Phosphate Fertilizer Industry Capacity Reduction Policy in China, Based on CGE Model*

Yu Qingqing, Chalermchai Panyadee, Somkid Kaewthip and Bongkochmas Ek-lem
School of Administrative Studies, Maejo University, Thailand
Corresponding Author, E-mail: mju6005501013@mju.ac.th

Abstract

This study tries to research phosphate fertilizer industry policy in China by qualitative analysis and quantitative analysis. Based on an analysis of the government's macro policies that have had a significant impact on phosphate fertilizer industry in recent years, as well as the current research situation in relevant fields at home and abroad, a Computable General Equilibrium model for phosphate fertilizer industry in China is constructed through the computable general equilibrium model theory, input-output theory, social accounting matrix theory, and GAMS programming method. Relevant basic data are collected, and a model database is established. A static Computable General Equilibrium (CGE) model is used to comprehensively evaluate and analyze the impact of export policies and value-added tax policies on relevant variables of phosphate fertilizer industry and macroeconomic. On the one hand, the research expands the development and application of CGE model research methods in China, on the other hand, it achieves a comprehensive evaluation of the effects of phosphate fertilizer export policies and value-added tax policies, and provides a useful reference for government decision-making.

Keywords: Phosphate Fertilizer; the Computable General Equilibrium (CGE) models; Food Safety; Overcapacity

---

*ได้รับบทความ: 8 เมษายน 2566; แก้ไขบทความ: 8 ธันวาคม 2566; ตอบรับตีพิมพ์: 12 ธันวาคม 2566
Received: April 8, 2023; Revised: December 8, 2023; Accepted: December 12, 2023

1. Introduction

Phosphate fertilizer industry in China has experienced a development from nothing, from small to large, from single nutrient, low concentration to high concentration, compounding and multi-variety. China has gone through a process of role the world phosphate fertilizer market, from imported phosphate fertilizer products to imported phosphate fertilizer technology, finally to export phosphate fertilizer country. During the process from the rising to be the world's largest phosphate fertilizer producer, industry policy has always played a crucial role.

The sustained and healthy develop ment of phosphate fertilizer industry is related to national food security, agricultural security, environmental security and economic security. Phosphorus rock, the raw material of fertilizer production, is a limited amount of non-renewable resources. China has implemented a socialist market economy system with Chinese characteristics since 1978. The macro-control policy is very important to ensure the healthy and stable development of the national economy. Overcapacity of phosphate fertilizer has become an extremely important and serious issue facing Chinese economy. The government urgently needs to formulate a scientific and rational policy for capacity allocation of phosphate fertilizer industry. The constraints of phosphate rock resources can be significantly transmitted to the phosphate fertilizer industry (Springer, 2017, pp. 319-328), ultimately threatening the safety of food production. Therefore, the capacity management of phosphate fertilizer industry is urgent and necessary. Wu (2016, pp. 45-54) estimated the phosphorus loss in Anhui Province in 2011 is about 398 kt, which is significantly higher than the amount of chemical fertilizer used in the same year (329 kt).

It is generally believed that the capacity utilization rate of phosphate fertilizer is less than 79%, which means that there is excess capacity. It can be seen that the production capacity of industry has been in surplus in recent years. (Fig.1) at present, the overcapacity of basic fertilizers in the phosphate and compound fertilizer industry and the shortage of high-end fertilizers exist simultaneously, and supply-side structural reforms still need to be accelerated. De-capacity, restructuring, and improving core competitiveness remain the main tasks.

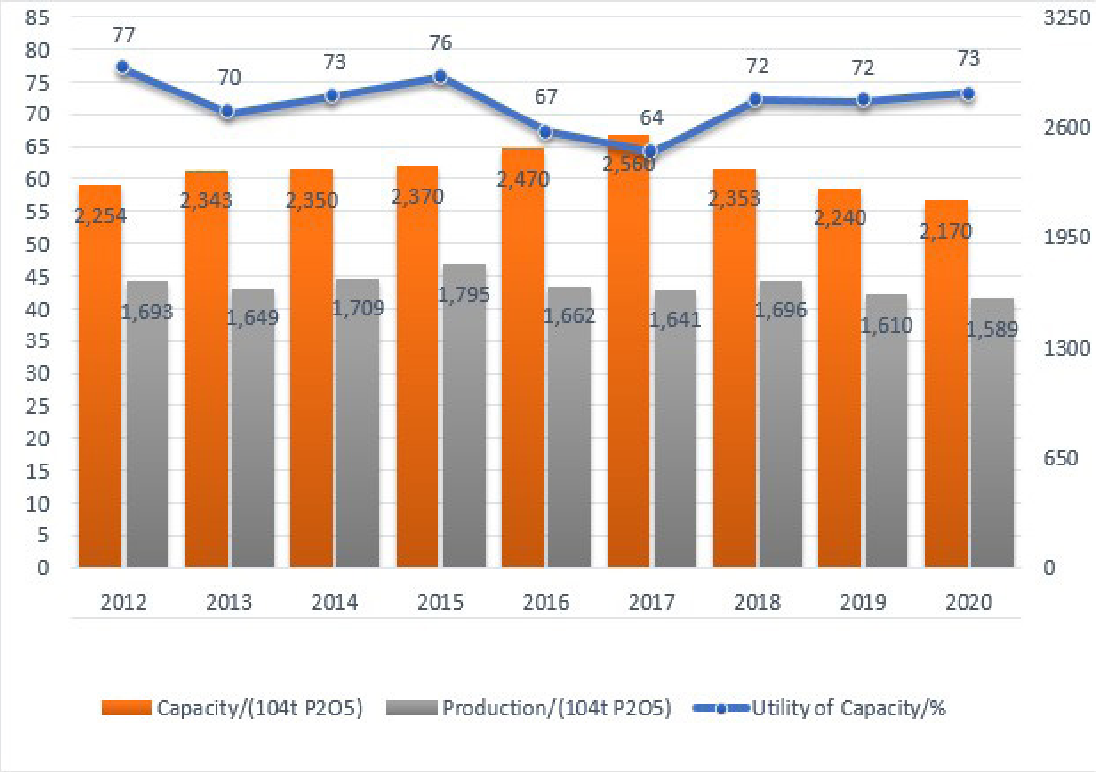

Figure 1 Phosphate Fertilizer Capacity, Production and Utility rate in China from 2012 to 2020 (Data source: Phosphate and Compound Fertilizer Industry Association)

2. Research Objectives

1. To study the current phosphorus fertilizer policies and analyze the impact on the capacity allocation management of phosphorus fertilizer industry in China.

2. To simulate the appropriate capacity allocation policy model for phosphorus fertilizer industry in China.

3. To propose the appropriate capacity allocation management policy model for phosphorus fertilizer industry in China.

3. Methods

The location of this research is the phosphorus fertilizer industry policy in China. The research regions is the nationwide of Chinese phosphorus fertilizer industry and the national policies from Chinese government.

1. Qualitative Method and Quantitative Method

First, this paper applies the literature analysis method, policy theoretical tools, and policy cycle theory to study, classify, and summarize phosphate fertilizer industry in China, and concludes the main eight categories of industrial policies and three policy stage of phosphate fertilizer industrial policies. Based on the above research, an interview questionnaire was designed to investigate several major phosphate fertilizer companies in Yunnan by using interview to understand the current situation of the phosphate fertilizer industry affected by policies in recent 10 years, and the main policies affecting the production plan of phosphate fertilizer producers and the profit of phosphate fertilizer companies were obtained. Finally, based on the research on the industrial policies that will have a significant impact on the phosphate fertilizer industry, the CGE model of phosphate fertilizer industrial policy in China is constructed, and the empirical analysis is used to study how to optimize the current phosphate fertilizer industrial policy through policy simulation.

2. Data Collection Tools

2.1 An Interview Design

An interview questionnaire was designed to investigate several major phosphate fertilizer companies in Yunnan by interview. To understand the current situation of the phosphate fertilizer industry affected by policies in recent years, and the main policies can affect the production plan of phosphate fertilizer producers and the profit of phosphate fertilizer companies were obtained.

2.2 Build the Data base of CGE Model (Cong, 2014, pp. 1-11) for phosphate fertilizer industry: Chinese Social Accounting Matrix (SAM)

According to the research objective and research methods of this study, the key data will be gathered from secondary data mostly obtained from public information release. Capacity allocation policies need to be formulated and implemented nationwide by the government, and the data of individual companies are not representative. Therefore, the data sources of this paper are mainly based on the macroeconomic data of phosphate fertilizer industry in China.

The macroeconomic data of phosphate fertilizer in China mainly come from the“China Statistical Yearbook”,“China Industrial Statistical Yearbook”, “China Economic Census Yearbook”, “China Energy Statistical Yearbook”, “The input-output table”, “China Financial Yearbook”, “China Tax Yearbook”. The main data resource comes from National Bureau of Statistics of China.

In order to achieve the CGE model, firstly it is necessary to assign values to the exogenous variables and parameters in the model. This is also a prerequisite for simulation implementation. The Social Accounting Matrix (SAM) can meet the requirements of the CGE model data set. Therefore, the preparation of the SAM table needs to be based on the basic assumptions of the CGE model. Firstly, the supply and demand of commodities are equal. Secondly, all industries have zero profits; thirdly, they meet the requirements of budgetary constraints; Finally, international needs remain balanced. In fact, the SAM has become the most common form of standard data organization for the CGE. As of now, the input-output extension table 2017 has been released. The macro SAM provides a total control reference for the microscopic SAM of the segment. The accounts in table 1 are properly classified depending on the study, and finally a macro SAM with an open economy covering 9 categories of accounts is generated.

2.3 Build the Data base of CGE Model for phosphate fertilizer industry: Chinese subdivision Social Accounting Matrix

The macro SAM constructs a comprehensive and consistent framework for Chinese social macroeconomic system. But for the needs of industry policy analysis, more detailed data is needed. So this study needs a subdivision SAM based on the Chinese macro SAM in 2017 (Chowdhury, 2017, pp. 945-963). In order to be consistent with the division of the 2017 input-output table, and taking the possibility of actually data collection into account. If the division is too detailed, data collection cannot be achieved. The refined SAM is mainly subdivided into production departments, institutions, production factors, and taxes. After splitting and merging, the 21 departments Chinese subdivision SAM of this study was formed.

4. Results

1. Phosphate fertilizer industrial policy in China

This study focus on the phosphate fertilizer industrial policy, so it is necessary to analyze and sort out industry policies from 1950 to the present. By listing a list of policy documents issued by a large number of Chinese governments and analyzing sufficient literature, it is concluded that there are main eight phosphate fertilizer industry policies in China.

1.1 Main PF industry policies in China. There are eight types of PF industry policies in China. These eight industrial policies have profoundly affected the development of Chinese PF industry in terms of phosphate raw materials, freight, prices, environmental protection costs, demand, application volume and foreign trade. (Fig. 2)

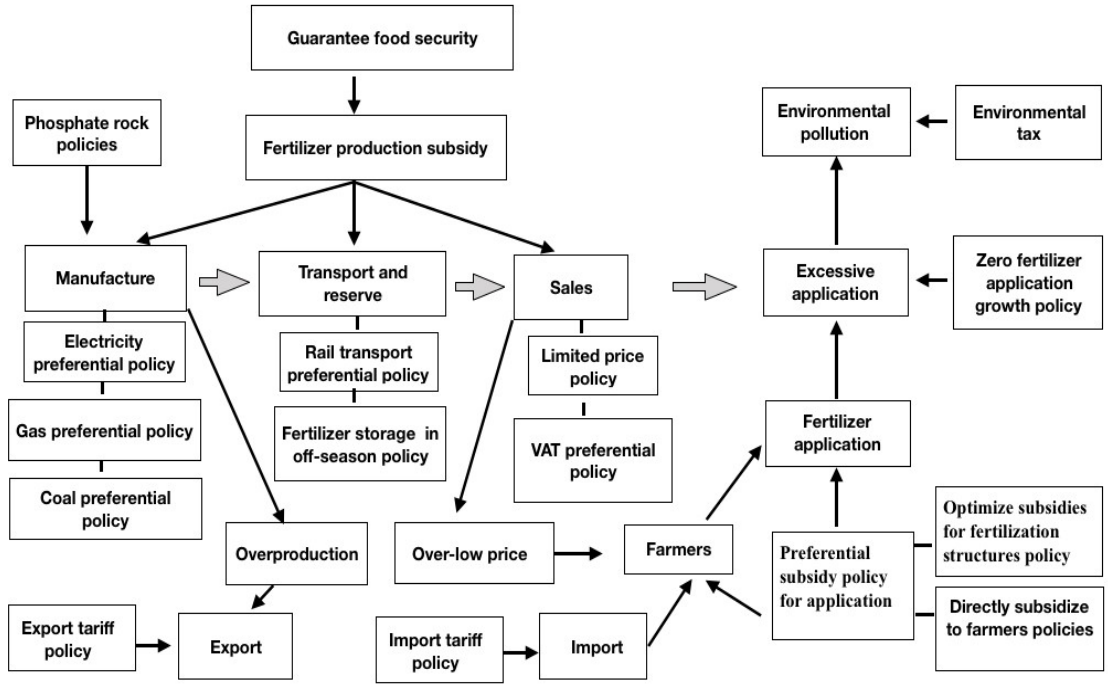

Figure 2 Main phosphate fertilizer industry policies

1.2 Three historical development stage

By applying the policy cycle theory and combining the development of phosphate fertilizer industry and the history of the promulgation and change of eight major policies, it is concluded that the history of phosphate fertilizer industry policy in China can be divided into three historical cycles. PF industrial policy in China has experienced three historical periods: "supporting period, planning management period and adjustment period" (Fig. 3). At present, phosphate fertilizer industry policy is in the third stage of historical adjustment (Gao, & Zhang, 2011, pp. 1-4).

Facing the contradiction of overcapacity in the phosphate fertilizer industry, how to evaluate the existing industry policy and optimize the design of phosphate fertilizer capacity allocation is the primary goal of phosphate fertilizer industry policy.

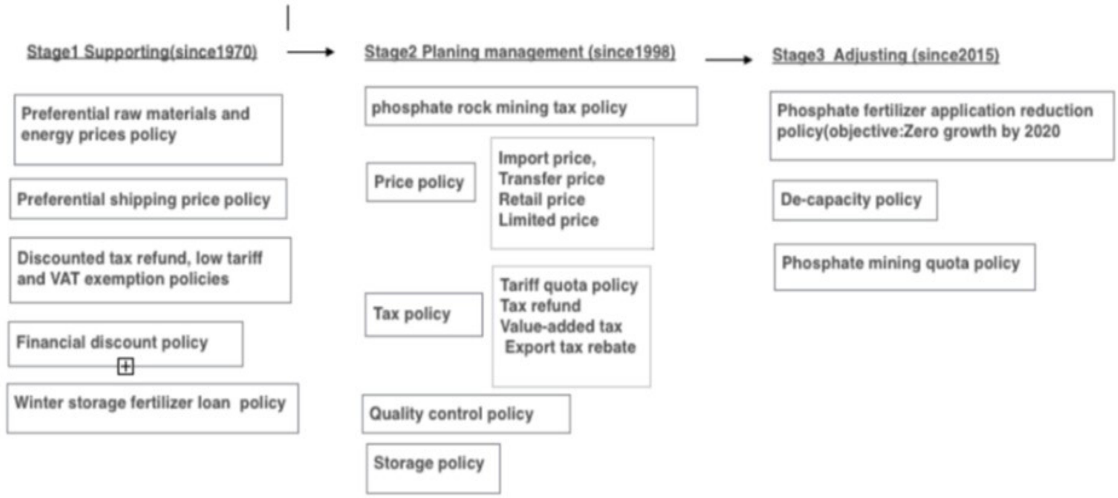

Figure 3 Historical development stage of phosphate fertilizer industry

1.3 Results of Interview

The subsidy policies previously adopted by the government for a long time have been largely abolished. Since the Chinese government put forward the Action Plan for Zero Growth of Fertilizer Use by 2020 in September 2017, the policy has indeed reduced the consumption of phosphate fertilizer, and the application of phosphate fertilizer in China has decreased year by year. For most enterprises, due to the reduction of domestic demand, expanding exports has become an inevitable choice to resolve the domestic surplus phosphate fertilizer production capacity. Faced with the dilemma of overcapacity, respondents from several companies said that the policies that will have a significant impact on the phosphate fertilizer industry in the past five years mainly include export policy, value-added tax policy and phosphate rock resource tax policy.

Export restriction policy

In terms of export tariffs, China will no longer impose export tariffs on potassium chloride, potassium sulfate, compound fertilizer and other chemical fertilizer commodities (Han, 2009). The complete elimination of export tariffs is conducive to reducing the pressure of domestic overcapacity by increasing exports. Many phosphate fertilizer manufacturers have also begun to make profits through export. However, under the situation that the Chinese government attaches great importance to “food security”, in order to ensure the supply of phosphate fertilizer to domestic agriculture, the macro-control goal of the phosphate fertilizer industry is first to ensure domestic demand, so from 2021, the Chinese government began to control the export of phosphate fertilizer and began to implement a series of strict export restrictions. As a result, the overall operating rate of the phosphate fertilizer industry is not high and the supply is limited.

Legal inspection policy for phosphate fertilizer export

On October 11, 2021, the General Administration of Customs of the People's Republic of China issued the Announcement of the General Administration of Customs on Adjusting the Catalogue of Import and Export Commodities Subject to Inspection (No. 81, 2021). According to the interview, due to the complicated legal inspection procedures for phosphate fertilizer export, the export of phosphate fertilizer enterprises has been subject to many restrictions, and even caused the general shutdown of enterprises. Medium and low concentration phosphate fertilizer enterprises in Yunnan are facing a life-and-death situation, and enterprises urgently appeal to speed up customs clearance. The enterprise said that if it goes on like this for a long time, the enterprise will inevitably lose money and close down. Finally, the international market will lose money and the domestic market will not be guaranteed.

Export quota system

The export quota of phosphate fertilizer is basically determined, and the price of phosphate fertilizer will improve in the following or peak season of agricultural demand. Due to the high price of domestic phosphate rock, the price of phosphate fertilizer products continued to rise, leading to the tightening of domestic phosphate fertilizer export policy. The total export quota of phosphate fertilizer is about 3.6 million tons, including monoammonium, diammonium, heavy calcium, superphosphate and nitrogen-phosphorus binary compound fertilizer. The quota amount of production enterprises includes the total amount of phosphate fertilizer output that the enterprise needs to export. At present, due to the uncertain export process, the export of phosphate fertilizer is suspended, and the price of phosphate fertilizer has dropped due to the low season of domestic agricultural demand. With the arrival of the autumn agricultural peak season and the determination of export policy, the demand will warm up and the price of phosphate fertilizer is expected to rise.

Value added tax

Before 2000, in order to support the development of phosphate fertilizer industry, the Chinese government exempted value-added tax on phosphate fertilizer. Since 2000, because phosphate fertilizer products have become self-sufficient, in order to cooperate with the domestic policy of "production for production", phosphate fertilizer will no longer be exempt from value-added tax, but will be taxed at 13%. By January 1, 2008, the Chinese government has exempted value-added tax on phosphate fertilizer. In 2017, the Chinese government issued the Notice on the Policy of Resuming the Levy of Value-added Tax on Chemical Fertilizers, which changed from VAT exemption to VAT collection. The sales and import of chemical fertilizers will be subject to domestic and import value-added tax at a uniform rate of 13%.

However, the interviewees believed that the levy of VAT had no obvious impact on the long-term cost of the industry, but would have an impact on the local market before and after the starting point of the levy due to the uncertainty of the buffer period and the different adjustment speed of enterprises. Some interviewees believed that the resumption of VAT meant a substantial step forward in the marketization of chemical fertilizer products and helped to eliminate backward production capacity in the industry to a certain extent. Value-added tax generally results in a cost increase of 1% to 3.5% for phosphate fertilizer products.

2. CGE Models for PF industrial policy in China

This model is centered on the LHR model (the standard CGE model developed by the International Food Policy Institute, Lofgren, (Harris, and Robinson, 2002) and consists of four components: the production market, the commodity market, the economic entity, and the macro equilibrium. This paper aims to control and influence the PF industry from phosphate mining to production process through policy shocks, to study the impact of industrial policy under different scenarios on macroeconomics, household consumption, and agricultural product prices. There are 34 sets of endogenous variables and 14 sets of exogenous variables. Zhang (2017, pp. 3349-3354) used a dynamic CGE model with energy and carbon emission modules to evaluate the impacts under different scenarios.

3. Policy simulation and result analysis

Based on the qualitative research in this paper, the macro policies of the government that have a great impact on the phosphate fertilizer industry in recent years are simulated. First, the model is run to obtain the baseline scenario without any policy disturbance until 2017. Then simulate each policy adjustment scenario, and compare the policy scenario results with the baseline scenario results, so as to obtain the dynamic changes of indicators under various policy scenarios, and analyze the effects of different policy adjustments on the phosphate fertilizer industry. This study is divided into three scenarios for policy simulation. Focus on the impact of policies on the output of the phosphate fertilizer industry, the impact of macroeconomic and the impact of residents' income.

3.1 Industrial value-added tax policy simulation

In order to control the output of phosphate fertilizer, or increase the production and sales costs of phosphate fertilizer products. This paper simulates the value-added tax policy of phosphate fertilizer products, and adjusts it from the current 10% value-added tax rate to 13%. The level of value-added tax has a direct impact on the sales price of PF products and the profits of enterprises. This will affect the production and capacity changes of the PF industry.

(1) Changes in macroeconomic indicators

Total absorption, household consumption, government consumption, total investment, export, import nominal GDP and real GDP are selected as macroeconomic indicators. See the following table for policy simulation results. It can be seen that with the increase of value-added tax, the production price of phosphate fertilizer products has increased correspondingly, and the total consumption has increased as a whole. Government revenue increased and government consumption increased. The consumption of residents increased by 0.00008%, and the total investment decreased. As the price of products in related industries rises after the increase, the export decreases correspondingly and the import volume increases. The impact on GDP is reflected in the impact on real GDP, which has declined to a certain extent. It is mainly affected by the reduction of investment and total absorption.

(2) Industrial effect analysis

To Increase the value-added tax of phosphate fertilizer industry and simulate the impact of policy changes on various industries mainly through the price, output, factor price and factor input of the production and commodity sectors. It reflects the changes in output prices, intermediate input prices and value-added prices of various industrial sectors. It can be seen from the table that the agricultural sector is the most affected by the policy. The increase in the price of phosphate fertilizer will correspondingly increase the cost of agricultural products and thus affect the price of agricultural products. In domestic sales prices and composite commodity prices, the price change trend of each department directly related to the phosphate fertilizer industry is the same as that of the phosphate fertilizer industry.

Through the change of output, total intermediate input and value-added input of the production department. It can be seen from the table that in the change of output, in addition to the reduction of phosphate fertilizer output, the output of the agricultural sector also decreased, and the output of the upstream phosphate rock industry decreased. It can be found that the phosphate fertilizer industry is directly affected, while other industries are mainly indirectly affected.

3.2 Simulation of phosphate fertilizer export policy

In terms of export tariffs, before 2009, the country's policy in all aspects of fertilizer production and marketing was basically based on fertilizer to ensure food production. In order to ensure the domestic demand for chemical fertilizers, the country has set a high export tariff of chemical fertilizers, which can be levied up to 110%. According to the Notice of the Tariff and Tariff Commission of the State Council on the Interim Tariff Adjustment Scheme for Import and Export in 2019 issued by the Tariff and Tariff Commission of the State Council, since January 1, 2019, China will no longer impose export tariffs on potassium chloride, potassium sulfate, compound fertilizer and other chemical fertilizer commodities.

In order to analyze the impact of phosphate fertilizer export policy on the phosphate fertilizer industry and macroeconomic, the phosphate fertilizer export quota was simulated. In 2017, 1.8413 million tons of phosphate fertilizer were exported. A policy simulation scenario was set to reduce the export volume of phosphate fertilizer to 1.4 million tons.

(1) Impact results in macro economic indicators

It can be seen that with the reduction of the export volume of phosphate fertilizer, the production price of phosphate fertilizer products has decreased correspondingly, and the total consumption has declined as a whole. Government tax revenue and government consumption decreased. Residents' consumption and total investment decreased. As the price of products in related industries rises after the increase, the export decreases correspondingly and the import volume increases. The impact on GDP is reflected in the impact on real GDP, which has declined to a certain extent.

(2) Impact results in Industrial sectors

With the reduction of the export volume of phosphate fertilizer Increase the value-added tax of phosphate fertilizer industry and simulate the impact of policy changes on various industries mainly through the price, output, factor price and factor input of the production and commodity sectors. It can be seen from the table that phosphate rock has been greatly impacted by the policy and the price has declined. The agricultural sector was impacted by policies and prices fell.

In domestic sales prices and composite commodity prices, the price change trend of each department directly related to the phosphate fertilizer industry is the same as that of the phosphate fertilizer industry reflects the changes in output prices, intermediate input prices and value-added prices of various industrial sectors. It can be seen from the table that the agricultural sector is the most affected by the policy. The increase in the price of phosphate fertilizer will correspondingly increase the cost of agricultural products and thus affect the price of agricultural products. In domestic sales prices and composite commodity prices, the price change trend of each department directly related to the phosphate fertilizer industry is the same as that of the phosphate fertilizer industry.

This research took China's phosphorus fertilizer industry as the research object. The policy tool theory was used to sort of and conclude the phosphorus fertilizer industry in China. The policy cycle theory was used to investigate the industrial policy cycle.

The main research results and innovations of this research were as follows: 1) There were eight main phosphate fertilizer industry policies in China phosphorus fertilizer industry policy in China had experienced three historical periods: "supporting period, planning management period and adjustment period". 2) The influencing factors of China's phosphorus fertilizer industry policy selection were systematically analyzed. Based on result of the interview, the policies that had a significant impact on the phosphate fertilizer industry in the past ten years mainly included export policy, value-added tax policy and phosphate rock resource tax policy. This research systematically analyzed the factors affecting the design of industrial policies. 3) The static CGE model of China's phosphorus fertilizer industry was designed for policy simulation and evaluation. China's social macro-social accounting matrix (SAM) and detailed 21-department SAM table for the CGE model was formed through reasonable splitting and merging. Then the value-added tax in sales and the export policy in international trade were set as the policy scenarios.

5. Discussion

The use of chemical inputs is an important symbol of modern agriculture, and chemical fertilizer is the "grain" of grain, which plays a key role in increasing crop production and ensuring national food security. This study focuses on the policies that have a substantial impact on phosphate fertilizer industry in the production and sales links. It comprehensively explains the design of the phosphate fertilizer industry policy framework and policy scenario design from policy design and policy simulation evaluation. CGE Models for PF industrial policy in China obtains policy impact results through GAMS software by simulating two policy scenarios. Finally, according to the analysis of the simulation results, the policy recommendations to promote the optimization phosphate fertilizer production capacity are given.

To simulate industrial value-added tax and phosphate fertilizer export quota policies respectively, and analyze the impact of phosphate fertilizer production capacity policy on economic and social development from the perspective of macroeconomic effects, industrial effects and social welfare effects. The study found that further limiting the export volume of phosphate fertilizer, GDP fell, the price of phosphate fertilizer fell, and the output of phosphate fertilizer fell, which had the largest impact on the price of the primary industry, the smallest impact on the price of the tertiary industry, and the income of rural residents and urban residents increased.

6. Suggestions

The influencing factors of phosphate fertilizer industry policy selection are systematically analyzed. Based on the theoretical basis, this paper systematically analyzes the factors that affect the design of industrial policies. The CGE model of phosphate fertilizer industry was designed. Based on the research results, industrial policy recommendations for further optimizing phosphate fertilizer capacity are put forward. The study found that the use of tax and export policies will have different impacts on phosphate fertilizer industry, and also have different impacts on the macroeconomic.

1. Implications to Policy

The government should revise the export policy every year according to the economic form, appropriately adopt the legal inspection quota system, and flexible the export quota system.

1.1 To make policy to improve the quality of phosphate fertilizer industry.

1.2 To make policy to change the development mode of phosphate fertilizer industry. The phosphate fertilizer industry should fundamentally change the past model of relying solely on capacity expansion. The industry and enterprises should realize that the linear development model of quantity expansion alone cannot continue. In the future, the focus of development should be shifted to improving its own quality.

1.3 To make policy to control the phosphate fertilizer industry accessing. Strict industry access, elimination of backward production capacity and further improvement of industrial concentration are the necessary conditions to control and solve overcapacity.

1.4 To make policy to optimize and strengthen the policy of reducing production capacity. Establish exit mechanism for capacity transfer.

1.5 To make a moderate export of phosphate fertilizer policy. China should allow proper export of phosphate fertilizer and digest some excess capacity. The current tariff policy should be integrated with agricultural subsidies. With the continuous strengthening of agricultural subsidies, the tariff policy should be adjusted in a timely manner. Properly increase the export quota of phosphate fertilizer and further implement zero tariff for phosphate fertilizer export. Appropriate exit mechanism for the legal inspection policy of phosphate fertilizer export.

1.6 To make policy to strengthen resource guarantee.

1.7 To make policy to strengthen support for waste treatment and recycling.

1.8 To make policy to strengthen the agricultural means subsidy, to promote farmers to actively grow grain, stabilize grain area and grain yield, and ensure national food security.

2. Implications to phosphate fertilizer manufacturer

2.1 To change the development mode of phosphate fertilizer industry.

2.2 To change the product structure.

2.3 To promote international development

7. Knowledge Assets

With this study topic found that there are eight main types of Chinese phosphate fertilizer industry policies and three policy cycles of Chinese phosphate fertilizer industry policies. It found the important policies that affect the production plans of phosphate fertilizer producers and the profitability of phosphate fertilizer companies by interview. Based on research on industrial policies that have a significant impact on the phosphate fertilizer industry, a CGE model for phosphate fertilizer industry policy in China was constructed using empirical analysis. This study has found that the CGE policy model can be used to simulate significant policy impacts, as well as the impact of policy changes on the macroeconomic, phosphate fertilizer industry, and other industrial sectors. It provides some policy recommendations for the government on how to optimize current phosphate fertilizer industry policies. As the knowledge assets graphic below:

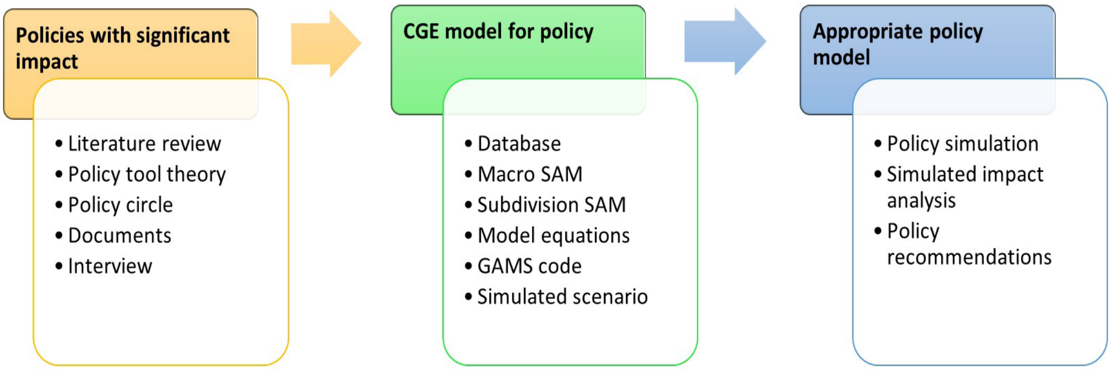

Figure 4 policy recommendations for the government

References

Chowdhury, R. B. (2017). Key sustainability challenges for the global phosphorus resource, their implications for global food security, and options for mitigation. *Journal of Cleaner Production*, 140, 945-963.

Cong, X. N. (2014). Multi-regional CGE simulation of carbon tariffs under the geopolitical economic framework. *Word regional studies*, 23(3), 1-11.

GAO, Y., & Zhang, S. (2011). Thought on adjustment and optimization of phosphate fertilizer industrial distribution in China under the current situation. *Phosphate & Compound Fertilizer*, 26(2), 1-4.

Han, H. (2009). *The Impact of China's tariff policy adjustment on the fertilizer industry and its countermeasures - take Yifu*. China: International Trade Co., Ltd.

Harris, R. I. D., and Robinson, C. (2002). *'Foreign Ownership and Productivity in the United Kingdom. Estimates for U.K. Manufacturing Using the ARD', Mimeograph*. Retrieved from http://www.dur.ac.uk/richard.harris/FDI productivity.pdf

Springer, N. P. (2017). Physical, technical, and economic accessibility of resources and reserves need to be distinguished by grade: Application to the case of phosphorus. *Sci Total Environ*, 577, 319-328.

Wu, H. (2016). A review of phosphorus management through the food system: identifying the roadmap to ecological agriculture. *Journal of Cleaner Production*, 114, 45-54.

Zhang, S. (2017). How shale gas will shape China's future? An evaluation based on dynamic Energy-CGE model. *Energy Procedia*, 105, 3349-3354.