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Research Article

Method to Study the Importance of Automobile Industry Chain Based on the Input-Output Model

Junlei Wang[1,2] **Fan Zhang**[1,2] **Zhaozhao Zhang**[1,2] **Liangliang Wang**[1,2] **and Collins Sam Ayipeh**[3]

[1]*China Automotive Technology & Research Center Co Ltd, Tianjin 300300, China*
[2]*China Auto Information Technology (Tianjin) Co Ltd, Tianjin 300300, China*
[3]*Kwame Nkrumah University of Science and Technology, Kumasi, Ghana*

Correspondence should be addressed to Fan Zhang; m13502037247_3@163.com and Collins Sam Ayipeh; csayipeh@st.knust.edu.gh

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This paper proposes a study based on the importance of the automobile industry chain based on the input-output model (IOM) to verify the importance of the automobile industry chain in the national economy. The available data shows interdependence among various industrial sectors and the automobile industry chain. The same is reflected in the input-output table. The input data is taken from the input-output table (IOTB) of the automobile industry chain. A mathematical model was developed that shows the equilibrium relationship indicating the direct and indirect technical as well as economic links amongst the different sectors. The static model of the IOM was selected. The static model herein reflects the technical and economic correlations amongst the sectors during the same period. The same was applied to analyze and study the contemporaneous production process. 153 fields(variables) were selected to verify multiple economic indicators of the automobile industry chain. The conclusion demonstrates that the auto parts and accessories in the automobile industry chain are in the top 10 among the 153 fields, in terms of their consumption coefficient (CC) and contribution degree. The purpose of the research was to verify the significance of the relationship between various fields which can optimize and upgrade the industrial structure. It also provides a scientific basis for formulating strategies and policies of the relevant industry chain.

1. Introduction

1.1. Background. The automobile sector contributes about 7% of GDP. The total domestic retail sales of automobiles reached RMB 3.7 trillion in 2021, accounting for 8.4% of the household expenditure. The proportion has remained between 8.3% and 11.1% in the past ten years. The purchase tax reduction of RMB 60 billion in stages exceeded the market expectations. In the past, the reduction and exemption policy on automobile purchase tax has been implemented in 2009, 2015, and 2020, respectively. It is found that several previous policy cycles for automobile promotion have indeed significantly boosted sales and market conditions. In 2008, confronted with the international financial crisis and natural disasters, the government launched a number of policies to boost the domestic economy. As a result, the sales volume of the automobile industry achieved significant growth. The sales of passenger vehicles increased by 53% and 33% in 2009 and 2010, respectively. The absolute returns and relative ones of the auto parts and finished automobile sections both exceeded 50% at the end of the policy cycle. It is not only necessary to understand the significant role of the finished automobile sections and auto parts in driving economic growth, but also to explore the intrinsic connection of the finished automobile sections and auto parts and other non-automobile manufacturing sectors, as well as the internal relationship between them. The IOM is, therefore, introduced to analyze the industrial structure and jointly promote its upgrading. [1–3]. The IOTB, as the basis of the input-output model, can comprehensively reflect the technical and economic relations of various sectors of the national economy and several links of the production. It is able to provide a large number of economic parameters, hence considered an important tool for economic analysis. The economic study based on the IOTB lays an important foundation for the overall balance of the national economy, improvement of the economic planning work, and enhancement of the economic management level.

1.2. The IOTB of the Automobile Industry

(1) Reveals the internal relations between the automobile manufacturing sectors and the non-automobile ones.

(2) Provides quantitative measures for the development status of the automobile industry economy.

(3) Gives the status of auto mobilization level in the economy and the society.

It is important to study the impact of the automobile industry on the development of the national economy as well as the industrial structure analysis.

This will help in the formulation of strategies and policies for industrial planning and development. This paper analyzes the input and output of the automobile industry in China in terms of economy and identifies a preliminary macroscopic measurement of China's automobile development level [4]. There are some challenges faced by the automobile industry some of them are:

(1) less vehicle sales,

(2) loss of labor,

(3) disrupted supply chain,

(4) liquidity availability,

(5) competitive environment,

The automobile industry plays an extremely important role in GDP growth and the generation of employment. It also forms a taxable base and revenue. It also generates a number of auxiliary industries. Since 2009, China is leading the automotive market. In China, 9.6% of the total retail sales of consumers is contributed by the automotive sector in 2019. That generates around 10% of total employment [5].

1.3. Literature Review. Taxation, vehicle loan interest rates, supply and demand, Government laws and regulations are some of the factors that affect the growth of the automobile industry. In [6], the author analyzed the impact of the digital economy (DE) on the division of labor in the global agricultural value chain based on the cross-border panel data of 37 countries in the world input-output database (WIOD). Based on the research conclusions, they put forward countermeasures and suggestions, such as vigorously developing the DE, accelerating the combination of the DE and agricultural production, and continuously expanding the openness of foreign trade. In [7], the authors established an IOM of China's digital trade on the basis of the input-output theory and compiled the international IOTB of digital trade. They proposed the decomposition and measurement ideas of the value-added index of digital trade. In [8], the authors proposed non-survey methods, and a city-level IOM to analyze and simulate the economic impact of urban development and strategic policies. The results indicate that the application of the city-level IOM has great prospects in China. It provides important decision support for urban development planning, strategy, and decision-making. In [9], the authors studied the automotive supply chain in European countries like the UK, Germany, France, and Italy. They employed WIOD data trade-SCN. They analyzed the local and imported inputs of production to evaluate the automotive supply chain. The analysis targeted the four variables, i.e., employment generation, value-addition, profits, and labor. In [10], the authors studied the mathematical formulation of the IOM in the economy. They introduced necessary and sufficient conditions for this model. The study emphasized the use of a Markovian approach developed by Kemeny and Snell (1976), which provides the weakest conditions for the IOM to hold. They analyzed the transaction matrix of the national economy of Mexico for the year 2003 using the proposed approach. In [11], the researchers studied the I-O models and provided an insight into the constructed multipliers' matrices and their derived indicators from the IOMs. Expansions were suggested for the I-O models.

This research proposes a method to measure the importance of the contribution of the automobile industry chain based on the input-output model, and further arrives at the developing relationship between each industry chain. An input-output data table of 153 industries was constructed. The mathematical logical relationship of each economic index was deduced. Each index parameter of the automobile industry chain was solved using MATLAB. The research significance of the proposed research is that it provides a solution model to accurately measure the impact and status of the automobile industry chain in the national economy. Government sectors can offer reasonable policy guidance according to the influence relationship between different industries and boost the economic vitality.

1.4. The Contribution of the Paper

(i) Compiling an input-output data table of 153 industries.

(ii) Proposing a method to measure the importance of the contribution of the automobile industry chain based on the input-output model.

(iii) Solving index parameter of the automobile industry chain using MATLAB.

1.5. Organizational Structure of This Paper

(i) Section 1: the background of the paper.

(ii) Section 2: research methods fall into seven parts including data source selection, CC calculation, requirement coefficient calculation, multiplier effect

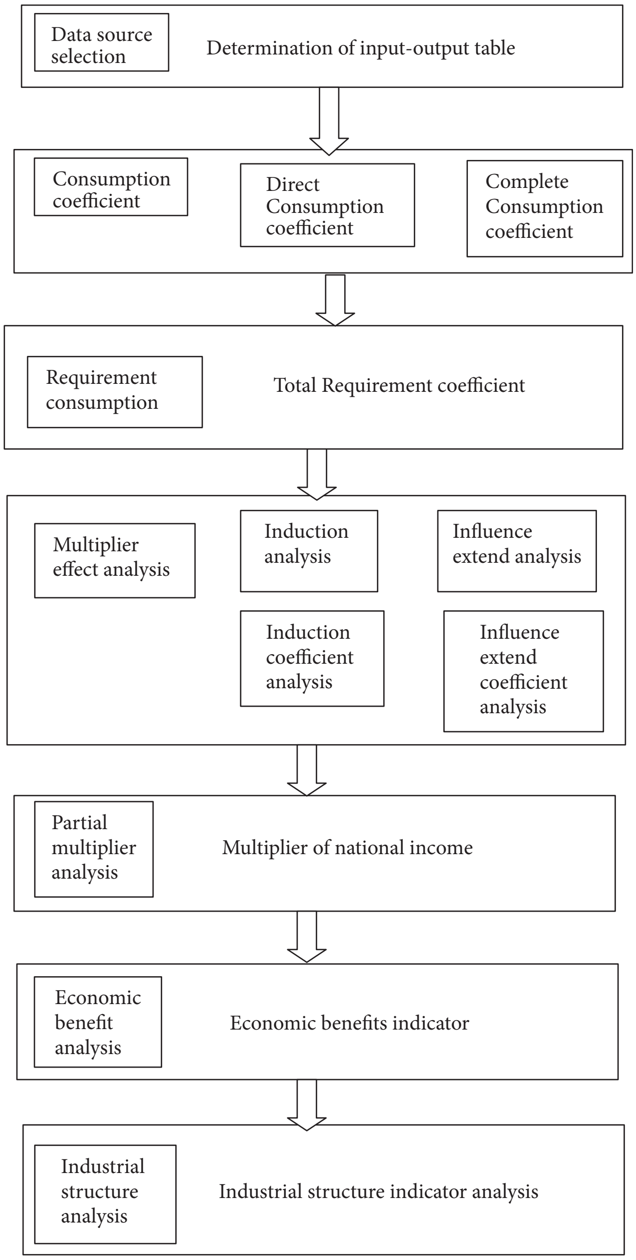

Figure 1: Text research method.

analysis, partial multiplier analysis, economic benefit analysis, and industrial structure analysis.

(iii) Section 3: pertains to case analysis and result.

(iv) Section 4: provides the conclusion.

(v) Section 5: provides bibliography.

2. Research Methodology

The IOTB of the automobile industry reflects the interdependence among various industrial sectors across the country in the table [12]. Based on the IOTB of the automobile industry, a mathematical expression of the equilibrium relationship was derived which indicates the direct and indirect technical as well as economic links between various sectors [13, 14]. The model can be categorized as a static model and a dynamic model. The static model herein reflected the technical and economic relations between sectors during the same period and was applied to analyze and study the contemporaneous production process. The dynamic model revealed the technical and economic relations between various sectors in different periods and was adopted to analyze and study the production at different times and the interrelations between the production processes at different stages [8]. This paper only involved the static model, and the research method is shown in Figure 1 below.

As it can be seen from Figure 1, the research method is divided into seven parts such as data source selection, CC calculation, requirement coefficient calculation, multiplier effect analysis, partial multiplier analysis, economic benefit analysis, and industrial structure analysis. Among them, the data source is to determine the dimension of the IOTB, that is, the number of industries to be selected to constitute the IOTB [15]. CC calculation includes the calculation of the direct CC (technical coefficient) and that of the complete CC. The economic significance of the direct CC is: the quantity of products of Sector i directly consumed for the production of total products per unit by Sector j. The economic significance of the complete CC is: the total amount of products of Sector i completely consumed for the production of total products per unit by Sector j. The economic significance of the calculation of the total requirement coefficient (Leontief inverse matrix) is the number of total products that Sector i needs to add when Sector j wants to add a unit of final products. Multiplier effect analysis is divided into induction analysis, influence extent analysis, induction coefficient analysis, and influence extent coefficient analysis [16, 17]. Induction refers to the total output value of the Sector i to be increased due to the increase of the final demand per unit of each sector in the national economic system (NES). Influence extent refers to the growing amount of the total output of each sector in the NES driven by the increase of the final product of Sector i for one unit. The induction coefficient represents the ratio of the induction of Sector i to the average induction of each sector in the NES. The influence extent coefficient represents the ratio of the influence extent of Sector j to the average influence extent of all sectors in the NES, reflecting the influence extent level of Sector j. Partial multiplier analysis is based on the total requirement coefficient, with the economic significance that shows an increase in national income caused by the increase of total output of each sector due to the addition of a unit of the final product in a certain sector in the NES. In the IOTB (Table 1), various economic benefit indicators can be calculated by these data. The industrial structure analysis mainly includes the proportional relationship between different industries, and the product structure and production factor structure within the same industry (the $\boldsymbol{i}$ and $\boldsymbol{j}$ in the text are shown in Table 1 of Subsection 2.1).

Table 1: Static IOTB of automobile industry.

Input			Output										
			Intermediate use						Final output				Total output
			Sector 1	Sector 2	...	Sector j	...	Sector n	Expenditure	Accumulation	Net export	Subtotal	
Intermediate input		Sector 1	x_{11}	x_{12}	...	x_{1j}	...	x_{2n}				y_1	x_1
		Sector 2	x_{21}	x_{22}	...	x_{2j}	...	x_{2n}				y_2	x_2
		...	...	...	...	...	...	...				...	...
		Sector n	x_{n1}	x_{n2}	...	x_{nj}	...	x_{nn}				y_n	x_n
Initial input	Depreciation of fixed assets		D_1	D_2	...	D_i	...	D_n					
	Newly created value	Remuneration for workers	V_1	V_2	...	V_i	...	V_n					
		Social net income	m_1	m_2	...	m_i	...	m_n					
Total input			x_1	x_2	...	x_i	...	x_n					

2.1. Compiling Input-Output Table. Input-output analysis is an economic model that shows the relationships between industrial sectors within an economy. It shows that the outputs of one sector can be input for another sector. The model was developed by Wassily Leontief. An industrial sector can act as a consumer and at the same time a supplier of inputs to other sectors in an economy. This interdependent relationship is described by the input-output analysis model. The analysis is typically presented in a matrix or table. It plays a vital role to analyze the economy-wide impacts in terms of demand and supply.

The impacts can be categorized into the following:

(i) Direct: the impact of a change in demand.
(ii) Indirect: the impacts that resulted from the hiring of a workforce to cater to the big demand.
(iii) Induced: as a result of an increase in personal consumption of goods and services.

The input-output database also includes socio-economic and environmental satellite accounts. The core of the input-output database is to provide data on international businesses in services and goods. It has wide country coverage (the EU-27 Member States, 13 non-EU countries, and the "rest of the world" region) [14]. The static IOM relates to the economy as a whole in a particular year. It shows the inter-industry goods and services flow.

The model becomes dynamic when the investment part of the final bill of goods is linked to the output.

The static IOM of the automobile industry describes the internal quantitative relationship between production and consumption among the sectors of the automobile industry and non-automobile industry in the same period from the perspective of the economy [18, 19]. This model can be used to study the industrial structure and predict the economic development of the automobile industry. The static IOM of the automobile industry and the mathematical symbols required by the model is given in Table 1.

Among them, the x_{ij} in Table 1 represents the quantity of the products of Sector $\boldsymbol{i}$ consumed by Sector $\boldsymbol{j}$ in production, or the quantity of the products produced by Sector $\boldsymbol{i}$ allocated to Sector $\boldsymbol{j}$ as intermediate products (both calculated according to their values). The initial input is the added value N, which consists of depreciation of fixed assets D, remuneration for workers V, and social net income m (the sum of net product tax and operating surplus). In terms of $N_j = D_j + V_j + m_j$ for Sector $\boldsymbol{j}$, the D_j is the depreciation of fixed assets of Sector j, V_j is the remuneration for workers of Sector j, and m_j is the net social income of Sector j. The meanings of other symbols are shown in Table 1. The matrix Q formed by the data of quadrant I is called the input-output flow matrix [18, 20] as shown in the Equation (1) as follows:

$$Q = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \vdots & \vdots & \vdots & \\ x_{n1} & x_{n2} & \cdots & x_{nn} \end{bmatrix}. \quad (1)$$

From each row of Table 1, intermediate use + final product (final use) = total output, i.e., Equation (2) as shown below:

$$\sum_{j=1}^{n} x_{ij} + y_i = X_i, i = 1, 2, \ldots, n. \quad (2)$$

From each column of Table 1, intermediate input + initial input = total input, i.e., Equation (3), as below:

$$\sum_{i=1}^{n} x_{ij} + N_j = X_j. \quad (3)$$

When $i = j$, it meets. $\sum_{l=1}^{n} x_{il} + y_i = \sum_{t=1}^{n} x_{tj} + N_j$, that is, the total output of each sector is equal to total input of the sector and the sum of the total input of all sectors is equal to the sum of the total output of all sectors, as shown in Equation (4).

$$\sum_{i=1}^{n} y_i = \sum_{j=1}^{n} N_j. \quad (4)$$

2.2. Consumption Coefficient. The calculation of the CC includes the calculation for the direct CC (technical coefficient) and complete CC. The theoretical model of direct CC is shown in Subsection 2.2.1, and that of the complete CC is shown in Subsection 2.2.2.

2.2.1. Direct Consumption Coefficient. Direct CC, also known as technical coefficient, is an important parameter of IOM and reflects the direct consumption relationship of products among sectors. In the production process, in addition to direct consumption, there is also an indirect consumption relationship between products of sectors. For example, the production of coal directly consumes electricity and also requires coal mining machinery. The necessary electricity consumed in the whole process of manufacturing coal mining machinery (mining, iron making, steel making, casting, machining, etc.,) is the indirect consumption of electricity by coal. Equation (5) can be obtained according to Equations (1) and (2).

$$a_{ij} = \frac{x_{ij}}{X_i} \left(X_j \neq 0 i, j = 1, 2, \ldots, n \right). \quad (5)$$

Equation (5) is called the direct CC. Its economic significance is: the quantity of products of Sector i directly consumed for the production of total products per unit by Sector j, substituting Equation (5) into Equation (2) to obtain Equation (6).

$$\sum_{j=1}^{n} a_{ij}X_j + y_i = X_i, i = 1, 2, \ldots, n. \quad (6)$$

6 is called the input-output line model. It is written in matrix form as shown in Equation (7).

$$AX + Y = X. \quad (7)$$

or. $(I - A)X = Y$

This is an important relation between X and Y.

$$A = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & \vdots & \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{bmatrix}, X = \begin{bmatrix} X_1 \\ X_2 \\ \vdots \\ X_n \end{bmatrix}, Y = \begin{bmatrix} y_1 \\ y_2 \\ \vdots \\ y_n \end{bmatrix}. \quad (8)$$

And I is the unit matrix. Substitute Equation (5) into Equation (3) to get Equation (9).

$$\sum_{i=1}^{n} a_{ij}X_j + N_j = X_j, j = 1, 2, \ldots, n. \quad (9)$$

Equation (8) is called the input-output column model and written in matrix form as shown in Equation (9).

$$(I - C)X = N. \quad (10)$$

2.2.2. Complete Consumption Coefficient. In Equation (10), C and N are calculated in Equation (11) as follows.

$$C = \left[\sum_{i=1}^{n} a_{i1} 0 \cdots 0 0 \sum_{i=1}^{n} a_{i2} \cdots 0 \vdots \vdots \vdots \mathbf{0} \cdots \sum_{i=1}^{n} a_{in} \right],$$
$$N = \begin{bmatrix} N_1 \\ N_2 \\ \vdots \\ N_n \end{bmatrix} = \begin{bmatrix} D_1 + V_1 + m_1 \\ D_2 + V_2 + m_2 \\ \vdots \\ D_n + V_n + m_n \end{bmatrix}. \quad (11)$$

The matrix C is called the intermediate input coefficient matrix, which can be expressed in Equation (12) as follows:

$$C = \text{diag}(s_1, s_2, \ldots, s_n), \quad (12)$$

where:

$$s_j = \sum_{i=1}^{n} a_{ij}, j = 1, 2, \ldots, n. \quad (13)$$

s_j the economic significance of S_j is that the sum of products of other sectors necessary to be consumed by Sector j for the production of total products for one unit.

From Equation (7)

$$X = (I - A)^{-1}Y. \quad (14)$$

Therefore, after the final product quantity Y is determined, the total output quantity X that shall be produced to ensure the completion of the planned indicators can be calculated from Equation (13).

A complete CC b_{ij} is defined to represent the total amount of products of Sector i that need to be completely consumed by Sector j for the production of total product for one unit. b_{ij} It can be deduced from a_{ij} in Equation (13) as follows:

$$b_{ij} = a_{ij} + \sum_{k=1}^{n} b_{ik}a_{kj}, i, j = 1, 2, \ldots, n. \quad (15)$$

Write Equation (14) as follows:

$$B = \begin{bmatrix} b_{11} & b_{12} & \cdots & b_{1n} \\ b_{21} & b_{22} & \cdots & b_{2n} \\ \vdots & \vdots & \vdots & \\ b_{n1} & b_{n2} & \cdots & b_{nn} \end{bmatrix}. \quad (16)$$

B is the complete CC matrix. Then, Equation (17) can be written as

$$B = A + BA. \quad (17)$$

Therefore,

$$B = (I - A)^{-1} - I. \quad (18)$$

2.3. Total Requirement Coefficient. The total requirement coefficient matrix is also known as Leontief inverse matrix, which means that the quantity of total products that Sector i needs to add when Sector j wants to add a unit of final products. The total requirement coefficient reflects the total demand for the total product of each sector to produce a unit of final product by a sector [20, 21]. Making use of the total requirement coefficient, the demand for the production scale and structure of the whole society to produce certain final products can be calculated [22]. Conversely, the total requirement coefficient can be used to calculate the final product quantity that can be provided when a certain production scale, and its structure is known. The importance of the total requirement coefficient lies in the fact that some multipliers (impact multipliers) reflecting the interrelationships between sectors can be calculated based on it.

Equation (19) can be obtained from Equation (12) and Equation (16) in 2.2.2.

$$\text{X} = \text{BY} + \text{Y}. \quad (19)$$

It is another form of the relationship between X and Y. It can be seen from Equation (10) and Equation (12) that the matrix $(I - A)^{-1}$ plays an important role. If $\widetilde{B} = (I - A)^{-1}$, the formula (11) can be written as the Equation (18).

$$X = \widetilde{B}Y. \quad (20)$$

$\widetilde{B}$ is called the total requirement coefficient matrix, also known as Leontief inverse matrix, and its element $\widetilde{b}_{ij}$ becomes the total requirement coefficient, or Leontief inverse coefficient. The economic significance of $\widetilde{b}_{ij}$: the quantity of total products that Sector i needs to add when Sector j wants to add a unit of final products. See Equation (20). According to Equation (18), $\widetilde{b}_{ij}$ has the following relationship with b_{ij}, such as Equation (21).

$$\widetilde{b}_{ij} = b_{ij}, i \neq j; \widetilde{b}_{ij} = 1 + b_{ij}, i = j. \tag{21}$$

2.4. Multiplier Effect Analysis. Multiplier effect analysis includes induction analysis, influence extent analysis, induction coefficient analysis, and influence extent coefficient analysis [9]. The induction and influence extent can be obtained from the total requirement coefficient. By induction and influence extent with their average levels, the induction coefficient and influence extent coefficient (also known as influence extent coefficient) can be obtained.

2.4.1. Induction Analysis. Induction indicates the total output value to be increased by the Sector i for each additional unit of the final demand of each sector in the NES. Induction μ_i of Sector i is defined as Equation (22).

$$\mu_i = \sum_{j=1}^{n} \widetilde{b}_{ij}, i = 1, \ldots, n, \tag{22}$$

where, $\widetilde{b}_{ij}$ is the total requirement coefficient. According to Equation (22), the induction of Sector i is the sum of the elements in row i of the total demand matrix.

2.4.2. Influence Extent Analysis. Influence extent indicates the growth of the total output of each sector of the NES when the final product of the Sector j increases by one unit. Influence extent ρ_j of Sector i is defined as Equation (23).

$$\rho_i = \sum_{i=1}^{n} \widetilde{b}_{ij}, j = 1, \ldots, n, \tag{23}$$

where, $\widetilde{b}_{ij}$ is total requirement coefficient. It can be seen from Equation (23) that the influence extent of the Sector j is the sum of the elements in the column j of the total demand matrix.

2.4.3. Induction Coefficient Analysis. The induction coefficient represents the ratio of average value of the induction of the Sector i to the induction of each sector of the NES. It reflects the comparative relationship between the total product quantity required to be increased by Sector i and the average level of the total product required to be increased by each sector when the final product of each sector of the national economy is increased by one unit. Take E_i as the induction coefficient, as shown in the following Equation (24).

$$E_j = n \frac{\sum_{j=1}^{n} \widetilde{b}_{ij}}{\sum_{i=1}^{n} \sum_{j=1}^{n} \widetilde{b}_{ij}}. \tag{24}$$

It can be obtained from Equation (20) that when the induction coefficient $E_i > 1$, it means that the induction degree of the Sector i is higher than the social average induction level (the average value of the induction degree of each sector); when induction coefficient $E_i = 1$, it indicates that the induction degree of Sector i is equal to the average social induction level; when the induction coefficient $E_i < 1$, it indicates that the induction degree of the Sector i is lower than the social average induction level.

2.4.4. Influence Extent Coefficient Analysis. The influence extent coefficient indicates the ratio of average level of the influence extent degree of the Sector j to the average level of the influence extent degree of each sector of the national economy, which reflects the level of the influence extent degree of the Sector j. Take F_j as the induction coefficient, as shown in the following Equation (25).

$$F_j = n \frac{\sum_{i=1}^{n} \widetilde{b}_{ij}}{\sum_{i=1}^{n} \sum_{j=1}^{n} \widetilde{b}_{ij}}. \tag{25}$$

It can be obtained from Equation (21) that when the influence coefficient $F_j > 1$, it indicates that the influence degree of the production of the Sector i on other sectors exceeds the average social influence level (that is, the average value of the influence on each sector); when influence coefficient $F_j = 1$, it indicates that the influence degree of the production of the Sector j on other sectors is equal to the average social influence level; when the influence coefficient $F_j < 1$, it indicates that the influence degree of the production of the Sector j on other sectors is lower than the average social influence level. Obviously, the greater the influence coefficient F_j, the greater the pulling effect of Sector j on other sectors.

2.5. Partial Multiplier Analysis. In the initial input in quadrant III of the IOTB, the depreciation of fixed assets is excluded to obtain the net output value of the sector, that is, the newly created value. The sum of the newly created values of the whole society is the national income (a part of the added value). The newly created value of a certain sector divided by the total input of the sector is the newly created value rate, which is also called the technical coefficient of national income. With the data in the IOTB of automobile manufacturing industry, the technical coefficient of national income of each sector can be calculated from the perspective of automobile manufacturing economy, and then, the partial multiplier of national income of each sector can be calculated [23].

The economic significance of the partial multiplier of national income is: the increase in national income caused by the increase of total output of each sector due to the addition of a unit of final product in a certain sector in the NES. Assuming that the column vector composed of column j elements of the total requirement coefficient matrix $\widetilde{B}$ (whose economic significance is that the total output to be increased by each sector when a unit of final product is added to Sector J; see Equation (20) in Part I) is denoted as b_j, and the row vector composed of technical coefficients of national income is N, then, the partial multiplier M_{pj} of national income in Sector j is defined as Equation (26).

Table 2: Economic Benefit Indexes to be Calculated.

Index	Formula	Index	Formula
Total input profit and tax rate	$\alpha = M/X$	Cost output rate	$\varepsilon^{(2)} = X/C + D + V$
Initial input profit and tax rate	$\gamma = M/X - C$	Net cost output rate	$\theta^{(2)} = N/C + D + V$
Net output value rate	$\beta = N/X$	Cost profit and tax rate	$\lambda^{(2)} = M/C + D + V$
Material consumption output rate	$\varepsilon^{(1)} = X/C + D$	Reward output rate	$\varepsilon^{(3)} = X/V$
Net material consumption output value rate	$\theta^{(1)} = N/C + D$	Net reward output value rate	$\theta^{(3)} = N/V$
Material consumption profit and tax rate	$\lambda^{(1)} = M/C + D$	Reward profit and tax rate	$\lambda^{(3)} = M/V$

C, intermediate inputs; *D*, depreciation of fixed assets; *X*, total output; N, net output value; *M*, net production tax; V, remuneration for workers.

Table 3: Top 10 industries for direct CC.

Industry	Direct CC	Ranking
Automobile parts and accessories	0.3120	1
Complete automobile	0.0802	2
Retail	0.0390	3
Wholesale	0.0358	4
Business services	0.0235	5
Steel calendered products	0.0224	6
Battery	0.0153	7
Boiler and initial equipment	0.0152	8
Furniture	0.0145	9
Road freight transportation (FT) and auxiliary activities (AA)	0.0138	10

Table 4: Top 10 industries for direct contribution coefficient.

Industry	Direct contribution coefficient	Ranking
Complete automobile	0.0802	1
Special equipment for mining, metallurgy (MM), and construction	0.0290	2
Special machinery for agriculture, forestry, animal husbandry, and fishery	0.0146	3
Material handling equipment	0.0129	4
Road FT and transportation AA	0.0058	5
Urban public transport (UPT) and highway passenger transport (HPT)	0.0043	6
Railway transportation and urban rail transit equipment	0.0029	7
Non-ferrous metal ore mining products	0.0029	8
Non-metallic ore mining products	0.0028	9
Automobile parts and accessories	0.0015	10

Table 5: Top 10 industries for complete CC.

Industry	Complete CC	Ranking
Automobile parts and accessories	0.5070	1
Non-ferrous metal and alloy	0.0957	2
Business services	0.0923	3
Wholesale	0.0923	4
Complete automobile	0.0888	5
Retail	0.0839	6
Steel calendered products	0.0737	7
Electric power and heating power production and supply	0.0730	8
Electronic components	0.0616	9
Monetary finance and other financial services	0.0615	10

Table 6: Top 10 industries for full contribution coefficient.

Industry	Full contribution coefficient	Ranking
Complete automobile	0.0888	1
Special equipment for MM and construction	0.0379	2
Special machinery for agriculture, forestry, animal husbandry, and fishery	0.0191	3
Material handling equipment	0.0171	4
Road FT and transportation AA	0.0072	5
UPT and HPT	0.0057	6
Railway transportation and urban rail transit equipment	0.0049	7
Non-ferrous metal ore mining products	0.0049	8
Non-metallic ore mining products	0.0045	9
Automobile parts and accessories	0.0038	10

Table 7: Top 10 Industries for total requirement coefficient.

Industry	Total requirement coefficient	Ranking
Complete automobile	0.0888	1
Special equipment for MM and construction	0.0379	2
Special machinery for agriculture, forestry, animal husbandry, and fishery	0.0191	3
Material handling equipment	0.0171	4
Road FT and transportation AA	0.0072	5
UPT and HPT	0.0057	6
Non-ferrous metal ore mining products	0.0049	7
Non-metallic ore mining products	0.0049	8
Railway transportation and urban rail transit equipment	0.0045	9
Mining AA and other mining products	0.0038	10

Table 8: Ranking of induction and induction coefficient of automobile industry chain.

Industry	Induction	Induction coefficient	Ranking
Electric power and heating power production and supply	14.1310	4.9980	1
Electronic components	13.2620	4.6906	2
Agricultural products	12.2008	4.3153	3
Monetary finance and other financial services	12.0086	4.2473	4
Business services	11.9349	4.2212	5
Wholesale	9.9519	3.5199	6
Refined petroleum and nuclear fuel processed products	9.2600	3.2752	7
Basic chemical raw materials	9.2212	3.2614	8
Automobile parts and accessories	5.3178	1.8808	22
Complete automobile	1.2991	0.4595	124

Table 9: Ranking of influence extent and influence extent coefficient of automobile industry chain.

Industry	Influence extent	Influence extent coefficient	Ranking
Computer	4.1132	1.4548	1
Audio and visual equipment	3.9711	1.4045	2
Communication equipment	3.9667	1.4030	3
Radio and television equipment, radar and corollary equipment	3.8699	1.3687	4
Electronic components	3.7886	1.3400	5
Cultural and office machinery	3.7602	1.3300	6
Knitted or woven products	3.7172	1.3147	7
Other electrical machinery and equipment	3.6890	1.3048	8
Automobile parts and accessories	3.4924	1.2352	14
Complete automobile	3.4277	1.2124	20

$$M_{pj} = Nb_j. \quad (26)$$

2.6. Economic Benefit Analysis. In early 2009, the Chinese government reduced the sales tax on small size vehicles. It was 10% initially which was reduced to 5%. This decision stimulated the auto demand. Sales of automobile in the criterion hiked by 0.6 million [13]. In the IOTB of automobile manufacturing industry, there are both input data and output data. With these data, we can calculate various economic benefit indexes, and then, analyze the economic benefits of sectors. The economic benefit indexes to be calculated are shown in Table 2.

2.7. Industrial Structure Analysis. Industrial structure analysis refers to the research and analysis of industrial composition, the proportional relationship among the industries and their characteristics. Input-output method is an influential tool for analysis of industrial structure. This paper mainly studied and analyzed the intermediate demand rate (IDR), intermediate input rate, final product structure, and added value structure of China's industrial sector from the perspective of automobile manufacturing economy.

2.8. Analysis of Intermediate Demand and Intermediate Input. The IDR reflects how much of the total output of each sector is needed by other sectors as intermediate products (such as raw materials or fuels). Generally speaking, the higher the IDR of a sector, the larger the part of its output used as the intermediate use of other sectors, and the more the characteristics of a basic sector. The intermediate input rate refers to the ratio of each department's intermediate input to total input. This index indicates the quantity of intermediate products that each department needs to purchase from other departments for a unit of total output in its own production activities. It reflects the strength of the department's pulling effect on the other departments. By comparing the IDR with the intermediate input rate, we can see the position and role of each major department in economic development.

2.9. Analysis on Final Product Structure and Added Value Structure. Final products refer to the material products and services that are provided to the society for consumption & use and have been processed & entered the market in the field of production within a specific time period, or have been withdrawn or temporarily withdrawn from the production activities of current period. The final product is composed of final consumption (resident + government), total capital formation (total fixed asset formation, inventory increase), and call-out. By studying the structure of final products, we can learn the proportional relationship between accumulation and consumption, the consumption structure and the market share of products in each department. The added value includes fixed asset depreciation and newly created value. By studying the composition of added value, we can learn the contribution of each department to GDP.

2.10. Analysis on Product Structure and Production Factor Input Structure. The so-called product structure refers to the proportional relationship between intermediate products and final products, as well as the internal proportional relationship of intermediate products, especially the relationship between accumulation and consumption in final products; the so-called production factor input structure denotes the proportional relationship among intermediate input, fixed asset depreciation, and labor requirement.

The final product distribution has two basic directions: consumption and accumulation. The consumption rate denotes the proportion of consumption in all final products, while the accumulation rate denotes to the proportion of accumulation in all final products. In order to quantitatively study the proportion relationship within the industrial structure, it is necessary to calculate the following coefficients as given in Equations (27), (28), and (29).

$$\text{Labor input structure coefficient} = \frac{\text{department labor income}}{\text{department total input}}, \quad (27)$$

$$\text{Fixed asset depreciation coefficient} = \frac{\text{department fixed asset depreciation}}{\text{department total input}}, \quad (28)$$

$$\text{Intermediate product structure coefficient} = \frac{\text{department intermediate input}}{\text{department total input}}. \quad (29)$$

3. Case Analysis

This article is based on the research method in the second section. Data of 153 industries were selected as the IOTB, and the corresponding index parameters were calculated in turn. The top 10 industries for direct CC are shown in Table 3.

The top 10 industries for direct contribution coefficient are shown in Table 4.

The top 10 industries for complete CC are shown in Table 5.

The top 10 industries for full contribution coefficient are shown in Table 6.

The top 10 industries for total requirement coefficient are shown in Table 7.

The ranking of induction and induction coefficient of automobile industry chain is shown in Table 8.

The ranking of influence extent and influence extent coefficient of automobile industry chain is shown in Table 9.

4. Conclusion and Analysis

Though there are many existing literature surveys that elaborate on the importance of the IOM for analyzing the impact of the output of one industry on the input of others, no specific study has been made to assess the influence of the automobile manufacturing industry in China, on its overall economy in

2018. The proposed research studies the importance of the IOM for analyzing the influence of the automobile manufacturing industry in China, on its overall economy. Through the investigation on the influence extent and influence extent coefficient of various industries in 2018, we can see that the automobile manufacturing industry has a high influence on China's overall national economy in 2018. In 2018, the influence extent of automobile manufacturing industry, automobile parts and accessories were 3.4277 and 3.4924, respectively. The influence extent coefficient of automobile manufacturing industry and automobile parts and accessories reached 1.2124 and 1.2352, respectively, and was far higher than the average level of various industrial sectors in the society, indicating that the impact of the automobile manufacturing industry and the production of automobile parts & accessories on other industrial sectors greatly exceeded the average level of social influence. Among the 153 sectors of the overall national economy, the influence extent of automobile manufacturing industry and automobile parts & accessories ranked 20th and 14th; as a result, the automobile manufacturing industry had a high influence on the overall national economy in 2018. In future the proposed model can be extended to be applied to study the impact of other sectors of the economy on the overall economic growth of the nations.

Data Availability

The data used to support the findings of the study can be obtained from the corresponding author.

Conflicts of Interest

The authors declare that they have no conflicts of interest regarding this article.

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