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Research on the Industrial Structure Rationality of Shanxi Province in China—A Multiplier Analysis Based on Social Accounting Matrix

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Abstract: **Taking data of 2007 as the base data, this paper introduces the preparation of social accounting matrix (SAM) (2007) of Shanxi Province. According to the accessibility of data and research purpose, this paper aggregates the account and prepares the 11 sectors SAM, and makes the SAM multiplier analysis. It concludes that the developing mode of Shanxi coal mining and washing industry is not very reasonable, so it can not play the vital role in the national economy. Meanwhile, the paper gets other 9 significant conclusions and makes the corresponding recommendations.**

Keywords: Shanxi; Industry structure; Social accounting matrix; Multiplier analysis

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1. Introduction

The economic development pattern of Shanxi Province has been in a "coal-dominant" situation since China's reform and opening up, which directly resulted that the economic development was at the expense of the environment. Indiscriminate digging, mine disaster and urban environmental pollution also made the economy vulnerable to a huge external environment changes. The financial crisis in 2008 had a huge impact on the energy sector, thus the GDP growth of Shanxi was -4.4% in the first half of 2009. Moreover, Shanxi was the only negative growth province of GDP growth in China in 2009. Under the arduous task of transformation, how to adjust the industrial structure in Shanxi Province and optimize the industrial structure development mechanism are the urgent issues.

Based on the backgrounds above, this paper mainly includes the following two parts: (1) preparing the 2007 Shanxi social accounting matrix to provide the data foundation for multiplier analysis; (2) quantitatively analyzing the relationships among the endogenous accounts of Shanxi SAM, simulating the response of different departments when subjected to exogenous shocks, and ultimately providing some help for the policy makers. It aims at optimizing the industrial structure of Shanxi and improving the development pattern.

2. Literature Review

So far, there has not been a completely uniform definition about Social Accounting Matrix (SAM) in academia and different scholars have different understandings of SAM. According to the definition of Jeffery I. Round, "SAM is a single-entry bookkeeping accounting system, and each row of the matrix and its corresponding column represents a macro account, rows record income and columns record spending."Taylor's definition of SAM emphasize on the internal mechanism of SAM [5].

Kang Wang [6]set up a variety of simulated scenarios and separately used a multiplier decomposition method and a structural path analysis method to do empirical analysis on the industrial structure and income distribution characteristics of Gansu Province, which is on the basis of 2007 Gansu social accounting matrix. Yunfang Luo [7] used input-output tables and social accounting matrix to do a research on water conservancy investment multiplier effect, and the results indicated that different water sectors had different investment multipliers. Jianhai Cao and Zhengshi Wen [8] based on the framework of social accounting matrix to clearly illustrate the internal relations among industrial added value, income distribution and final demand by expanding the Income output loop system. The results showed that: the interaction within the economy implied a set of macroeconomic multipliers, and each of them corresponded to a series of industrial portfolio which followed the same path, and the portfolio could be identified and quantified.

Roberts [1] analyzed the flow effects of urban and rural population by creating a two regional SAM model which allowed product and factor income to flow, and the multiplier decomposition method was used to analyze the nature of population movements. The results showed that there was a stronger migration effect from countryside to city than from city to countryside. Santos [2] prepared the 1998 Portugal

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SAM on the basis of national accounting data, which was used to plan the budget balance among various government departments, and to estimate the pure import of national economy. In this study, the importance of capital of central government was given special attention, while the calculated SAM multiplier and its decomposition helped to identify those factors that promote the improvement of the economic situation; Llop and Manresa [3] used linear SAM multiplier model to analyze the process of income distribution of Catalan region in Spain. Miguel and Perez-Mayo [4] used SAM to analyze the unfair changes of cities in Spain.

Table 1 2007 Shanxi macro SAM

	Activity	Commodity	Labor	Capital	Urban resident	Rural resident	Enterprise	Government	Foreign areas	Other regions in China	Fixed capital formation	Inventory change	Summary
Activity		14195.98											14195.98
Commodity	8462.63				1322.26	547.33		718.64	496.77	1917.49	2953.02	292.5	16710.64
Labor	1845.45												1845.45
Capital	3123.34												3123.34
Urban resident			1291.81	77.4			620.44	204.38					2194.03
Rural resident			553.64	121.07			114.86	30.54					820.11
Enterprise				2883.28				-134.49					2748.79
Government	764.56	39.66			234.96	82.56	223.15						1344.89
Foreign areas		383.09		41.59									424.68
Other regions in China		2091.91											2091.91
Fixed capital formation					636.81	190.22	1790.34	525.82	-72.09	174.42			3245.52
Inventory change											292.5		292.5
Summary	14195.98	16710.64	1845.45	3123.34	2194.03	820.11	2748.79	1344.89	424.68	2091.91	3245.52	292.5	

3. Materials and Method

The data of this paper is from 2007 Shanxi input-output table, 2008 and 2009 Shanxi Statistical Yearbook, 2008 China Financial Yearbook, 2008 China Tax Yearbook and some other statistical data.

The basic assumption of the multiplier analysis is that the economy's income is from payments, which is from production activity sectors to the factor sectors. And the nature of this income is derived from economic entities' "injection", it is this "injection" that triggers a multiplier effect and participates in the process of appreciating.

The core and foundation of multiplier analysis method is decomposition, that is, the multiplier matrix M is decomposed into the product of M1, M2 and M3. M1 reflects the transfer effect, such as profits distribution from enterprise to household. M2 and M3 describe the income flow effects. And M2 describe the cross effect, while M3 describe the overall cycle effect. As shown below (Figure 1).

$$Y_n=A_n y_n+x_n,\quad y_n=(I-A_n)^{-1}x_n=M_a x_n \qquad 3.1$$

$$A_n=\begin{bmatrix}0 & 0 & A_{13}\\ A_{21} & A_{22} & 0\\ 0 & A_{32} & A_{33}\end{bmatrix} \qquad 3.2$$

Define $\hat{A}_n$:

$$\hat{A}_n=\begin{bmatrix}0 & 0 & 0\\ 0 & A_{22} & 0\\ 0 & 0 & A_{33}\end{bmatrix} \qquad 3.3$$

$$A^*=\begin{bmatrix}0 & 0 & A_{13}^*\\ A_{21}^* & 0 & 0\\ 0 & A_{32}^* & 0\end{bmatrix},\quad \begin{Bmatrix}A_{13}^*=A_{13}\\ A_{21}^*=(I-A_{22})^{-1}A_{21}\\ A_{32}^*=(I-A_{33})^{-1}A_{32}\end{Bmatrix} \qquad 3.4$$

Decompose M_a, and we get M_{a1}, M_{a2}, M_{a3}:

$$M_{a1}=(I-\hat{A}_n)^{-1};\quad M_{a2}=(I+A^*+A^{*2});\quad M_{a3}=(I-A^{*3})^{-1} \qquad 3.5$$

$$M_a=M_{a1}M_{a2}M_{a3} \qquad 3.6$$

Figure 1. Decomposition of multiplier matrix.

4. SAM Preparation and Multiplier Analysis

4.1. SAM Preparation

As shown above (Table1), Shanxi macro SAM is a 13 × 13 matrix (including summary rows and summary columns), there are many elements in the matrix which are zero, and that's because there are no economic exchanges between the corresponding rows and

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columns.

This paper divide "commodity" and "productive activities" account into 11 departments according to the characteristics of various departments and data accessibility.

4.2. Multiplier Analysis

The endogenous accounts of this paper are like as below (Table 2).

Table 2 The endogenous accounts of 2007 Shanxi SAM

Production Accounts	(1)Agriculture
	(2)Coal mining and washing
	(3)Other mining industries
	(4)Manufacturing
	(5)Electricity, gas and water production and supply industry
	(6)Building industry
	(7)Transport, storage and communications industry
	(8)Commercial Catering
	(9)Financial industry
	(10)Other Service industry
	(11)Health, social security and social welfare industry
Factor Accounts	(L)Labor
	(C)Capital
Institution Accounts	(U)Urban resident
	(R)Rural resident
	(E)Enterprise

Table 3 lists the net effect, transfer effect, open-loop effect (O) and closed-loop effect (C).

Table 3 Multiplier net effect and its decomposition

Sec-tors	Ma	Net effect	Transfer effect	Open loop effect	Close loop effect
(1)	2.5252	1.5252	1.3846	0.0000	0.1406
(2)	2.1724	1.1724	1.1316	0.0000	0.0408
(3)	1.4279	0.4279	0.4235	0.0000	0.0044
(4)	3.0386	2.0386	1.7781	0.0000	0.2604
(5)	2.4059	1.4059	1.3481	0.0000	0.0578
(6)	2.0280	1.0280	1.0214	0.0000	0.0066
(7)	2.0975	1.0975	1.0220	0.0000	0.0755
(8)	2.1202	1.1202	1.0093	0.0000	0.1109
(9)	2.0628	1.0628	1.0343	0.0000	0.0286
(10)	2.2859	1.2859	1.1167	0.0000	0.1692
(11)	2.0365	1.0365	1.0264	0.0000	0.0101
(L)	1.1899	0.1899	0.0000	0.0000	0.1899
(C)	1.0975	0.0975	0.0000	0.0000	0.0975
(U)	1.2011	0.2011	0.0000	0.0000	0.2011
(R)	1.0863	0.0863	0.0000	0.0000	0.0863
(E)	1.0772	0.0772	0.0000	0.0000	0.0772

We can find some characteristics of Shanxi industrial structure from Table 3: Taking manufacturing as an example, the transfer effect of manufacturing sector ranked first in all industrial sectors, indicating that the current development of manufacturing industry in Shanxi is developed, and it has rich industrial chain, high-level and multi-sector collaboration, and thus its development driving force to other industries is the strongest. At the same time, from the entire economic system's point of view, the manufacturing sector solves the employment problem of the vast majority of people, and it is the main source of income for the industrial population. Therefore through the cycle effect of income redistribution, the driving force of manufacturing sector to the national economy is the biggest.

Meanwhile, the transfer effect of agriculture ranked second in all industry sectors, indicating that the agriculture development in Shanxi is advanced, the labor way is relatively advanced, and multi-sector collaboration level is high, the driving force to the development of other industries is strong; From the entire economic system's point of view, agriculture industry solves the employment problem of vast majority of the rural population, and it is the main income source of agricultural population. So through the cycle effect of income redistribution, the driving force of agriculture sector to the national economy is considerable, and its closed-loop effect is only inferior to manufacturing industry and other services industry.

4.3. Point to Point Simulation

Another important use of SAM multiplier decomposition method is point to point analysis. This section analyzes the impact on the other sectors after receiving exogenous shocks on main production activities accounts and resident accounts. As shown in below (Table 4, 5 and 6).

Table 4 analyzes the impact on the other production activities when exogenous shocks are put on a certain production activity account. In this case, because the starting and ending points are the same type of account, the open loop effect is 0. Therefore, the multiplier effect of one production department to another production department can be decomposed into transfer effect and closed loop effect. For example, if agriculture department is given an external injection of 10,000 units, it will result that the output of coal mining and washing industry increase 868 units. And the multiplier decomposition results show that the 868 units

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include 285 units transfer effect and 583 units closed-loop effect, which indicates the direct correlations between coal mining and washing industry and agriculture industry are relatively low. However, external injection on agriculture industry will cause great changes on coal mining and washing industry after a circle in the entire economic system,

Table 4 Production industries point to point multiplier analysis

Shocked accounts	Impacted accounts	Net effect	Transfer effect	Open loop effect	Close loop effect
(1)	(2)	0.0868	0.0285	0.0000	0.0583
	(3)	0.0298	0.0126	0.0000	0.0172
	(4)	1.0624	0.4505	0.0000	0.6119
	(5)	0.1468	0.0499	0.0000	0.0970
	(6)	0.0149	0.0042	0.0000	0.0107
	(7)	0.1636	0.0458	0.0000	0.1178
	(8)	0.4011	0.1999	0.0000	0.2011
	(9)	0.0554	0.0200	0.0000	0.0354
	(10)	0.1858	0.0151	0.0000	0.1707
	(11)	0.0103	0.0004	0.0000	0.0099

Table 5 analyzes the impact on factor departments when external injection is put on different activity sectors. In the above case, the starting and ending points are not the same type of account, so the transfer effect is zero. As shown as below (Table 5), the pull effect of employment and income of agriculture on labor is the strongest, and the labor force may increase 5,758 units when given 10,000 units of exogenous shock to agriculture sector, which includes 4,698 units of closed-loop effect and 1,060 units open-loop effect. Health, social security and social welfare industry and other services industry's pull effect to employment and income are only inferior to agriculture industry, followed by 5571 units and 5276 units respectively, and the open-loop effect is much greater than the closed-loop effects. Coal mining and washing industry's pull effect of employment and income ranked fifth among 11 sectors.

Table 5 Production sectors to factor sectors simulation

Shocked accounts	Impacted accounts	Net effect	Transfer effect	Open loop effect	Close loop effect
(1)	(L)	0.5758	0.0000	0.4698	0.1060
(2)	(L)	0.3459	0.0000	0.2716	0.0744
(3)	(L)	0.1212	0.0000	0.0943	0.0269
(4)	(L)	0.1768	0.0000	0.1315	0.0452
(5)	(L)	0.2250	0.0000	0.1620	0.0630
(6)	(L)	0.3054	0.0000	0.2400	0.0654
(7)	(L)	0.2566	0.0000	0.1890	0.0676
(8)	(L)	0.2363	0.0000	0.1779	0.0584
(9)	(L)	0.3905	0.0000	0.3051	0.0854
(10)	(L)	0.5276	0.0000	0.4226	0.1050
(11)	(L)	0.5571	0.0000	0.4488	0.1083
(1)	(C)	0.4631	0.0000	0.2872	0.1759
(2)	(C)	0.5122	0.0000	0.3888	0.1234
(3)	(C)	0.1972	0.0000	0.1526	0.0446
(4)	(C)	0.4200	0.0000	0.3450	0.0751
(5)	(C)	0.6554	0.0000	0.5507	0.1047
(6)	(C)	0.4475	0.0000	0.3388	0.1086
(7)	(C)	0.6536	0.0000	0.5413	0.1123
(8)	(C)	0.5165	0.0000	0.4196	0.0969
(9)	(C)	0.6106	0.0000	0.4688	0.1418
(10)	(C)	0.5969	0.0000	0.4227	0.1743
(11)	(C)	0.5729	0.0000	0.3933	0.1797

Table 6 analyzes the impact on different industrial sectors after external shocks exerted on urban residents and rural residents respectively. As can be seen from the table, no matter external shocks are exerted on urban residents or on rural residents, the impact on manufacturing is far greater than any other industry; Meanwhile, the open-loop effect of all sectors are greater than the closed-loop effect. And exogenous shocks on rural residents will cause more output than on urban residents.

Table 6 Household accounts to production sectors simulation

Shocked accounts	Impacted accounts	Net effect	Transfer effect	Open loop effect	Close loop effect
(U)	(1)	0.2196	0.0000	0.1650	0.0546
(U)	(2)	0.0939	0.0000	0.0713	0.0226
(U)	(3)	0.0289	0.0000	0.0222	0.0067
(U)	(4)	1.0235	0.0000	0.7856	0.2379
(U)	(5)	0.1747	0.0000	0.1369	0.0378
(U)	(6)	0.0195	0.0000	0.0153	0.0042
(U)	(7)	0.2264	0.0000	0.1804	0.0460
(U)	(8)	0.3614	0.0000	0.2831	0.0784
(U)	(9)	0.0627	0.0000	0.0489	0.0138
(U)	(10)	0.3157	0.0000	0.2491	0.0666
(U)	(11)	0.0178	0.0000	0.0140	0.0038
(R)	(1)	0.3293	0.0000	0.2700	0.0593
(R)	(2)	0.1293	0.0000	0.1047	0.0246
(R)	(3)	0.0356	0.0000	0.0283	0.0073
(R)	(4)	1.2679	0.0000	1.0092	0.2587
(R)	(5)	0.1706	0.0000	0.1295	0.0411

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(R)	(6)	0.0184	0.0000	0.0138	0.0045
(R)	(7)	0.1726	0.0000	0.1226	0.0500
(R)	(8)	0.3560	0.0000	0.2708	0.0852
(R)	(9)	0.0652	0.0000	0.0502	0.0150
(R)	(10)	0.2804	0.0000	0.2080	0.0724
(R)	(11)	0.0171	0.0000	0.0129	0.0042

5. Conclusion

Using multiplier analysis, the paper studies the industrial structure of Shanxi Province and draws the following conclusions. (1) The multiplier of manufacturing industry of Shanxi is the largest among all the sectors, and it's the most important sector in the national economy. (2) Due to the dominance situation of coal mining and washing industry in Shanxi, other mining industries are relatively weak. Agriculture industry's SAM multiplier is the second, indicating that agriculture plays a vital role in the national economy. (3) From the entire economic system point of view, manufacturing industry solved the employment problem of the majority of people, and it's the main income source of the industrial population, thus the pull effect of manufacturing sector to the national economy is the largest through income redistribution. (4) Through the effect of income redistribution, the pull effect of electricity, gas and water production and supply industry and the coal mining and washing industry to the national economy are relatively low, indicating that the developing mode of Shanxi's coal mining and washing industry is not very reasonable, which doesn't play the role in the national economy. (5) Through the effect of income redistribution, the pull effect of other service industry and Commercial Catering industry to the national economy are relatively strong. (6) Electricity, gas and water production and supply industry has the largest correlation with Coal mining and washing industry, followed by Building industry and Manufacturing industry. (7) Agriculture industry's direct pull effect to the employment is the largest, followed by Health, social security and social welfare industry and other service industry. (9) Electricity, gas and water production and supply industry's pull effect to capital is largest, followed by Transportation, storage and communications industry and financial industry. (10) Exogenous shocks on rural residents will cause more output than on urban residents.

6. Policy Implications

According to the conclusions above, the following suggestions are proposed. (1) The issue, whether it is manufacturing industry or coal mining and washing industry, plays a vital role in the national economy, and we should make good use of them. (2) Regulating the mode of development of coal mining and washing industry via the integration of coal resources. (3) Developing the service industry, and shifting the economic center to the tertiary industry gradually. (4) Regulating electricity, gas and water production and supply industry and making it promote the national economy. (5) Making good use of building industry and transportation, storage and telecommunication industry to make it a strong support for the development of other industries. (6) Regulating the development of the financial industry to making it play the role on driving capital. (7) Improving and deepening service system gradually to make it play the leading role on increasing employment. (8) Given that exogenous shocks on rural residents will cause more output than that on urban residents, the government should take more care of rural residents in transfer payment policy.

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