro ref	9.1	0.3	-2.1	1.0	0.0	1.7	2.8	0.9	0.0	8.2	8.2
13	Coking, gas	9.8	1.1	0.8	-1.9	0.0	0.7	-1.2	0.6	0.0	9.2	9.2
14	Chemicals	4.5	0.7	0.8	-1.2	-0.6	-0.9	-2.7	-1.2	-0.6	6.3	5.7
15	Non-metal	5.1	2.0	3.4	-0.7	-2.4	-2.7	-5.8	-0.4	0.0	5.5	5.5
16	Metals smelt.	10.8	0.8	2.0	1.6	-0.2	-0.5	0.8	3.7	1.7	5.5	7.1
17	Metal prod	3.5	1.3	1.4	-2.6	-1.6	-2.2	-6.4	-3.6	-0.3	7.4	7.1
18	Machinery	3.1	1.4	2.8	-1.6	-1.4	-3.5	-6.5	-2.3	-0.7	6.2	5.4
19	Transport eq	5.1	1.2	2.6	-0.9	-1.3	-2.0	-4.2	-0.4	-0.1	5.6	5.4
20	Electric mach	3.9	0.7	0.7	-1.9	-0.7	-1.3	-3.9	-2.4	-0.4	6.7	6.3
21	Com Eq	0.2	0.9	-0.4	-2.4	-0.9	-0.8	-4.1	-3.6	-2.1	5.9	3.8
22	Instruments	2.1	2.2	2.3	-0.8	-2.0	-3.9	-6.7	-2.1	-0.2	4.5	4.2
23	Mach repair	3.8	1.6	1.8	-0.5	-2.0	-2.1	-4.6	-1.2	0.0	5.1	5.1
24	Other mfg	1.7	4.8	8.8	-2.1	-5.3	-10.2	-17.6	-4.0	-0.7	6.4	5.7
25	Construction	10.4	2.9	1.9	1.3	-0.8	-0.4	0.2	5.0	0.1	5.4	5.4
26	Post & com	11.9	2.4	6.2	2.6	-1.4	-1.5	-0.2	8.4	0.3	3.2	3.5
27	Commerce	23.2	3.8	10.7	4.9	-0.3	-1.1	3.5	17.9	2.0	3.2	5.2
28	Edu. Utilities	8.0	2.8	3.0	0.8	-2.1	0.1	-1.2	4.6	0.3	3.0	3.3
29	Finance & ins	11.0	3.5	-0.1	9.1	-0.8	-3.0	5.4	8.8	0.2	2.0	2.2
30	Public adm	17.9	13.0	2.9	4.6	-6.1	-0.9	-2.4	13.6	0.0	4.3	4.3

Note: The average change rate of prices in all sectors is 8.8%

Table 2 Changes in Prices (Cost Structures): 1992-1997 (% annual)

Code	Sectors	Change in prices	Direct effects							Indirect effects		
			Change in wage	Change in Capital	−ΔTFP				Total	Own	Others	Total
					Intermediate input	labor	Capital	Total				
01	Agriculture	8.7	11.6	0.7	1.8	-7.3	-0.5	-6.0	6.2	1.5	1.0	2.5
02	Coal Mining	8.4	9.8	2.8	0.0	-5.6	-1.6	-7.2	5.4	0.3	2.6	3.0
03	Crude oil,gas	14.5	2.8	8.3	0.7	0.5	0.6	1.8	12.9	0.4	1.2	1.6
04	Metal ore	6.2	8.3	5.6	0.9	-6.2	-6.2	-11.5	2.4	0.5	3.3	3.8
05	Non-ferrous	7.2	5.5	2.6	0.2	-2.7	-1.8	-4.3	3.8	0.3	3.1	3.3
06	Food mfg	5.6	2.3	2.8	-1.8	-1.2	-2.0	-5.0	0.0	0.0	5.5	5.5
07	Textiles	4.1	3.5	2.6	-2.6	-2.2	-1.4	-6.2	-0.1	0.0	4.2	4.1
08	Apparel	3.0	6.3	2.2	-3.5	-4.2	-1.5	-9.2	-0.6	-0.1	3.7	3.7
09	Furniture	2.7	5.3	3.0	-2.0	-3.9	-3.3	-9.1	-0.8	-0.2	3.8	3.6
10	Paper, printing	3.5	5.8	0.8	-2.2	-3.9	-0.7	-6.8	-0.1	0.0	3.6	3.6
11	Electr. Steam.	11.7	2.7	2.5	3.6	-0.7	-0.2	2.7	7.9	0.5	3.3	3.8
12	Petro ref	9.2	0.8	1.8	-1.4	-0.1	-1.4	-2.9	-0.3	0.0	9.5	9.5
13	Coking, gas	9.6	6.2	-0.6	1.2	-4.2	1.0	-2.0	3.6	0.1	5.9	6.0
14	Chemicals	2.7	2.9	1.3	-1.7	-1.8	-1.9	-5.4	-1.2	-0.7	4.6	3.9
15	Non-metal	3.2	4.9	1.1	-1.1	-3.5	-2.0	-6.6	-0.7	-0.1	4.0	3.9
16	Metals smelt.	4.7	2.1	-0.9	0.4	-0.9	-0.8	-1.2	0.1	0.0	4.6	4.7
17	Metal prod	1.6	3.9	0.4	-2.4	-3.1	-1.1	-6.5	-2.2	-0.3	4.1	3.8
18	Machinery	1.3	3.6	1.9	-2.9	-2.4	-1.7	-7.0	-1.4	-0.4	3.2	2.8
19	Transport eq	-1.2	2.9	0.8	-2.6	-2.0	-2.1	-6.7	-2.9	-1.1	2.9	1.8
20	Electric mach	0.4	3.3	1.6	-2.6	-2.6	-2.4	-7.6	-2.7	-0.5	3.6	3.1
21	Com Eq	0.0	4.2	3.1	-2.0	-3.5	-3.7	-9.3	-1.9	-1.1	3.0	1.9
22	Instruments	-0.4	3.8	4.5	-2.1	-3.5	-5.4	-10.9	-2.6	-0.3	2.5	2.2
23	Mach repair	1.7	5.0	2.7	-3.2	-2.5	-2.2	-7.9	-0.2	0.0	2.0	2.0
24	Other mfg	3.4	2.0	8.7	-5.3	-1.0	-4.3	-10.6	0.1	0.0	3.3	3.3
25	Construction	3.5	3.1	1.4	-0.1	-2.4	-1.5	-4.0	0.5	0.0	2.9	2.9
26	Post & com	8.2	4.4	0.7	1.3	-1.4	0.8	0.7	5.9	0.4	1.9	2.3
27	Commerce	6.8	3.2	1.1	-0.1	0.0	-0.7	-0.8	3.5	0.5	2.7	3.2
28	Edu. Utilities	6.6	7.6	1.3	2.4	-5.5	-1.5	-4.6	4.3	0.4	1.9	2.3
29	Finance & ins	13.4	2.6	0.7	1.5	0.6	5.6	7.6	10.8	0.9	1.7	2.6
30	Public adm	7.6	4.6	0.0	1.8	-1.8	0.1	0.1	4.7	0.0	2.9	2.9

Note: The average change rate of prices in all sectors is 4.5%

Table 3 Analysis of Changes in Prices 1987-1992 (% annual): total (direct and indirect) contributions of each sector

Code	Sectors	△P	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
01	Agriculture	8.2	6.8	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	-0.2	0.0	0.1	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.9	0.1	0.2	0.0
02	Coal Mining	12.5	0.3	8.9	0.2	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	-0.1	0.0	0.4	-0.2	-0.3	0.0	-0.1	0.0	0.0	0.0	-0.1	0.0	0.4	2.0	0.2	0.4	0.0
03	Crude oil,gas	12.3	0.1	0.1	10.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	-0.1	0.0	0.3	-0.1	-0.3	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.2	1.3	0.1	0.3	0.0
04	Metal ore	7.3	0.3	0.3	0.3	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	-0.2	0.0	0.4	-0.1	-0.2	0.0	-0.1	0.0	0.0	0.0	-0.1	0.0	0.4	2.2	0.2	0.5	0.0
05	Non-ferrous	6.1	0.5	0.3	0.3	0.0	2.2	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	-0.2	0.0	0.3	-0.1	-0.2	0.0	-0.1	0.0	0.0	0.0	-0.1	0.0	0.4	1.9	0.1	0.3	0.0
06	Food mfg	7.3	3.4	0.1	0.1	0.0	0.0	0.5	0.0	0.0	0.0	-0.1	0.2	0.0	0.0	-0.2	0.0	0.1	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.6	2.2	0.2	0.4	0.0
07	Textiles	6.3	1.9	0.2	0.2	0.0	0.0	0.0	-0.7	0.0	0.0	-0.1	0.2	0.0	0.0	-0.3	0.0	0.2	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.5	3.7	0.2	0.6	0.0
08	Apparel	3.7	1.6	0.1	0.2	0.0	0.0	0.0	-0.3	-3.0	0.0	-0.1	0.2	0.0	0.0	-0.3	0.0	0.2	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	-0.2	0.0	0.5	4.1	0.2	0.6	0.0
09	Furniture	2.2	0.7	0.3	0.3	0.0	0.2	0.0	-0.1	-0.1	-3.9	-0.1	0.4	0.0	0.0	-0.3	0.0	0.6	-0.3	-0.2	0.0	-0.1	0.0	0.0	0.0	-0.1	0.0	0.5	3.4	0.2	0.6	0.0
10	Paper, printing	3.7	1.2	0.2	0.2	0.0	0.0	0.0	-0.1	0.0	0.0	-2.5	0.3	0.0	0.0	-0.3	0.0	0.4	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.5	3.5	0.2	0.5	0.0
11	Electr. Steam.	11.7	0.2	1.5	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.9	0.1	0.0	-0.1	0.0	0.3	-0.1	-0.2	0.0	-0.1	0.0	0.0	0.0	-0.1	0.0	0.5	1.7	0.1	0.3	0.0
12	Petro ref	9.1	0.1	0.1	5.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	1.0	0.0	-0.1	0.0	0.2	-0.1	-0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	1.9	0.1	0.3	0.0
13	Coking, gas	9.8	0.3	3.6	0.8	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.7	0.1	0.6	-0.1	0.0	0.4	-0.1	-0.3	0.0	-0.1	0.0	0.0	0.0	-0.1	0.0	0.8	2.9	0.2	0.5	0.0
14	Chemicals	4.5	1.0	0.3	0.5	0.0	0.1	0.0	0.0	0.0	0.0	-0.1	0.5	0.0	0.0	-1.8	0.0	0.3	-0.1	-0.2	0.0	-0.1	0.0	0.0	0.0	-0.1	0.0	0.5	3.0	0.2	0.6	0.0
15	Non-metal	5.1	0.4	0.6	0.4	0.0	0.1	0.0	0.0	0.0	0.0	-0.2	0.7	0.1	0.0	-0.2	-0.4	0.5	-0.1	-0.2	0.0	-0.1	0.0	0.0	0.0	-0.1	0.0	0.5	2.6	0.2	0.5	0.0
16	Metals smelt.	10.8	0.2	0.6	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	-0.1	0.0	5.3	-0.1	-0.3	0.0	-0.1	0.0	0.0	0.0	-0.1	0.0	0.5	2.7	0.2	0.7	0.0
17	Metal prod	3.5	0.4	0.4	0.3	0.1	0.0	0.0	0.0	0.0	0.0	-0.1	0.5	0.0	0.0	-0.2	0.0	2.0	-3.9	-0.2	0.0	-0.1	0.0	0.0	0.0	-0.1	0.0	0.5	3.2	0.2	0.6	0.0
18	Machinery	3.1	0.3	0.3	0.2	0.1	0.0	0.0	0.0	0.0	-0.1	-0.1	0.4	0.0	0.0	-0.2	0.0	1.3	-0.2	-3.1	0.0	-0.2	-0.1	0.0	0.0	-0.1	0.0	0.5	3.2	0.2	0.7	0.0
19	Transport eq	5.1	0.3	0.2	0.2	0.1	0.0	0.0	0.0	0.0	0.0	-0.1	0.3	0.0	0.0	-0.3	0.0	1.0	-0.1	-0.5	-0.5	-0.2	-0.1	0.0	0.0	-0.1	0.0	0.5	3.3	0.2	0.7	0.0
20	Electric mach	3.9	0.4	0.3	0.3	0.1	0.0	0.0	0.0	0.0	0.0	-0.1	0.4	0.0	0.0	-0.3	0.0	1.6	-0.2	-0.3	0.0	-2.8	-0.1	0.0	0.0	-0.1	0.0	0.5	3.4	0.2	0.7	0.0
21	Com Eq	0.2	0.3	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.3	0.0	0.0	-0.3	0.0	0.6	-0.1	-0.2	0.0	-0.3	-5.7	0.0	0.0	-0.1	0.0	0.5	3.9	0.2	0.8	0.0
22	Instruments	2.1	0.3	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.3	0.0	0.0	-0.2	0.0	0.8	-0.2	-0.3	0.0	-0.2	-0.5	-2.4	0.0	-0.1	0.0	0.4	2.9	0.2	0.7	0.0
23	Mach repair	3.8	0.3	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.4	0.0	0.0	-0.2	0.0	0.9	-0.2	-0.4	-0.1	-0.2	-0.1	0.0	-1.2	-0.1	0.0	0.5	3.0	0.2	0.6	0.0
24	Other mfg	1.7	0.8	0.2	0.3	0.0	0.0	0.0	-0.1	-0.1	-0.1	-0.1	0.3	0.0	0.0	-0.3	0.0	0.7	-0.1	-0.2	0.0	-0.1	-0.1	0.0	0.0	-4.7	0.0	0.5	3.7	0.2	0.6	0.0
25	Construction	10.4	0.3	0.3	0.3	0.1	0.1	0.0	0.0	0.0	-0.1	-0.1	0.4	0.0	0.0	-0.2	-0.1	1.0	-0.3	-0.3	0.0	-0.1	0.0	0.0	0.0	-0.1	5.0	0.6	3.0	0.2	0.5	0.0
26	Post & com	11.9	0.2	0.2	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.1	0.0	-0.1	0.0	0.2	-0.1	-0.1	0.0	-0.1	0.0	0.0	0.0	-0.1	0.0	8.7	1.7	0.2	0.3	0.0
27	Commerce	23.2	0.9	0.1	0.2	0.0	0.0	0.1	0.0	0.0	-0.1	-0.1	0.2	0.0	0.0	-0.1	0.0	0.2	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	-0.2	0.1	0.9	19.9	0.4	0.9	0.0
28	Edu. Utilities	8.0	0.4	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.3	0.0	0.0	-0.2	0.0	0.2	-0.1	-0.1	0.0	-0.1	-0.1	0.0	0.0	-0.1	0.1	0.4	1.8	5.0	0.3	0.0
29	Finance & ins	11.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.1	0.0	0.0	-0.1	0.0	0.1	-0.1	-0.1	0.0	0.0	-0.1	0.0	0.0	-0.1	0.1	0.4	1.0	0.5	9.0	0.0
30	Public adm	17.9	0.3	0.2	0.3	0.0	0.0	0.0	0.0	0.0	0.0	-0.2	0.2	0.0	0.0	-0.1	0.0	0.3	-0.1	-0.2	0.0	-0.1	-0.1	0.0	0.0	-0.1	0.2	1.0	1.9	0.6	0.3	13.6

Table 4 Analysis of Changes in Prices 1992-1997 (% annual): total (direct and indirect) contributions of each sector

Code	Sectors	△P	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
01	Agriculture	8.7	7.7	0.1	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	-0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.2	0.3	0.0
02	Coal Mining	8.4	0.3	5.8	0.4	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	-0.2	0.0	0.0	-0.1	-0.2	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.4	0.4	0.3	0.6	0.0
03	Crude oil,gas	14.5	0.1	0.1	13.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	-0.1	0.0	0.0	0.0	-0.1	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.1	0.4	0.0
04	Metal ore	6.2	0.3	0.2	0.5	2.8	0.1	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	-0.2	0.0	0.0	-0.1	-0.2	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.5	0.5	0.3	0.8	0.0
05	Non-ferrous	7.2	0.4	0.2	0.5	0.0	4.1	0.0	0.0	0.0	0.0	0.0	0.9	0.0	0.0	-0.2	0.0	0.0	-0.1	-0.2	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.5	0.4	0.2	0.6	0.0
06	Food mfg	5.6	4.0	0.1	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	-0.2	0.0	0.0	-0.1	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.4	0.2	0.5	0.0
07	Textiles	4.1	2.0	0.1	0.3	0.0	0.1	0.0	-0.1	0.0	0.0	0.0	0.4	0.0	0.0	-0.4	0.0	0.0	0.0	-0.1	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.3	0.6	0.2	0.8	0.0
08	Apparel	3.0	1.6	0.1	0.3	0.0	0.0	0.0	0.0	-0.7	0.0	0.0	0.3	0.0	0.0	-0.3	0.0	0.0	-0.1	-0.1	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.4	0.7	0.3	0.8	0.0
09	Furniture	2.7	0.9	0.2	0.4	0.0	0.3	0.0	0.0	0.0	-1.1	0.0	0.5	0.0	0.0	-0.3	0.0	0.0	-0.2	-0.1	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.5	0.7	0.3	0.8	0.0
10	Paper, printing	3.5	1.2	0.2	0.3	0.0	0.1	0.0	0.0	0.0	0.0	-0.2	0.5	0.0	0.0	-0.3	0.0	0.0	-0.1	-0.1	-0.1	-0.1	-0.1	0.0	0.0	0.0	0.0	0.4	0.7	0.2	0.7	0.0
11	Electr. Steam.	11.7	0.2	1.0	1.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	8.4	0.0	0.0	-0.1	0.0	0.0	-0.1	-0.1	-0.1	-0.2	0.0	-0.1	0.0	0.0	0.0	0.4	0.4	0.2	0.6	0.0
12	Petro ref	9.2	0.2	0.1	7.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	-0.3	0.0	-0.1	0.0	0.0	0.0	-0.1	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.4	0.4	0.2	0.5	0.0
13	Coking, gas	9.6	0.3	2.0	1.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.9	0.0	3.7	-0.1	0.0	0.0	-0.1	-0.2	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.6	0.7	0.3	0.7	0.0
14	Chemicals	2.7	1.0	0.2	0.7	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	-1.9	0.0	0.0	-0.1	-0.1	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.4	0.6	0.3	0.9	0.0
15	Non-metal	3.2	0.4	0.4	0.6	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.9	0.0	0.0	-0.2	-0.8	0.0	-0.1	-0.1	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.5	0.6	0.2	0.8	0.0
16	Metals smelt.	4.7	0.3	0.4	0.6	0.4	0.1	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.1	-0.2	-0.1	0.1	-0.1	-0.2	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.6	0.6	0.3	1.1	0.0
17	Metal prod	1.6	0.3	0.3	0.4	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.1	-0.2	0.0	0.1	-2.5	-0.2	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.6	0.7	0.3	1.1	0.0
18	Machinery	1.3	0.3	0.2	0.4	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	-0.2	0.0	0.0	-0.1	-1.9	-0.1	-0.3	-0.1	0.0	0.0	0.0	0.0	0.5	0.6	0.3	1.0	0.0
19	Transport eq	-1.2	0.3	0.2	0.4	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	-0.3	0.0	0.0	-0.1	-0.4	-4.1	-0.2	-0.1	0.0	0.0	0.0	0.0	0.5	0.7	0.3	1.0	0.0
20	Electric mach	0.4	0.4	0.2	0.4	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	-0.3	-0.1	0.0	-0.2	-0.2	-0.1	-3.1	-0.1	0.0	0.0	0.0	0.0	0.5	0.7	0.3	1.2	0.0
21	Com Eq	0.0	0.4	0.1	0.3	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	-0.3	-0.1	0.0	-0.1	-0.1	-0.1	-0.4	-3.1	0.0	0.0	0.0	0.0	0.4	0.8	0.3	1.2	0.0
22	Instruments	-0.4	0.3	0.2	0.3	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	-0.3	-0.1	0.0	-0.1	-0.2	-0.1	-0.3	-0.4	-2.9	0.0	0.0	0.0	0.4	0.7	0.3	1.1	0.0
23	Mach repair	1.7	0.3	0.2	0.4	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	-0.2	0.0	0.0	-0.2	-0.3	-0.8	-0.2	-0.1	0.0	-0.2	0.0	0.0	0.4	0.6	0.2	0.9	0.0
24	Other mfg	3.4	1.0	0.2	0.4	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	-0.3	0.0	0.0	-0.1	-0.1	-0.1	-0.1	0.0	0.0	0.0	0.2	0.0	0.4	0.6	0.2	0.7	0.0
25	Construction	3.5	0.3	0.2	0.5	0.1	0.2	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	-0.2	-0.2	0.0	-0.2	-0.2	-0.1	-0.2	0.0	0.0	0.0	0.0	0.5	0.6	0.7	0.3	0.7	0.0
26	Post & com	8.2	0.2	0.1	0.9	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	-0.1	0.0	0.0	-0.1	-0.1	-0.3	-0.1	0.0	0.0	0.0	0.0	0.0	6.2	0.4	0.2	0.5	0.0
27	Commerce	6.8	0.8	0.1	0.3	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	-0.1	0.0	0.0	-0.1	-0.1	-0.1	-0.1	-0.1	0.0	0.0	0.0	0.0	0.6	4.0	0.4	0.8	0.0
28	Edu. Utilities	6.6	0.4	0.1	0.3	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	-0.2	0.0	0.0	-0.1	-0.1	-0.1	-0.1	-0.1	0.0	0.0	0.0	0.0	0.4	0.4	4.7	0.5	0.0
29	Finance & ins	13.4	0.2	0.1	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	-0.1	0.0	0.0	0.0	-0.1	-0.1	-0.1	-0.1	0.0	0.0	0.0	0.0	0.4	0.3	0.7	11.7	0.0
30	Public adm	7.6	0.3	0.1	0.4	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	-0.1	0.0	0.0	-0.1	-0.1	-0.2	-0.1	-0.1	0.0	0.0	0.0	0.0	0.8	0.5	0.6	0.5	4.7

3. Cost Analyses

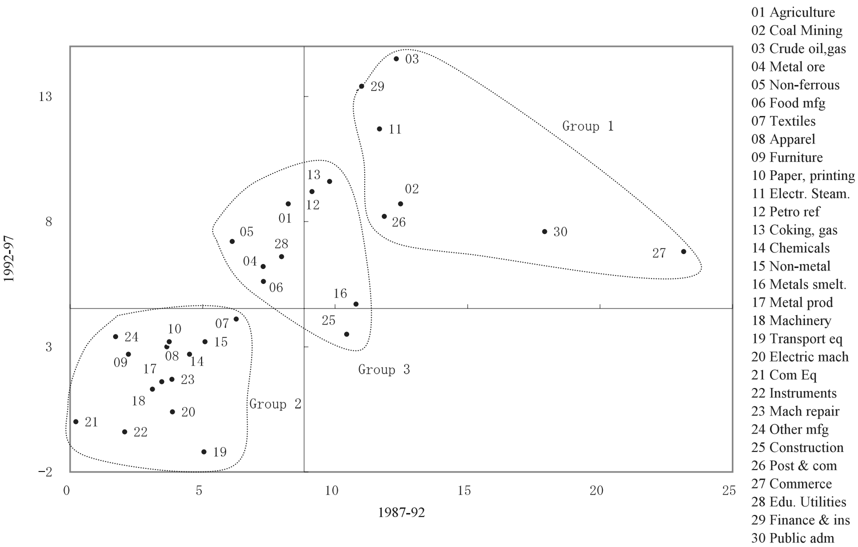
Tables 1 and 2 show the results of calculating price growth rates during the period 1987 to 1992 and the period 1992 to 1997 by using the equation shown in the previous section. The detailed results of "indirect effects (other sectors)" (affected by other sectors) in these two tables are shown in Tables 3 and 4. The diagonal factor corresponding to each sector indicates "total own effects" which is the sum of direct indirect effects from the sector itself. The off-diagonal factors in a row-wise direction indicate the indirect effects from the other sectors. Before explaining the results in Tables 1, 2, 3 and 4, let us review the growth rates of prices in each sector during the two periods.

As shown in the footnotes to Tables 1 and 2, the average growth rate of prices in all sectors was 8.8% during the period of 1987-1992, and 4.5% during the period of 1992-1997. The classification of sectors and the code numbers of the sectors in this paper is the same as those used by Li Qiang and Xue Tiandong (1998). For the convenience of analysis, these 30 sectors are rearranged as follows: agriculture (01), raw materials and non-ferrous mineral mining (04, 05), energy mining (02, 03), energy processing and supply (11, 12, 13), light industry (06-10), chemical and heavy industry (14-24), construction (25), and tertiary industry (26-30).

Figure 1 shows the distribution of growth rates of prices in all sectors during the two periods. The intersection point of the horizontal axis and the vertical axis is the average growth rate of prices in all sectors during the two periods. As shown in Figure 1, all sectors are divided into three groups. Group 1 is a collection of sectors with growth rates higher than the average during the two periods. Energy mining (02, 03), electricity (11), and tertiary industry (except culture, education and science (28)) are sectors in this group. Group 2 encompasses sectors with growth rates lower than the average in both periods. Light industry, chemical and heavy industry are included in this group (except food processing (06) and metal smelting & pressing. Sectors with growth rates close to the average during the two periods are in the third group, such as agriculture (01), raw materials and non-ferrous mineral mining (04, 05), energy processing and supply (12, 13), manufacture and processing of food (06), metal smelting (16), construction (25), and education, science. (28).

From Tables 1 and 2, from the viewpoint of costs (supply side) of the sectors, we can summarize the reasons for and nature of price rises in the following four points[5]:

Figure1 Growth Rates of Prices by Sectors: 1987-1992-1997
(% annual)



Firstly, the direct effects of the sectors among group 1 are larger than the indirect effects. If we use the concept of "total own effects", which is defined as the direct effect in addition to the indirect effect of the sector itself, most of the price rises in this sector can be explained by total own effects. This is clearly due to the fact that these sectors have weak backward linkages. In the first period (1987-1992), the direct effects of energy mining (02, 03), electricity, steam and hot water supply (11) and finance and insurance (29) arise from the decrease in TFP; the direct effects of transportation, post and telecommunications (26) and commerce and restaurants (27) are generated from changes in profit rates; the direct effects on administration, and other service sectors (30) are generated from changes in wage rates. In the later period (1992-1997), the direct effects of coal mining & processing (02), electricity, steam & hot water production and supply (11), post and telecommunications (26), commerce & restaurants (27), public administration & others (30), crude oil, natural gas products (03), and finance and insurance (29) are generated from the decrease in TFP.

Secondly, the indirect effects of the sectors among group 2 are larger than their direct effects. There are two reasons why these sectors have larger indirect effects than direct effects: (1) these sectors have strong backward linkage effects, so they were affected by price rises in group 1 sectors, for example, agriculture, energy and raw materials, as shown in Tables 3 and 4; and (2) the wage rates and profit rates in these sectors rose, but the significant improvements in TFP absorbed many of these effects.

Thirdly, there are no clear trends among the sectors of group 3. More specifically, agriculture (01) and education & science (28) have large direct effects, while the other sectors have large indirect effects. What should be remembered is that the TFP of many sectors, especially sectors related to energy and raw materials, declined in the first period and improved in the second period, but the improvement was lower than that of other sectors, especially that of sectors in group 2.

Table 5 Total Contributions of Each Factor to Each Sector: 1987-1992-1997 (% annual)

Code	Sectors	1987-1992							1992-1997						
		Change of prices	Change of wages	Change of capital	−△TFP				Change of prices	Change of wage	Change of capital	−△TFP			
					Intermediate input	Labor	Capital	Total				termediate inp	Labor	Capital	Total
01	Agriculture	8.2	7.7	2.2	1.4	-2.5	-0.6	-1.7	8.7	16.7	2.0	1.6	-10.2	-1.5	-10.0
02	Coal Mining	12.5	5.7	4.8	6.6	-2.5	-2.2	2.0	8.4	15.5	5.2	-0.7	-8.6	-3.1	-12.4
03	Crude oil,gas	12.3	2.2	5.4	5.0	-0.8	0.6	4.7	14.5	5.9	9.8	0.2	-1.1	-0.3	-1.2
04	Metal ore	7.3	3.8	7.0	3.5	-2.5	-4.6	-3.6	6.2	15.7	9.2	0.4	-10.3	-8.8	-18.7
05	Non-ferrous	6.1	5.9	4.1	4.0	-3.9	-3.9	-3.9	7.2	11.4	5.1	-0.3	-5.7	-3.3	-9.4
06	Food mfg	7.3	5.5	4.8	0.4	-2.1	-1.3	-3.0	5.6	13.2	5.0	-1.6	-7.6	-3.5	-12.7
07	Textiles	6.3	4.9	5.2	1.2	-2.0	-2.9	-3.8	4.1	13.6	6.4	-4.4	-7.9	-3.6	-15.9
08	Apparel	3.7	5.5	6.4	-0.1	-3.3	-4.9	-8.2	3.0	16.1	6.3	-5.8	-9.7	-3.9	-19.4
09	Furniture	2.2	4.0	6.8	-0.7	-3.2	-4.8	-8.7	2.7	14.5	6.8	-3.5	-9.1	-6.0	-18.6
10	Paper, printing	3.7	5.1	4.8	0.2	-2.9	-3.5	-6.2	3.5	15.1	4.1	-3.9	-9.1	-2.8	-15.7
11	Electr. Steam.	11.7	3.3	6.3	4.5	-1.4	-1.0	2.0	11.7	8.9	5.4	3.0	-3.9	-1.7	-2.6
12	Petro ref	9.1	2.1	2.3	4.1	-0.7	1.3	4.7	9.2	6.2	8.4	-1.6	-1.7	-2.1	-5.3
13	Coking, gas	9.8	5.1	7.1	2.0	-1.8	-2.5	-2.3	9.6	15.5	3.3	0.7	-9.0	-0.8	-9.1
14	Chemicals	4.5	4.1	6.1	0.3	-2.1	-3.9	-5.7	2.7	11.3	4.8	-2.9	-6.3	-4.1	-13.3
15	Non-metal	5.1	5.1	8.3	1.0	-4.0	-5.4	-8.3	3.2	12.6	4.2	-2.0	-7.6	-4.0	-13.6
16	Metals smelt.	10.8	3.8	7.7	4.3	-1.7	-3.4	-0.7	4.7	10.8	2.7	0.0	-5.4	-3.4	-8.7
17	Metal prod	3.5	4.6	6.4	-0.2	-3.2	-4.2	-7.5	1.6	12.3	3.2	-3.0	-7.4	-3.5	-14.0
18	Machinery	3.1	4.6	8.6	0.0	-3.1	-6.9	-10.0	1.3	11.3	4.9	-4.3	-6.5	-4.0	-14.9
19	Transport eq	5.1	4.6	11.6	0.5	-3.2	-8.4	-11.1	-1.2	11.2	3.9	-4.8	-6.5	-4.9	-16.2
20	Electric mach	3.9	4.1	7.3	0.0	-2.4	-5.2	-7.6	0.4	12.1	4.9	-4.0	-7.3	-5.2	-16.6
21	Com Eq	0.2	4.3	6.3	-2.0	-2.8	-5.7	-10.4	0.0	13.6	7.5	-4.4	-9.2	-7.6	-21.1
22	Instruments	2.1	5.3	8.2	0.4	-3.7	-8.1	-11.4	-0.4	11.7	8.1	-3.8	-8.0	-8.4	-20.2
23	Mach repair	3.8	4.7	7.4	0.9	-3.8	-5.4	-8.3	1.7	12.3	5.5	-5.0	-6.5	-4.5	-16.0
24	Other mfg	1.7	9.0	16.2	-0.7	-7.6	-15.2	-23.5	3.4	9.9	12.3	-6.9	-5.3	-6.6	-18.8
25	Construction	10.4	6.3	6.9	2.9	-2.9	-2.7	-2.8	3.5	11.2	4.4	-1.3	-6.9	-3.9	-12.1
26	Post & com	11.9	4.2	9.7	3.7	-2.3	-3.5	-2.0	8.2	8.9	3.1	0.4	-3.7	-0.5	-3.8
27	Commerce	23.2	6.9	14.6	6.6	-1.8	-3.2	1.6	6.8	9.4	3.4	-0.7	-3.3	-2.0	-6.0
28	Edu. Utilities	8.0	4.9	6.6	1.6	-3.2	-1.9	-3.5	6.6	13.2	3.5	1.6	-8.7	-3.0	-10.1
29	Finance & ins	11.0	4.9	2.4	9.7	-1.6	-4.4	3.7	13.4	7.3	2.3	1.2	-2.1	4.6	3.8
30	Public adm	17.9	15.5	7.0	5.7	-7.5	-2.9	-4.6	7.6	10.7	2.2	1.1	-5.1	-1.3	-5.3

Lastly, the general effects of primary factors (wage rates, profit rates and TFP) on price rises are examined after considering their forward and backward effects, that is to say, the effects of the Leontief inverse matrix. In order to calculate the effects of each factor, the indirect effects of the sector itself and the indirect effects of the other sectors were first of all separated from the total effects shown in Tables 1 and 2, according to each factor, and then added to the direct effects according to the corresponding factor. The results of this calculation are shown in Table 5. The most obvious characteristic is the fact that, in the first period, price rises in many sectors were generated by rises in profits, while in the later period, price rises in all sectors were generated by rises in wages.

4. TFP and Inflation

The growth rates and structures of total factor productivity in the two periods 1987-1992 and 1992-1997 are shown in Table 6. The results of this table are the same as the columns named "-TFP" in Tables 1 and 2 but with the opposite signs, indicating TFP growth. Measurements of the growth rates of TFP and their decompositions are based on the equations shown in Section 2. We can use Table 6 to analyze the reasons for the improvement in TFP and the relationship between TFP and price rises in each sector, as follows:

Table 6 TFP Growth and Its Structure: 1987-1992-1997
(% annual)

Code	Sectors	1987-1992				1992-1997			
		Intermediate input	Labor input	Capital input	Total	Intermediate input	Labor input	Capital input	Total
01	Agriculture	-0.9	1.7	-0.1	0.7	-1.8	7.3	0.5	6.0
02	Coal Mining	-5.3	1.2	-0.1	-4.2	0.0	5.6	1.6	7.2
03	Crude oil,gas	-4.3	0.0	-3.0	-7.2	-0.7	-0.5	-0.6	-1.8
04	Metal ore	-1.9	1.2	2.3	1.6	-0.9	6.2	6.2	11.5
05	Non-ferrous	-2.8	2.8	1.3	1.3	-0.2	2.7	1.8	4.3
06	Food mfg	1.0	0.3	-0.5	0.8	1.8	1.2	2.0	5.0
07	Textiles	0.4	0.4	0.6	1.4	2.6	2.2	1.4	6.2
08	Apparel	1.6	1.5	2.2	5.2	3.5	4.2	1.5	9.2
09	Furniture	2.2	1.3	1.9	5.4	2.0	3.9	3.3	9.1
10	Paper, printing	1.2	1.2	0.8	3.2	2.2	3.9	0.7	6.8
11	Electr. Steam.	-2.4	0.4	-1.0	-3.0	-3.6	0.7	0.2	-2.7
12	Petro ref	-1.0	0.0	-1.7	-2.8	1.4	0.1	1.4	2.9
13	Coking, gas	1.9	0.0	-0.7	1.2	-1.2	4.2	-1.0	2.0
14	Chemicals	1.2	0.6	0.9	2.7	1.7	1.8	1.9	5.4
15	Non-metal	0.7	2.4	2.7	5.8	1.1	3.5	2.0	6.6
16	Metals smelt.	-1.6	0.2	0.5	-0.8	-0.4	0.9	0.8	1.2
17	Metal prod	2.6	1.6	2.2	6.4	2.4	3.1	1.1	6.5
18	Machinery	1.6	1.4	3.5	6.5	2.9	2.4	1.7	7.0
19	Transport eq	0.9	1.3	2.0	4.2	2.6	2.0	2.1	6.7
20	Electric mach	1.9	0.7	1.3	3.9	2.6	2.6	2.4	7.6
21	Com Eq	2.4	0.9	0.8	4.1	2.0	3.5	3.7	9.3
22	Instruments	0.8	2.0	3.9	6.7	2.1	3.5	5.4	10.9
23	Mach repair	0.5	2.0	2.1	4.6	3.2	2.5	2.2	7.9
24	Other mfg	2.1	5.3	10.2	17.6	5.3	1.0	4.3	10.6
25	Construction	-1.3	0.8	0.4	-0.2	0.1	2.4	1.5	4.0
26	Post & com	-2.6	1.4	1.5	0.2	-1.3	1.4	-0.8	-0.7
27	Commerce	-4.9	0.3	1.1	-3.5	0.1	0.0	0.7	0.8
28	Edu. Utilities	-0.8	2.1	-0.1	1.2	-2.4	5.5	1.5	4.6
29	Finance & ins	-9.1	0.8	3.0	-5.4	-1.5	-0.6	-5.6	-7.6
30	Public adm	-4.6	6.1	0.9	2.4	-1.8	1.8	-0.1	-0.1

The TFPs of industries in group 2, mainly light industries (06-10) and heavy and chemical industries (14-24), improved in both periods and the improvement in the second period is larger. The improvement of TFPs in many sectors in groups 1 and 3 during the second period is greater than that during the first period, but the improvement is smaller than that of the sectors in group 2. There are a few sectors in which TFPs declined in both periods. Crude oil & natural gas mining (03), and electricity, steam, etc. (11) are examples of this, but the extent of the decline was reduced in the later period compared with the first one. By contrast, the TFPs of some tertiary sectors such as transportation, post and telecommunications (26) and finance and insurance (29) were declining and the extent of the decline was greater in the second period compared with the first.

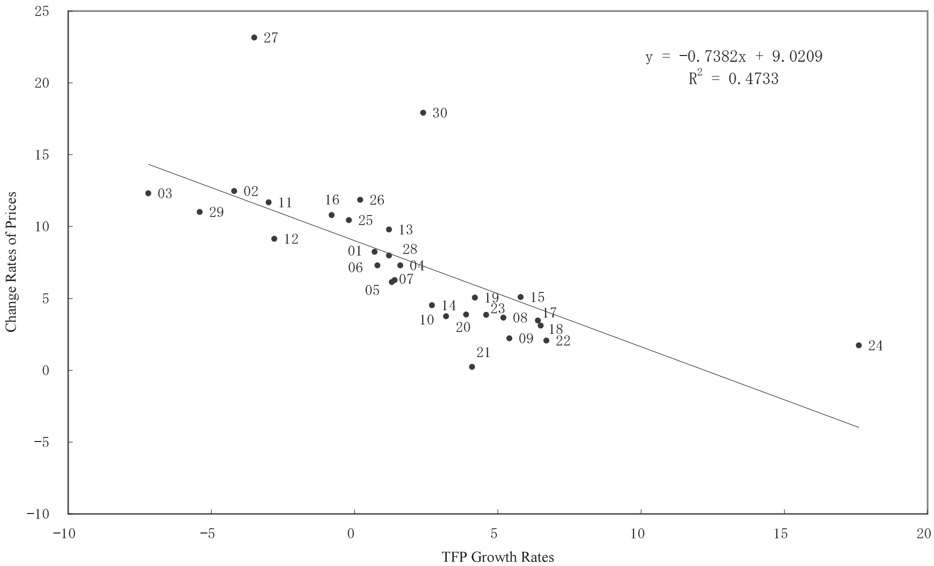
The reasons for the improvement in TFP varied from industry to industry in different periods. However, both the labor and capital input efficiency of most industries (with a few exceptions) improved in the two periods. The intermediate input efficiency of industries in group 2 showed a tendency to improve in the two periods, while the intermediate input efficiency of industries in groups 1 and 3, especially energy, raw materials mining (02-05, 11-13) and tertiary industry (26-30) tended towards a decline in both periods. The intermediate input efficiency of petroleum refining (12), construction (25), and commerce & restaurants (27) became positive in the later period, but it was low compared with that of the other industries. This is considered to be one of the important reasons for the decline of TFP.

Let us next examine the relationship between TFP growth and inflation. Figures 2 and 3 show the rates of TFP growth and inflation in the two periods. From these two figures, we can see that light industries (06-10) and heavy and chemical industries (14-24), most of which belong to group 2, have relatively high TFP growth rates and low inflation rates, while those industries which experienced high inflation, such as energy, raw materials mining and tertiary industry— in other words, industries in group 1— tended to decline or show little improvement in their TFPs. This trend can be explained as follows:

The TFPs of light industries (06-10) and heavy and chemical industries (14-24) improved, and this improvement absorbed, to some extent, the inflationary effects of energy and raw materials. In other words, price reforms in the energy and raw materials industries promoted the improvement in TFPs in light industries, and also heavy and chemical industries, to some extent. Energy, the raw materials mining industry and tertiary industry experienced high inflation rates, mainly because price reforms focused on these sectors, but another reason is the decline or low improvement in TFPs in these sectors. TFPs in these sectors did not absorb the effects of price rises, but exacerbated this trend.

Figures 4, 5, 6 and 7 show the relationship between wage cost (growth rate of wage rate × share of wage) and inflation rate, and the relation of capital cost (growth rate of profit rate×share of profit), but we can see no clear trend in these[6]. Energy, the raw material mining and processing industries (02-05, 11-13) and tertiary industries (26-30) (industries in groups 1 and group 3 in Figure 1) feature in the upper part of these figures; light industries (06-10) and heavy and chemical industries (14-24) (mostly in group 2 in Figure 1) are in the lower part. Looking at industries that have the same wage or capital costs in the vertical direction of the figures, it can be seen that these industries experienced different inflation rates. The variation in TFPs in these industries is one of the important factors in this. In other words, the TFP improvement in light industries (06-10) and heavy and chemical industries (14-24) (belonging mostly to group 2 in Figure 1) absorbed the effects caused by the increase in wage and capital costs, but the TFPs of energy, raw materials mining and processing industries (02-05, 11-13) and tertiary industries (26-30) (belonging to groups 1 and 3 in Figure 1) improved slowly (or declined), and they were unable to absorb the effects resulting from the increase in wage and capital costs.

Figure 2 TFP Growth and Price Change: 1987-1992
(% annual)



Note: The numbers (01-29) in this figure are code numbers of the sectors

Figure 3 TFP Growth and Price Change: 1992-1997
(% annual)

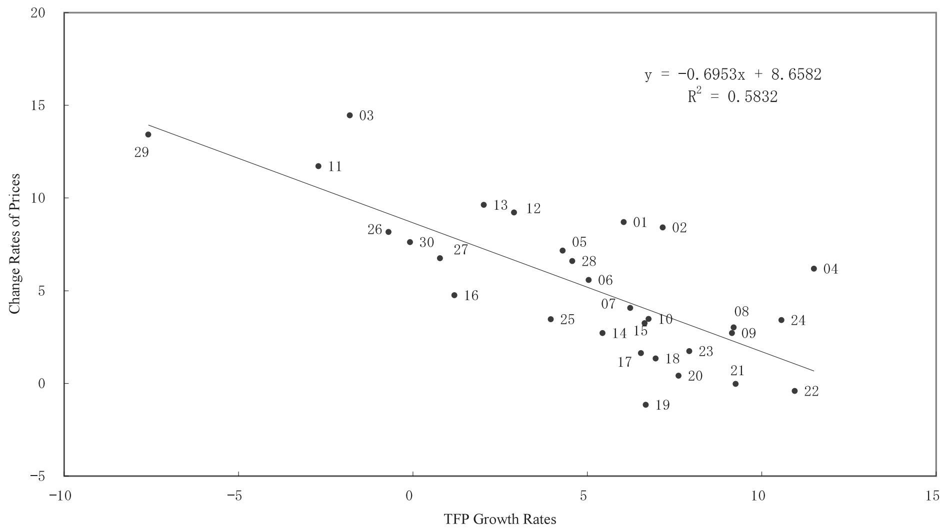


Figure 4 Wage Growth and Price Change: 1987-1992
(% annual)

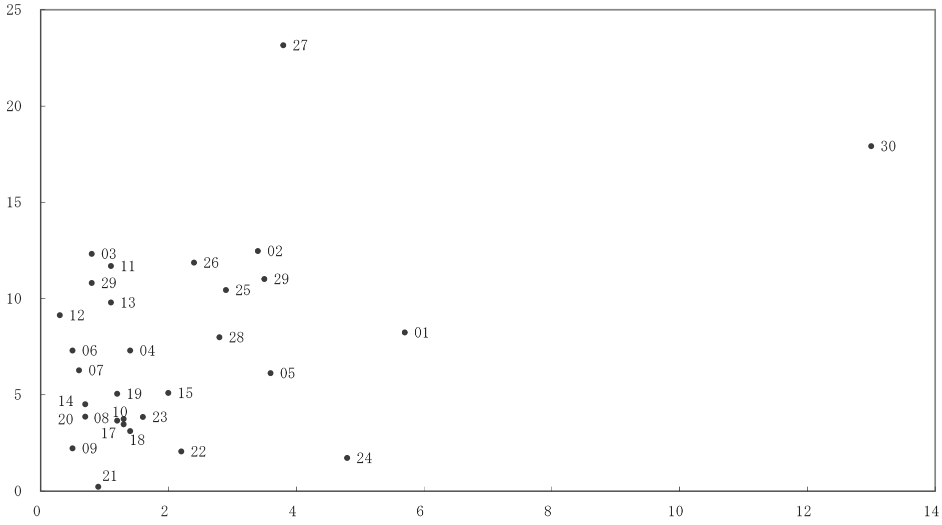


Figure 5 Profit Growth and price Change: 1987-1992
(% annual)

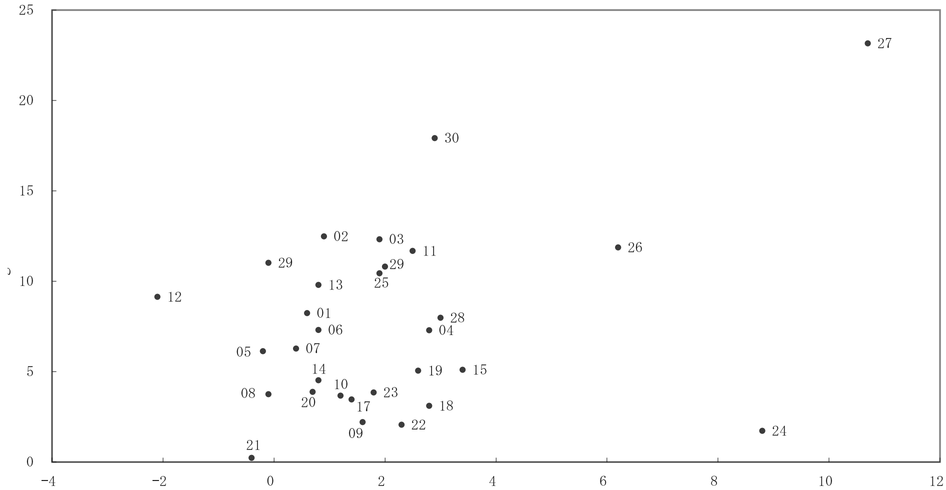


Figure 6 Wage Growth and Price Change: 1992-1997
(% annual)

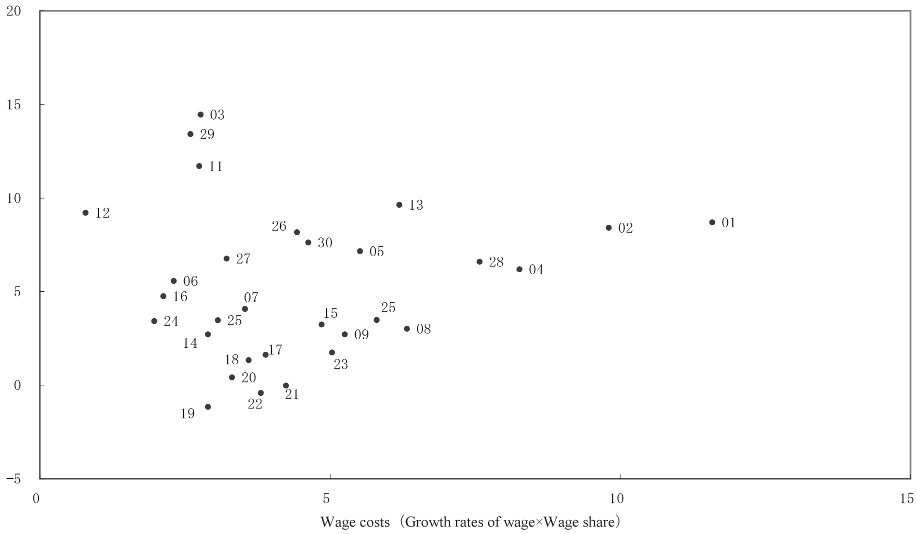
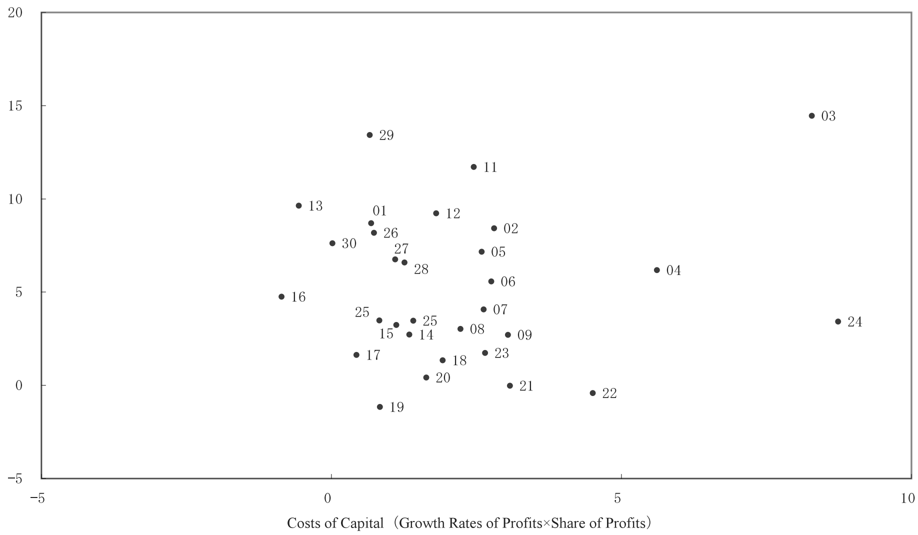


Figure 7 Profit Growth and Price Change: 1992-1997
(% annual)



5. Summary and Conclusions

This paper analyzed the cost structure of inflation and productivity (TFP) in detail for the period 1987-1997. The following is a summary of the discussion and conclusions.

It is a common view that, until the 1990s, inflation in China was generated by price reforms relating mainly to energy and raw materials, and the unbalanced structures of supply and demand. This paper finds that price rises in sectors in group 1 were generated by direct effects through the TFP, wages and capital costs, while price rises in sectors in group 2 were generated by indirect effects through the intermediate inputs of other sectors. Our findings support the common view but the point to be stressed is the fact that the slow improvement of TFP in the energy, raw materials and service sectors was closely connected to inflation in China.

Generally, it is believed that rises in wage and capital costs are the main reason for price rises in many sectors. However, from the results of calculations in this paper, it is evident that only the TFPs have a clear relationship to price rises (negative relationship), while wages and capital costs do not have a clear relationship with inflation in the sectors. Prices rose moderately in sectors such as the light, heavy and chemical industries, which experienced a significant improvement in TFPs, but rose significantly in sectors such as the energy, raw materials mining, processing and tertiary industries, in which TFPs declined or improved only slowly. These facts show that the improvement in TFP in the light, heavy and chemical industries absorbed the effects of inflation in the field of energy and raw materials. In other words, reforms of the irrational price system (liberalization of prices), which focused on increasing the price of energy and raw materials, triggered the improvement in TFPs in the light, heavy and chemical industries. After adopting the polices of reform and opening up, a series of policies, such as the introduction of foreign capital and technology, and the deregulation of private investment, contributed to the improvement of TFPs in the light, heavy and chemical industries; price reforms also show the same important contribution to the improvement of TFPs.

Because the government made the decision to establish a "socialist market economy" and began to liberalize prices fully in 1992, the period of ten years under study is divided into two parts: before and after 1992. Compared with the period before 1992 (1987-1992), the period after 1992 (1992-1997) was one in which the TFP of more industries improved or demonstrated a greater improvement. The TFPs in some sectors declined continuously, but the declines in the later period were lower than those in the first period. The result can be considered to be one of the achievements of adopting the market mechanism (price liberalization). Better control of the inflation rate in the later period than in the first period was mainly the result of successful macro-economic control policies and the improvement of supplies, but the contribution of the improvement in TFP should not be ignored[7]. The improvement of labor productivity and capital productivity contributed greatly to the improvement in TFPs.

There still exist many regulations in certain sectors, such as the energy and raw materials sectors, with regulations on tertiary sectors especially severe. For example, transportation, post and telecommunications (26) and finance and insurance (29) are monopolized by the state. The uncompetitive environment, which is protected by government regulations, is the main reason for decline or slow improvement of the TFPs in these sectors. Transportation, post and telecommunications (26) and finance and insurance (29) are important sectors in China, but the continuous decline in TFPs in these sectors is a severe problem that should be resolved as soon as possible. China has been a member of the WTO since December 2001 and Chinese enterprises in these two sectors will have to compete with foreign enterprises. Certainly, competition with foreign firms would improve the problem of low efficiency, but it is hard to say that Chinese firms in these two sectors could stay competitive. This is a problem that should be considered at the level of industrial and economic policy.

The present round of inflation, since 2003, is almost the same as previous bouts of inflation in the 1980s and 1990s in terms of the rates of price increase by industry. Past inflation, however, was closely connected with price reforms (i.e. market pricing), while the present round of inflation is attributable in far greater part to the structure and system (i.e. state versus private enterprises, fiscal and financial structure, etc.) of the Chinese economy. Investment in China is now almost 40% of GDP and most of it is implemented by the government, either directly or indirectly. Energy, raw materials and major services are still monopolized by the government, tending to cause price increases in the event of rising costs, without absorbing those costs through efficiency improvements. The Chinese economy still seems to be oriented toward rapid and "extensive" growth without making due allowance for waste and inefficiency. Investment, in particular, is inefficient and overlapping. These are the reasons for the current coexistence of inflation and deflation.

In its ninth five-year plan (1996-2000), the Chinese government advocated two transformations (into the market economy and "intensive" growth) as its major objectives. These two objectives have yet to be fully realized. The latter transformation, in particular, can be said to have been completely neglected. Reforms of the economic structure and system are unavoidable if the transformation of the growth method from an extensive to an intensive one is to be realized.

Inflation is being repeated in China, so it is necessary to re-examine whether or not the policy of macro-control in 1992-1996 was really a success. The policy of macro-control being implemented now is the same as before and needs to be examined in light of the reforms of the structure and system of the Chinese economy.

Notes

[1] Ezaki and Sun (1998, 1999) estimated capital stocks and TFP, applied the data to macro-economic analysis of the Chinese national and provincial economies, and also demonstrated an estimation method within the framework of growth accounting. Because this method is not sufficient to obtain reasonable data in the sectors, the Young method has been renovated and used in this paper.

[2] In practice, the estimated capital stock in a sector is smaller than investment in that sector, and estimated capital stocks in a few sectors are negative.

[3] See Ezaki and others (1996). See also Chapter 8 of Fujikawa (1999) for Japan, which also includes the impacts of import price on inflation. We use the official IO tables of China, which assume competitive imports in their estimates, so our measurement misses out the differentiated impacts of import prices on inflation. A non-competitive IO table is not yet available in China. We will undertake a research project

to estimate this, as well as to extend and supplement our analysis in this paper in the near future.

[4] Capital costs include business surplus, depreciation of fixed assets and production tax, but it is difficult to break these data down. In addition, imports are assumed to be competitive, making that element also difficult to be broken down.

[5] Because a new sub-industry of discarded lumber and rejected articles was established under the sector of other industry in the I-O table for 1992, the TFP of the direct effects became extremely large. This sector is excluded from discussions in this paper.

[6] The figures are based on the contributions of labor and capital costs, which are measured by multiplying the labor cost and capital cost respectively to its distribution ratio, but they are similar to the figures drawn by using the growth rates of wage rates and the growth rates of profit rates.

[7] Demand factors are also important in explaining the change in price by sector. In the latter five-year period of price deregulation (1992-1997), for example, government fixed investment and FDI inflows are said to have been a significant factor in inflation in China, affecting the inflation rate by sector differentially. Our analysis basically allows for such demand effects from the supply side through two kinds of change in the cost structure: changes in input coefficients (i.e. the substitution effect which constitutes part of TFP change) and changes in the rate of return to capital (i.e. the residual profit margin which partly reflects the utilization rate of capital). An extended analysis of cost structure is needed in order clearly to separate the effects of the demand side from those of the supply side.

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Appendix

Framework of Price Analysis by Sector

We present here the framework for analyzing price changes between two time points from the point of view of input costs, where input-output tables (I-O tables) in constant prices are available (or I-O tables in nominal prices and deflators are available).

We discuss the framework, first, based on continuous time (i.e. time differential) and then discrete time (i.e. time difference). The starting point of the discussion is that the price and cost are equal in each industry, i.e. the identity in the supply side of the I-O table:

$$P=P\cdot A+Q\cdot B \qquad \cdots\cdots \quad (1)$$

Here, P= output price vector (1×n), Q= (q_1, q_2) = (w, r) =factor price vector (1×2), w=nominal wage rate, r=rent price of capital, A= $\{a_{ij}\}$ = matrix of intermediate input coefficients (n×n), B= $\{b_{mj}\}$ = matrix of factor input coefficients (2×n) (n= number of sectors) . It is needless to say that an assumption of different wage rates (w_j) and profit rates (r_j) in different industries is more realistic. It may also be better to add imports to primary factor inputs, allowing for import prices in addition to wages and profits. It should be noted that neither A nor B are fixed coefficients but changeable ratios (input/total production) over time:

$$A=\{a_{ij}\} = \{X_{ij}/X_j\} \ (i=1\ldots n;\ j=1\ldots n) \qquad \cdots\cdots \quad (2)$$
$$B=\{b_{mj}\} = \{Z_{mj}/X_j\} \ (m=1,2;\ j=1\ldots n) \qquad \cdots\cdots \quad (3)$$

where X_j=total production, X_{ij}=intermediate input, Z_{mj}= input of factors, $Z_{1j}=L_j$=input of labor, $Z_{2j}=K_j$=input of capital. Then, differentiating the equation (1) with respect to time, we get:

$$\dot{P}=(\dot{Q}\cdot B+P\cdot \dot{A}+Q\cdot \dot{B})\cdot (I-A)^{-1} \quad \cdots\cdots \quad (4)$$

In other words, changes in output prices by industry are the product of changes of factor prices and productivity (intermediate input coefficients) in all industries and the Leontief inverse matrix.

We introduce total factor productivity (TFP) explicitly into this relationship. The TFP of industry j is usually defined in terms of growth rates (i.e. TFP growth = output growth - input growth) as:

$$\dot{T}_j/T_j=\dot{X}_j/X_j-[\sum_{i=1}^{n}(p_i\cdot X_{ij}/p_jX_j)\cdot (\dot{X}_{ij}/X_{ij})+\sum_{m=1}^{2}(q_{mj}\cdot Z_{mj}/p_jX_j)\cdot (\dot{Z}_{mj}/Z_{mj})] \quad \cdots\cdots \quad (5)$$

From the definition of intermediate coefficients shown in equations (2) and (3), it can also be defined as:

$$\dot{T}_j/T_j=-[\sum_{i=1}^{n}(p_i\cdot X_{ij}/p_jX_j)\cdot (\dot{a}_{ij}/a_{ij})+\sum_{m=1}^{2}(q_{mj}\cdot Z_{mj}/p_jX_j)\cdot (\dot{b}_{mj}/b_{mj})] \quad \cdots\cdots \quad (6)$$

If the Leontief inverse matrix $(I-A)^{-1}$ is written as $\{c_{ij}\}$, the equation (4) can be rewritten as:

$$\{\dot{p}_j\} = \{\sum_{m=1}^{2}\dot{q}_m\cdot b_{mj}+\sum_{i=1}^{n}p_i\cdot \dot{a}_{ij}+\sum_{m=1}^{2}q_m\cdot \dot{b}_{kj}\} \cdot \{c_{ij}\}$$

$$= \{p_j \sum_{m=1}^{2}(q_m\cdot Z_{mj}/p_jX_j)\cdot (\dot{q}_m/q_m)$$

$$+ p_j[\sum_{i=1}^{n}(p_i\cdot X_{ij}/p_jX_j)\cdot (\dot{a}_{ij}/a_{ij})+\sum_{m=1}^{2}(q_m\cdot Z_{mj}/p_jX_j)\cdot (\dot{b}_{mj}/b_{mj})]\} \cdot \{c_{ij}\}$$

$$= \{p_j\cdot [(wL_j/p_jXj)\cdot (\dot{w}/w)+(rK_j/p_jX_j)\cdot (\dot{r}/r)-\dot{T}j/Tj]\} \cdot \{c_{ij}\}$$

$$= \{\sum_{h=1}^{n}p_h[S_{Lh}\cdot (\dot{w}/w)+ S_{Kh}\cdot (\dot{r}/r) -\dot{T}_h/T_h]\} \cdot \{c_{hj}\} \quad \cdots\cdots \quad (7)$$

where $S_{Lh}=wL_h/p_hX_h$ (labor share of industry h), $S_{Kh}=rK_h/P_hX_h$ (capital share of industry h). Note that $S_{Lh} + S_{Kh} =1-\sum (p_iX_{ih}/p_hX_h)<1$. If factor j is written in form of the growth rate, equation (8) can be figured out ($c_{jj}>1$).

$$\dot{p}_j/p_j =[S_{Lj}\cdot (w/w)+ S_{Kj}\cdot (\dot{r}/r) -\dot{T}_h/T_h] \cdot c_{jj}$$

$$+\sum_{h=j}^{n}(p_h/p_j)[S_{Lh}(\dot{w}/w)+ S_{Kh}\cdot (\dot{r}/r) -\dot{T}_h/T_h] \cdot c_{hj} \quad \cdots\cdots \quad (8)$$

The equation shows that, in industry j, the growth rate of output price is generally determined by the growth rate of wage rate, the growth rate of rental capital price, the growth rate of TFP (negative) and the multiplier (Leontief inverse) of the industry, and then affected also by the multiplier effects of other industries.

In order to apply this methodology to actual time series data, we must express equations (1) — (8) in terms of discrete time. The point of departure is the same as the continuous model, i.e., the identity between price and input cost in the benchmark year 0 and the comparative year 1:

$$P_0=P_0 \cdot A_0+Q_0 \cdot B_0 \quad , \quad P_1=P_1 \cdot A_1+Q_1 \cdot B_1 \qquad \cdots\cdots \quad (9)$$

We measure change in the matrix products above by average evaluation. For example:

$$\Delta(P \cdot A)=\Delta p \cdot \bar{A}+\bar{p} \cdot \Delta A$$

Corresponding to equation (4), the discrete model can be worked out:

$$\Delta P= (\Delta Q \cdot \bar{B}+\bar{P} \cdot \Delta A+\bar{Q} \Delta B) \cdot (I-\bar{A})^{-1} \qquad \cdots\cdots \quad (10)$$

If $(I-\bar{A})^{-1}$ is replaced by $\{\bar{c}_{ij}\}$, the discrete model corresponding to equation (8) can be expressed as:

$$\triangle p_j/\bar{p}_j=[(\bar{w}_j \cdot \bar{b}_{Lj}/\bar{p}_j) \cdot (\triangle w_j/\bar{w}_j)+(\bar{r}_j \cdot \bar{b}_{Kj}/\bar{p}_j) \cdot (\triangle r_j/\bar{r}_j)-\triangle T_j/\bar{T}_j] \cdot \bar{c}_{jj}$$

$$+\sum_{h \neq j}^{n} (\bar{p}_h/\bar{p}_j)[(\bar{w}_j \cdot \bar{b}_{Lj}/\bar{p}_j) \cdot (\triangle w_j/\bar{w}_j)+(\bar{r}_j \cdot \bar{b}_{Kh}/\bar{p}_j) \cdot (\triangle r_j/\bar{r}_j)-\triangle T_h/\bar{T}_h]\bar{c}_{hj} \qquad \cdots\cdot \quad (11)$$

TFP growth $(\triangle T_j/\bar{T}_j)$ in industry j is expressed as:

$$\triangle T_j/\bar{T}_j =-[\sum_{h=1}^{n} (\bar{p}_h \cdot \bar{a}_{hj}/\bar{p}_j) \cdot (\triangle a_{hj}/\bar{a}_{hj})+(\bar{w}_j \cdot \bar{b}_{Lj}/\bar{p}_j) \cdot (\triangle b_{Lj}/\bar{b}_{Lj})$$

$$+(\bar{r}_j \cdot \bar{b}_{Kh}/\bar{p}_j) (\triangle b_{Kj}/\bar{b}_{Kj})] \qquad \cdots\cdots \quad (12)$$

A point to note is that the rates of change in prices and input coefficients are measured based on the averages in the denominators for equations (11) and (12).

A Method for Constructing an Interregional Input-Output Model of China for 2000

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Abstract

Institute of Developing Economies (IDE) -JETRO in Japan and the State Information Center (SIC) in China organized the research group for compiling interregional input-output model for China in 2001 and completed its compilation work in 2003 under the severe circumstance of the data availability. This paper attempts to discuss what we have done and what we have solved the problem occurred on the compilation process of interregional Input-Output Model for China. In the discussion, we explained that we applied the Chenery-Moses type (column) model, we conducted the sample survey and executed Gravity model for estimating the interregional commodity flow. To our best knowledge, it is the first attempt both in China and abroad to build the CMRIO in terms of this scale and conducting the survey. It is no doubt that there might be the space to improve the estimation methodology.

KEYWORDS: interregional input-output model, interregional commodity flows, gravity model

1. Introduction

In 1999, then Chinese President Jiang Zemin announced the "Western Region Development Policy (Xibu Dakaifa)", which aims at the economic development of the western region of China. It was a new strategy for China's regional development, which aims to enhance the development level of the western area. After the central government of China implemented the open door policy, China applied the "Step Ladder policy" to the development of the region, starting with the development of the coastal region; in doing this, it is expected that development in that region will permeate the inland region. Actually, rapid economic development has mainly occurred in the coastal region of China, but the inland region is relatively underdeveloped. As a result, regional disparity has become one of the challenges for the central government of China. In this regard, many analysts have paid more attention to the regional development of China and the problem of regional disparity.

According to recent studies on regional development in China (for example, Wu 2002), regional disparity has become a significant problem, and thus many policy makers as well as researchers have paid attention to the issue of how we might develop underdeveloped regions such as the Chinese interior. It should be noted, however, that most of their approaches so far have been focused on a specific region itself, without taking into account interregional interdependency. Therefore, in order to add something worthwhile to their previous studies, we keenly felt the necessity to make an effort to quantitatively clarify the interregional feedback effects and/or

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spatial interactions when focusing on regional development. This was the main reason why we compiled the full-scale interregional input-output model for China as a useful analytical tool of space economy. When we reviewed the existing literature on the empirical implementation of interregional input-output analysis of regional economic issues in China, we discovered that there has been little compilation work (Akita et al., 1999; Ichimura and Wang, 2003) on the subject and even fewer applications of input-output analysis to a real regional economy.

However, we admit that we have suffered from severe limitations on the availability of interregional transaction data for China. Under these conditions, we have had to deal with this problem as best as we could by obtaining or estimating reliable interregional input-output data for China. The Institute of Developing Economies (IDE-JETRO) in Japan and the State Information Center (SIC) in China organized a research group for compiling an interregional input-output model for China in 2001; the group completed its compilation work in 2003 under the aforementioned situation with regard to data availability. Through the discussions of our research group, we felt that it was necessary to discuss the compilation methodology with the public and then we would be able to improve the estimation technique.

This paper discusses what we have done and how we have solved the problems that occurred during the process of compiling the interregional input-output model for China. The paper consists of three parts. Firstly, the structure of the multi-regional input-output model will be introduced, followed by a discussion of how we decided on the sector classification and definition of the region. Secondly, we will show the estimation procedures used for the related data and the method used to balance those data. Finally, problems and some notes for further work are discussed in the concluding remarks

2. The structure of the model

2.1 Data conditions in China

In 1987, an input-output table was first constructed for China at the national level and published[1] . The 1990 table was constructed as an extended form of the 1987 table. The 1992 table, which was based on the System of National Accounts, consisted of 118 sectors, including the scrap & waste sector. The 1995 table was an updated form of the 1992 table. The latest input-output table for China at the national level is for 1997 and consists of 124 sectors. The 2000 table, which was updated from the 1997 table, was published in the Statistical Yearbook with only 17 sectors.

Along with the development of input-output information at the national level, input-output data at the provincial level have also been constructed (Polenske and Chen, 1991)[2] . However these are still confidential data, especially to researchers outside China[3] . Accordingly, these data were carefully referenced by SIC. Besides this, other provincial data, such as some macro data, are provided, having been sourced from the provincial statistical yearbook.

As for the interregional commodity flow data, which are very important for the interregional input-output model, the OD (Origin-Destination) table is only available from the data of the Yearbook of China Transportation & Communications for a few commodities, using just the railway transport mode.

Under these circumstances, we have carefully collected data from various publications and have estimated the data for the uncollected items. Therefore, SIC has played an important role in conducting joint research into compiling an interregional input-output model for China[4] .

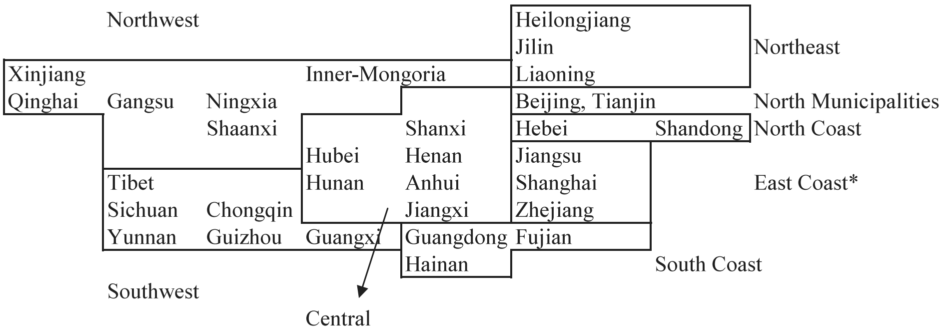
2.2 Regional and Sector classification

The regional aggregation was decided based on criteria listed in Richardson (1978) and the availability of data. Richardson (1978, pp.19-25) discusses the classical method of conceptualizing regions and identifies three types of region, namely the homogeneous region, the nodal (or polarized) region and the planning region. Of these three types, we mainly rely on the concept of the homogenous region, because the main purpose of using the interregional input-output model is to capture the amount of interregional interdependency or spatial interaction among regions. So the 'region' itself should be at the same level of economic development or have a similar industrial structure. However we also considered the concept of the planning region. For example, we grouped Inner Mongolia and Guangxi into the northwest and the southwest respectively. This classification is according to the regional definition in the Western Region Development policy, which has been in effect since 2000. Therefore, it can be said that our regional division is mainly based on two concepts of the region: the planning region and the homogenous region. Then, we identify eight regions as follows:

- Northeast (Heilongjiang, Jilin, Liaoning)
- Northern municipalities (Beijing, Tianjin)
- North coast (Hebei Shandong)
- East coast (Jiangsu, Shanghai, Zhejiang)
- South coast (Fujian, Guangdong, Hainan)
- Central (Shanxi, Henan, Anhui, Hubei, Hunan, Jiangxi)
- Northwest (Inner Mongolia, Shaanxi, Ningxia, Gansu, Qinghai, Xinjiang)
- Southwest (Sichuan, Chongqing, Yunnan, Guizhou, Guangxi, Tibet[5])

Taiwan, Hong Kong and Macau are excluded.

Figure 1 Regional Definition



Note: * East Coast was named Central Coast in CMRIO (IDE, 2003). However we use "East Coast" according to the usage of Chinese in this research.

As we mentioned above, the latest national input-output data is from the 1997 table with a classification of 124 sectors. (National Bureau of Statistics, 1999). The provincial input-output data is basically compiled in line with the national input-output framework. However there were some difficulties in collecting data and it seemed unnecessary to compile such detailed interregional tables, so we then discussed and decided upon a classification of 40 sectors for the national input-output table for China. Finally, we decided 30 sectors classitication. This was mainly due to our ability to get data on interregional transactions in the service sectors, so most of the service sectors were aggregated.

Table 1 Converter Table Between 30 Regional Sectors and 40 National Sectors

	30 Sectors (Regional Level)		40 Sectors (National Level)
1	Agriculture	1	Agriculture
2	Coal mining and processing	2	Coal mining and processing
3	Crude petroleum and natural gas products	3	Crude petroleum and natural gas products
4	Metal ore mining	4	Metal ore mining
5	Non-ferrous mineral mining	5	Non-ferrous mineral mining
6	Manufacture of food products and tobacco processing	6	Manufacture of food products and tobacco processing
7	Textile goods	7	Textile goods
8	Apparel, leather, furs, down and related products	8	Apparel, leather, furs, down and related products
9	Sawmills and furniture	9	Sawmills and furniture
10	Paper and products, printing and record medium reproduction	10	Paper and products, printing and record medium reproduction
11	Petroleum processing and coking	11	Petroleum processing and coking
12	Chemicals	12	Chemicals
13	Nonmetal mineral products	13	Nonmetal mineral products
14	Metals smelting and pressing	14	Metals smelting and pressing
15	Metal products	15	Metal products
16	Machinery and equipment	16	Machinery and equipment
17	Transport equipment	17	Transport equipment
18	Electric equipment and machinery	18	Electric equipment and machinery
19	Electric and telecommunication equipment	19	Electric and telecommunication equipment
20	Instruments, meters, cultural and office machinery	20	Instruments, meters, cultural and office machinery
21	Maintenance and repair of machine and equipment	21	Maintenance and repair of machine and equipment
22	Other manufacturing products	22	Other manufacturing products
23	Scrap and waste	23	Scrap and waste
24	Electricity, steam and hot water production and supply	24	Electricity, steam and hot water production and supply
25	Gas production and supply	25	Gas production and supply
26	Water production and supply	26	Water production and supply
27	Construction	27	Construction
28	Transport and warehousing	28	Transport and warehousing
		32	Passenger transport
29	Wholesale and retail trade	30	Wholesale and retail trade
30	Services	29	Post and telecommunications
		31	Eating and drinking places
		33	Finance and insurance
		34	Real estate
		35	Social services
		36	Health services, sports and social welfare
		37	Education, culture and arts, radio, film and television
		38	Scientific research
		39	General technical services
		40	Public administration and other sectors

2.3 Model

It was impossible for us to construct the interregional input-output table of China on a full-survey basis because it would have required a huge amount of time, funds and manpower, which are far beyond our capacity. So we implemented a multi-regional input-output (MRIO) model at first and then estimated an interregional table from the results of the implemented model. In MRIO settings, the technical structure of production in each region and interregional trade structures for various products are separately built into models. Therefore, the information needed to implement a MRIO model is usually more easily available than the information necessary for the direct construction of an interregional input-output (IRIO) table. In addition to this huge advantage, the separation of the regional technical structure and the trade structure allows us to update the table more easily.

Of the various kinds of MRIO model, we mainly considered four models established by previous research. These are: (1) the column coefficient model (Moses, 1955 etc.); (2) the row coefficient model (Polenske, 1970); (3) the gravity model (Leontief and Strout, 1966); and (4) the linear programming model (Moses, 1960). We first excluded the LP model because in ordinal settings it does not allow the existence of crosshaulings that are widely observed in the Origin-Destination (OD) tables. After comparing the former three models, we concluded that the column coefficient model (Chenery-Moses model) is best for our purpose. The reasons for this are threefold. Firstly, the non-negativity of the Leontief inverse matrix is secured only in the column coefficient model. It is possible that negative entries might happen in a Leontief inverse matrix when we utilize the latter two models. This is especially the case for the row coefficient model, sometimes even leading to a negative projection of outputs (Polenske, 1980; Bon, 1984; Toyomane, 1988, etc.). Secondly, the performance of the column coefficient model is known to be fairly good. Polenske (1970) used sets of Japanese interregional input-output tables to check the accuracy of these three models. From the comparison between the estimated outputs and interregional trade flows by the models and the real data listed in the table, she showed that the accuracy of the row coefficient model is considerably worse than those of the other two models, and that the column coefficient model is almost as accurate as the Leontief-Strout gravity model. In the estimation process of Polenske's US MRIO account, an attempt was made to implement the Leontief-Strout gravity model for 79 industries and 44 regions by an iterative procedure; the iteration, however, did not converge and they eventually used the column coefficient model (Polenske 1980; 108). Thirdly, the amount of data necessary for the estimation of these three models is almost identical.

Let us demonstrate the column model of MRIO. Assuming that there are two regions in China, region 1 and region 2, and the regional value added, final demand, total output, technical coefficients and trade coefficients are given, then the multi-regional input-output model can be represented as follows (Miller and Blair 1985; 69-85):

$$\begin{matrix} \hat{C}^{11} & \hat{C}^{12} \\ \hat{C}^{21} & \hat{C}^{22} \end{matrix} \quad \begin{matrix} A^{1} & 0 \\ 0 & A^{2} \end{matrix} \quad \begin{matrix} X^{1} \\ X^{2} \end{matrix} + \begin{matrix} \hat{C}^{11} & \hat{C}^{12} \\ \hat{C}^{21} & \hat{C}^{22} \end{matrix} \quad \begin{matrix} F^{1} \\ F^{2} \end{matrix} + \begin{matrix} E^{1} \\ E^{2} \end{matrix} - \begin{matrix} M^{1} \\ M^{2} \end{matrix} = \begin{matrix} X^{1} \\ X^{2} \end{matrix}$$

Here:
X^R :Total output in region R
F^R :Final Demand in region R
E^R :Foreign exports from region R
M^R :Foreign imports into region R
A^R :Technical coefficient matrix of region R
$\hat{C}^{RS}$:Trade coefficient matrix from region R to region S, as a diagonal matrix of coefficients.
(R, S = 1 and 2)

The elements of the trade coefficient matrix, denoted by c_i^{RS}, show the proportion of all of good i used in region S that comes from each region R. Trade coefficients are derived from the transaction from R to S divided by the total inflow of S, defined as:

$$c_i^{RS} = \frac{t_i^{RS}}{\sum_{R}^{n} t_i^{RS}} \qquad (n=1,2)$$

t_i^{RS} shows the amount of good i moved from region R to region S. In the background to this, there is the assumption that each sector in the region purchases the commodities and services from the other region at the same ratios.

By using the above formulae, the format of the interregional input-output model, or Isard format, was developed. The model layout of our multi-regional input-output model for China (CMRIO) is shown in Figure 2.

Figure 2 Layout of the Multi-regional Input-Output Model for China

		Intermediate Demand (A)								Final Demand (F)											
		North East	North Municipalitie	North Coast	East Coast	South Coast	Central Region	North West	South West	North East	North Municipalitie	North Coast	East Coast	South Coast	Central Region	North West	South West	Export	Import	Statistical Desprepancy	Total Output
	code	(AA)	(AB)	(AC)	(AD)	(AE)	(AF)	(AG)	(AH)	(FF)	(FB)	(FC)	(FD)	(FE)	(FF)	(FG)	(FH)	(LE)	(LM)	(QX)	(XX)
Intermediate Input	North East (AA)	A^{AA}	A^{AB}	A^{AC}	A^{AD}	A^{AE}	A^{AF}	A^{AG}	A^{AH}	F^{AA}	F^{AB}	F^{AC}	F^{AD}	F^{AE}	F^{AF}	F^{AG}	F^{AH}	LE^{A}	LM^{A}	Q^{A}	X^{A}
	North Municipalities (AB)	A^{BA}	A^{BB}	A^{BC}	A^{BD}	A^{BE}	A^{BF}	A^{BG}	A^{BH}	F^{BA}	F^{BB}	F^{BC}	F^{AD}	F^{BE}	F^{BF}	F^{BG}	F^{BH}	LE^{B}	LM^{B}	Q^{B}	X^{B}
	North Coast (AC)	A^{CA}	A^{CB}	A^{CC}	A^{CD}	A^{CE}	A^{FF}	A^{CG}	A^{CH}	F^{CA}	F^{CB}	F^{CC}	F^{AD}	F^{CE}	F^{FF}	F^{CG}	F^{CH}	LE^{C}	LM^{C}	Q^{C}	X^{C}
	East Coast (AD)	A^{DA}	A^{DB}	A^{DC}	A^{DD}	A^{DE}	A^{DF}	A^{DG}	A^{DH}	F^{DA}	F^{DB}	F^{DC}	F^{AD}	F^{DE}	F^{DF}	F^{DG}	F^{DH}	LE^{D}	LM^{D}	Q^{D}	X^{D}
	South Coast (AE)	A^{EA}	A^{EB}	A^{EC}	A^{ED}	A^{EE}	A^{EF}	A^{EG}	A^{EH}	F^{EA}	F^{EB}	F^{EC}	F^{AD}	F^{EE}	F^{EF}	F^{EG}	F^{EH}	LE^{E}	LM^{E}	Q^{E}	X^{E}
	Central Region (AF)	A^{FA}	A^{FB}	A^{FF}	A^{FD}	A^{FE}	A^{FF}	A^{FG}	A^{FH}	F^{FA}	F^{FB}	F^{FF}	F^{AD}	F^{FE}	F^{FF}	F^{FG}	F^{FH}	LE^{F}	LM^{F}	Q^{F}	X^{F}
	North West (AG)	A^{GA}	A^{GB}	A^{GC}	A^{GD}	A^{GE}	A^{GF}	A^{GG}	A^{GH}	F^{GA}	F^{GB}	F^{GC}	F^{AD}	F^{GE}	F^{GF}	F^{GG}	F^{GH}	LE^{G}	LM^{G}	Q^{G}	X^{G}
	South West (AH)	A^{HA}	A^{HB}	A^{HC}	A^{HD}	A^{HE}	A^{HF}	A^{HG}	A^{HH}	F^{HA}	F^{HB}	F^{HC}	F^{AD}	F^{HE}	F^{HF}	F^{HG}	F^{HH}	LE^{H}	LM^{H}	Q^{H}	X^{H}
Value Added	(VV)	V^{A}	V^{B}	V^{C}	V^{D}	V^{E}	V^{F}	V^{G}	V^{H}												
Total Input	(XX)	X^{A}	X^{B}	X^{C}	X^{D}	X^{E}	X^{F}	X^{G}	X^{H}												

3. Data estimation

3.1 Regional technical coefficient and exogenous data

3.1.1 Regional technical coefficient

The intermediate transaction tables for each province were aggregated to the corresponding region and used to calculate the regional technical coefficient. It is assumed that the technical coefficient for 2000 should not change from 1997.

3.1.2 Final demand and value added

Firstly we checked the totals of the provincial tables and compared them with the national one. We found that there were some discrepancies between regional aggregated data and national data. Consequently, we set the national input-output data as the control total and then made an adjustment for total output, final demand items and value added items so as to be consistent with the national input-output data and the regional total, which was collected from different data sources. In order to ensure the convergence of the data, a matrix convergence method like RAS was applied to the adjustment procedure. However, the operating surplus in value-added items was not estimated because it might be used as the balancing item between total input and other inputs.

Foreign exports and imports at the provincial level were also not consistent with national data, and some provinces have no export and import vectors in their input-output accounts. These data are therefore estimated by using provincial input-output structure and foreign trade data in the Provincial Statistical Yearbook and the National Statistical Yearbook.

From looking at the expression of out- and inflows with separate regions (including foreign trade) of provincial IO tables, we can see that provinces exhibited three patterns: 1) those that are completely separated into four column vectors of domestic outflows, exports, domestic inflows, and imports respectively (e.g. Beijing, Tianjin, Jiangsu, Shanghai, Guangdong, Ningxia, Xinjiang and Guangxi); 2) those separated into two column vectors, one of which is the sum of domestic outflows and exports, and the other the sum of domestic inflows and imports (e.g. Jilin, Zhejiang, Fujian, Hainan, Shanxi, Henan, Jiangxi, Hubei, Inner-Mongolia, Shaanxi, Qinghai, Sichuan and Yunnan.); and 3) those with a simple single column vector expressed as net outflow, i.e. the sum of domestic outflows and exports minus the sum of domestic inflows and imports (e.g. Heilongjiang, Shandong, Anhui, Hebei, Chongqing and Gansu).

In order to estimate data for foreign trade in the case of pattern 2), customs statistics concerning the value of exports and/or imports by category of commodity were obtained from Provincial Statistical Yearbooks, and data concerning exports (and imports) separated from the sum of domestic outflows and exports (and the sum of domestic inflows and imports).

Next, for the estimates in the case of pattern 3), the initial steps were similar to the aforementioned steps for pattern 2), separating exports and imports from this column to obtain three columns, for net domestic outflows, exports and imports.

Finally, all data for exports and imports by region and by sector were adjusted in accordance with national input-output data and total export/import data at the regional level.

The service industry was divided from the national service industry according to the share of provincial commodity trade in national commodity trade. It should be noted that these IO structure and exogenous data are estimated based on the 1997 data [6].

According to the provincial total output (input), called Control Totals (CT), provincial data such as value added, final demand and foreign trade, must be estimated. Value added and final demand were estimated from the provincial input-output structure and the provincial data, and adjustments were made in light of the consistency of national input-output data.

3.2 Interregional commodity flows

In China, there are very few statistics concerning interregional shipments of commodities by region, so we then applied two methods of estimating the interregional commodity flow: a survey and a model.

3.2.1 Survey

In order to obtain information on inter-provincial commodity flows, a survey was conducted in 2001. We selected 549 state-owned enterprises (SOEs) and business groups that are regarded as important in terms of enterprise size and economic activity in China, and distributed questionnaires to them concerning their figures for 2000 (Zhang and Zhao, 2002). Because of the limitations of the survey scale and response ratio, some sectors like the service sector and some regions like the northwest region did not provide enough data on commodity flows. However, the survey provided us with very important information on commodity shipments over the region.

3.2.2 Estimation model

Since trade coefficients among regions are the most important data for estimating the column model, we tried to choose the most suitable estimation method for our case from several options: (1) linear-programming models; (2) classes of gravity models; (3) Wilson's entropy model (Wilson 1970); and (4) other types of entropy model (the Informational Path Capacity model by Kobayashi, 1972; the Information Inaccuracy model by Theil, 1967, etc.). To check the feasibility of each method, we compared the amount and variety of data available to us with the amount and variety of data necessary for making estimates using each technique. Then we conducted test estimates using some of the feasible methods and compared the results with some perfect OD tables available to us. Based on these considerations, we finally came to the conclusion that the Leontief-Strout Gravity (LSG) model is the best for our purposes. It can be defined as:

$$t_i^{RS} = \frac{x_i^R \, d_i^S}{\sum_{R} x_i^R} Q_i^{RS}$$

Where:

x_i^R :Total supply of good i in region R (The element of X^R)

d_i^R :Total demand of good i of region S

Q_i^{RS} :Spatial friction factor of movement of good i from region R to region S

For the purpose of estimating Q_i^{RS} , the Railway Transport Origin-Destination table (RTOD table), which is provided in the Yearbook of China Transportation & Communications, was used as the basic information for spatial movements of the commodity over the region. However, the RTOD table does not provide details of interregional commodity shipments by other transportation modes, such as road and water transport. OD tables in the base year should contain the flows of all three transportation modes (ship, road, and railway)[7] . Though the complete OD tables for various products are available for railway transport, they are not fully available for road and water transport. So in the latter cases, we estimated the OD tables both for some products and each transport mode using the total outflow of each product from each region and other information, such as the average distance of shipment for every single product in each region. In estimating them, we used a supply-constrained gravity model with a constraint condition to ensure that the average distance of the estimated commodity flow would be close to the known average distance.

Through the work discussed above, the OD tables for some products using the three transport modes have been estimated. However, since some products cannot entirely correspond to the sector classification of the input-output table, we estimate the Q_i^{RS} by the estimated OD tables based on the assumption that commodity flows in the input-output sectors are the same as the flows of one of the representative products (see table 2).

Q_i^{RS} was estimated based on the following formulae:

$$Q_i^{RS} = \frac{H_i^{RS}}{\frac{H_i^{RO} H_i^{OS}}{H_i^{OO}}}$$

Here,

H_i^{RS} The amount of i commodity flow from R region to S region

H_i^{RO} The total amount of i commodity flow departing from R region

H_i^{OS} The total amount of i commodity flow arriving in S region

H_i^{OO} The total amount of i commodity flow in all regions

Table 2 Correspondence of OD table and Q

Estimated OD matrix	**Q**
Commodity	Sector
Grain	01
Cotton	01
Coal	02
Coal products	02
Petroleum	03
Petroleum products	03
Coke	03
Metal ore	04
Non-metal ore	05
Salt	05
Timber	09
Chemical fertilizer & agricultural chemicals	12
Mineral materials for construction	13
Cement	13
Iron and steel	14
All products	15-23

3.2.3 Some adjustments

The trade coefficient of manufacturing sectors was estimated as discussed above. However, special adjustments were made in some sectors.

1) Electricity, gas and tap water (Sector 24, 25, 26)

Although we used the OD table of all products to estimate Q, the trade coefficient should be zero in of the event that there are no borders between the regions. This implicitly assumes that electricity, gas and water cannot be transported to regions a long way away.

2) Construction (Sector 27)

We assumed that all construction activity occurred inside the region and assumed no trade among the regions.

3) Trade and transport (Sector 28, 29)

We estimated transactions among the regions in the same way as manufacturing sectors, based on the assumption that trade and transport transactions would increase when there were more transactions of merchandise commodities.

4) Other services (Sector 30)

We assumed that there is no trade among the regions, because of a lack of reliable data.

5) Self-sufficient ratio

When we checked the intra-regional column coefficient ratio, it was found that the self-sufficiency ratios of intra-region estimated from the trade coefficients were overestimated compared with those of regional input-output data. Therefore, the necessary adjustments were made to the column coefficient.

3.3 Model implementation and reconciliation

After estimating the regional technical coefficient, final demand and trade coefficient, we implemented the column coefficient model and obtained the interregional input-output table from the results of the implemented model. Comparing the outputs obtained by the model to the real data, we found that there were relatively large errors in some sectors and regions.

Firstly we checked the sectors with an error ratio over 30%. Assuming that these errors come from errors in the estimation of interregional commodity flows, we corrected the trade coefficient according to the opinion of the experts and the survey results. Secondly, the sectors with a relatively large error (an error ratio over 10%) were reconciled based on the assumption that the process degree between the related sectors was over- or under-estimated. Finally the reconciliation and balancing work were wholly carried over to the crucial cell by using the survey results so that the 'Holistic Accuracy' (Jensen, 1980) of the CMRIO could be ensured. However, there still exist relatively large statistical discrepancies in the mining, metal processing, electricity, gas and water supply and service sectors because of data inconsistency between the regional and national levels.

4. Some Concluding Remarks

In our CMRIO model, the input structure and exogenous data were for 1997 and the interregional trade flow was estimated based on the 2000 survey results and data. Therefore, the technical structure between sectors in the region and the structure of value added, final demand and total output are implicitly assumed to be the same in 1997 and 2000. It is accepted that the regional shares or proportions of the whole nation's economy in 2000 are at least almost the same as those in 1997, according to the Statistical Yearbook. Accordingly, we are convinced that this model would be useful for analyzing the spatial structure or interaction over the region for the reference year 2000.

Our CMRIO model could be regarded as a hybrid type model. After constructing the preliminary CMRIO , we calculated the Leontief inverse and checked the crucial cell generating the error in the row-direction and affecting the accuracy of the Leontief inverse. The crucial cells were adjusted using superior data, survey results and input-output specialists. Consequently, we are convinced that this model could also be applied for impact analysis at a high level of accuracy.

To the best of our knowledge, this is the first attempt —both in China and abroad— to build a CMRIO on this scale and by conducting a survey. There is no doubt that there might be scope to improve the estimation methodology and there would still be errors occurring as a result of the lack of data. Comments and other research will be welcomed to improve future work.

Notes

[1] Before the 1987 table, the 1973 and 1981 tables were mainly compiled by the State Planning Commission and Chinese Academy of Social Sciences respectively. See Polenske and Chen (eds.) (1991, Chapters 1, 2).

[2] However, no table for Tibet has ever been compiled.

[3] For researchers outside China, Okamoto, Zhang and Zhao (2004) discusses the regionalization of national IO data.

[4] Needless to say, even though research members in Japan are involved in this research, they are not permitted to access provincial IO data.

[5] Despite of the lack of a table for Tibet, that area is included in the Southwestern region. The negative influence occurred by this treatment must be negligible because the economic scale of Tibet is extremely small compared to the national economy.

[6] We had intended to update this data to 2000 if national input-output table for 2000 had been available. However, we were unable to do so for two reasons: (1) the national input-output table had not been published at the time of compilation, and (2) we considered the originally estimated data to be better than the updated data.

[7] The omission of air and pipeline shipments may not lower the accuracy of our estimation very much, since their relative volume is not so large in comparison with those of other transportation modes.

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Regional Input-Output Tables Based on Supply and Use Frameworks: The Case of the Russian Far East

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Abstract

This paper presents approaches to constructing regional input-output tables based on supply and use frameworks. This technique was applied to estimating the regional input-output table for the Russian Far East for 2002. Data for national and regional accounts, industrial statistics and special surveys conducted by national and regional statistical bodies were used for these estimates. Macroeconomic aggregates based on SNA and estimated detailed use tables at purchasers' prices are also presented.

KEYWORDS: regional input-output tables, supply and use frameworks, use table, Russian Far East

1. Introduction

The system of national accounts of the Russian Federation, published by the Federal State Statistics Service of the Russian Federation (FSSS RF)[1], now includes national accounts reflecting all major phases of the economic process (production, generation and distribution of income, consumption and capital formation, transactions with financial instruments and so forth). The statistical indicators in accordance with SNA published by regions officially are significantly less comprehensive than national statistics and, in contrast to the system of national accounts, do not provide a general view of the regional economy. They are focused more on showing the position of the region within the national economy in terms of production, consumption and capital accumulation and, as such, are insufficient for a complex analysis of regional development and modeling.

Regional statistical bodies develop and publish some regional accounts, usually production accounts, generation of income accounts and use of income accounts, but the list of accounts depends on what is available in different regions and the initiatives taken by the statistical organizations there, so the set of parameters varies between administrative regions. Goskomstat regards the data published by regional statistical bodies as preliminary and subject to specification and updating.

The list of parameters of regional accounts published by Goskomstat is growing by the year; the first figures published for gross value added (GVA) and gross regional product (GRP) in accordance with SNA by administrative region were for 1994, while calculations of the actual final consumption of households have been carried out since 1995. The first figures published for components of the income generation account (structure of the gross value added) were for 2002. Time indices of the gross value added in constant prices have been calculated since 1997.

Input-output tables in accordance with SNA have been developed for Russia

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since 1995; however, the construction of regional input-output tables has yet to be established as an objective by Goskomstat. The Russian input-output tables for 1995 were based on a unique survey conducted by regional statistical bodies, but the collected data were used for the construction of regional input-output tables in only four regions (Sayapova, Sutyagin, 2001). Few estimates of regional tables have been submitted by researchers (Zaitseva, 2001; Sayapova, Sutyagin, 2001; Serebryakov, Uzyakov, Yantovskii, 2002), with those that have been submitted being based on unique techniques for the construction of regional symmetric tables.

This paper presents some macroeconomic indicators of regional accounts submitted for the Russian Far East by Goskomstat, the method of constructing regional input-output tables based on supply and use frameworks and estimated input-output tables for the Russian Far East for 2002.

2.General outline of estimates

The methods of developing regional input-output tables can be classified into three groups, according to the statistical data upon which they are based: special surveys, non-survey methods, and hybrid methods. It has been universally recognized that the hybrid method appears to be the most cost-effective, with an acceptable level of accuracy (Lahr, 1993).

The hybrid method covers three approaches for the development of regional input-output tables: top-down, bottom-up and horizontal (Imansyah, 2000). The top-down approach is the most commonly used and uses national tables to produce regional input-output tables by applying such regionalization techniques as LQ and RPC (Jensen, Mandeville and Karunaratne, 1979). The bottom-up approach uses local data for to estimate regional tables. The horizontal approach uses available regional tables as the base for new estimates and is, as a rule, used in updating tables (Antille, 1990, Imansyah, 2000). Each approach has its advantages and deficiencies, and the effectiveness of their use is defined by available statistical data.

Traditionally, regional input-output tables are constructed on the basis of national "commodity by commodity" or "industry by industry" tables. However, the construction of regional "commodity by industry" tables on the basis of national supply and use (S&U) tables is recently becoming increasingly popular. Supply and use tables are routinely used in national accounting and, according to some completed projects, can be applied at the regional level as well. There have been some positive experiences of constructing regional tables on the basis of S&U tables in the Netherlands (Eding et al., 1998), Denmark (Madsen and Jensen-Butler, 1998, 1999), Canada (Siddiqi and Salem, 1995), Finland (Piispala, 2000) and Austria (Fritz, Kurzmann, Streicher, Zakarias, 2002).

As an accounting framework, S&U tables are superior to square (symmetric) tables, since fewer assumptions and less modeling are needed to construct them and more primary (not estimated) statistical data are also used. As argued in Madsen and Jensen-Butler (1998), the data presented in S&U tables have a sounder theoretical basis; they show how firms -which form industries when put together- use commodities as inputs and turn them into other commodities in production, whereas in square tables the interrelations between commodities are reflected and firms drop out of consideration (Piispala, 2000).

An S&U table (or rectangular table) was used as the basic framework for constructing a regional "commodity by industry" table. The simplified S&U table is presented in Figure 1.

Figure 1 Simplified supply and use table.

	Commodity	Industry	Final demand	Rest of the world	Other regions	Total
Commodity		U	Y	E	W	Q
Industry	X^T					G
Rest of the world	M					
Other regions	V					
Gross value added		T				
Total	Q'	G'				

Table of symbols: U - intermediate use of commodities by industries, Y - final demand by commodities, E - export by commodities to the rest of the world, W - export by commodities to other regions, Q - total use by commodities in the region, Q ' - total resources by commodities in the region, G - total use by industries in the region, G ' - total resources by industries in the region, XT - resources by industries (transposed resources table), M - import by commodities from the rest of the world, V - import by commodities from other regions, T - value added by industries. Marked cells are not filled.

The rectangular table can be simply transformed into a "commodity by commodity" symmetric table if several additional hypotheses concerning the structure of the regional resource table are accepted. Compared to the traditional symmetric table with a functional classification ("commodity by commodity"), S&U tables are superior from the descriptive point of view, since the data of industrial statistics are used directly, thereby increasing the clarity of the analysis and interpretation of estimate results. Despite the growing popularity of the development of regional tables in the S&U framework, traditionally the symmetric input-output table is used in regional analysis and modeling. However, the symmetric table could be calculated on the basis of an estimated S&U table.

There are several stages in the compilation of an S&U table:

1. The formation of an aggregated regional S&U table for ten sectors of the economy in accordance with the classification of aggregated sectors in the Russian input-output tables [Sistema...,2004]. The production accounts and regional macroeconomic aggregates published by Goskomstat, and the generation of income accounts and the use of income accounts developed by regional statistical bodies as the share parameters of the national tables are used as the initial data. As long as the classification of the ten aggregated commodities and ten aggregated sectors coincides, the "commodities by industries" use table and "commodity by commodity" symmetric table appear to be identical. An aggregated S&U table was used as a reference table in constructing a detailed matrix.

2. Estimates of outputs by industries, intermediate consumption and gross value-added components are recalculated next into the same indicators by commodities; estimates of the final use components, and exports and imports by commodity are also made.
3. Estimates and balancing of the S&U table detailed by industry.

The method of constructing an S&U table can be described as hybrid. The "Table of Use of Goods and Services in the Russian Economy at Purchasers' Prices" and "Table of Resources of Goods and Services", which were developed by Goskomstat [Sistema...,2004], were applied as the initial basis for calculations. Total S&U tables are formed on the basis of regional accounts as the internal structure of the matrix, which was adjusted by using regional data.

The statistical base of estimations includes the following (Figure 2):

Production accounts and some macroeconomic indicators published by Goskomstat by administrative regions;

Regional accounts, published by regional statistical bodies;

Industrial surveys of large and medium-sized enterprises (statistical form 5-z) conducted by regional statistical bodies;

Household sampling survey conducted by Goskomstat.

Figure 2 Data available from Goskomstat RF and regional statistical organizations (available data are marked by filled cells)

	Production accounts (Goskomstat)	Generation of income accounts (regional)	Use of income accounts (regional)	Industrial survey (form 5-z, regional)	Household survey (Goskomstat)
Republic of Sakha (Yakutia)	■		■	■	■
Primorsky krai	■		■	■	■
Khabarovsk krai	■		■	■	■
Amur oblast'	■	■		■	■
Kamchatka oblast'	■	■	■	■	■
Magadan oblast'	■	■	■	■	■
Sakhalin oblast'	■		■	■	■
Jewish autonomous oblast'	■			■	■
Chukotka autonomous okrug	■				■

In addition, superior data published by state and regional statistical bodies were used. The data published by Goskomstat refer to 2002. The most complete regional data refer to 2001, and were used as share parameters for estimating intermediate consumption and the component structure of gross value added by industries.

3. Aggregated supply and use table

The compilation of a consistent system of regional macroeconomic aggregates used as totals is an initial stage in the construction of an S&U table. The construction of aggregated balances of resources and the use of goods and services was applied as a method of verifying available data from the point of view of their consistency, as well as estimates of missing values, including the balance of inter-regional trade.

Resources in the economy of the region are formed due to production, imports from abroad (from the rest of the world) and imports from other regions. The data on production by sectors of the economy are presented at basic prices, so the resource part of the balances of goods and services are also presented at basic basis prices. Production accounts by the Far Eastern subjects of the Russian Federation for 2002, submitted by Goskomstat, contain indicators of output, intermediate consumption, gross value added, and net taxes on products as GRP.

Total imports of goods from the rest of the world, which refers to industry as a whole, are also published by Goskomstat (Regiony...,2004), allowing the generation of resources of goods and services. Although data on imports from other regions are not available, this is typical in the construction of regional tables, with the balance of inter-regional trade being estimated as a discrepancy of resources and use.

Use of goods and services includes intermediate consumption, final consumption expenditures of households, final consumption expenditure of non-profit institutions serving households, expenditures of general government on individual goods and services and on collective services, gross fixed capital formation, changes in inventories and net acquisition of valuables as exports to the rest of the world and exports to other regions. Use of goods and services is presented at purchasers'prices.

In order to estimate intermediate consumption of goods and services by sector, a matrix of inter-sectoral transactions was constructed, with the data on output and intermediate consumption available from production accounts being used initially. The preliminary variant of a matrix of input-output coefficients was derived by splitting the column sums of intermediate consumption according the structure of a corresponding Russian matrix.

Goskomstat's data for use of goods and services include: actual final consumption of households divided by final consumption expenditures of households and social transfers in kind (final consumption expenditure of non-profit institutions serving households and expenditures of general government on individual goods and services) and gross fixed capital formation by administrative regions. Regional accounts for use of income are available for only six Far Eastern administrative regions[2] but the regional data practically coincide with the corresponding indicators published by Goskomstat, which was the reason for applying the regional accounts data as share parameters for calculating the final use components by sector.

As mentioned above, the resources of goods and services are calculated at basic prices while use is calculated at purchasers' prices. In order to balance the S&U table, the transport and trade margins as net taxes on products should be added to outputs at basic prices, just as the cif/fob price difference should be added to imports. We were unable to obtain data to the evaluate cif/fob price difference so preliminary estimated imports were not adjusted.

The following assumptions were accepted for estimating margins. Due to its huge territory, remoteness from the main domestic markets and low population density, the Russian Far East differs from other regions in that it has a higher transport cost: 0.120 per unit of output in 2002, compared with the Russian average of 0.087. Therefore, we assumed that transport margins in the Far East are approximately 1.4 times higher than the national average.

The opposite situation occurs with regard to trade margins, which were 0.123 in the Far Eastern region, whereas the national average was 0.207; i.e. the Far Eastern margin is about 60% higher than the national average. The high trade margins in Russia noted by M. Kuboniwa (Kuboniwa, 2002) are attributable to the high share of export incomes earned by oil and gas companies being included into the incomes of trade intermediary companies. Therefore, transport and trade margins were adjusted according to the ratio of margins in the region and the national average.

Rates of taxes on products and subsidies on products were calculated in accordance with national data for total net taxes on products, which are available from production accounts.

The discrepancy between resources and use of goods and services by sector defines the interregional trade balance, i.e. net exports to other regions if the balance is positive and net imports from other regions if the balance is negative. According to our assumptions, a non-zero interregional trade balance can only occur in goods-producing sectors (industry, agriculture and other activities), so the discrepancy between resources and use was applied in estimates of the inter-regional trade balance.

The output of the construction sector differs only slightly from use. The balance showed an increase in the share of construction in gross capital formation and a decrease in the share of industry, which seemed reasonable because the share of construction in capital formation in the Russian Far East is traditionally higher than the national average.

Outputs and uses by services are balanced in the region, so adjustments were carried out in the service sectors on the basis of available regional data.

Goskomstat published a regional breakdown for 2002 of the components of GRP formation, including compensation of employees, net taxes on production, gross profit of the economy, and gross mixed income, which were applied as totals.

The gross value added by sectors was determined as the difference between output and intermediate consumption. The tentative estimate for compensation of employees, including the contributions of employers to social insurance funds, was calculated on the basis of an industrial survey (statistical form 5-z), net of other taxes on production that were defined in accordance with national tax rates.

The system of consistent indicators in ten sectors of the economy appeared as a result of estimates of an aggregated S&U table, representing resources of goods and services and their use.

4. Estimate of indicators by industry and commodity

4.1 Output by industry

Data concerning output and value added by industry in accordance with SNA are not published by regions so we used industrial statistics that provided data by activity rather than commodity as the main data source (Regiony..., 2004). Firstly, output by industrial activity was estimated and then the share parameters of the national resources table were used for calculating output by commodity.

Total industrial output in accordance with SNA does not coincide with data from industrial statistics. This discrepancy is caused by methodological differences in their calculation resulting from different prices, the registration of goods made on commission, goods in process and some other peculiarities, such as estimates of unregistered activities being included in SNA indicators. Therefore, total industrial output in accordance with SNA exceeds data from industrial statistics for Russia and the RFE by approximately 25%; the discrepancy by industry is more striking in the oil refining industry (4.29 times), in which the scheme of goods made on commission is used widely and in light industry and the food processing industry (1.7 times and 1.55 times respectively), in which the share of unregistered activities is a fundamental element.

Data from industrial statistics across the Russian Far East were used as an initial estimate of output by industry, and were then adjusted according to national average parities of output based on SNA and industrial statistics.

4.2 Final consumption expenditure

The national average structure of household expenditure for final consumption was applied as a preliminary variant, adjusted according to parities of regional and national household expenditure structure available from the household sampling survey [Dohody..., 2003]. The household sampling surveys conducted by Goskomstat focus mainly on expenditure on goods and are incomplete with regard to the consumption of services, so the data for available regional accounts were used for estimating the share of services. In comparison with the national average, the Far Eastern structure of household expenditure is characterized by higher expenditure on fuel and energy, construction materials, commodities produced by light industry and the food processing industry, housing services and lower expenditure on chemical and machine-building goods, education and health services.

General government expenditure on individual goods and services and the final consumption expenditure of non-profit institutions serving households make up the total value of social transfers in kind published by Goskomstat. Total transfers in kind, of which the overwhelming majority is accounted for by services in the fields of public health care, social security, education and culture, was split by commodity in accordance with the national structure.

General government expenditure on collective services covers services relating to agriculture and science, and financial intermediary and general administration services calculated as a share of the national average, corresponding to a regional sector's share in the national GVA.

4.3 Gross capital formation

The national share parameters of gross fixed capital formation were used for the distribution of the total value of gross capital formation in the RFE by commodity and service.

The total value of changes in inventories is reflected in regional use accounts available only in a few regions (Table 2). The share of total output accounted for by changes in inventories in the specified regions is 3.5 %, compared to the national average of 1.7 %; the excess can be explained by unfavorable climatic conditions, the seasonal transport accessibility of some territories, and significant seasonal inventories. Therefore, we estimated the total changes in inventory as 3.5 % of regional output and used national share parameters for distribution by commodity.

4.4 Export and import (trade with the rest of the world)

Data on the export and import of goods in the RFE and the commodity structure are published by Goskomstat (Regiony..., 2004). These data are based on customs statistics presented by commodity group (Tamozhennaya..., 2004) in US dollars.[4]

These commodity groups do not cover the total value of exports and imports. The official statistics do not publish data on commodity group 71, which encompasses precious metals and stones and products created from them, including diamonds, which are an important export commodity for the RFE. Accordingly, all unallocated exports were attributed to nonferrous metallurgy as unallocated imports of light industry commodities (commodity groups 50-67), since consumer goods are one of the main groups of Far Eastern imports from abroad.

The estimated parameters were recalculated from dollars into rubles using the average annual exchange rate. The only data presented for exports and imports of services are for the export and import of technologies and services of a technical nature, which are also given in dollars. They were also calculated in rubles and attributed to "cience and scientific services" Trade and transport margins in exports and imports were calculated in accordance with regional average margins.

5. Detailed supply and use table

Intermediate consumption by commercial enterprises is defined through the development of input-output tables in accordance with the statistical form 5-z, which provides data on the production costs of goods and services. The available regional forms 5-z relate to 2001, therefore they were applied as an initial variant of estimates of shares of intermediate consumption, wages and salaries, and contributions to social funds by industries.

The input-output coefficients of the national use table and the shares of material inputs in output by sector and industry estimated above were used for calculating the initial variant of the regional matrix of input-output coefficients (A matrix), which was later adjusted to take into account the available data on production costs in the RFE. The adjustments mainly concerned three groups of industries, reflecting the peculiarities of regional production: the high cost of fuel and energy in the region, increased transport costs and trade margins that are lower than the national average.

The input-output coefficients by industry of the fuel-energy complex in A matrix were replaced by the regional data presented in the statistical form 5-z. The consumption of energy resources in the RFE is characterized by the higher share of coal and lower share of gas in comparison with the national picture; accordingly, this peculiarity was taken into account in updating the ratio of coal and gas costs by industry.

The data on costs in the oil refining industry, submitted in form 5-z, show a very low share of input costs, including crude oil (less than 1 % of total inputs), reflecting the use of the "goods on commission" scheme, therefore the national data were applied as inputs in oil refining.

The discrepancy between total inputs and the sum of material inputs by adjusted industries was distributed among the non-adjusted industries using the input shares presented in the national table. The share of inputs estimated on the basis of regional data is around 85% in the electric power industry, and around 70% in transportation and communication, and housing and communal services. The lowest share (around 20-30%) is in manufacturing industries.

Value added by industries was determined as the difference between output and intermediate consumption. Statistical form 5-z was used as the share parameter for estimating wages, salaries and contributions by employers to social insurance funds. Other taxes and subsidies on production were calculated using estimated total taxes and subsidies on production in industry and national rates of taxes and subsidies by industrial branches. Gross profit and mixed income were defined as the difference between the gross value added and the compensation of employees estimated above, as well as consumption of fixed capital and net other taxes on production.

5.1 Balancing the use matrix

The preliminary variant of the use table, which included 14 industries and 9 sectors of the economy and 23 corresponding commodities and services, was constructed as a result of various calculations. Resources of goods and services are presented at basic prices, while the use of products and services is reflected at purchasers' prices. The table is inconsistent, as interregional trade flows have not yet been estimated. Transport and trade margins as taxes and subsidies on products by total industry, as estimated above, were distributed by commodity in accordance with the national share parameters and tax rates.

The lack of data is main problem in estimating interregional trade indicators. In the Russian experience of regional input-output tables, net exports to other Russian regions (or imports from the other Russian regions) were usually defined as a balancing item. It is known a priori that the balance of interregional trade in the RFE is negative (imports exceed exports) for almost all commodities. Goskomstat conducted a survey of large and medium-sized wholesale trade enterprises, which documented interregional imports and exports in administrative regions by 25 commodity groups in kind; this indicated that the negative balance of interregional trade for some commodities is comparable with output.

Comparison of the use of goods and services and resources at purchasers' prices provides a discrepancy that can be considered as an initial estimate of the balance of inter-regional trade in the region, representing net imports in the event that the discrepancy is positive, and net exports in the opposite case.

The preliminary estimate of the inter-regional trade balance shows that imports from other regions exceed exports to other regions in all commodities, except nonferrous metals, processed food and electric power; this basically corresponds to the available data. The situation with regard to nonferrous metals and foodstuffs (mainly fish in the RFE), the defined specialization of the region, also looks to be realistic. In order to balance output and consumption of electricity, inputs and household consumption were adjusted.

The estimated use table at purchasers' prices for 23 commodities and 23 industries and sectors for the Russian Far East for 2002 and the resources table are presented below, in Tables 1 and 2.

Table 1 The Russian Far East 2002 Use Table at Purchasers' Prices (mln rubles)

	Products \ Sectors	Power industry 01	Oil producing industry 02	Oil-refining industry 03	Natural gas industry 04	Coal industry 05	Ferrous metallurgy 06	Non-ferrous metallurgy 07	Chemical and petrochemical industry 08	Machine-building and metal-working 09
01	Electric power	8541.2	432.1	905.6	11.4	1080.5	1586.9	4909.9	356.2	1122.5
02	Crude Oil	306.3	567.6	11065.3	3.5	0.0	0.0	0.2	117.6	0.6
03	Oil products	6435.2	807.2	271.1	11.2	82.4	38.4	4481.3	68.2	431.7
04	Gas	2873.5	73.3	4.4	11.1	149.6	26.6	412.8	122.8	45.2
05	Coal	14499.6	38.2	22.1	39.5	754.8	134.0	2083.0	35.3	228.0
06	Ferrous metals	199.3	546.7	158.2	7.6	416.2	3183.0	1363.3	61.9	2916.4
07	Non-ferrous metals	381.2	38.2	31.0	5.2	6.7	468.6	45225.9	33.2	1702.4
08	Chemical and petrochemical products	418.8	907.7	474.5	61.0	1142.9	110.2	1523.5	627.5	1211.2
09	Machine, equipment and products of metal-working	1143.4	1106.4	566.4	16.8	1843.5	289.6	2731.9	60.9	6846.2
10	Wood and paper	36.7	20.9	28.5	0.7	346.3	40.7	199.1	58.7	260.1
11	Construction materials	99.0	121.9	19.5	0.5	148.6	34.2	124.4	17.1	118.8
12	Products of light industry	20.5	35.1	5.1	1.7	100.5	25.7	38.1	15.1	106.7
13	Products of food industry	17.1	23.8	19.1	0.2	27.7	10.7	56.2	23.2	37.1
14	Other industries	202.4	39.7	151.1	17.8	103.9	35.2	111.3	12.1	123.4
15	"Industry", total	35174.3	4758.6	13721.8	188.1	6203.8	5983.9	63260.9	1609.8	15150.3
16	Products of construction	1616.0	982.2	532.1	68.1	206.0	135.9	936.2	32.3	376.2
17	Products of agriculture	22.5	11.2	31.8	0.2	1.1	9.4	15.3	3.2	17.6
18	Transport and communication service	658.6	893.2	63.3	14.8	1181.2	107.1	1465.7	61.9	579.0
19	Trade intermediation service	521.4	116.8	55.9	57.2	210.1	35.4	1271.4	15.6	372.3
20	Other activities	374.9	202.5	206.5	16.9	167.1	42.6	339.2	13.0	153.0
21	Housing and communal service	613.2	162.6	32.2	4.7	352.6	43.8	408.3	11.6	249.4
22	Healthcare, physical culture, social security, education, culture and art service	38.4	12.2	15.1	0.4	15.9	4.7	21.0	0.7	9.9
23	Science and scientific services	169.1	92.7	25.6	9.1	30.9	24.1	632.4	29.6	590.6
24	Financial intermediation, social organizations, general government services	654.1	570.9	281.9	16.1	251.4	127.0	677.2	10.3	144.8
25	Intermediate consumption total	39842.6	7802.9	14966.1	375.6	8619.9	6514.0	69027.7	1788.1	17643.1
26	Wages and salaries	7319.5	3578.1	1373.1	154.9	2667.3	1020.5	10840.8	446.0	6497.3
27	Contributions of employers to social insurance funds	2489.0	1054.1	440.2	53.8	957.1	370.9	3696.3	154.2	2393.4
28	Gross profits and gross mixed income	3347.6	3899.9	1229.0	379.8	3133.6	663.3	44211.1	28.1	15742.5
29	Net other taxes on production	155.3	1150.5	114.1	37.9	233.1	32.8	1588.2	12.0	301.9
30	Gross Value added	13311.3	9682.5	3156.5	626.3	6991.2	2087.5	60336.3	640.4	24935.1
31	Gross outputs at basic prices	53153.9	17485.4	18122.6	1001.9	15611.0	8601.5	129364.1	2428.5	42578.2

Table 1 The Russian Far East 2002 Use Table at Purchasers' Prices (mln rubles) - continued

	Sectors / Products	Wood and paper industry 10	Construction material industry 11	Light industry 12	Food industry 13	Other industries 14	"Industry" total 15	Construction 16	Agriculture 17	Transport and communication 18
01	Electric power	649.4	886.8	136.4	967.2	311.0	21897.2	1958.9	483.4	4631.8
02	Crude Oil	0.4	0.5	0.0	0.0	0.2	12062.2	2.7	0.0	271.1
03	Oil products	1515.6	531.0	24.5	8272.8	166.5	23137.2	3829.4	1693.6	11885.4
04	Gas	87.8	102.8	6.5	422.6	17.4	4356.4	64.9	85.4	293.6
05	Coal	443.0	518.8	32.8	2132.3	88.0	21049.5	327.6	430.7	1481.5
06	Ferrous metals	188.6	422.6	3.5	76.4	43.1	9586.6	4296.6	7.6	710.8
07	Non-ferrous metals	156.6	78.8	0.7	107.3	937.1	49172.9	313.9	0.0	28.8
08	Chemical and petrochemical products	717.5	250.5	97.0	357.0	271.5	8170.7	2125.6	528.8	1172.5
09	Machine, equipment and products of metal-working	770.6	197.2	11.9	482.4	127.2	16194.6	7759.5	986.9	6336.4
10	Wood and paper	4900.1	101.3	3.8	570.4	559.0	7126.4	3165.1	22.0	474.8
11	Construction materials	79.8	1123.7	1.0	137.0	10.3	2035.7	14331.2	54.2	613.9
12	Products of light industry	198.5	25.9	561.2	80.5	63.6	1278.1	127.5	25.3	218.3
13	Products of food industry	25.5	3.2	3.9	10081.8	129.2	10458.8	32.5	637.1	136.1
14	Other industries	38.4	17.2	2.8	238.4	279.2	1372.9	98.5	1005.5	309.9
15	"Industry", total	9771.6	4260.4	886.2	23926.2	3003.3	187899.2	38434.1	5960.6	28564.9
16	Products of construction	105.7	58.5	8.1	121.4	24.2	5202.9	291.0	171.0	3501.7
17	Products of agriculture	5.3	1.0	43.6	14031.4	695.8	14889.4	0.2	7449.4	0.1
18	Transport and communication service	624.2	193.1	19.5	901.6	66.8	6830.2	2412.2	713.4	7074.7
19	Trade intermediation service	182.2	66.2	12.5	674.5	42.7	3634.1	919.9	66.0	5747.0
20	Other activities	58.1	36.2	4.2	162.9	35.9	1812.8	597.0	35.3	863.4
21	Housing and communal service	106.8	51.8	10.4	194.9	39.3	2281.5	598.5	99.4	1801.0
22	Healthcare, physical culture, social security, education, culture and art service	4.0	3.1	0.2	9.5	3.4	138.7	38.3	2.2	190.5
23	Science and scientific services	30.3	2.5	1.2	50.9	8.5	1697.5	29.8	1.3	69.5
24	Financial intermediation, social organizations, general government services	100.5	20.5	2.2	109.9	31.4	2998.3	305.8	42.2	1542.2
25	Intermediate consumption total	10988.7	4693.3	988.0	40183.2	3951.2	227384.5	43626.7	14540.6	49354.9
26	Wages and salaries	3172.2	1003.5	868.1	9158.4	786.6	48886.1	19395.5	8078.6	20783.3
27	Contributions of employers to social insurance funds	1104.5	367.5	243.9	2849.8	248.7	16423.5	6310.7	2069.1	6813.3
28	Gross profits and gross mixed income	4742.6	746.2	391.3	16244.4	1005.7	95765.0	23495.6	13264.9	31188.2
29	Net other taxes on production	200.6	35.7	20.2	335.6	16.7	4234.6	865.5	-81.0	2885.0
30	Gross Value added	9219.9	2152.8	1523.5	28588.2	2057.7	165309.1	50067.3	23331.6	61669.8
31	Gross outputs at basic prices	20208.6	6846.1	2511.4	68771.3	6008.9	392693.6	93693.9	37872.2	111024.8

Table 1 The Russian Far East 2002 Use Table at Purchasers' Prices (mln rubles) -continued

	Sectors / Products	Trade and catering 19	Other activities 20	Housing and communal services 21	Health care, physical culture, social security, education, culture and art 22	Science and scientific service 23	Finance, social organizations and general government 24	Intermediate demand total 25
01	Electric power	4479.8	68.2	2378.5	8379.1	99.6	1499.0	45875.6
02	Crude Oil	0.0	0.0	0.0	0.0	13.9	0.0	12350.0
03	Oil products	3387.8	186.0	3224.2	1410.4	263.1	1474.8	50491.9
04	Gas	98.4	5.1	1479.5	961.8	9.8	117.5	7472.3
05	Coal	496.3	25.6	7465.7	4853.4	49.2	592.7	36772.2
06	Ferrous metals	97.5	6.0	248.9	6.3	82.6	1.3	15044.2
07	Non-ferrous metals	8.9	0.4	9.0	1.6	56.0	0.0	49591.4
08	Chemical and petrochemical products	1039.4	32.2	297.1	405.2	358.5	240.0	14370.1
09	Machine, equipment and products of metal-working	1407.5	221.8	577.6	131.6	609.0	2370.5	36595.4
10	Wood and paper	722.3	276.4	115.4	44.2	53.2	265.1	12264.8
11	Construction materials	352.8	5.7	367.7	55.4	44.4	17.3	17878.3
12	Products of light industry	319.8	22.5	64.5	95.4	26.4	564.2	2741.9
13	Products of food industry	1619.1	15.5	40.4	676.4	33.1	1444.4	15093.4
14	Other industries	315.0	879.1	206.3	54.1	50.9	445.0	4737.3
15	"Industry", total	14344.6	1744.3	16474.7	17075.0	1749.8	9031.7	321278.9
16	Products of construction	501.2	12.8	2830.2	763.6	98.6	793.0	14166.0
17	Products of agriculture	746.0	0.0	18.6	761.5	14.0	724.0	24603.2
18	Transport and communication service	13738.5	245.6	578.1	1435.8	199.2	3629.6	36857.3
19	Trade intermediation service	3232.0	182.5	281.9	788.6	83.3	662.3	15597.4
20	Other activities	1832.9	378.7	248.4	852.6	62.5	546.6	7230.0
21	Housing and communal service	553.4	43.9	1003.5	1516.1	181.1	1893.0	9971.5
22	Healthcare, physical culture, social security, education, culture and art service	52.9	7.7	23.4	931.2	5.4	46.4	1436.8
23	Science and scientific services	15.5	4.1	4.1	4.3	1010.1	1308.4	4144.4
24	Financial intermediation, social organizations, general government services	408.1	54.8	181.8	442.5	66.5	1520.6	7562.8
25	Intermediate consumption total	35425.1	2674.5	21644.7	24571.2	3470.6	20155.6	442848.3
26	Wages and salaries	29335.2	2826.9	10883.0	20579.8	1560.9	13416.2	175745.5
27	Contributions of employers to social insurance funds	5957.0	860.4	3279.0	6899.5	551.1	1705.1	50868.7
28	Gross profits and gross mixed income	41921.9	2059.2	7248.6	18882.3	2285.9	6696.3	242807.8
29	Net other taxes on production	706.9	73.7	608.9	276.9	76.3	142.4	9789.3
30	Gross Value added	77921.1	5820.2	22019.5	46638.6	4474.2	21960.0	479211.3
31	Gross outputs at basic prices	113346.1	8494.6	43664.2	71209.7	7944.8	42115.6	922059.6

Table 1 The Russian Far East 2001 Use Table at Purchasers'Prices (mln rubles) -continued

	Sectors		Final consumption expenditure					
	Products	households 26	Government on individual goods and services 27	Government on collective services 28	Gross fixed capital formation 29	Changes in inventories 30	Exports to ROW 31	Use of goods and services at purchasers' prices total 32
01	Electric power	4849.3	0.0	0.0	0.0	0.0	4172.9	54897.8
02	Crude Oil	0.0	0.0	0.0	0.0	230.0	15812.9	28392.9
03	Oil products	3391.1	19.9	0.0	0.0	579.8	16559.1	71041.7
04	Gas	279.2	0.0	0.0	0.0	78.9	0.0	7830.5
05	Coal	289.4	29.9	0.0	0.0	842.1	6182.2	44115.8
06	Ferrous metals	0.0	0.0	0.0	0.0	1838.5	7859.4	24742.2
07	Non-ferrous metals	0.0	0.0	0.0	100.2	5788.9	25609.6	81090.1
08	Chemical and petrochemical products	5636.2	365.6	0.0	0.0	1088.4	1009.5	22469.8
09	Machine, equipment and products of metal-working	15050.8	274.6	0.0	33147.9	7726.6	12800.2	105595.5
10	Wood and paper	3976.5	0.0	0.0	373.6	1231.8	18465.2	36312.0
11	Construction materials	1453.8	0.0	0.0	0.0	548.5	0.0	19880.6
12	Products of light industry	36316.3	117.9	0.0	0.0	1215.9	0.0	40392.1
13	Products of food industry	83417.4	1.6	0.0	0.0	4095.0	10248.3	112855.6
14	Other industries	1559.4	105.3	0.0	1127.2	465.4	0.0	7994.5
15	"Industry", total	156219.3	914.8	0.0	34748.9	25730.0	118719.3	657611.1
16	Products of construction	1110.9	0.0	0.0	80816.3	0.0	0.0	96093.2
17	Products of agriculture	17775.7	0.0	504.2	15.9	6468.1	0.0	49367.0
18	Transport and communication service	22238.9	1580.5	0.0	0.0	0.0	8357.9	69034.6
19	Trade intermediation service	4310.6	0.0	0.0	0.0	0.0	830.0	20738.0
20	Other activities	1125.8	0.0	0.0	204.4	68.1	0.0	8628.3
21	Housing and communal service	16357.5	2494.9	0.0	0.0	0.0	0.0	28823.9
22	Healthcare, physical culture, social security, education, culture and art service	9408.8	57832.1	0.0	1718.1	0.0	0.0	70395.8
23	Science and scientific services	0.0	0.0	1028.6	3185.2	0.0	3.6	8361.8
24	Financial intermediation, social organizations, general government services	4545.6	5121.7	24889.7	0.0	0.0	0.0	42119.7
25	Intermediate consumption total	233093.1	67944.0	26422.5	120688.7	32266.2	127910.8	1051173.5

Table 2 The Russian Far East 2002 Resources Table (mln rubles)

	Sectors / Products	Power industry 01	Oil producing industry 02	Oil-refining industry 03	Natural gas industry 04	Coal industry 05	Ferrous metallurgy 06	Non-ferrous metallurgy 07	Chemical and petrochemical industry 08	Machine-building and metal-working 09
01	Electric power	52390.4	20.4	4.1	4.7	57.0	79.9	911.8	10.2	315.0
02	Crude Oil	0.0	17221.5	0.0	0.1	0.0	0.0	0.0	0.0	0.0
03	Oil products	0.1	63.4	17805.7	84.9	0.0	0.0	0.0	63.9	0.0
04	Gas	0.0	136.9	3.7	906.6	0.0	0.3	0.0	0.7	0.1
05	Coal	0.0	0.0	0.0	0.0	15463.7	4.7	2.1	0.0	0.0
06	Ferrous metals	0.0	0.1	0.0	0.0	0.0	8323.1	121.8	0.0	146.4
07	Non-ferrous metals	0.0	0.0	0.0	0.0	0.1	23.4	126072.8	0.7	61.5
08	Chemical and petrochemical products	20.3	0.3	275.2	4.1	0.2	42.1	868.5	2293.9	72.7
09	Machine, equipment and products of metal-working	143.3	34.1	3.3	0.3	58.0	99.5	763.1	26.8	41658.3
10	Wood and paper	3.8	0.1	0.0	0.0	6.3	4.4	51.3	1.7	79.4
11	Construction materials	7.3	4.8	29.5	0.1	20.5	19.0	349.5	13.8	64.2
12	Products of light industry	0.9	2.4	0.0	0.0	0.0	0.2	1.6	2.5	30.5
13	Products of food industry	21.3	1.1	0.4	0.1	2.5	4.0	48.3	9.1	32.6
14	Other industries	566.6	0.3	0.6	1.0	2.6	0.8	173.2	5.1	117.4
15	"Industry", total	53153.9	17485.4	18122.6	1001.9	15611.0	8601.5	129364.1	2428.5	42578.2
16	Products of construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	Products of agriculture	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	Transport and communication service	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	Trade intermediation service	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	Other activities	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21	Housing and communal service	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	Healthcare, physical culture, social security, education, culture and art service	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	Science and scientific services	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
24	Financial intermediation, social organizations, general government services	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
25	Total (sum of rows 15-24)	53153.9	17485.4	18122.6	1001.9	15611.0	8601.5	129364.1	2428.5	42578.2

Table 2 The Russian Far East 2002 Resources Table (mln rubles) - continued

	Products \ Sectors	Wood and paper industry 10	Construction material industry 11	Light industry 12	Food industry 13	Other industries 14	"Industry" total 15	Construction 16	Agriculture 17	Transport and communication 18
01	Electric power	120.0	36.1	8.9	44.5	26.7	54029.6	0.0	0.0	0.0
02	Crude Oil	0.0	0.0	0.0	0.0	0.0	17221.6	0.0	0.0	0.0
03	Oil products	0.0	3.1	0.0	0.0	0.0	18021.1	0.0	0.0	0.0
04	Gas	0.0	0.3	0.0	0.0	0.0	1048.7	0.0	0.0	0.0
05	Coal	0.0	0.0	0.0	0.0	0.0	15470.5	0.0	0.0	0.0
06	Ferrous metals	3.6	14.7	0.0	0.3	0.0	8610.3	0.0	0.0	0.0
07	Non-ferrous metals	7.8	0.3	0.0	0.0	8.3	126175.0	0.0	0.0	0.0
08	Chemical and petrochemical products	60.3	50.5	8.3	114.3	18.5	3829.0	0.0	0.0	0.0
09	Machine, equipment and products of metal-working	83.3	45.2	10.3	15.4	7.6	42948.6	0.0	0.0	0.0
10	Wood and paper	19828.9	42.0	7.9	3.1	21.1	20050.2	0.0	0.0	0.0
11	Construction materials	15.6	6634.7	2.8	6.9	25.1	7193.9	0.0	0.0	0.0
12	Products of light industry	9.3	2.3	2467.7	5.2	17.0	2539.8	0.0	0.0	0.0
13	Products of food industry	37.5	3.8	3.1	68047.4	54.6	68265.9	0.0	0.0	0.0
14	Other industries	42.3	13.0	2.4	534.2	5829.9	7289.3	0.0	0.0	0.0
15	"Industry", total	20208.6	6846.1	2511.4	68771.3	6008.9	392693.6	0.0	0.0	0.0
16	Products of construction	0.0	0.0	0.0	0.0	0.0	0.0	93693.9	0.0	0.0
17	Products of agriculture	0.0	0.0	0.0	0.0	0.0	0.0	0.0	37872.2	0.0
18	Transport and communication service	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	111024.8
19	Trade intermediation service	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	Other activities	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21	Housing and communal service	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	Healthcare, physical culture, social security, education, culture and art service	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	Science and scientific services	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
24	Financial intermediation, social organizations, general government services	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
25	Total (sum of rows 15-24)	20208.6	6846.1	2511.4	68771.3	6008.9	392693.6	93693.9	37872.2	111024.8

Table 2 The Russian Far East 2002 Resources Table (mln rubles) -continued

	Products / Sectors	Trade and catering 19	Other activities 20	Housing and communal services 21	Health care, physical culture, social security, education, culture and art 22	Science and scientific service 23	Finance, social organizations and general government 24	Output by goods and services at basic prices 25
01	Electric power	0.0	0.0	0.0	0.0	0.0	0.0	54029.6
02	Crude Oil	0.0	0.0	0.0	0.0	0.0	0.0	17221.6
03	Oil products	0.0	0.0	0.0	0.0	0.0	0.0	18021.1
04	Gas	0.0	0.0	0.0	0.0	0.0	0.0	1048.7
05	Coal	0.0	0.0	0.0	0.0	0.0	0.0	15470.5
06	Ferrous metals	0.0	0.0	0.0	0.0	0.0	0.0	8610.3
07	Non-ferrous metals	0.0	0.0	0.0	0.0	0.0	0.0	126175.0
08	Chemical and petrochemical products	0.0	0.0	0.0	0.0	0.0	0.0	3829.0
09	Machine, equipment and products of metal-working	0.0	0.0	0.0	0.0	0.0	0.0	42948.6
10	Wood and paper	0.0	0.0	0.0	0.0	0.0	0.0	20050.2
11	Construction materials	0.0	0.0	0.0	0.0	0.0	0.0	7193.9
12	Products of light industry	0.0	0.0	0.0	0.0	0.0	0.0	2539.8
13	Products of food industry	0.0	0.0	0.0	0.0	0.0	0.0	68265.9
14	Other industries	0.0	0.0	0.0	0.0	0.0	0.0	7289.3
15	"Industry", total	0.0	0.0	0.0	0.0	0.0	0.0	392693.6
16	Products of construction	0.0	0.0	0.0	0.0	0.0	0.0	93693.9
17	Products of agriculture	0.0	0.0	0.0	0.0	0.0	0.0	37872.2
18	Transport and communication service	0.0	0.0	0.0	0.0	0.0	0.0	111024.8
19	Trade intermediation service	113346.1	0.0	0.0	0.0	0.0	0.0	113346.1
20	Other activities	0.0	8494.6	0.0	0.0	0.0	0.0	8494.6
21	Housing and communal service	0.0	0.0	43664.2	0.0	0.0	0.0	43664.2
22	Healthcare, physical culture, social security, education, culture and art service	0.0	0.0	0.0	71209.7	0.0	0.0	71209.7
23	Science and scientific services	0.0	0.0	0.0	0.0	7944.8	0.0	7944.8
24	Financial intermediation, social organizations, general government services	0.0	0.0	0.0	0.0	0.0	42115.6	42115.6
25	Total (sum of rows 15-24)	113346.1	8494.6	43664.2	71209.7	7944.8	42115.6	922059.6

Table 2 The Russian Far East 2002 Resources Table (mln rubles) -continued

	Sectors / Products	Import from the rest of the world 26	Imports from other regions (+) export to other regions (-) 27	Resources of goods and services at basic prices 28	Transport margins 29	Trade margins 30	Net taxes on products 31	Resources of goods and services at purchasers'prices 32
01	Electric power	0.0	0.0	54029.6	0.0	0.0	868.2	54897.8
02	Crude Oil	0.0	510.3	17731.9	3086.7	6522.8	1051.5	28392.9
03	Oil products	410.7	37533.2	55965.0	4562.8	8903.7	1610.2	71041.7
04	Gas	0.0	2837.1	3885.7	638.4	2692.5	613.8	7830.5
05	Coal	0.0	142.0	15612.6	17583.6	10530.3	389.3	44115.8
06	Ferrous metals	2128.7	10167.5	20906.5	2456.4	1236.1	143.2	24742.2
07	Non-ferrous metals	0.0	-68668.7	57506.3	7326.7	14220.6	2036.6	81090.1
08	Chemical and petrochemical products	5552.1	11382.1	20763.2	551.5	1007.4	147.8	22469.8
09	Machine, equipment and products of metal-working	16026.1	33772.4	92747.1	2176.8	9006.7	1665.0	105595.5
10	Wood and paper	614.5	5341.2	26005.9	4315.5	5091.5	899.1	36312.0
11	Construction materials	0.0	8165.1	15359.0	3212.6	1144.3	164.7	19880.6
12	Products of light industry	10339.2	23206.6	36085.7	195.5	3718.5	392.5	40392.1
13	Products of food industry	7536.5	-2815.5	72986.9	2682.1	29239.5	7947.2	112855.6
14	Other industries	0.0	0.0	7289.3	95.0	486.3	123.9	7994.5
15	"Industry", total	42607.8	61573.3	496874.6	48883.5	93800.0	18053.0	657611.1
16	Products of construction	0.0	0.0	93693.9	0.0	0.0	2399.2	96093.2
17	Products of agriculture	0.0	9659.0	47531.2	564.8	978.7	292.3	49367.0
18	Transport and communication service	2333.0	4463.3	117821.1	-49460.5	0.0	674.0	69034.6
19	Trade intermediation service	981.0	1069.7	115396.9	0.0	-94778.7	119.8	20738.0
20	Other activities	0.0	0.0	8494.6	12.1	0.0	121.6	8628.3
21	Housing and communal service	0.0	0.0	43664.2	0.0	0.0	-14840.3	28823.9
22	Healthcare, physical culture, social security, education, culture and art service	0.0	0.0	71209.7	0.0	0.0	-814.0	70395.8
23	Science and scientific services	314.8	0.0	8259.7	0.0	0.0	102.1	8361.8
24	Financial intermediation, social organizations, general government services	0.0	0.0	42115.6	0.0	0.0	4.1	42119.7
25	Total (sum of rows 15-24)	46236.6	76765.3	1045061.5	0.0	0.0	6112.0	1051173.5

6. Symmetric table

In order to construct the symmetric table, it is necessary to accept some additional assumptions concerning the technology used in the region, which makes the interpretation of commodity and industry transactions submitted in the S&U table less transparent.

The first additional assumption was already applied in the transformation of output by industry into output by commodity: we assumed that the structure of the table of resources for the RFE corresponds to the Russian structure. The second one assumed that technology (input structure) used by industry coincides with technology by corresponding commodity.

Following on from this assumption, the S&U table can be transformed from a "commodity by industry" framework into a "commodity by commodity" one by multiplying the first and third quadrants of the S&U table and the resources table.

More precisely, the first and third quadrants of the use table should be multiplied by the matrix Xs, to generate the structure of the transposed resources table:

$U^s = U X^s$

$T^s = T X^s$

Where: U^s - intermediate use of commodities by commodities; T^s - gross value added by commodities.

The use of commodities reflected in the second quadrant of the symmetric and use tables coincide. The symmetric matrix is consistent due to the constructing technique used.

7. Macroeconomic parameters of the Russian Far East

The official macroeconomic aggregates for the RFE are presented in Table 3.

Table 3 Economic indicators of national accounts for the Russian Far East,million rubles (till 1998 billion rubles)

	1994	1995	1996	1997	1998	1999	2000	2001	2002
GVA	35351.8	81276.8	115337.5	134642.1	144787.2	237639.2	312981.4	394458.9	485323.4
share in RF	6.7	5.8	5.9	6.0	6.0	5.7	5.0	5.1	5.1
Indices of GVA in the RFE	...	...	...	98.3	92.5	106.2	103	105.9	103.8
Indices of GVA in Russia	...	...	...	101.2	93.6	105.6	110.7	106.0	105.6
Actual final consumption	...	53760.1	76519	88617.9	92769.1	132217.5	171209.8	233041.1	301037.1
share in RF	...	5.7	6.1	5.6	5.4	4.9	4.7	4.9	5.0
Households consumption		39472.8	56789.6	66749.5	70817.8	108781.5	138216.2	187234	233093.1
share in RF	...	5.6	5.5	5.4	5.0	4.5	4.4	4.5	4.5
Social transfers		14287.3	19729.4	21868.4	21951.3	23436	32993.6	45807.1	67944
Gross capital formation	...	...	...	...	24901	40493.5	52826.9	93272.8	120688.7
share in RF	...	...	...	...	5.2	5.8	4.5	5.6	6.3
GRP per capita	4587.1	10743.7	15454.4	18246.9	19850	32979.8	43903.8	55842.7	69288.8
to RF	1.27	1.12	1.17	1.20	1.20	1.16	1.02	1.04	1.05

Source: Natsional'nye..., 2004.

From Table 3, we can see that the share of the RFE in total GRP by Russian regions was reduced during the period considered, with a particularly large fall occurring in 2000-2001, when the Russian economy grew intensively. Growth rates in the Far East were lower then the national average, as the RFE lost its position in the national indicators. The regional share in gross value added decreased from 6.7 % in 1994 to 5.1% in 2002, while the region's share in actual final consumption of households decreased from 5.7 % in 1995, when the indicator was published for the first time, to 5.0 % in 2002.

The Russian Far East also lost its advantage of higher per capita GRP, which exceeded the national average by 27% in 1994. The excess was caused by higher wage and salary levels in the region. In 2000-2002, per capita GRP production in the RFE almost equaled the national average. As the share of compensation of employees in gross value added in the RFE remains above the national average as before, the comparative profitability of production in the region is decreasing.

A general view of the economy of the Russian Far East was received as a result of the input-output estimates. As a matter of fact, the estimated indicators represent a kind of economic model for the Russian Far East, so applying the input-output method is an argument for the reliability of this model. Due to the inclusion in the estimates of plenty of direct and indirect ties as the rigidity of the interrelation of resources and uses by each kind of goods and services, the input-output framework enables the compiling of a consistent system of regional indicators and the description of a possible equilibrium in the regional economy.

The values of the basic macroeconomic aggregates in the estimated input-output tables coincide with the official data; however, a number of estimates that are not published officially were received.

According to our estimates, the total trade balance of the RFE is close to zero. This means that exports to the rest of the world plus exports to other regions approximately balance out imports from the rest of the world and imports from other regions. The region's total exports exceed imports to an insignificant degree, but the balance amounts to 0.5% of regional output and is located within the margin of error. However, the nature of foreign and inter-regional trade is diverse. In foreign trade, exports exceed imports by 2.8 times, while in inter-regional trade the situation is the opposite.

Regional output accounts for 81.2% of total resources; 18.8% of resources are formed due to imports from other regions, while only about 4.4% are attributable to imports from the rest of the world. The share of final demand accounts for 57.9% of total resources. Exports to the rest of the world account for about 12.2% of total demand, taking into account even the minimal estimate of exports to other regions (net exports by industry); external demand accounts for one-fifth of total demand, with the share of external demand in final demand exceeding 33%.

Estimates of the cost structure of output by industry provide a picture of their comparative efficiency. In the majority of industries in the Russian Far East, the share of material inputs is less than the national figure, so the share of gross value added to total output is higher than the national average. The share of GRP in total output in the Far East amounts to 52.6% while the national figure is 50.0%; however, the share of gross profit and mixed income in GRP is only 50.0 % in the RFE, compared with the national figure of 53.8%. The share of gross profit and mixed income in gross value added in the majority of industries is lower than national average, due to the higher share of compensation for employees. The shares of gross profit and mixed income were only significantly higher than the national average in two industries: nonferrous metallurgy and machine building. The machine building industry focuses mainly on exports to the rest of the world and is one of the most effective industries in the region, along with the food processing and wood and wood-processing industries.

8. Conclusion

This paper presents the techniques used in estimating regional input-output tables based on supply and use frameworks, and the results thereof. Some formal description of S&U tables was given. The S&U tables are superior to symmetric tables, since fewer assumptions and less modeling are needed to construct them and more primary statistical data are used. The data presented in S&U tables has a sounder theoretical basis, making the estimate results more transparent.

The technique was applied in estimating supply and use tables for the Russian Far East in 2002. The estimate is based on three types of statistical sources: data for national and regional accounts in accordance with SNA, data from industrial statistics, and data from special surveys conducted by Goskomstat and regional statistical bodies. Most of the working procedures were determined by the availability of data.

As a matter of fact, the results of the estimates represent a kind of model of the Far Eastern economy. The argument for its reliability is the application of the input-output method. Collecting and balancing diverse statistical data within the rigid framework of input-output tables enables the objective description of the regional economy in terms of macroeconomic indicators, presenting it as a possible regional equilibrium. Many regional modeling systems, like social accounting matrices and general equilibrium models, need information as it is basically presented in S&U tables. Thus, this should benefit the construction of such models.

Notes

[1] Hereafter referred to by its more customary title: Goskomstat. In Russia, only Goskomstat publishes official statistical data.
[2] Republic of Yakutia, Primorskiy and Khabarovskiy Krais, and Kamchatka, Magadan and Sakhalin Oblasts.
[3] Compensation of employees in regions does not include hidden wages that were calculated only for Russia as a whole.
[4] Figures for exports and imports by region are submitted by Goskomstat for six commodity groups: foodstuffs and raw materials (groups 1-24), fuel and energy complex (group 27), petrochemical complex (group 28-35, 37-40), wood and wood products (groups 44, 47, 48), ferrous and nonferrous metals (groups 72-81), and machine-building products (groups 84-90).

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China's Balance of Payment Model: A Prototype Approach Based on New IMF Data

Wang Tong*

Abstract

Based on newly revised annual statistical data that fully follows the IMF formula, an econometric model was constructed as a prototype model for the international balance of payments block for China, although this covers only a short period from 1997 to 2003. The model (CBIP) contains 20 endogenous and 7 exogenous variables. The model was tested for the observation period and also extrapolated for 2004. The results are compared against actual performance. Interesting features of the Chinese international balance of payments are also discussed in the context of the modeling.

KEYWORDS: international balance of payments, IMF formula, current account, capital and finance account, reserve assets

1. The Balance of International Payments and the Balance of International Payments Model

The balance of international payments reflects all external economic and financial activities of an economic body (a country or region). The balance of international payments table is compiled according to the IMF's statistical rules. The following table summarizes China's balance of international payments for 2003:

Table 1 Summarizing China's Balance of International Payments for 2003

Unit: $1 million

	Items	Balance	Credit	Debit
1	Current Account	45875	519581	473706
2	Capital and Finance Account	52726	219631	166905
3	Reserve Assets	-117023	0	117023
4	Net Error and omission	18422	18422	0

The Chinese Balance of International Payments Model (CBIP) was constructed using yearly data from several tables relating to the balance of international payments; this enabled the analysis of changes in the main items in China's balance of international payments, the identification of the relationship between these changes and the world economy and global finance, as well as their relationship to China's economic development and monetary policy, the quantitative forecasting of the future basic situation of China's balance of international payments, and the formulation of a scenario analysis of the influence of China's monetary policy on

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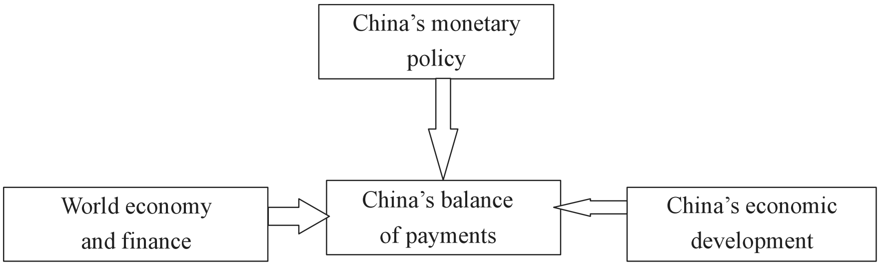
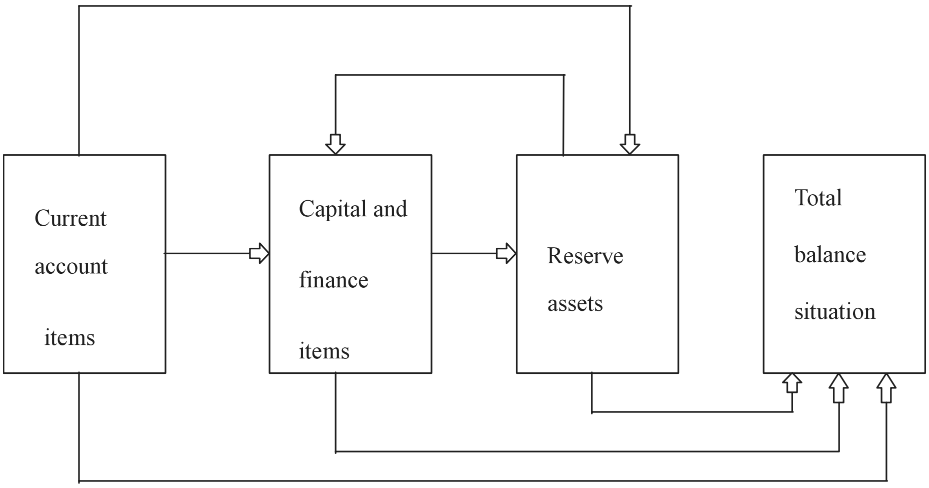
China's balance of international payments.

2. The Theoretical Base and Overall Structure of the CBIP Model

Since China's entry into the WTO, its economy has become increasingly closely connected to the global economy, world trade and world finance. The status of China's balance of international payments and the changes in its main items depend not only on China's economic development and monetary policies, but also on the global economy and world finance.



The CBIP Model consists of 4 blocks: the current account block, the capital and finance account block, the international reserve assets block and the total balance situation block. This economic and financial relationship is illustrated in the following diagram:



China is a developing country and the RMB (Renminbi - the Chinese currency unit) is still internationally unconvertible; the current account items block is the basic block in the CBIP Model and connects with all other blocks, while the capital and finance items block influences the reserve assets block and the total balance situation block.

3. The Main Contents of Blocks in the CBIP Model

3.1 Terminology

The total volume of goods exported and imported is called the scale of goods trade; the total sum of all service credits is called the total amount of service credit; the total sum of all service debits is called the total amount of service debit; the sum of the total amount of service credit and the total amount of service debit is called the scale of service trade; the total sum of all current account credits is called the total amount of current account credit; the total sum of all current account debits is called the total amount of current account debit; the sum of the total amount of current account credit and the total amount of current account debit is called the total scale of current account items; the difference between these two totals is called the balance of current account items; the total sum of all capital and finance account credits is called the total amount of capital and finance account credit; the total sum of all capital and finance account debits is called the total amount of capital and finance account debit; the sum of the total amount of capital and finance account credit and the total amount of capital and finance account debit is called the total scale of capital and finance account items; the difference between these two totals is called the balance of capital and finance account items; the sum of the total scale of current account items and the total scale of capital and finance account items is called the total scale of external economic and financial activities.

3.2 A common description of the CBIP Model

The CBIP Model is an econometric model with a small sample. The sample period is from 1997 (the year of the Asian monetary crisis) to 2003.The CBIP Model has 20 endogenous variables and 7 exogenous variables, 13 regression equations and 7 definition equations. We should also mention that China used its own statistical coverage for the balance of payments before 1997. It was only from 1997 that China started to follow the IMF and use its statistical coverage and methodology for the balance of payments.[1]

The exogenous variables in the CBIP Model are as follows:

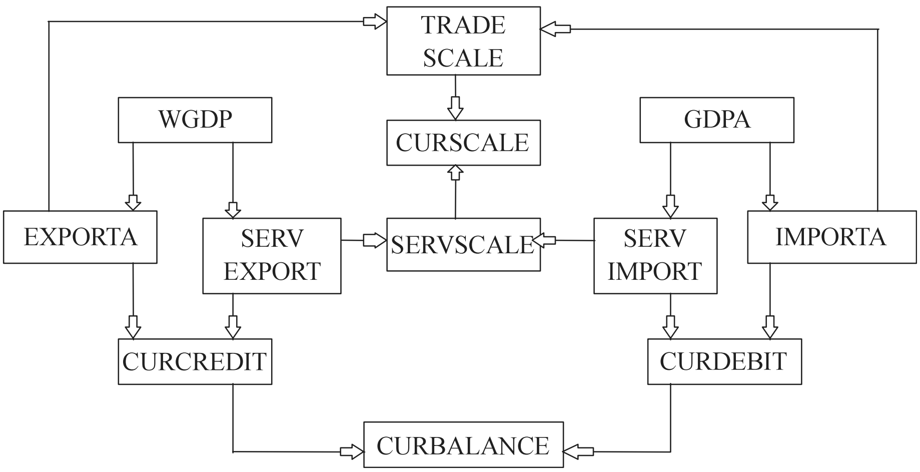
1. GDPA: China's GDP in US$;
2. EXRATE: annual average exchange rate of RMB against the US$;
3. I: annual average interest rate of RMB;
4. IA: annual average interest rate of US$;
5. WGDP: world economic growth index, WGDP (1978) = 100. (UN data);
6. OTHERINVCREDIT: total amount of other investment credits;
7. OTHERINVDEBIT: total amount of other investment debits;

The endogenous variables in the CBIP Model are as follows:

1. EXPORTA: total volume of goods exported in US$;
2. IMPORTA: total volume of goods imported in US$;
3. TRADESCALE: scale of goods trade;
4 SERVEXPORT: total amount of service credits;
5. SERVIMPORT: total amount of service debits;
6. SERVSCALE: scale of service trade;
7. CURSCALE: scale of current account items;
8. CURBALANCE: balance of current account items;
9. CURCREDIT: total amount of current account credits;
10. CURDEBIT: total amount of current account debits;
11. FDI: foreign direct investment in China;
12. CDISTOCK: stock of China's direct investment abroad, starting from 1990;
13. CAPCREDIT: total amount of capital and finance account credits;
14. CAPDEBIT: total amount of capital and finance account debits;
15. CAPSCALE: scale of capital and finance account items;
16. CAPABALANCE: balance of capital and finance account items;
17. RESERVEINC: increase of foreign reserve;
18. RESERASS: increase of international reserve assets;
19. BALANCE: total balance of international payment (net errors and omissions);
20. TOTALSCALE: total scale of external economic and financial activities.

3.3 The current account items block

The following diagram shows the current account items block:

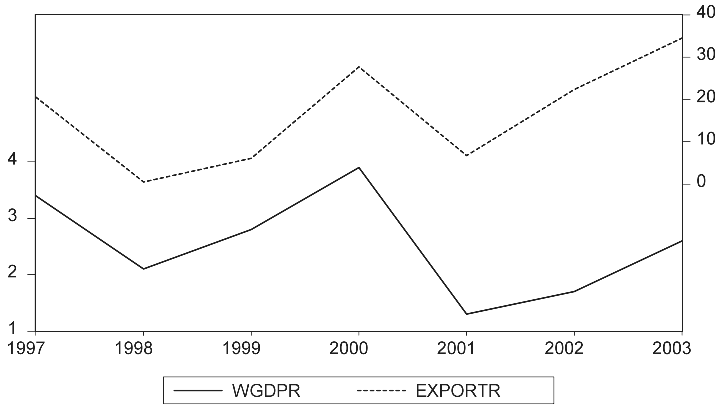


There are 7 regression equations and 3 definition equations in the current account items block. The R*2, D.W. test and T tests of all coefficients are listed for each regression equation.

1. LEXPORTA = 10.497874*LWGDP - 46.534867
(11.7) (-10.0)
R*2 = 0.99 D.W. = 2.2

China's goods exported EXPORTA is the demand of world economic development for China's goods. World economic development may be denoted by the change of index WGDP. According to UN statistics, we can take 1978 as the base year for WGDP, WGDP (1978) = 100, WGDP (2003) = 186.8.

In the 25 years since the start of China's economic reforms, China's economy has been closely connected to the global economy. In 2003, China's degree of openness (EXPORTA + IMPORTA)/GDPA reached 60%. In the last 7 years, the fluctuations in the growth of China's goods exported has been the same as world economic growth; both are basically synchronous, as shown below.



In this chart, WGDPR is the growth rate of the world economy, while EXPORTR is the growth rate of China's goods exported.

2. LIMPORTA = 2.4572881*LGDPA - 15.21080
(18.3) (-12.2)
R*2 = 0.99 D.W. = 2.6

China's goods imported is the demand of China's economic development for foreign goods (mainly for high-tech. equipment, oil and mineral resources). In recent years, this demand has been very strong: when China's GDP increases by 1%, IMPORTA increases correspondingly by 2.5%. This trend has continued since China's entry into the WTO.

3. TRADESCALE = EXPORTA + IMPORTA

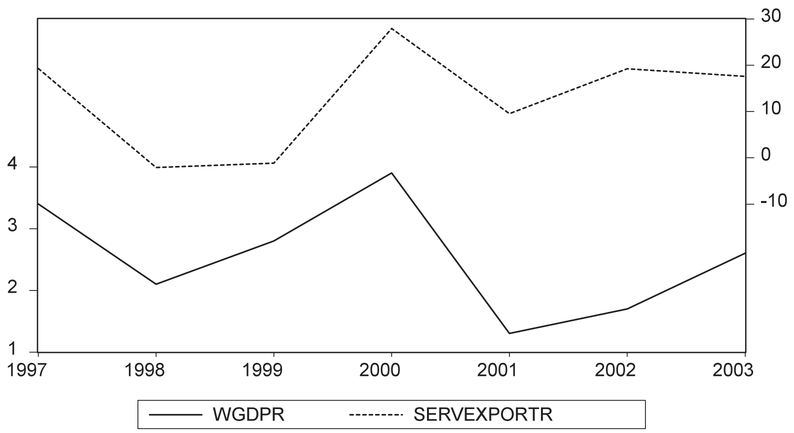
This is a definition equation.

EXPORTA = EXPORT/ EXRATE, IMPORTA = IMPORT/ EXRATE;

4. LSERVEXPORT = 5.8553342*LWGDP - 24.524314
(7.6) (-6.2)
R^2 = 0.94 D.W. = 1.6

China's service exports are also a kind of demand towards China on the part of world economic development.

In the last 7 years, the fluctuation situation of China's service export growth has been the same as world economic growth; both are basically synchronous as shown as in the next chart.



In this chart, WGDPR is the growth rate of the world economy, while SERVEXPORTR is the growth rate of China's service exports.

5. LSERVIMPORT = 1.4754248*LGDPA - 7.7966952
(11.5) (-6.5)
R^2 = 0.96 D.W. = 1.7

China's service imports are a kind of demand towards foreign countries on the part of China. When China's economy grows by 1%, SERVIMPORT grows correspondingly by 1.5%.

6. SERVSCALE = SERVEXPORT + SERVIMPORT

This is a definition equation.

7. CURSCALE = 1.036021*TRADESCALE + 1.3288966*SERVSCALE
(13.6) (2.4)
R^2 = 1.0 D.W. = 2.1

The scale of goods traded and the scale of services traded are the main parts of the scale of current account items, the statistical relationship of which is mentioned above.

8. CURCREDIT = 1.1726057*EXPORTA + 59.630626
(411.0) (6.8)
R^2 = 1.0 D.W. = 2.7

This is a statistical relationship between the total amount of current account credits and goods exported.

9. CURDEBIT = 1.0844872*IMPORTA + 470.18199
(144.8) (23.2)
R^2 = 1.0 D.W. = 3.0

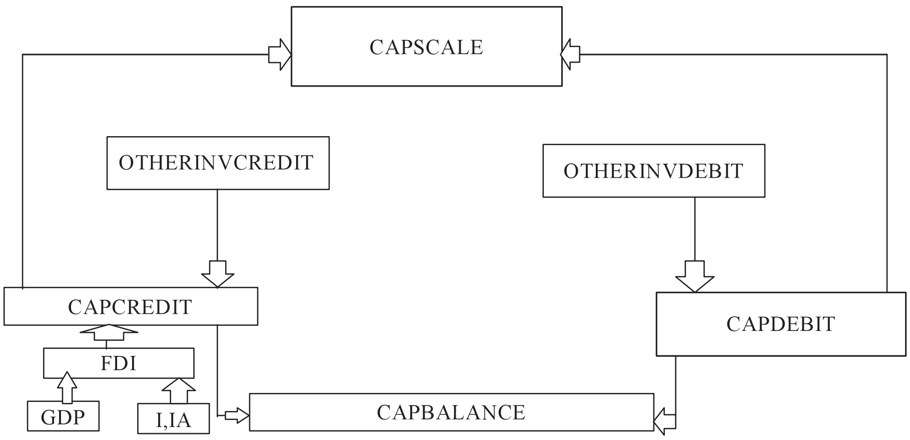
This is a statistical relationship between the total amount of current account debits and goods imported.

10. CURABALANCE = CURCREDIT - CURDEBIT

This is the definition of the current account balance.

3.4 The capital and finance account items block

The following diagram shows the capital and finance account items block.



In the capital and finance account items block there are 4 regression equations and 2 definition equations.

11. LFDI = 0.033991482*ICA + 0.65002008*LGDPA (ICA=I-IA)
(1.4) (214.7)
R^2 = 0.87 D.W. = 2.3

The increase in foreign direct investment reflects the demand for foreign investment on the part of China's economic development; at the same time, the improvement of China's investment environment and difference between interest on the RMB and the US$ create good conditions for foreign investment in China. The promotion coefficient of China's economic development for foreign investment is 0.65.

12. CDISTOCK = 0.18494221*RESERVEINC + 225.03584
(6.3) (11.8)
R*2 = 0.93 D.W. = 2.5

China's direct investment abroad is based on continuous increases in foreign reserves.
In the years following 1997, the stock of China's direct investment abroad reached more than US$20 million; the increase during the period is about 1/5 of the annual increase in foreign reserves.

13. CAPCREDIT = 1.0788334*FDI + 1.0647652*OTHERINVCREDIT
(14.4) (23.9)
R*2 = 1.0 D.W. =2.5

The total amount of capital and finance account credits is estimated using its main items OTHERINVCREDIT and FDI.

14. CAPDEBIT = 0.83650256*OTHERINVDEBIT + 330.19412
(16.5) (6.7)
R*2 = 0.99 D.W. = 2.7

The total amount of capital and finance account debits is estimated using its main item OTHRINVDEBIT.

15. CAPSCALE = CAPCREDIT + CAPDEBIT

This is the definition of the scale of capital and finance account items.

16. CAPBALANCE = CAPCREDIT - CAPDEBIT

This is the definition of the balance of capital and finance account items.

3.5 The international reserve asset block and the total balance situation block

There are 2 regression equations and 2 definitions.

17. RESERVEINC = 1.6895486*CURBALANCE + 1.2447191*CAPBALANCE - 261.37255
(105.1) (123.2) (-83.3)
R*2 = 1 D.W. =2.2

The main sources of the increase in China's foreign reserves are the surplus of current account items and the surplus of capital and finance account items.

18. RESERASS = 1.0076464*RESERVEINC
(167.9)
R*2 = 1 D.W. = 2.2

When China's foreign reserves increase, China's international reserve assets also increase.

19. BALANCE = CURBALANCE + CAPBALANCE - RESERASS

This is a definition.

20. TOTALSCALE = CURSCALE + CAPSCALE

This is also a definition.

3.6 A simulation of China's balance of international payments in the last three years

The simulation error of an economic indicator is

JJER = (JJF (T) - JJ (T)) / JJ (T)

Here, JJER is the simulation error of an economic indicator JJ, JJ (T) is the real value of JJ in the year T, JJF (T) is the simulated value of JJ in the year T calculated using the CBIP Model; T can take the value 2001, 2002 and 2003.

The next table lists all simulation errors of 20 endogenous variables of the CBIP Model from 2001 to 2003 .

Obs.	EXPORTAER	IMPORTAER	SERVEXPORTER	SERVIMPORTER
2001	0.028893	0.035346	0.041357	0.037873
2002	0.011155	0.001978	-0.034239	-0.035564
2003	-0.012456	-0.010167	-0.046540	-0.014969
TRADESCALEER	CURSCALEER	CURCREDITER	CURDEBITER	SERVSCALEER
0.023193	0.039472	0.016122	0.028768	0.023492
0.022606	-0.034953	0.019149	0.011596	0.002197
0.022674	-0.029428	0.019564	-0.012296	-0.008819
CURBALANCEER	FDIER	CDISTOCKER	CAPCREDITER	CAPDEBITER
0.119890	0.003377	0.065452	0.016795	-0.061283
0.105035	-0.035150	-0.071490	0.005555	0.014667
-0.048203	-0.021028	0.040937	-0.006709	-0.011768
CAPSCALEER	TOTALSCALEER	CAPBALANCEER	RESERVEINCER	RESERASSER
-0.013982	0.161882	0.224997	0.215582	-0.511317
0.009803	-0.022169	0.068642	0.058132	0.177568
0.009455	0.009306	-0.025073	-0.019298	0.177568
BALANCEER				
0.016893				
-0.008893				
0.011592				

In the abovementioned 3x20 = 60 simulation errors, only 11 errors are greater than 5%, while 49 errors are less than 5%. There are also 10 simulation errors less than 1%. In particular, it should be noted that there are no errors over 5% in 20 simulation errors for 2003.

This estimate of CBIP Model simulation errors shows that the CBIP Model basically provides an accurate simulation that traces the changes in China's balance of international payments in recent three years.

3.7 A quantitative forecast of the status of China's balance of international payments in 2004

In order to use the CBIP Model to forecast the basic status of China's balance of international payments in 2004, we assume that:
1. The growth rate of the world economy in 2004 is 3.7%; (UN forecast in April 2004)
2. The growth rate of China's economy in 2004 is 8.5%; (Wang Tong's forecast in April 2004)
3. In 2004, China's interest rate maintains the same level as 2003, i.e. the deposit rate of the RMB is 1.98% for one year;
4. The deposit rate of the US$ within China is 0.56% for one year;
5. In 2004, the exchange rate of the RMB against the US$ maintains the same level as in 2003.
6. In 2004, the increase rate of other investment credit (OTHERINVCREDIT) and debit (OTHERINVDEBIT) take the same level as their average level in the last three years (2001-2003).

Under these assumptions, we solve the CBIP Model for April 2004 and obtain the following results:
In 2004, China's goods exported are about US$590 billion; goods imported: US$543 billion; services exported: US$55 billion USD; services imported: US$66.5 billion; balance of the current account: US$62 billion surplus; FDI in China will be US$58 billion; China's direct investment abroad will increase by about US$10 billion; the balance of the capital and finance account will be US$72 billion. By the end of 2004, China's foreign reserves will be about US$570 billion. In 2004, China's international reserve assets will increase by US$170 billion, while China's scale of external economic and financial activities will be US$1777 billion. The ratio of this to GDP is 109%, with an 11% increase compared with 2003. This means that in the third year after China's entry into the WTO, its economy and finance are in greater harmony with the world economy and global finance.

The aforementioned forecast was published in June 2004 in the author's book in Chinese (Reference 1)

3.8 An ex post facto test for the 2004 April forecast using the CBIP Model

In March 2004, China's National Statistic Bureau published a statistical communiqué. Comparing the data in this communiqué and the forecasts above, we get the next table, which shows the forecast ability and the accuracy of the CBIP Model.

(US$1 billion)

Indicator	Actual	Forecast
Good exports	593	590
Good imports	561	543
FDI in China	60.6	58
Foreign reserves	610	570

Other data about China's balance of payments will be published in April 2005. Using these new data, the CBIP Model will be updated, along with the forecast for 2005 China's balance of payments situation.

Note

1 For the Chinese international balance of payments model based on China's own data, see Tang Quoxin (2000).

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Testing a Profitability-Concentration Relationship: An Empirical Study

Donghun Kim*

Abstract

In this paper we evaluate the relative importance of firm efficiency and market power to performance in Korean manufacturing industries. Among the paper's distinguishing features is the specification of firms' price-cost margins as the weighted sum of domestic price-cost margin and export price-cost margin to control for the more competitive export price-cost margin in the evaluation of domestic market power. We estimate Tobit models to overcome the truncation bias of the ordinary least squares estimation and introduce Spline Regressions to test the structural differences among conjectures that represent the various ranges of competition. We verify that there is a strong market-power effect in the Korean manufacturing sector after controlling for the market share-profit efficiency effect.

KEYWORDS: Price Cost Margin, Firm Efficiency, Market Power, Korean Manufacturing Industries, Tobit Model, Spline Regression.

1. Introduction

This paper examines the relative importance of firm efficiency and market power to performance in Korean manufacturing industries. Scherer and Ross (1990, p. 411) state that firm efficiency hypothesis versus market power hypothesis is the main question in empirical industrial organization in the latter part of the twentieth century. Market power hypothesis suggests that greater concentration of industries leads to collusive behavior among firms or the exertion of market power, which results in greater industry profitability. This view, following Bain (1951), has been based empirically mainly on cross-sectional industry data studies. However, a group of economists following Demsetz (1973, 1974) asserted that asymmetry in technology and corporate efficiency causes the observed positive correlation between industry concentration and profitability.[1] The contending schools of thought have been deadlocked ever since. Only with better data could the impasse be resolved (Scherer et al., 1987). The US Federal Trade Commission (FTC) designed and implemented a large-scale program to gather detailed data from large companies by lines of business (LOB). This data provided a rich basis for new studies during the 1980s that have changed the view on the structure-performance relationship.[2] Most LOB studies confirm that market share is a more important structural variable than market concentration for profitability. Moreover, many economists have believed that the positive relationship between market concentration and industry profitability is spurious, the result of the aggregation of market share and firm profitability at the industry level. Hence, LOB studies in the US have failed to show that market concentration is an important variable when market share is included in the model.

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In this paper, we have constructed a new firm panel data set for the Korean manufacturing sector, a panel from 1987 through 1995, and analyze firm efficiency and market power effect using econometric models. Our approach is in line with Clarke et al. (1984; hereafter CDW) who took a two-step approach. They first select industries that display the efficiency effect and then investigate whether there was also a residual market power effect by regressing concentration on conjectures. The conjectures are devised to measure the degree of collusiveness in the markets and they are estimated in the first step of an intra-industry analysis. They found that both the market power and efficiency effects work for a subset of industries in the UK manufacturing sector. However, their two-step approach poses the econometric problem of truncation because it does not capture the full range of competition in the industries. Choi (2001) examined firm efficiency and market power effect in the Korean manufacturing sector using plant level data that range from 1990 to 1994. He extended CDW by estimating a Tobit MLE to overcome the problem of data truncation. He found that both the firm efficiency effect and the market power effects are supported by the data.

Our methodology is similar to CDW and Choi (2001). We generalize the conjectures such that we can analyze the whole range of market competition from Bertrand competition to monopoly. CDW focus only on the range of competition from Cournot competition to monopoly. We also estimate a Tobit Model to test the truncation bias of OLS by CDW.[3] We then test the structural differences among conjectures that represent the different ranges of competition using a Spline Regression. There are, however, many features that distinguish our work from previous studies. For one thing, we incorporate the export portion of price-cost margin (PCM) to evaluate domestic market power after controlling for the influence of competition from the foreign market. For empirical work, we use firm level panel data that range from 1987 to 1995. Therefore, the data coverage and the unit of observation are different from Choi (2001), who used plant level data. Plant level data can pose a potential bias in measuring firms' behaviors in the markets. Theoretically, it is difficult to justify that firms engage in plant level competition. Suppose that there are two firms and each firm has two plants. What would the market structure then be? We should think of it as the market of duopoly firms rather than that of four oligopoly plants. The data used in this paper also have an advantage over many other data sets in that we have firm specific measures of capital-output ratio. Most earlier studies have been restricted to the industry average. In addition, an almost unique element in our panel data is market concentration being measured as the annual three firm concentration ratio calculated from raw census data provided by the National Statistical Office (NSO).[4] In Korea, with high manufacturing growth rates, there is an adequate amount of volatility to ensure that having annual data provides power to our tests.

We verify from the various tests - after controlling for the profit-share efficiency effect - that there is a strong market power effect in the Korean manufacturing sector. We cannot reject the null hypothesis that the relationship between conjectural variation and concentration is positive and significant. We also find that the market power effect is stronger in more concentrated industries than in less concentrated ones. Moreover, the magnitude of market power effect is stronger in our paper than that in Choi (2001). This is because we control for the influence of more intense foreign market competition and we add greater inter-temporal variation in our data, increasing the power of the tests. Also, plant level data can cause a downward bias in the measurement of conjecture. Therefore, the relationship between the conjecture and market concentration can be underestimated.

In Section 2 we survey the related literature on the effect of market concentration and market share on firms' market performance, while in Section 3 we specify estimation models. In Section 4 we explain the data and in Section 5 we explain the estimation results. Section 6 summarizes our conclusions.

2. Related Literature

Since Bain's pioneering efforts (detailed in Bain (1951)), the positive statistical association between industry profits and seller concentration has traditionally been interpreted as evidence of monopoly power. A concentrated market structure facilitates oligopolistic coordination and leads to higher prices. Concentration is seen as a proxy for the ability to collude. Such collusion may be achieved through either explicit agreement or tacit cooperation.

The concentration-profits relationship has been one of the most thoroughly tested hypotheses in economics.[5] Weiss (1974) surveys the 46 studies since Bain (1951). This survey indicates that the bulk of the studies show a significant positive effect of concentration on profits or margins. The sample covers the years 1936-1970 and includes the experiences of Britain, Canada, and Japan as well as that of the US. The positive relationship is strong in normal years, while it is weakened or disappears in periods of accelerating inflation or directly following such periods.

The collusion interpretation has, however, been questioned by several researchers, for example Demsetz (1973, 1974). They argued that some firms are more efficient than others, producing comparable products at a lower cost. Efficient firms grow over time, resulting in larger and more efficient firms. Therefore, market concentration and profit increase without any form of collusive behavior.[6] So, this view also predicted a positive relationship between market concentration and profitability even if concentration does not facilitate collusion on market power.

The contending schools of thought were thus deadlocked. Even with clean industry-level data, it was not possible to separate the effect of market share on profitability from the effect of market concentration on profitability.[7] Only with better data could the impasse be resolved (Scherer et al., 1987).

For the years 1974-1977, the US Federal Trade Commission's Line of Business (LOB) Program obtained data on sales, costs, profits, and assets from the 471 largest U.S manufacturing enterprises broken down into 261 standard manufacturing industry categories. Nearly 4,000 individual company/industry segments reported per year.[8] Ravenscraft (1983) noted that, even though sampling is non-random and the data are not perfectly representative of the U.S manufacturing domain, the sample is larger and more broadly representative than those used in previous firm or LOB studies.[9] The LOB of the FTC provided a rich basis for new studies during the 1980s. These studies included Long (1982), Martin (1983), Muller (1983), Ravenscraft

(1983), Schmalensee (1985), and Kwota and Ravenscraft (1986). Most of the LOB studies found that, with regard to profitability, market share is a more important structural variable than market concentration. Moreover, many economists have believed that the positive relationship between market concentration and industry is spurious and results from the aggregation of market share and firm profitability at the industry level.

CDW (1984) suggested a two-step model for evaluating the relative importance of efficiency effect and market power. They selected industries in which there is a positive market share-profit relationship, which captures the efficiency effect, and in the second stage they investigated the association between conjecture and market concentration. This methodology was applied to the UK manufacturing sector in the mid-1970s. They found that the market power and efficiency effects existed simultaneously in the UK manufacturing sector. Ross (1988) applied the CDW model to the US FTC LOB data and found a positive significant effect of concentration on conjectures, but only for a small sub-sample of industries. His paper unfortunately has not been completed due to the unavailability of LOB data since then.

Important studies of structure and performance in Korean industries include Jeong and Masson (1990), Choi (2001), Jeong and Masson (2003), Jakubson et.al. (2004a), and Jakubson et al. (2004b). Jeong and Masson (1990) estimated a recursive model of structure and performance with entry. They found that there was a significant market power effect in 62 Korean manufacturing industries for the years 1976-1981. Choi (2001) evaluated the effect of market power versus firm efficiency effect using plant level panel data that range from 1990 to 1994 and found that both market power and firm efficiency effects matter during the sample period. Jeong and Masson (2003) estimated the first-order adjustment model of concentration with adjustment speed and steady-state profit and concentration estimated as latent variables. They found both a short-term and long-term positive relationship between profit and concentration in their industry-level data study. Jakubson et.al (2004a) developed a nonlinear fixed-effect model of price-cost margin and tested the effects of market power and firm efficiency on firms' price-cost margins. They found that both market power and firm efficiency effects existed in the Korean manufacturing sector but that the influence of market power is greater. Jakubson et al. (2004b) related the business cycle to the movement of firms' price-cost margins and found that firms' price-cost margins in more concentrated industries were more procyclical.

3. Model Specification

Our models follow the two-step approach as in CDW (1984). In the first step, we estimate the relationship between market share and firms' price-cost margin and construct a conjecture that measures the degree of collusiveness for the industries in which the efficiency effect exists. In the second step, we estimate the relationship between the estimated conjecture and market concentration. Hence, we test market power as a residual effect in the second step after we control for the efficiency effect in the first step. As noted, however, there are many features in this paper that distinguish its approach from that of CDW (1984). First, we generalize the definition of firms' price-cost margins. In some economies, especially in a small open economy like Korea's, trade with the outside world plays an important role in the country's economic activities. When a significant portion of firms' sales comes from exports, the effect of exports on firms' profitability with regard to market power and firm efficiency should be modeled. To test the market power effect in domestic markets, we must control for profitability from exports because the PCM for a firm is the sales-weighted average of its domestic and export PCM, as we can see from the accounting identity (1). If we do not separate these PCMs, we might underestimate the effect of domestic market power on firms' profitability because firms' price-cost margins are contaminated by more competitive export margins. From the following accounting identity, we derive an estimation equation with export adjustment.

$$PCM = PCM^{D} \cdot \Gamma^{D} + PCM^{X} \cdot \Gamma^{X} \qquad (1)$$

where PCM^D is PCM from domestic sales and PCM^x is PCM from exports. Γ_i^D is the proportion of domestic sales in a firm's total shipments, and Γ_i^x is the proportion of export sales in a firm's total shipments.

We observe each firm's price-cost margin, PCM, the proportion of domestic sales, Γ_i^D, and the Γ_i^x, the proportion of export sales. However, we cannot observe the PCM^D and PCM^x separately. Hence, we estimate these PCMs as latent variables. We model the domestic PCM, PCM^D, as a function of a firm's domestic market share and export PCM, PCM^x, as a function of the share in an industry's export and exchange rate (ExChgRate).[10] The exchange rate should be the weighted average of foreign exchange rates. Nevertheless, we are going to use the exchange rate against US dollars since most of the settlement for trade with the outside world has been made in US dollars for Korean exporters. We normalize exchange rates such that the mean of exchange rates during the sample period is equal to 1. Hence, export-adjusted PCM can be represented as follows:

$$PCM_{it} = (\varphi_0 + \varphi_1 s_{it}{}^{D})\Gamma_{it}{}^{D} + (\varphi_2 + \varphi_3 s_{it}{}^{X})(ExChgRate_t)\Gamma_{it}{}^{X} + \varepsilon_{it}, \quad (2)$$

where s_{it}^D is a firm's share of the industry domestic shipments, s_{it}^x is a firm's share of industry exports and j_i represents a parameter. From the domestic price-cost margin, $PCM^D = j_0 + j_1 s^D$, we can estimate the conjecture following Clarke and Davies (1982; hereafter, CD).[11] When j_0 is positive, $\alpha = j_0/(j_0+j_1)$ is a legitimate estimate for the conjecture. Industries with a positive share-profitability relationship are those for which the firm efficiency effects and market power effects can be estimated separately. The positive share-profit industries are classified into two categories. In the first category, the conjecture $\alpha = j_0/(j_0+j_1)$ turns out to be positive in the regression and can be a direct measure of conjecture γ. The greater value of $\alpha = j_0/(j_0+j_1)$ indicates the extent to which collusion or market power is estimated to be a factor in each industry. If the estimate of j_0 is estimated to be negative in a within-industry regression, however, $\alpha = j_0/(j_0+j_1)$ falls into the negative range and cannot be regarded as a well-defined estimate of conjecture. To augment this weakness in conjecture $\alpha = j_0/(j_0+j_1)$, we introduce λ, based on Cowling and

Waterson (1976; hereafter, CW).[12] λ captures firm behavior between Bertrand competition and Cournot competition in the homogeneous product setting. For Cournot competition the value of conjecture is 0, while it is -1 for Bertrand price competition. To derive its estimates for industries with a positive slope coefficient but a negative intercept (positive j_1 and negative j_0), we estimate the following variant:

$$PCM_{it} = \delta_1 \cdot s_{it}^D \cdot \Gamma_{it}^D + \delta_2 \cdot s_{it}^X \cdot ExChgRate_t \cdot \Gamma_{it}^X + u_{it}, \qquad (3)$$

where δ_1 and δ_2 are parameters, and u_{it} is an error term. The value of $\delta_1/(j_0+j_1)$-1 provides the estimate of λ for each industry, where $1/h = j_0+j_1$ is estimated using the result of regression (3). Therefore, we can specify a more generalized conjectural variation.

$$\begin{aligned} \gamma = \alpha &= \varphi_0 / (\varphi_0 + \varphi_1) && \text{when} \quad \varphi_0 > 0 \qquad (4) \\ = \lambda &= \delta_1 / (\varphi_0 + \varphi_1) - 1 && \text{when} \quad \varphi_0 < 0 \end{aligned}$$

In the second stage, we estimate the relationship between conjecture and market concentration. Our approach in the second stage falls into three parts. First, we estimate the relationship between the conjecture and market concentration using OLS estimation. Our conjecture is, however, more generalized than that of CDW. The regression equation for the second step of the inter-industry regression becomes (5):

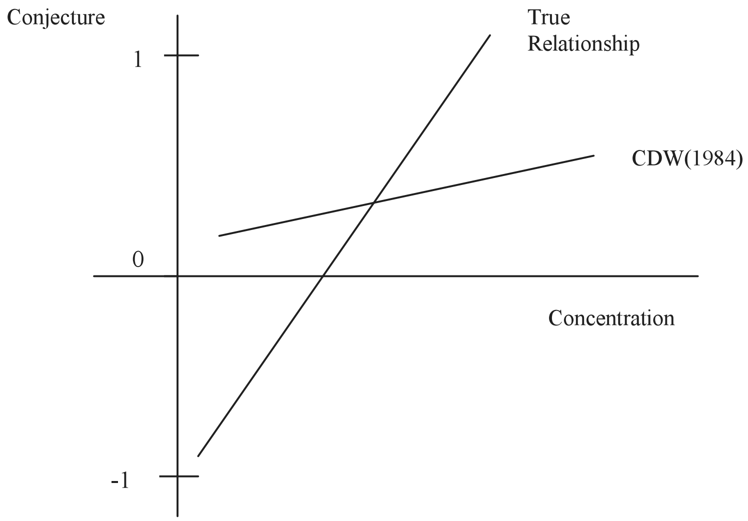
$$\hat{\gamma}_j = \psi_0 + \psi_1 * CR_j + e_j \qquad (5)$$

Next, we decompose the positive relationship between conjectural variation and concentration into two ranges of γ since γ is composed of two differently defined measures. First, the relationship between α (only in cases of positive b_0) and industry concentration is estimated using a simple linear regression, following CDW:

$$\hat{\alpha}_j = \pi_0 + \pi_1 * CR_j + e_j \qquad (6)$$

In the equation, π_0 is an intercept and π_1 is a parameter for market concentration. Meanwhile, e_j represents an error term.

Figure 1 Truncation Bias of CDW (1984)



To evaluate the truncation bias of conjecture, we estimate a lower-censored Tobit that is robust for the lower truncation.[13]

$$\alpha_j = \pi_0 + \pi_1 * CR_j + e_j, \quad \text{if } \alpha > 0 \qquad (7)$$
$$\alpha_j = 0 \qquad \text{if } \alpha \leq 0,$$

where e_j is independently and normally distributed with mean zero and a variance of σ^2.

Another approach involves a Spline Regression model. Even though two conjectures α and λ have a linear relationship with concentration, the relationship between γ and concentration may not be described by a straight line because the two conjectures are estimated differently. We therefore estimated the Spline Regression in order to capture the difference in the relationship of α and λ with concentration. The desired relationship between γ_j and concentration CR would be

$$\gamma_j = [\phi_1 + \phi_2 \cdot CR_j] \cdot D + [\phi_3 + \phi_4 \cdot (CR_j - C^*)] \cdot (1 - D) + u_j \qquad (8)$$

In the equation, D is a dummy variable whose value is 1 if CR is less than C^* and otherwise it is equal to zero. However, this piece-wise regression is in general discontinuous at C^*. Therefore, we restrict the values of the coefficients such that the two lines meet C^*. This suggests that $\phi_3 = \phi_1 + \phi_2 \cdot C^*$ should hold. Since the function should meet at $\gamma_j = 0$, we need an additional restriction in the model, i.e., $\gamma_j = \alpha = \lambda_j = 0$ when the market concentration is at C^*. This implies that $\phi_3 = \phi_1 + \phi_2 \cdot C^* = 0$. If we insert these constraints into (9), the Spline Regression becomes

$$\gamma_j = \phi_2 \cdot (CR_j - C^*) \cdot D + \phi_4 \cdot (CR_j - C^*) \cdot (1 - D) + u_j. \qquad (9)$$

Hence, this Spline Regression converts the piece-wise linear approximation (8) into a multiple regression where dependent variable γ is regressed on two composite variables whose values are constructed from the data for CR. The slopes of the Spline Regression, ϕ_2 and ϕ_4, can be estimated using ordinary least squares estimation without an intercept term in the model.

4. DATA

Our data comes from various sources. For the firm-level panel data, we use balance sheets, income statements, and cost information from the Korean Investors Service, Inc. database (the KIS Line). The coverage of the panel ranges from 1987 to 1995. We select data for firms only in the manufacturing sector. We then match firms to industry according to the four-digit KSIC (Korean Standard Industry Code) to measure market share and concentration. For industry selection in the manufacturing sector, we exclude NEC industries, which are not classified specifically. Industries that include only single firms in the sample are also excluded because these industries have at most nine sample points, given sample coverage of 1987-1995. In total, we sampled 54 industries.

For firm sales data, the KIS Line data contain all the information on firms' domestic and export sales. Firms' total sales can be divided into manufacturing sales and merchandise sales. We treat manufacturing sales as a real economic activity and exclude merchandise sales. When we mention a firm's exports, we mean the firm's manufacturing export sales. These manufacturing export shipments and domestic shipments are also readily available in the KIS dataset. For industry sales information we obtained each industry's value of shipment from the "Report on Mining and Manufacturing Survey", issued by the National Statistical Office in Korea. The survey is classified according to KSIC. We merge industry export and import data, which comes from the Input-Output Table released by the Bank of Korea. Some discrepancies exist between the KSIC and Input-Output industry classifications. We reclassify the Input-Output industry code for compatibility with that of the KSIC. The definitions of variables are as follows.

4.1 Price-Cost Margin (PCM)

The price-cost margin is defined as the difference between price and marginal cost divided by price. Since marginal cost is not observable, most studies in the market power literature have used the profit-sales ratio as a PCM proxy. If average cost is equal to marginal cost, the PCM is total sales minus total cost, divided by total sales. Moreover, if marginal cost is equal to average variable cost, PCM becomes total sales minus total variable cost, divided by total sales. In some studies, the capital cost variable is included as an independent variable in the regression to control for the bias that comes from using a PCM proxy without considering capital cost.[14] In this paper we subtract capital cost from a firm's operating income to measure PCM. A firm's gross sales are divided into manufacturing goods sales and merchandise goods sales. As mentioned above, we treat only manufacturing goods sales as a firm's sales and exclude merchandise sales from gross sales to measure PCM. We obtain the cost information from a "statement of cost of goods manufactured" in the KIS Line dataset. The manufacturing cost includes raw material cost, labor cost, and other manufacturing expenses such as electricity and utilities.

$$PCM = \frac{Sales\ of\ Manufactured\ Goods - Cost\ of\ Manufactured\ Goods - Capital\ Cost}{Sales\ of\ Manufactured\ Goods} \tag{10}$$

Capital cost is a normal return on capital. It is defined as the opportunity cost of capital times capital stock, divided by value of shipment. Our data have an advantage over many other data sets in that we have firm specific measures of capital stock and value of shipment. Many earlier studies have been constrained to industry average. For the opportunity cost of capital, we use each year's financial expense to as a proportion of total borrowing in the manufacturing sector published in the Financial Statement Analysis by the Bank of Korea.

4.2 Market Share and Concentration

To estimate domestic market share and domestic market concentration, we must adjust exports and imports to measure domestic market size. The market share in the domestic market in each industry is defined as follows:

$$s_{ijt} = \frac{x_{ijt} - e_{ijt}}{X_{jt} - EX_{jt} + IM_{jt}}, \tag{11}$$

where χ_{ijt} is the value of shipments of firm i in industry j, e_{ijt} is export shipments of firm i in industry j, χ_{jt} is the industry value of shipments, EX_{jt} is exports of industry j, IM_{jt} and is imports for industry j. A firm's value of shipments is a firm's manufacturing sales, while export shipments is a firm's export sales of manufacturing goods, which we can observe in the KIS Line database. Industry shipments come from the "Mining and Manufacturing Survey". Industry export and import data are obtained from the input-output (IO) table and reclassified according to KSIC.

The three-firm concentration ratio is used as the measure of domestic concentration. Initially, we observe the concentration ratio without adjusting for export and import for each year and each industry. For the export and import adjustment, we can measure domestic market size, which is a denominator, since all of the variables are observed. For the calculation of the numerator, we use information in the firm's sales data in the sample. When the information on all three firms is not available in our dataset, however, we adjust the numerator - assuming that the three firms' export share in the industry is proportional to their share in the industry's total value of shipments.

$$CR_{jt} = \frac{\sum_{i=1}^{3}(x_{ijt} - e_{ijt})}{X_{jt} - EX_{jt} + IM_{jt}} \tag{12}$$

5. Empirical Results

Table 2 represents the results of conjecture estimation for each industry with export adjustment. $\hat{j}_0$ and $\hat{j}_1$ columns represent the parameter estimates in the domestic price-cost margin while $\hat{j}_2$ and $\hat{j}_3$ columns are those in the export price cost margin. We construct the conjectures, i.e. degree of collusiveness, in the domestic markets using the equation (4). The last column shows the estimated conjectures. Our results indicate that the parameter values in the domestic price-cost margin and the export price cost margin differ considerably in their magnitude and signs. If we average the domestic and export market data and project the average price-cost margin onto the average market share, we will obtain parameters that are roughly the weighted average of $\hat{j}_0$ and $\hat{j}_2$ for the constant term and the weighted average of $\hat{j}_1$ and $\hat{j}_3$ for the coefficient of market share. Therefore, the estimated conjectures might differ significantly from those in Table 2 and might misrepresent the degree of collusiveness in the domestic market. This emphasizes the importance of controlling for the influence of export price-cost margins in the evaluation of domestic market competition.

The regression results show that, of the 54 industries in the study, 38 exhibit a positive share-profit relationship while 16 exhibit a negative relationship. There can be two possible hypotheses for the relationship between the market share and profitability. One is firm efficiency hypothesis. This represents a concept of static relationship. The hypothesis suggests that efficient firms have low marginal costs and make high profits. In this case, there is no reason why market share should have a negative relationship with a firm's price-cost margin, whether in the domestic or export market, because a firm's large market share is simply a result of the firm's efficiency. The other hypothesis is related to the firm's dynamic pricing for market penetration. According to the hypothesis, the relationship between market share and profitability might be negative, especially in export markets. This is because firms sometimes engage in the practice of "dumping" to increase market share. This is especially true when exporters have significant domestic market power. If Korean manufacturers had significant domestic market power, they could impose high prices in domestic market and charge a very competitive price in export markets in order to increase their market shares. The prices in the export market could be lower than their marginal costs. Therefore the share and the export price cost margin might have a negative relationship. Since the main purpose of this paper is to evaluate the relative importance of firm efficiency and market power to Korean manufacturing firms' market performance, only 38 positive-share industries, which show a firm efficiency effect, are selected for further analysis. Among the 38 positive share-profit industries, 17 industries show a positive relationship at the 10% level and 14 show a positive relationship at the 5% level.

Table 3 shows the result of the inter-industry regression. For the inter-industry regression, three sets of industries that show a positive market share-profit relationship are used. These are: (1) all 38 industries with positive share-profit relationships, (2) the 17 industries with positive share-profit relationships at the 10% significance level, and (3) the 14 industries with positive share-profit relationships at the 5% significance level.

For all three samples, a significant and positive relationship between conjectural variation and concentration is obtained. The magnitudes of the coefficients on market concentration are 0.737, 0.664 and 0.396 and the t-values are 2.12, 2.11 and 1.57, respectively.[15] The coefficients are significant at 5% in the first and the second samples and at 10% with one-tail for the third sample. These results suggest strong evidence of the market power effect after controlling for the share-profit efficiency effect.

Meanwhile, we also estimate the relationship for conjectures that are estimated without export adjustment with market concentration for comparison. We find that the coefficients of concentration for three parallel groups of industries are 0.493, 0.298 and 0.343, respectively, and their t-values are 1.85, 1.88 and 2.95. Therefore, with export adjustment, the coefficients in the samples increase by 50%, 123% and 15%, respectively. This implies that the effect of the domestic market concentration on the firms' behavior in the domestic market can be underestimated if we do not remove the influence of more competitive export market competition from firms' price-cost margins.

Tables 4 and 5 demonstrate the result of the OLS and Tobit MLE for the Cournot-Monopoly industries whose conjectures range from zero to one. In these industries, conjecture and concentration have a positive and significant relationship in the OLS and Tobit MLE. The results again confirm the existence of the market power effect.

Comparing the OLS with the Tobit MLE in the Cournot-Monopoly industries, the direction of bias of the OLS estimation depends on the sub-samples. In samples (2) and (3), the coefficients of MLE increase and significance also increases in sample (3).

Table 6 represents the results of Spline Regression. To estimate the Spline Regressions, we must estimate C^*. A maximum likelihood search over the range of CR between 0.1 and 0.9 obtains C^*, which minimizes the sum of squares errors. The Spline Regression captures well the structural difference in the relationship between α and CR versus that of λ and CR. The coefficients in the competitive range of less-concentrated industries are negative and those for the more concentrated ones are positive and significant. This result indicates that the market power effect is stronger in the more concentrated industries, where concentration is greater than C^*, than in the less concentrated industries.

6. Conclusion

One of the most thoroughly tested hypotheses in empirical industrial organization is that of the market power hypothesis versus the firm efficiency hypothesis. In this paper, we estimate econometric models for the evaluation of the relative importance of market power against the efficiency effect and apply them to Korean manufacturing industries. In the models, we generalize the concept of conjecture such that the whole range of market competition can be covered for the analysis. We introduce the export price-cost margin specifically to control for competition from the foreign market to test the effect of domestic market power. We find that there is a strong market power effect in Korean manufacturing industries. The degree of market power varies, however, with the concentration level. The market power effect is stronger in more concentrated industries than in less concentrated industries.

Table 1 Sample Statistics

Variable	Mean	Std. Dev.	Max	Min
CR (3-firm concentration)	0.394	0.179	0.997	0.065
PCM (price cost margin)	0.142	0.156	0.715	-0.264
S^D (domestic share of firm in industry)	0.046	0.083	0.785	0.000
S^X (export share of firm in industry)	0.098	0.175	0.976	0.000
Γ_i^D (ratio: domestic to total firm sales)	0.663	0.319	1.000	0.000
Γ_i^X (ratio: export to total firm sales)	0.337	0.319	1.000	0.000

Table 2 Share-Profit Relationship with Export Adjustment

KSIC	# of firms	$\hat{\varphi}_0$	$\hat{\varphi}_1$	$\hat{\varphi}_2$	$\hat{\varphi}_3$	$\hat{\delta}_1$	$\hat{\delta}_2$	Sign	Conjecture
1511	2	0.0626	-0.0847	3.3405	-1.8762			4	-
1512	5	0.0428	0.2604	-0.0692	1.1284			1	0.1411
1520	3	0.1938	0.1768	-1.0384	1.9689			1	0.5228
1541	4	0.1620	0.5098	-5.1569	6.0574			3	0.2412
1544	2	0.2171	0.0440	-3.0761	3.3674			1	0.8314
1545	4	0.1831	0.3213	-1.3688	5.5316			3	0.3629
1551	3	0.1211	1.2249	31.7387	-44.9771			3	0.0899
1554	5	0.2958	0.0804	-1.5044	1.8035			1	0.7863
1711	23	0.0671	1.7924	0.0829	-0.6229			3	0.0361
1721	2	0.0076	1.7292	0.1033	-0.0254			1	0.0044
1812	18	0.2948	2.1197	0.1136	-1.3320			3	0.1221
1911	7	0.0569	1.6156	0.0386	-0.0083			1	0.0339
1920	3	-0.2712	1.3453	-0.1372	0.5401	0.9424	-0.1596	1	-0.1249
2021	2	-0.2213	2.1511	0.3324	-0.1281	0.6984	0.0865	3	-0.6381
2101	20	0.1075	-0.0242	-0.0361	1.3797			4	-
2102	6	0.0621	-1.9102	1.2565	-3.9610			4	-
2211	2	0.3571	3.5057	-6.3784	-4.2170			3	0.0925
2321	5	0.0925	0.6561	0.0861	-0.2280			3	0.1236
2322	3	0.1609	2.4375	-0.1040	-0.1300			3	0.0619
2411	17	0.1086	-0.2286	0.0584	0.0129			4	-
2412	5	0.1716	0.1654	-0.1224	-0.3456			1	0.5092
2413	9	0.0384	0.4372	0.1071	-0.2657			2	0.0807
2421	5	0.2387	0.1214	-0.0499	0.0912			1	0.6629
2422	5	0.1066	0.4535	0.3308	-0.0980			1	0.1903
2423	23	0.5598	-1.7680	0.1151	-2.5197			4	-
2424	4	0.5444	0.3994	-1.2553	4.4216			1	0.5768
2430	11	0.4488	-3.7206	0.0539	0.0193			4	-
2511	4	-0.0496	-0.5731	0.1283	0.6513			4	-
2519	3	0.0499	1.9869	0.2264	-0.7609			1	0.0245
2521	7	0.0243	2.2585	0.1344	-0.2288			3	0.0107
2610	5	0.1291	0.3202	-0.2495	0.3264			1	0.2874
2694	9	0.1040	0.1498	1.4969	-8.4063			1	0.4097
2695	2	0.1139	-3.0489	0	0			4	-
2696	2	0.1530	0.1758	-0.5845	7.6425			1	0.4652

2712	18	0.0349	-0.1724	-0.0175	1.0531			4	-
2721	5	0.0615	0.0041	-0.3269	0.8633			1	0.9382
2723	10	-0.4079	11.6879	1.4144	-10.7206	3.7189	1.3458	3	-0.6703
2891	2	-0.0826	3.7387	-0.1668	5.8833	1.3309	1.8218	2	-0.6360
2893	2	-0.1593	12.0351	0.3413	-2.1907	8.0601	0.0868	3	-0.3213
2899	4	0.0461	-0.2330	0.2519	-0.4634			4	-
2922	2	0.1817	3.7349	-0.2694	0.5699			1	0.0464
3001	8	0.1152	0.5317	0.0505	0.1645			2	0.1781
3002	2	0.1517	-0.0156	0.9502	-0.8839			4	-
3120	2	0.0485	3.3643	0.1891	21.5882			1	0.0142
3130	7	-0.0105	0.2298	0.0882	-0.2262	0.1296	0.0074	1	-0.4092
3140	2	0.6401	-1.3308	0.2432	-0.5978			4	-
3150	2	0.1658	-0.8450	-0.0062	0.8336			4	-
3210	25	0.0237	0.6272	0.0777	0.0566			1	0.0364
3220	7	0.0959	-0.0284	0.1062	0.0179			4	-
3230	10	0.0747	7.4092	0.0615	-0.0354			3	0.0099
3410	6	0.0584	-0.1693	-0.3408	0.9889			4	-
3430	14	0.0582	1.9735	0.1209	0.5526			3	0.0287
3511	3	-0.3601	1.6933	0.1266	-0.4187	0.1530	-0.0409	1	-0.8852
3692	2	0.2047	-0.2882	0.0995	-0.0651			4	-

Notes
1: positive relationship
2: positive relationship at the 10% significance level
3: positive relationship at the 5% significance level
4: negative relationship

Table 3 Relationship Between Conjecture and Concentration: Dependent Variable, γ

Sample	Intercept	CR	R^2	N
(1)	-0.1642	0.73701	0.1106	38
	(-1.06)	(2.12) **		
(2)	-0.25110	0.66413	0.2284	17
	(-1.87)	(2.11) **		
(3)	-0.12013	0.39625	0.1704	14
	(-1.08)	(1.57) ***		

Note: ( ) t-statistics
*: significant at 1%,**: significant at 5 %, ***: significant at 10%

Table 4 Relationship Between Conjecture and Concentration: Cournot-Monopoly Industries

Sample	OLS Intercept	CR	R^2	N
(1)	-0.09749	0.85430		
	(-0.90)	(3.49) *	0.296	31
(2)	-0.02405	0.32634	0.333	13
	(-0.39)	(2.34) **		
(3)	-0.02671	0.32374	0.343	11
	(-0.39)	(2.17) **		

Note: ( ) t-statistics for OLS and χ^2 for MLE
*: significant at 1%, **: significant at 5 %, ***: significant at 10%

Table 5 Tobit MLE (Lower Censored)

	Intercept	CR	Log Likelihood	N
(1)	-0.1601	0.8224	-9.718	38
	(1.80)	(9.94) *		
(2)	-0.0841	0.3884	8.283	17
	(1.62)	(6.52) **		
(3)	-0.0707	0.3473	6.718	14
	(0.94)	(4.51) *		

Note: ( ) χ^2 for MLE
*: significant at 1%, **: significant at 5 %, ***: significant at 10%

Table 6 Relationship Between Conjecture and Concentration: Simple Spline Regression

Sample	ϕ_2	ϕ_4	C*	R^2	N
(1)	-0.38756	1.11088	0.3199	0.2543	38
	(-0.46)	(3.47) *			
(2)	0.44548	0.87189	0.4122	0.2440	17
	(1.03)	(1.94) **			
(3)	-0.14486	0.86401	0.4119	0.4126	14
	(-0.45)	(2.87) *			

Note: ( ) t-statistics
*: significant at 1%, **: significant at 5 %, ***: significant at 10%

Table 7 Sample Industries

KSIC (four digit)	Industry
1511	Processing and preserving of meat
1512	Processing and preserving of fish
1520	Manufacture of dairy products
1541	Manufacture of bakery products
1544	Macaroni, noodles and similar products
1545	Condiments and food additive products
1551	Rectifying and blending of spirits
1554	Manufacture of ice and soft drinks
1711	Preparation, spinning, and weaving of textiles
1721	Manufacture of made-up textile goods
1812	Ready-to-wear apparel
1911	Tanning and dressing of leather
1920	Manufacture of footwear
2021	Veneer sheets and other boards
2101	Pulp, paper, and paper board
2102	Corrugated paper and containers of paper
2211	Publishing of books
2321	Refined petroleum products
2322	Re-processing of petroleum refinery
2411	Manufacture of basic chemicals
2412	Manufacture of chemical fertilizers
2413	Synthetic rubber and plastics
2421	Pesticide and other agro-chemical products
2422	Paints and printing inks
2423	Pharmaceuticals, medicinal chemicals
2424	Soap and detergents
2430	Manufacture of man-made fibers
2511	Production of rubber tires and tubes
2519	Manufacture of other rubber products
2521	Primary general plastic products
2610	Manufacture of glass and glass products
2694	Manufacture of cement, lime, and plaster
2695	Articles of concrete, cement
2696	Cutting, shaping, and finishing of stone
2712	Steel rolling and extruding steel
2721	Primary smelting and refining
2723	Rolling and extruding of non-ferrous metals
2891	Products of metal forging, pressing, metallurgy
2893	Cutlery, hand tools, and general hardware
2899	Other products of metal assembly
2922	Processing machine-tools
3001	Computers and connecting outfits
3002	For office, calculating, accounting
3120	Electrical supply and control devices
3130	Insulated wire and cable
3140	Storage and primary batteries
3150	Light bulbs and lighting devices
3210	Manufacture of electronic valves and tubes
3220	Manufacture of transmitters and apparatus
3230	Television sound recording apparatus
3410	Automobiles and engines
3430	Automobile parts
3511	Building and repairing of boats
3692	Manufacture of musical instruments

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Notes

[1] Williamson (1968) and Peltzman (1977) offer the same arguments.
[2] See Scherer et al., 1987.
[3] Choi (2001) indicated that the coefficients on market concentration are 23~33 % larger in the OLS estimation than those in the Tobit MLE.
[4] For example, Domowitz, Hubbard, and Petersen (1986a, 1986b) had to extrapolate between Census years. Choi (2001) used only one year market concentration data for his analysis.
[5] Weiss (1974) p.201
[6] Ravenscraft (1984) shows in a simulation analysis that a regression analysis at the industry level could result in positive profit concentration coefficients, both when there is no price-raising effect present and when leading sellers have unit-cost advantages over smaller firms. This result supports the Demsetz view.
[7] Martin and Ravenscraft (1982).
[8] Scherer and Ross (1990, p. 418).
[9] There was bitter industry opposition to the program while it was under way and the Reagan administration halted data collection for the years following 1977 (Scherer and Ross, 1989, p. 419).
[10] We can derive the functional form of the domestic PCM, which is a function of domestic market share, using the first-order condition of profit maximization. The functional form of the export PCM is derived by analogy to that of the domestic PCM.
[11] $PCM_i=[s_i+\alpha_i(1-s_i)]/h=[\alpha_i+(1-\alpha_i)]/h$. α, s_i, and h represent conjecture, market share, and elasticity.Therefore, $PCM^D=j_0+j_1 s_i+u_i$ for i=1, 2, 3, . . . N, firms for each industry. We can identify parameters such that $j_0=\frac{\alpha}{h}$, $j_1=\frac{1-\alpha}{h}$ and $\frac{j_0}{j_0+j_1}=\alpha$.
[12] $PCM^i=s^i(1+\lambda^i)/h$, where λ^i is a conjectural variation term. Cowling and Waterson (1976) assume that conjecture $\lambda=\lambda_i$ for all i in each industry. The conjecture λ well captures the firms' behavior between Bertrand competition and Cournot competition in homogeneous product settings. For Cournot competition, the value of conjecture $\lambda=0$. In the case of Bertrand competition, it should be -1, since PCM=0.
[13] This truncation bias comes from the omitted variable problem. Suppose that $y_i=\beta'\chi_i+\varepsilon_i$, where $\varepsilon_i \sim N(0,\sigma^2)$, then $E(y|y>0)=\beta'\chi+E(\varepsilon_i|\varepsilon_i>\beta'\chi)=\beta'\chi+\sigma\frac{\phi(\beta'\chi/\sigma)}{\Phi(\beta'\chi/\sigma)}$,where ϕ and Φ are the density function and the distribution of the standard normal distribution. For the subpopulation from which the data are drawn, $y_i|y_i>0=E[y_i|y_i>0]+u_i=\beta'\chi+\sigma\lambda_i+u_i$, where u_i is y_i minus its conditional distribution and $\lambda_i=\frac{\phi}{\Phi}$. If we estimate this equation with an ordinary least squares regression of y on X, we have omitted a variable, the nonlinear term $\lambda_i\ \frac{\phi}{\Phi}$.
[14] See, for example, Ravenscraft (1983) and Schmalensee (1987).
[15] In Choi (2001), the coefficients of market concentration were 0.188, 0.173 and 0.198 and their t-values were 1.78, 1.98 and 1.86. Therefore, the market power effect is more strongly supported in our data.

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