Doctoral Thesis

Study on Industrial performance of renewable resource industry in China

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1. Introduction

1.1 Background and significance

1.1.1 Background

Environmental pollution and resource depletion is an important issue constraining sustainable economic development. As an important access to resources, renewable resources receive more and more attention, and it is the same with related economic activities.

Recycling renewable resources is an effective way to achieve sustainable economic development, and countries all over the world are actively exploring the recycling of resources. Some developed countries have taken measures, such as the legalization of resources recycling and policies to support the renewable resources industry, to encourage the recycling of renewable resources since 1920s and 1930s. Now, the renewable resources industry has become the world's fastest growing sunrise industry, and it has entered a mature stage in developed countries, playing an important role in saving resources and protecting the environment. The development of China’s economy and the rise of recycling economy have brought both opportunities and challenges to the renewable resources industry. The principle of 3R (reduces, reuse and recycle), which is based on circular economy, is of strategic importance to the achievement of China's natural ecosystems and socio-economic virtuous cycle.

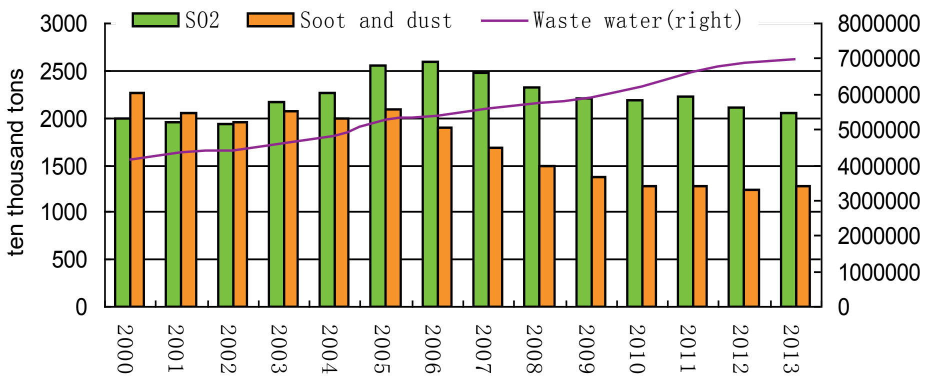

Fig.1-1 Discharge of major Pollutants in China (2000-2013)
Sources: [105].

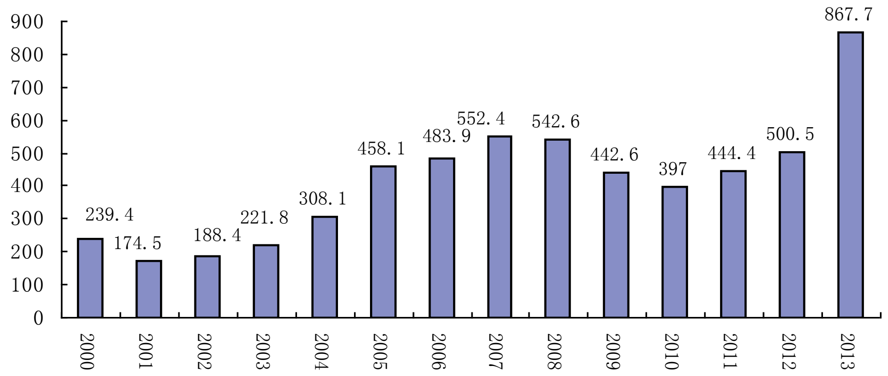

Fig.1-2 Investment Completed in the Treatment of Industrial Pollution (billion Yuan)
Sources: [105].

With China’s further economic development in recent years, the constraints of resource and environment become more extrusive, and it is more evident that resource shortages and environmental pollution pose a grave threat to economic and social development. China's economic development has long followed the extensive traditional economic growth model, which is featured with "three high and one low"(that is, high energy consumptions, high pollution, high emissions and low utilization), bringing resource depletion, environmental pollution and other problems. The emission of SO_2, China’s major pollutants, declines in recent years, but the annual emission is still over 20 million tons; the emission of waster water reached 69,544,330,000 tons in 2013, with an average annual growth rate of 4%; the figure of smoke (powder) reduced gradually after 2005, but remains at around 12.5 million tons in recent years (Fig. 1-1). China adopts the mode of “producing while polluting and governing”, and the high investment in environmental pollution control has become one of the factors restricting China's sustainable economic development. From 2000 to 2013, the average annual investment in pollution control projects of China was about 41.58 billion Yuan (Fig.1-2). Meanwhile, the production of main raw materials such as ferrous metal, ferrous metal, paper and plastics consumes a lot of energy. Figure1-3 shows that in recent years, the energy consumption of metal, paper and plastic accounts for more than 30%; especially, the proportion of ferrous metal smelting and rolling processing industry energy consumption is over 20%. For another, China imports large quantities of this kind of resources products annually. Data show that total imports remain at around $ 200 billion, much of which belongs to plastic and non-ferrous metals; the total import of plastics and plastics products is $ 72.39 billion, and that of non-ferrous metals and non-ferrous metals products is $ 65.363 billion (Fig.1-4).Therefore, increasing the recycling of domestic waste resources products and reducing the imports of raw materials can not only decline energy consumption and improve environment, but also achieve significant economic benefits.

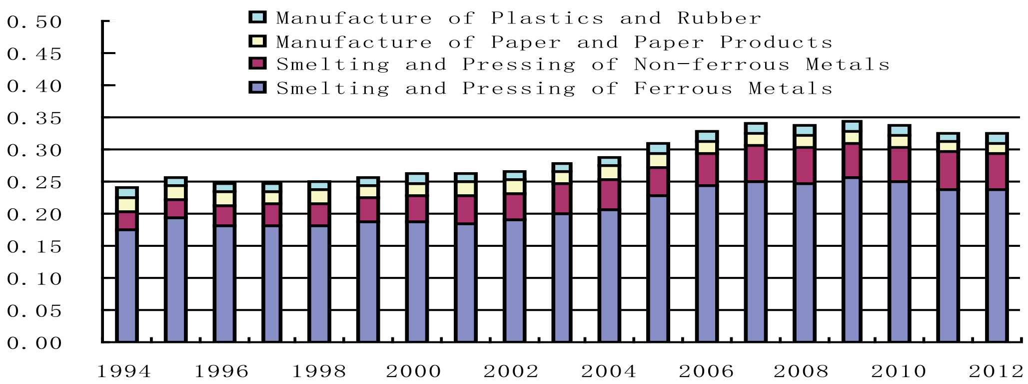

Fig.1-3 Proportion of part of China's energy consumption industry (1994-2013)
Sources: [105].

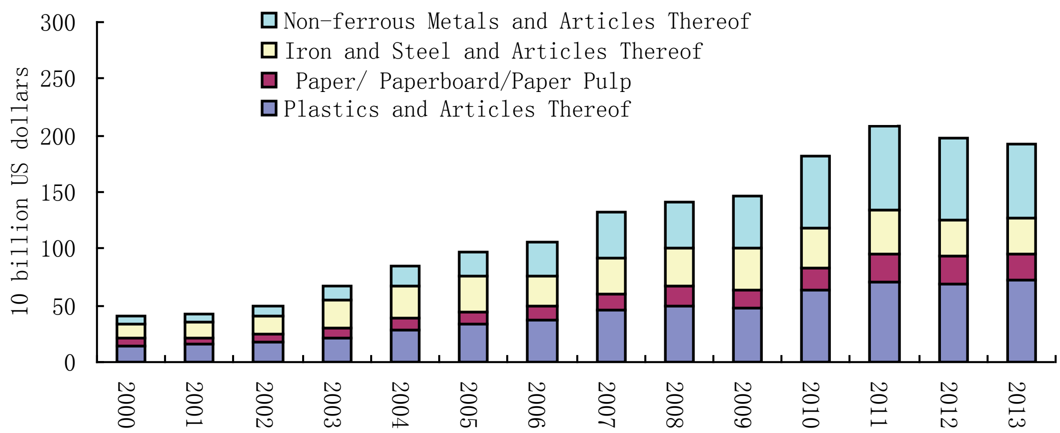

Fig.1-4 Total value of China's major imported resources products (2000-2013)
Sources: [105].

1.1.2 Significance

The background reveals that researching the performance of the renewable resources industry is very important.

First of all, research on the renewable resources industry is helpful for the exploration of how this industry develops. Proper guidance can promote development of the industry, thereby increasing the scale and efficiency of resources recycling; by increasing the recycling of waste resources and reducing imports of raw materials, energy consumption can be reduced and significant economic benefits can be also achieved.

Secondly, if waste materials are not used and disposed effectively, they will cause environmental pollution to a certain extent. Researching the renewable resources industry’s activities, especially the engineering, facilities and means, and applications of renewable resources recycling, enables the waste materials to be used and disposed by a more advanced and less polluted way, thereby reducing waste that gets into terminal processing and decrease problems about land use and pollution.

Thirdly, the waste recycling processing and utilization is essential to the national economy, and the research on the renewable resources industry not only has a demonstration effect on extensive economic growth model, but also helps change people’s vague understanding of the development of this industry. In China, the recycling processing of renewable resources is still not mature, and some wastes that can be used as raw materials are considered as "foreign garbage" and are restricted or prohibited importing. Renewable resources are often seen as “rubbish” or “scrap”, and it is common that activities about waste recycling and processing as well as relevant staff receive some degree of prejudice and discrimination

Fourthly, the renewable resources industry is a new sunrise industry in China, and its development and changes have distinctive Chinese characteristics, reflecting the evolution of our institutions, systems and policies to some extent. Research on China's renewable resources industry enables us to have a better understanding of the evolution logic of industrial policies and the features of the ownership structure system. Predicting the future development of the renewable resources industry can provide inspiration for innovation of similar industries in China.

Practices at home and abroad show that the recovery and utilization of renewable resources is an effective way to develop "circular economy". As an important carrier and effective support, the renewable resources industry helps to reduce waste emissions, ease resource scarcity and shortages, accelerate the construction of resource saving and environmental friendly production methods, and enhance the sustainable development ability. Therefore, the development of the renewable resources industry is an effective and important way to solve such problems as resources depletion, energy shortages and environmental pollution

1.2 Literature Review

The following summarizes the research status at home and abroad, focusing on the performance of the renewable resources industry.

1.2.1 Foreign Research Status

Foreign scholars study the renewable resources industry focusing on the following points:

1. The development of renewable resources industry and its effect on environmental pollution, focusing on solving issues of resources harmless, minimization and resource utilization. Robert B. Wenger , Charles R. Rhyner (1997) analyzed the differences between utilization rate and reduction rate in the process of waste recycling, and pointed out that people should use different indices to calculate different wastes. Fabiana Calo`, Mario Parise (2009) and A.M. GenaidyR，Sequeira (2009) analyzed the solid waste pollution of groundwater and the pollution prevention of secondary lead and waste minimization technologies. Tao Jiange (2012) researched the current status and management of solid waste pollution in China. Tsai C. Kuo (2013) used the Petri Net (PN) analysis to determine the optimal tradeoff between the cost and environmental effectiveness of the disassembly processes.

2. roles of policies and micro subject (enterprises, government, public) in the marketization process of renewable resources industry. Alexis M. Troschinetz, James R. Mihelcic (2009) analyzed factors influencing developing countries' renewable resources recycling activities and emphasized the important role of policy, especially tax policy, in renewable resources industry. Faten Loukil, Lamia Rouached (2012) used differentiation model to test the effectiveness of eco-tax policy and a recycling subsidy on environment in terms of packaging waste minimization, emphasizing consumers and the government are responsible for the packaging waste minimization. Sebastian Maier, Luciano Basto Oliveira (2014) assessed the economic feasibility of

Brazil's national policy on different solid waste disposal facilities. Kiriaki M. Keramitsoglou*, Konstantinos P. Tsagarakis (2013) noted that it is importance for the public to participate in waste disposal. Kenisha Garnett，Tim Cooper (2014) used the analytical-deliberative procedure as a legal tool of waste management decision-making and emphasized the necessity of local governments, community groups and the public to participate in waste disposal.

3. Waste Management and Evaluation. Kirkeby Birgisdottir (2006) proposed "EASEWASTE model" and evaluated the economical efficiency of the city sewage circulation scheme, using the analysis method of life cycle and economic system. Samuel Niza, Eduardo Santos (2014) provided an assessment of waste management evolution in Portugal, with a particular emphasis on the improved performance brought by the adoption of EPR (extended producer responsibility). Atiq Uz Zaman (2014) measured waste management performance in Adelaide using ZWI (the Zero Waste Index) and found the optimal developing area. Shaufique F. Sidique, Satish V. Joshi (2010) analyzed the effect of several recycling and wastes management policies that affect recovery rate using panel data. Cherilyn Vossberg, Kyle Mason-Jones (2014) and C. Buratti, M. Barbanera (2015) used life cycle assessment to estimate the effect of waste resource utilization on energy requirements and greenhouse gas emission and the impact of organic waste management on environmental performance.

4. Industrial activities, markets and prices. John E. Tilton (1999) pointed out that production of secondary metals based on wastes recycling is limited by a new waste stream, instead of prices of metals or recovery costs. Renewable production is sensitive to costs and prices, so increases of resources' prices may bring profits. However, technology innovation can make real prices of resources decline. Therefore, renewable producers should make efforts to reduce costs thorough technology innovation, rather than expect prices of resources to rise. Nongnrad Sunthonpagsit, MichaelR. Duffey (2004) studied the production activity of scrap tyres and scrap rubbers, and pointed out that this process existed in different consumer markets and that the total demand and the number of submarkets both growed. However, the

expectation of potential investors and the government is different from that of existing producers, leading to the complexity of production planning and production activity; renewable producers have to face not only the real prices decline but also uncertainty of the market and competition from the government's support for enterprises. Hitoshi Hayami, Masao Nakamura (2015) used the input-output analysis to estimate the average discharge of wastes in the process of manufacturing supply chain and suggested that for manufacturing supply chains in Japan, the adoption by a downstream assembler of green procurement policies can improve both environmental and economic performance. Anna Mansikkasalo, Robert Lundmark (2014) pointed out that the elasticity of recycled paper supply is between 0.2 and 0.3 and it helps to explain fluctuations in market prices and has an effect on waste management policy based on price and quantity. Kentaka Aruga, Shunsuke Managi (2011) pointed out that in the long term, there are linkages among the copper futures, primary and copper scrap markets.

1.2.2 Domestic Research Status

Researches of domestic scholars mainly concentrate on industrial waste; some of them are about the renewable resources industry itself. As for industrial waste, it consists of four areas: solid waste, electronic waste, agricultural waste and packaging waste. Among them, researches on solid waste are the most, and the second is electronic waste.

1. Solid waste

As an important part of comprehensive utilization of resources, the recycle of solid waste in China started in the sixties from metallurgical industry waste residues. However, it was in 1985 that it was lifted to a strategic height and was seen as a significant technical and economic policy. Especially, "Provisions on carrying out the comprehensive utilization of resources" from the national economic council promoted the recycle of solid waste and even resources to start designedly and systematically. In 1989, "medium and long-term science and technology development program" compiled by the national science and technology commission became one of China's basic national policies; it made the development and utilization of renewable resources the 21st area and emphasized to take the reasonable utilization of resources as the core.

The first stage (1990-1995), scholars did researches gradually from hazardous solid waste to industrial solid waste to urban solid waste. They used disposal technology and waste pollution control to study resources harmless, and gradually turned to resources minimization and resource utilization. During this period, researches on disposal technology of solid waste mainly include: Cai Jinlu (1990) suggested using curing method and burning method to dispose China's hazardous solid waste; Song Yuyin (1991) systematically introduced current status and disposal technology of urban solid waste at home and abroad, and pointed out that process of foreign solid waste disposal started from resources harmless, and then turned to resources harmless, resources minimization and resource utilization. Song Yanjun (1992) analyzed the current situation and recycling technologies of steel scrap, plastic waste and rubber waste in detail. On the basis of analysis of natural, economic and environmental factors affecting methods of waste disposal in urban life, Fang Man (1994) used Analytic Hierarchy Process (called AHP) to construct decision model of municipal waste treatment methods, and found that landfill and high temperature composting together is the best approach fitting China's national conditions. Xiong Wenqiang, Yang Guang (1995) described the development trend of solid waste recycle technology from the technical level. As for pollution control research, Liu Shukai (1991) emphasized that waste recycling is an important way to alleviate environmental pollution and resource crisis, and he proposed countermeasures. Gao Shuting, Zhang Huiqin (1994) conducted simulation and trend forecasting for the generation, treatment, utilization and emissions of China's industrial solid waste, analyzed the investment and benefits of comprehensive utilization and proposed control measures.

The second stage (1996-2005), takes the research project "Standardization research on solid waste recovery and recycling" that was completed by China Institute of Standardization and Information Classification and Coding as the starting point for this stage. Starting from the beginning of 1996, this paper discussed China's solid waste policy as well as the solid waste recycling technology and condition of industrialization. It emphasized that solid waste is one ring of R-P-R (Resource→Product→Reuse) and the resources recycle of waste is an important way of eliminating and controlling pollution, improving the environment and saving energy, and it introduced waste policies and measures of developed countries. After that, domestic researches on solid waste focused mainly on the following two aspects: one is the status, problems and the recovery, recycling and treatment measures of solid waste and municipal waste. The main studies include: Guo Yifan (1997) researched on the status, problems and countermeasures of municipal waste's elimination; Huang Ziyi, Ge Baoxiang (2000) proposed specific ways of domestic and industrial waste resources recycling from the system design level; Feng Yabin, Ji Xiaomin (2001) discussed in detail operational countermeasures of municipal waste's recycling, utilization and processing from deeper level; Chen Yang, Wang De (2003) proposed a new way of thinking, one that combine triple benefits-environment, society and economy. Hu Chunhua, Chen Wen (2005) noted that our country could learn from foreign experience and improve domestic renewable resources management, after they introduced solid waste management practices of foreign countries. The other is the study of industrial composition and realization path of China's solid waste. The main studies included: Zhu Jincheng (1999) first proposed countermeasure of formatting China's solid waste resources utilization enterprise groups, and the purpose is to concentrate talents and technological advantages and establish research and production bases. Wu Jiesheng (2002) studied the meaning, composition and characteristics of renewable resources industry and the difference between this industry and environmental protection industry, and he pointed out the specific objects that renewable resources industry should include.

The third stage (2006~), there are new trends about researches (contents and methods) on waste. For research contents: one is studying waste comprehensive utilization from the perspective of recycling economy, establishing small cycles, medium cycles and big cycles of solid waste from three different levels: enterprises, regions and societies, and comprehensively evaluating waste from economy, policies and the environment. The main studies include: Li Botao, Mou Ruifang (2006) used the basic principles of circular economy to explore the circular economy model of municipal solid waste's problems, that is establishing small cycles, medium cycles and big cycles of solid waste from three different levels: enterprises, regions and societies, through source control and the establishment of solid waste industry chains and separate collection systems. This provided new ideas for solving problems of urban solid waste. Yuan Ting (2006) pointed out that the development of recycling economy requires total control and recycling of a growing number of municipal solid wastes. She proposed to start from five aspects that are formulating and improving relevant laws and regulations strengthening the government's guidance, encouraging enterprises to adopt effective measures, improving the public consumers' attitudes and encouraging private enterprises, and explore an effective way to solve problems of the urban solid waste recycling. Huang Juwen, Li Guangming (2007) combined methods that Shanghai solid waste utilization employed and used application of analytic hierarchy process to evaluate its impact on economy, policies and environment. They pointed out that the establishment of solid waste two-way separation system is the direction to the utilization of solid waste as well as the key point of Shanghai solid waste utilization. The other is that we should not only emphasize the role of government-oriented in solid waste management from a legal policy level, but also pay attention to market-oriented and multi-stakeholder involvement. Zhang Xia (2007) pointed out that laws and regulations about solid waste disposal in China can learn from experiences of developed countries and regions, that is using national laws to regulate solid waste disposal's problems. Zhang Jing (2009) noted that the main problem of industrial solid waste management is the lack of accurate and timely information about industrial solid waste pile. The target of solid waste management emphasizes too much on decontamination, solid waste management policies lack separate laws, regulations and some specific guidance documents, and the management lacks public participation and information disclosure mechanism, so the government should take pump priming policy to achieve the management objectives. Song Yu (2009) noted that there were three management models of municipal solid waste: government-oriented, market-oriented and multi-stakeholder involvement. Evaluation of the three models were mainly conducted according to environmental benefits and economic benefits. Zheng Fenyun (2011) analyzed in detail the drawbacks and plights of China's municipal solid waste management and proposed to learn from developed countries' advanced experience such as "Complete Management System" and "Management Process Integration". She encouraged China to build its own management model from legal, technical, management, business, social consciousness and other levels, so that we can change the existing management system and promote the development of cities' circular economy. In recent years, two major changes occur in the study method of solid waste: one is using empirical analysis to study solid waste's characteristics from a quantitative point of view, on the basis of common economics standard analysis method. For example, Song Yuchen, Lv Wenliang (2010) took solid waste generation and discharge in our national secondary industry of each sector as well as the 31 provinces and cities as the object of study in their "An Empirical Study of the Status of the Solid Waste Based on Cluster Analysis". They took the data on national environment statistical yearbook as the basis and used cluster and comparative analysis method, researched the present situation of the solid waste; then, proposed the related countermeasures. The second is combining computer technology and geographic information system (GIS) to study solid waste management. For instance, Qin Li, Chen Bo (2009) pointed out the convenience, flexibility, and visual advantages of applying GIS to planning solid waste management. They stressed that strengthening the integrity and universality of GIS and realizing network can greatly enhance the scientificalness, normalization and reliability of solid waste management and decision.

2. Electronic waste

Researches on electronic waste are as below:

(a) The recycling situation, processing technology and countermeasures of electronic waste. Tong Xin (2002) pointed out that recycling is the best way to achieve electronic waste's resources utilization. Not only people should improve disposal solutions, but also people need to innovate systems from the production -

consumption integration perspective. Utilization of electronic waste must be industrial, and governments, especially local governments and NGO, should play their roles in specification, self-discipline, supervision, guidance and coordination of the industry, on the basis of making full use of the market adjustment mechanism. Cha Jianning (2002) discussed the main reasons for electronic waste pollution, and combined recycling, treatment and clean production to propose specific measures on prevention and control of electronic waste pollution. Wang Haifeng, Duan Chenlong (2004) introduced systems and technologies of domestic and foreign electronic waste resources utilization and pointed out that realizing the resources utilization should give priority to mechanical and physical recovery methods. Wang Peng (2005) pointed out that it was of great importance to legislate relevant laws and regulations about e-waste pollution's prevention and resources utilization. As the manager, the government plays a crucial role in e-waste management. Xu Fan, Wang Guoliang (2007) emphasized in "The Pollutions of E-waste and the Policies for Recycling and Utilization" that people should establish and improve China's e-waste recycling systems, including: (1) make some policies to make the recycling system of e-waste productions operational; (2) develop new disposal technique of e-waste productions; (3) encourage manufacturers to develop green products; (4) implement relevant certification system about processing enterprises.

(b) The recycling and industrial issues about electronic waste. Dong Suocheng, Fan Zhenjun (2005) pointed out that taking legal means to force the recycling of electronic waste not only contributes to the whole management of e-waste disposal, but is the guarantee of electronic waste recycling marketization. People should promote e-waste recycling industrialization with policies, make reasonable recycling and disposal policies and technology research about e-waste disposal, and adopt preferential policies in terms of capital, tax, markets and technical services. Chen Kui, Yao Congrong (2006) analyzed roles and responsibilities of enterprises, governments and the public in the process of e-waste recycling. Sun Yunli, Duan Chenlong (2007) gave the definition, classifications and sources of electronic waste, indicated that the e-waste has many characteristics such as large quantity, large harm, high potential value and processing difficulties, and presented an overview of e-waste recycling research and technology. Du Huanzheng, Liu Xiaojing (2007) pointed out that we should make laws according to all aspects including production and disposal to make sure the full recovery of e-waste and promote renewable resources to be fully utilized. Wan Hao (2008) proposed ideas and recommendations about China’s electronic waste disposal and recycling systems based on circular economy mode.

(c) Legal system construction and management strategies in the electronic waste recycling system. Xing Hong (2007) noted the main problems in the recycling and put forward countermeasures: (1) establish legal mechanisms, consider the circular economy legislation as the guiding ideology and consider "extended producer responsibility" as the most important basic principles of managing e-waste;(2) use economic means reasonably. Set up an environmental tax or establish a deposit system. Jia Xingang (2008) pointed out that the successful foreign experience about e-waste disposal is based on “3R” (reduce, reuse, recycle) principle, following the “resources – products – renewable resources” harmonious recycling economy development model. Implement "extended producer responsibility", format joint manufacturers associations or NGO, and use relevant laws to ensure that the logistics and cash flow of e-waste is unimpeded, so that comprehensive recycling utilization of e-waste can be achieved. Wang Hongmei, Yu Yunjiang (2010) systematically introduced electronic waste recycling systems and relevant laws and regulations of developed countries and proposed to establish management systems that are fit for China’s situation.

(d) Analyze quantitatively the prediction model of e-waste amount and the decision-making model of waste products recycling. Zhang Wei, Jiang Hongqiang (2013) used Stanford model to quantitatively predict China’s major electronic waste production and distribution between 2011 and 2020, according to domestic sales, product life cycle and average weight of electrical and electronic products as well as data like provinces ownership. Yu Fumao, Zhong Yongguang (2014) discussed the decision-making problem about the e-waste collecting and recycling considering the leading of the government’s premium mechanisms. The analysis shows that, theoretically, there is no absolute dominance of e-waste recycling model and the combination of extended producer responsibility and third-party collecting (MDC-CTR) can achieve higher recycling rate. Therefore, they recommend improving relevant guide incentive mechanism from the aspects of systems, objects and procedures.

3. Agricultural waste

Researches about agricultural waste are as below:

(a) Agricultural waste utilization technologies. Zhang Zengqiang, Meng Zhaofu (2001) and Zhang Chenglong (2002) discussed agricultural waste utilization technologies and outlook from a technical perspective. Hu Mingxiu (2004) proposed methods of multi-channel and problems of agricultural waste utilization, according to characteristics and status of agricultural waste. Chen Zhiyuan, Shi Dongwei (2010) reviewed a variety of domestic and foreign agricultural wastes progress and summarized its resource utilization. Ai Ping, Zhang Yanlin (2010) analyzed the current situation and problems about agricultural waste, introduced the main processing technology, and proposed classification utilization model and recommendations about the development of agricultural waste.

(b) Strategies about agricultural waste resource recycling under the economic theory. Sun Yongming, Li Guoxue (2005) analyzed the resource potential of agricultural waste as well as constraints and bottlenecks in the process of resource recycling, and proposed key points of development strategy regarding to technology and industrialization of agricultural waste resource recycling. Sun Zhenjun, Sun Yongming (2006) and Liu Rongzhang (2006) proposed that the development of agricultural waste resources utilization should follow the circular economy theory and start from the ecological cycle of waste and develop to circulation agriculture and circulation society step by step. Gu Huashan (2009) pointed out the necessity and fundamental principles of agricultural waste recycling utilization, focusing on the recycling mode. Yin Changbin, Zhou Ying (2013) explained systematically the content, features, theoretical basis and principles of the circular agriculture, pointed out that the its essential characteristic is resource conservation and industrial chain extension, and proposed institutional innovation and compensation mechanism of recycling agricultural development as well as the build of a circular economy chain closed loop system.

(c) Countermeasures about development of agricultural waste resource utilization. Peng Jing (2009) pointed out several development direction of China's agricultural waste utilization and proposed that the countermeasures are establishing and improving relevant laws and regulations, increasing financial support and accelerating industrialization process. Du Yanyan, Zhao Yunhua (2012) proposed countermeasures of agricultural waste resource utilization according to its development trend. Liu Combining China's social and economic development objectives, Zhendong, Li Guichun (2012) proposed that we should start from agricultural waste recycling and promoting industrialization of biomass has a great influence on further solving environmental pollution and resource shortages, speeding up the industrialization process of agriculture and promoting new socialist countryside. Zhang Ye, He Tieguang (2014) comprehensively analyzed situation, environmental hazards and several major ways of utilizing of China's agricultural waste and summarized constraints and bottlenecks in this development process. At the same time, they combined China's social and economic development objectives and put forward specific policy recommendations about agricultural waste recycling.

(d) use models to quantitatively analyze problems about agricultural waste recycling. Li Peng, Yang Zhihai (2013) used DEA model to measure agricultural waste recycling performance and resolved technical efficiency of each DMU to find the main reason for the lower recycling efficiency. On this basis, they explored the regional performance differences and reasons for the differences. Feng Junhui, Zhang Junbiao (2014) adopted binary Logistic model to analyze the key factors that affect farmers' behavior against agricultural waste recycling, from the four aspects-information costs, learning costs, production costs and risk costs.

4. Packaging waste

Researches about packaging waste focus on the three areas:

(a) Situation, recycling and strategies of packaging waste. Guo Caifeng, Xu Bo

(2004, 2007) proposed a model about packaging waste recycling system, described the structure and operating mechanism of recycling system and made recommendations that the government should implement macro-control, improve regulations about packaging and packaging waste and raise public's awareness of environmental protection. He Quanguo, Nie Libo (2011) analyzed deep the way of plastic packaging waste recycling and proposed basic policy recommendations for plastic packaging waste recycling.

(b) Packaging waste and environmental pollution. Considering harmless, minimization and recycling, people should lay emphasis on the management of packaging waste and ultimately reduce packaging waste pollution. Zhou Zhongfan (2000) encouraged to take control measures against clean production and reduction of packaging waste generation in the packaging industry. Li Jun, Shi Xiaohong, Ye Hong (2002) discussed how to reduce packaging waste pollution on the environment from aspects of green packaging materials, green packaging design technology, the importance of packaging waste management and reinforce of the packaging waste management. Hu Ziyue (2007) proposed a series of recommendations for reducing the packaging industry's environmental pollution from an environmental perspective.

(c) 3R principles of packaging waste management and waste recycling mode from three levels: enterprises, regions and societies, under the perspective of circular economy. Yuan Xiaoli (2003) emphasized that effective measures to reduce environmental pollution of packaging waste is not extensive end-of-treatment, but controlling and managing the source of the waste as well as classifying and recycling packaging waste. Ding Weifei (2008) pointed out that packaging waste recycling is the requirement of circular economy and waste recycling mode should be on the enterprises, regions and societies levels.

5. Renewable resources industry

Researches about renewable resources industry focus on the following areas:

(a) Strategies and countermeasures about renewable resources industry under the concept of circular economy. Yang Lvrong, Zhu Shengxun (2003) put renewable resources industry under the 3R(Reduction, Reuse, Recycling) and 4E(Economy, Energy, Ecology, Efficiency) background, and encouraged people to focus on technology development and government's support in funding and policies, so that China could find technologies and methods, from the source, to avoid or reduce waste. Chen Demin (2003) studied China's renewable resources comprehensive utilization in terms of strategic guiding ideology, basic principles, vision and development paths. She promoted countermeasures and suggestions for China's comprehensive utilization of renewable resources from raising awareness, strengthening management, financing, developing technology and improving legislations. Xu Shufan (2004) pointed out that the promotion of development of renewable resources industry should proceed from the production system, the consumer system and the recycling system. The renewable resource industry system should consist of three subsystems: the recovery system, the dismantling utilization system and the harmless waste disposal system. Huang Shaopeng (2006) discussed the concept of resource and resource recycling regulations under the concept of circular economy and analyzed the current situation and problems about China's renewable resource industry. Zhu Yuli, Wang Liping (2007) pointed out that building the waste recycling system is the key to the development of circular economy. They put forward relevant policy and technical advice for these three subsystems. Zhou Hongchun (2008a, 2008b, 2008c) described the status, problems and countermeasures of renewable resource industry in China.

(b) Government regulation countermeasures in the process of renewable resources industry's marketization. Li Wendong (2007) pointed out that the government should make full use of policies' positive effects to address the inefficiencies existing in renewable resources market mechanism. Wang Peixuan (2008) pointed out that there were still some problems in government regulation of the renewable resources industry development. For instance, the division and distribution of government administration is not reasonable, the tax policy is defective and lack of market access rules leads to problems such as disorderly competition. Therefore, it is of great importance to speed up the choice of renewable resources industry countermeasures, establish and perfect the renewable resources recycling operation platform, promote and regulate the system reform of renewable resources industry and accelerate the development of renewable resources industry. Feng Huijuan, Zhang Jicheng (2009) discussed the policies and governmental theoretical base of recycling resources industry and presented approaches to the sustainable development of recycling resources industry, including allowance policy, administrative means and increasing industrial concentration.

(c) Research on prices, structures, performances and development systems of renewable resources industry. In the perspective of the substitution between raw resources and recycling resources, Zhang Feifei, Li Huiming(2009) analyze the correlation between the price fluctuation of raw resources and the one of recycling resources, and the impacts of the price fluctuation on the structure of resources consumption market and recycling resources industry. Based on SWOT, Liu Guangfu, Lu Shengpeng (2012) discussed systematically the framework of the top design of China's renewable resource industry and put forward several recommendations to promote industrial development. Pu Yongjian, Zhong Haigang (2014) used the Malmquist index approach to estimate the TFP of renewable resources industry and found that TFP showed significant regional differences, the main reason for which is the regional difference of technical efficiency.

1.3 Research ideas and methods

1.3.1 Research ideas

Based on "structure - conduct - performance" (SCP) paradigm of the theory of industrial organization, this paper did empirical research on the performance of China's renewable resource industry, from the perspective of factors affecting industrial performance. Industrial policy is an important factor affecting industrial development, and this paper analyzed and summarized the background, status, evolution history and characteristics of the industrial policy and then sorted and summarized this policy. It shows the significant influence industrial policy has on renewable resource industry and its industrial performances, contributing to the judgments on development trends and directions of renewable resource industry as well as the supplement, improvement and adjustment of industrial development policy.

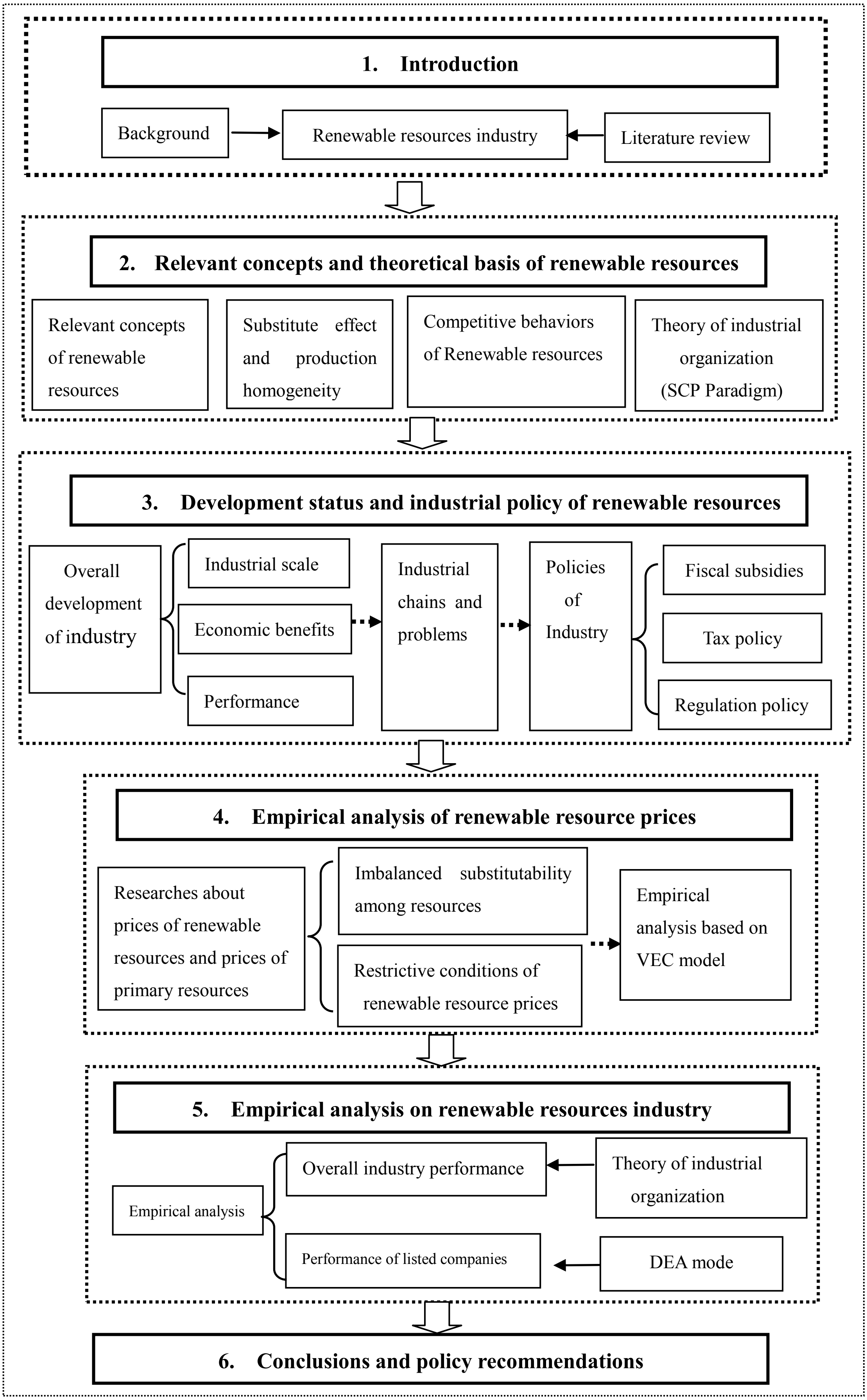

Fig. 1-1 Research ideas and framework

The substitute effect of renewable resources determines the limitation of their prices and production homogeneity determines the importance of their prices in affecting market structures and industry competition. By studying the imbalanced relationship between the prices of renewable resources and that of initial resources, this paper derived the correlation between them, analyzed the impact of price changing on corporate behaviors and market structures, and revealed the factors that determining the performances of renewable resources industry.

Researches on renewable resources industrial performances from the empirical analysis perspective are also important contents of this paper. This paper analyzed empirically the performances from the industry level and the listed companies level, aimed at comprehensive analyzing factors affecting China's renewable resources industry performances from the meso and micro level and holding the key factors affecting the overall situation of this industry, so that specific suggestions can be put forward to provide a useful reference for the advance of the performance. Specific research ideas and framework are shown in Figure 1-1.

1.3.2 Research methods

This paper is based on the theory of industrial organization. It combined existing literatures and current situation of renewable resource industry development, and used econometrics and data envelopment analysis (DEA) to study the performance of renewable resources industry in China. The main research methods include:

1. Theoretical analysis is combined with empirical analysis, but the latter is more important. Mainly used theoretical analysis when defining relevant concepts, analyzing competitive behaviors and the policy development of this industry, and talking about SCP, while used empirical analysis when it refers to quantitative analysis about the prices linkages and overall performances and the prediction of efficiency of listed companies.

2. Combine quantitative analysis and qualitative analysis. This paper adopted mainly quantitative analysis when it collected data to study status and effect of policies on performances, while the study of how prices influence market structures and industry competition, thereby affecting the analysis of industry performance, overall performances of renewable resources and performance of listed companies in a micro level, is done with qualitative analysis.

1.4 Main content and innovation

1.4.1 Research content

This paper is divided into six chapters:

The first chapter is the introduction. It introduces the background and significance, research ideas and frameworks, and research methods and content, and it reviews relevant literatures at home and abroad.

The second chapter describes the content and definition of renewable resources and renewable resources industry, the features of renewable resources industry, as well as the relationship between prices of renewable resources and that of primary resources, and analyzes two important attributes of renewable resources, that are substitute effect and production homogeneity. Based on this, the real competitions in the renewable resource companies were discussed.

The third chapter introduces development status of renewable resource industry, summarizes industrial development policies and analyzes effects of these polices on this industry.

The fourth chapter expounds the imbalanced alternative relationship between prices of renewable resources and primary resources, and take this as a prerequisite to derive the price correlation between the two as well as changes in business behaviors and market structure when prices fluctuate. Fluctuations conduction between renewable resources and primary resources are studied empirically.

The fifth chapter is empirical analysis of renewable resources industry performance. Analyzing the performance from the industrial level is based on the theory of industrial organization. Analyzing factors affecting industry performance from the medium perspective of structure - behavior – performance and analyzing the performance of 19 listed companies from the micro level is aimed at revealing the factors influencing the performance of China's renewable resources industry and industrial performance level.

The sixth chapter is the conclusion and policy recommendations. It summarizes the development performance, the influence factors, the implementation ways and specific measures about China’s renewable resources industry, and puts forward the obstacles faced by the renewable resources industry and countermeasures.

1.4.2 Innovation

The innovation of this article is mainly manifested in the perspective of innovation. Academia's researches focus on recycling treatment technology of renewable resources, recycling of waste and problems of industrialization, whereas there are few researches on performances from aspects of legal system construction and management measures in the recycling systems and the renewable resources industry development strategy and countermeasures under the concept of circular economy. This paper studied the performance of renewable resources industry from the level of the industry and the level of listed companies, which has important theoretical significance and practical significance.

2. Definition and basic theories about renewable resource

Is renewable resource the same as the waste or scrap? How could we describe its feature? This chapter mainly illustrates the definition and explanation about renewable resource and renewable resource industry, as well as summarizing the feature of renewable resource, analyzing the difference between renewable resource and recyclable economy or comprehensive utilization of resources. As the substitutability and homogeneity of renewable resource been illustrated, meanwhile, the competing behavior of renewable resource enterprises is also conveyed.

2.1 The definition and feature description of concepts related

2.1.1 The definition of renewable resource

Renewable resource is the general term of all scraps that generated from social production, circulation and consumption progress, and has lost all of its initial value or part of them before they went through the recycling progress. The renewable resource refers to all the recyclable scraps generated in production and consumption progress, including the scraps that can be recycled repeatedly, which can be industry scraps or residential scraps.

The concept of renewable resource is gradually improved and illuminated with the developing of the time. It is the result of changing in objective environment which leads to progress in notion. The earliest concept related to renewable resource arise in domestic areas were seen in『The instructions about repurchasing and recycling of scraps released by state council』issued in 1958, which illustrated as “scraps”. “Scraps” refer to goods that have lost all the original form and function but could be used after recycling. The concept of “Renewable resources”, however, emerges after reform and opening up. The concept of renewable resources is defined in 1987, 『notice about problems in using renewable resources further』: A renewable resource is the kind of scraps generated from social production and consumption process, and has certain sum of value in use. No doubt, the definition is superficial and fuzzy. After entering into 21st century, renewable resources as an important part of recycling economy has been further focused on. The definition in 『The administrative method of renewable resources』(commerce department, 2007, No.8) has been widely used, which pointed out that renewable resources is the kind of scraps generated from social production and consumption process and has lost its original value and value of use, but have new use after recycling. Scraps including harmful scraps, scraps which lost all of its value and scraps which can be recycled, and recyclable scraps are renewable resources. So, renewable resources are a part of scraps. In the early period of reform and opening up, raw materials is urgently needed in industry production. Means of production are offered by scraps. With the advance of reform and opening up, resource and environmental factors have become the constraint factor in economic development, and whether the resources are renewable or not have raised more attention. As renewable resource has weaken the influence of its feature of scraps, which taken place by the feature of resource, taking the part of front end turns out to have more significance.

Through the recycle process that taken huge cost, scraps could turn into resources. Obviously, renewable resource industry means a lot to the recycling of scraps. So, the definition of renewable resource industry should be reconsidered clearly.

2.1.2 The definition of renewable resource industry

Renewable resource industry refers to the industry whose purpose is saving the resource and lessen the population in national economy to resolve the problem of scraps recycling, and was taken place in renewable resources commodity circulation, processing, exploitation and machining. According to these above, the three main part is recycling of renewable resources, processing of resources and reuse.

Renewable resource industry is easy to be confused with other concepts such as "comprehensive utilization of resources", "recycling economy" and "environmental protecting industry". In fact, there are both relation and differences among renewable resource industry and them.

1. Relationship with "comprehensive utilization of resources"

Comprehensive utilization of resources has a wide range, which can be divided into three stages. First, the comprehensive exploitation and utilization of paragenous minerals during exploitation process. Second, recycling and reusing of residue, liquid waste and excessive heat or pressure. Third, recycle and reuse of scraps generated in social production and consumption process. It can be seen that the recycle and reuse activity of renewable resource is a part of comprehensive utilization of resources. Comprehensive utilization of resources is liked with many industries, among them where renewable resource industry is, to some extent, special.

2. Relationship with “recycling economy”

The concept Recycling economy emphasizes the efficient usage and recyclable usage of resources. There is a wide definition and a narrow one concerning recycling economy. In wide sense, recycling economy means production or reproduction activity proceeded under the idea of efficient usage of resources and environmental-friendliness. And, in narrow sense, recycling economy promotes sustainable development of economy through recycling and reuse of scraps. The essence of recycling energy is recycling and comprehensive using of scraps according to the 3R principle (Reduction, recycling, resource) about recycling economy. So, renewable resource industry follows the idea of recycling economy, and is featured by recycling of resources. It is the essential part of “resource – product – scraps – recycled resource” feedback cycle.

3. Relationship between “environmental protecting industries”

It is generally accepted that environmental protecting industry is a term including all the activities that works on preventing pollution in urban and rural areas, improving ecological environment and protecting natural resources, like exploiting, production, commodity circulation, using of resource, information services and project contraction etc. Content of its industrial activity can be basically classified into two types. 1) Direct settlement of polluting matters, for example, the innocent treatment of wasted gas, liquid and solid scraps. 2) Supporting industry activities towards these types of recycling activities that providing equipment, technology, technique information and other services. It is revealed that there are great relation and differences between recycling resources industry and environment protecting industry. First, both are bound to deal with scraps generated in people’s living and production activities. Second, both could extracts useful materials from scraps. Third, the waste settlement activities of both will cause certain environmental effect. But, there will also be huge differences between the purpose and consequence of both in certain condition. Renewable resource industry will draw certain extent of environmental protecting effect through the processing of scraps, but the purpose and consequence majorly lies in economic, efficiency and sustainable utilization of resources, and the economic benefit brought by the processing of certain resource. But environmental protecting industry, especially the basically governing activities, has to get economic benefit from the environmental protecting services it offered to society although, the matter social "purchased" from it is just the clearing of negative effect in environment, even these services will probably generate "side" economic benefit in the recycling process of certain recyclable resource. Therefore, generally speaking, the purpose and consequence of environmental protecting industry is for environmental benefit instead of economic benefit. The basic pursuit of environmental industry is obtaining the largest amount of environmental benefit through the smallest amount of economic cost, instead of obtaining material benefit.

2.1.3 Features of renewable resource industry

Renewable resource industry is also called "vein industry" a lot in western countries. Features of renewable resource industry are different from traditional industries. Viewing from the angle of economic and industry, features of the industry is reflected majorly in those aspects below.

1. Features viewed from public welfare

Viewed from the circulation of object or commodities been produced, resource reproduction industry is different from traditional industry department which starts from nature resources to waste matters. By means of laboring that turns these scraps generated in social production and consumption process into secondary resource that could be used, renewable resource industry reduces the exploit speed and intensity of nature resources, makes the material circulation in economic system be smooth, and attaining sustainability of resources. The most important feature of this industry draws social benefits in environment protection and resource-saving aspects, which has remarkably benefit in public welfare.

2. The feature as quasi-public goods

Public goods should be offered by government department in theory. Quasi-public goods have the feature of both public goods and private goods, and calls for function from government and market. When viewing from the aspects of whole society, the recycling of renewable resources has reduced the consuming of nature resources in one, and in another reduces the amount of scraps, furthermore saving costs of waste disposal, makes the environment better for general public. So it has the no excludability and competitiveness in consumption, and has the feature of quasi-public goods. The power of market is needed in promoting the recycling of renewable resources. But, if market has taken the whole part, recycling process will be unsteady as well as pollution to be hard to control as being driven by economic benefit. Therefore, the progress of renewable resource is based on both government and market's effort. The feature of renewable resource industry as quasi-public good could be extended that industry has double externalities. Described in two aspects, the positive externalities refer to the positive side, as better environment has been brought about to the behavior agent outside the industry through recycling. And the negative externality refers to the secondary pollution caused in the recycling and handling process of renewable resources.

3. Labor concentrated and technology concentrated feature

The reclaiming of renewable resources in China relies on large amount of "junkman" majorly. But as the origin of renewable resource is separated, in different shape and has complex composition, the transportation or classification and other relevant basic process towards it must be completed through handwork, which means the industry, is a typical labor concentrated industry. Meanwhile, renewable resource industry could reuse the recycled resource only if advanced technology is possessed.

4. Relatively limitation on industry scale

Except for small part of scraps like wasting tires, wasting cars in urban areas and electronic scraps, most of the scraps are limited in concentration degree, together with the features of limitation on aggregate supply, separateness in reclaiming, processing on the spot, unsteadiness in channels and amount that obtained and narrow in using range. It is hard to attain certain using ratio of resource, which calls for the necessary policy regulation on reclaiming market to ensure the minimum scale, means the industry should kept certain degree of natural monopoly features.

2.2 The substitutability and homogeneity of renewable resource

2.2.1 Substitutability

With the progress in learning and distinguishing the means of growth about "recycling economy", the relationship between resource and scrap has been further understood. It is realized that scraps as well as the externalities cause by it occurred during production and consumption process is inevitable and normal. Furthermore, the settlement or purification technology towards scrap won't wipe out these scraps, but changes its form, or just transformed into other transmitters (Ayres and Kneese, 1969). Therefore, recycling and purification is not bound to be the best solution, for scraps could return back into economic system through recycling process in certain circumstances. Many scholars also hold the view that, scrap could, to some extent, take the place of initial resources after recycling and processing and could be put into production and consumption process again. But this kind of substitution function is under the limit divided to two aspects. The technological feasibility of transmitting scraps into renewable resources in one. In common ways, production and consumption process turns raw material into commodities, and then into scraps. But it is difficult or even irreversible considered in technology to reverse this process. And in another, whether the substitution of initial resources by renewable resources is economic or not is under consideration. The recycling process of scraps also consumes energy and resources, and has the probability to pollute scraps. All of these factors will increase the total cost, There are no free recycling (Nicholas Georgescu Roegen, 2001). As a respond, Daley (2006) draws the point of "restricted substitution", announcing "recycling of materials could be taken as a kind of trade-off", which means that we could choose a combination of two among material factor, the running out of energy and pollution to minimize the total cost in certain partial condition. But the "total cost" here means the total cost of ecological factor which is difficult to estimate, instead of the total cost calculated by price.

2.2.2 Homogeneity

Concerning renewable resources, or even most of the natural resource market, there are certain degree of homogeneity or non-distinctiveness between resource products supplied by different enterprises, but research concentrated on the homogeneity of renewable resource product and the influence it brought about is lacked. The product diversity theory considered that all the differences existed, such as information, product feature and network externalities etc., will help the product be easier to match different demand of consumers, and further influence the optional activities of consumers. Meanwhile, enterprises could make their products and services different from other competitors through differentiation strategy to form partial scarcity and competitive advantage, and gaining excessive profit. MingJie Miao and Xiang Li (2007) pointed out that an enterprise has the motivation to maximize the differentiation of products. Especially where there is difference in enterprise cost, these enterprises involved in disadvantages on cost could prevent to be obsolete or even obtain further profit through practicing of products differentiation.

2.3 The competitive behavior of renewable resource enterprises

2.3.1 Limitations in the price of substitution resources

Assuming that the elasticity of substitution between initial resources and renewable resources (σ) could be defined as the formula below.

R_1, R_2 refers to the variation ratio of initial resources and renewable resources respectively. Q_1, Q_2 refers to the marginal output of initial resources and renewable resources respectively.

$$\sigma = \frac{\dfrac{d(R_2/R_1)}{R_2/R_1}}{\dfrac{d(Q_2/Q_1)}{Q_2/Q_1}}$$

The variation range of the elasticity of substitution is from 0 to infinity, and the probability of substitution could be reflected by the radian of indifference curve. Based on review of the relative literature above, it is obvious there is limited substitution between renewable resources and initial resources. Therefore, the substitional relationship between them is a kind of radian between L-shaped curve and straight line. (As Fig. 2-1)

Considering that to some extent can renewable resources could replace initial resources input, there are probable association between their prices, otherwise manufactures won't choose renewable resources instead of initial resources (Yang Su, HongChun Chow, 2004). Meanwhile, some scholars pointed out through research that the price of scraps could surpass the price of natural resource, and the price premium could be offset by increase in unit output or reduction in pollution. However, there are still price limitations on renewable resource, whose price level will make the profit enterprises generate from recycling economy and non-recycling economy to be undifferentiated (YongXin Deng, TiYan Shen, 2007). As Fig.2-2 shows, on account of the substitution function of renewable resources to initial resources, makes up the "natural" toplimit for the price of renewable resources. Only the price is on the scope below the toplimit could the effective demand for renewable resources be generated. Therefore, the competition between renewable resource enterprises is restricted in limited demand range. And, the sum of toplimit of price is related to the scale of substitutional function. The greater substitutional function is the closer toplimit of price to the price of initial resources. While, the space of demand build by toplimit of price and demand curve becomes the absolute capacity of market demand of renewable resource, named as D_0（α）。

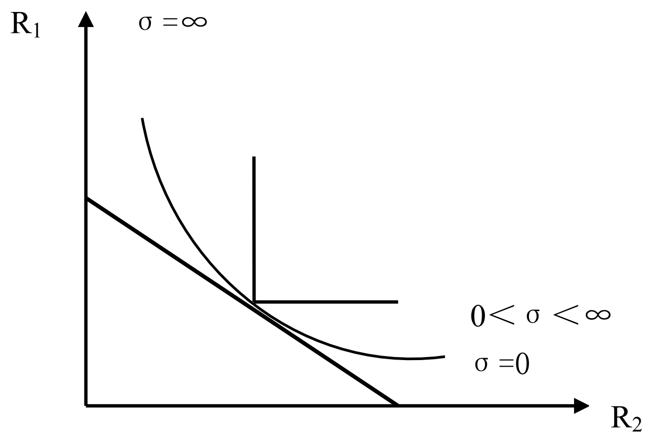

Fig. 2-1 Shape of substitional probability and equeal-product curve

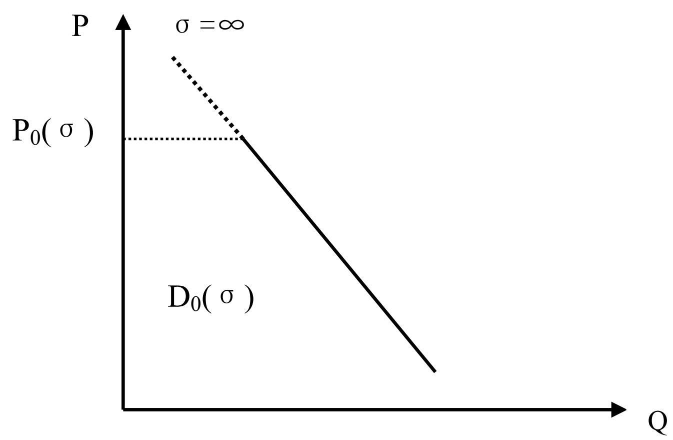

Fig. 2-2 Space of demand under function of price toplimit

Based on these, substitution of initial resources by renewable resources demands technological feasibility. In many cases, the user of resource has to update the facilities and technique, train staffs. Those will increase expenditure as well as collection, analyze and compare of relevant information. These expenditures together makes up the substitutional costs, which refers to the costs generated in the process renewable resources replace initial resources. And, this kind of cost is easily to be influenced by factors such as technological feasibility, scale of sunk cost and the difficulties in searching information. To the suppliers of renewable resources, the existing substitutional cost compresses the space of demand of renewable resources they faced for the second time. This phenomenon could be accounted by shifting left of demand curve or shifting down of price toplimit. Moreover, the relationship of amount and price with substitutional cost is remained for discussion. To simplify the analysis, the influence of amount and price towards substitutional costs is considered to be not exists, but performed as further movement downward of price toplimit. The movement range is the substitutional costs（c_r）, and relevant price toplimit is P_1（c_r）, meanwhile the space of demand renewable resource enterprises faced has been further pressed to D_1（c_r）, (as Fig.2-3).

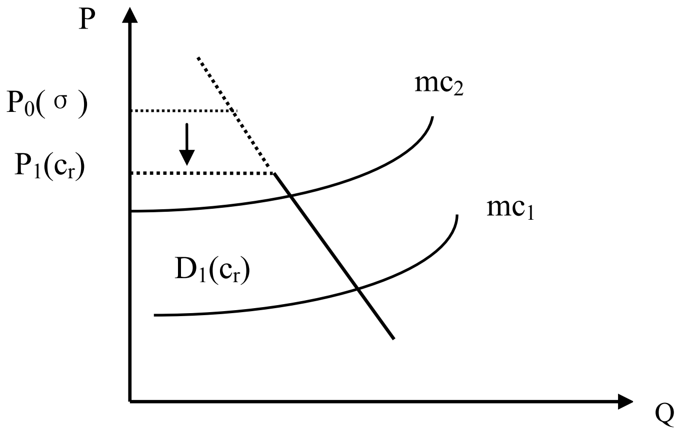

Fig. 2-2 the competition relationship among renewable resource enterprises in limited demand space

2.3.2 Analysis on the competition behavior among renewable resources enterprises

In a market with certain demand, there are substitional and competitive relationship among the product offered by renewable resources enterprises, and customer make choice among different renewable resources product. Concerning the difference in resources environmental externalities in production process, the level of technology and facilities and the recycle ratio of resources, costs of small workshop and big enterprises respectively is different. Obviously, compared with small workshop, the marginal cost of big enterprises is closer to the product price frontier, meanwhile small workshop could gain a relatively greater space of profit, so small workshop takes advantages in cost competition.

So, apart from the cost competition, why couldn't big enterprises strike back through other strategies? With rich capitals, advanced technology and facilities, as well as higher environmental friendliness level and greater resource recycling ratio, why couldn't big enterprises take advantage of these effectively?

In the progress of industry, it is not rare to see small workshop with cost advantage to be the strongest competitor of big enterprises. But normally, big enterprises could avoid the competition with small workshop through strategies of differential positioning and differentiated marketing, such as founding brands and offering better and cheaper product or pricing discrimination method to satisfy differential demand, especially producing and selling in sectors of which technology and capital level is impossible for small workshop to reach. However, because of the renewable resources' price "roof" in its market, big enterprises is hard to take advantage through offering renewable resource product with better quality, higher resource-environmental benefit, while price rises sharply. In fact, among traditional renewable resource sector, barely did any high-end demand that exist. Renewable resources are used on sectors that products of which calls for low level of quality such as cement, building materials and fillers. Because of the existing of substitution effect and substitutional costs, more stimulate is needed for consumers to replace initial resources by renewable resources.

Faced with current demand market of renewable resources, big enterprises which choose the price following strategy in competition will fail. First, assume that consumer could transform freely between products produced by big enterprises and small workshop. Then, small workshop could make use of the price reduction strategy, which means offering products of which price much lower than that offered by big enterprises, according to its cost advantage. After that, considering the homogeneity of renewable resource product, consumers will soon transform into products with lower price produced by small workshop, for consumers are sensitive to product price. The market share of small workshop will soon rise from original low level to higher level, or even possess the entire market. Later, big enterprises will take the following strategy to deal with. After many times of price reduction competition, big enterprises is easier to fail according to higher cost and the price toplimit, soon will big enterprises lose all of its market share and eliminate.

Second, assume that consumer have to pay transforming cost in the transforming process from product produced by one enterprises to another such as information searching, product comparison and contract amendment. In that way, the price following strategy taken by big enterprises will make them eliminate even quicker. As the consumers which sensitive to price will soon turning into products produced by small workshop when small workshop takes the price reduction strategy and the reduction range surpassed the transforming cost. Meanwhile, if big enterprises take the price following strategy, consumers won't transform into products produced by big enterprises even if the price falls to the same as small workshop according to transforming cost. Consumers has involved into a kind of inertance or stickiness towards products produced by small workshop. To win back the market share previously owned, big enterprises have to offer products in lower prices, which even accelerate the process to reach the baseline of cost. Therefore, elimination comes faster.

3. The current status of renewable resource industry and research on its industry policy

3.1 Progress of renewable resource industry

The renewable resource industry of China starts from the 50s of 20th century, when scrap recycling activities of merchandise sector emerges firstly. In 1955, scrap recycling activities were seen as special industry according to national policy. After 1975, a situation that two big system, supply and marketing cooperative and commodity department, monopolize the operating of scrap recycling activities has been formed. In this period, our nation allocates scraps uniformly as a kind of regulation matching the highly centralized planned economy. In 1958, The State Council issued 『instruction about enhancing the repurchase and recycle activities of scraps』, which is an important regulatory document in the early times in progress of Chinese renewable resource industry. The document gives principles towards commercial sector and industrial sector for repurchasing and recycling process of scraps:” all the scraps that should be repurchased by nation unified should be repurchased, processed and distributed by state-run commercial sectors. Except for goods that demand difficult processing program or advanced technology or materials that states claimed to control unifiedly, all the common scraps should take the principle of repurchasing, processing and recycling locally.” These principles have laid the foundation of progress of Chinese renewable resource industry.

After reform and opening up, significant changes have taken place in Chinese scrap recycling system and regulation condition. Individual commerce mode appeared and keeps growing stronger. In 1984, circulation system reform is carried out by the government. Scrap recycling industry begins to opening up and entering the marketization process. Together with the emerge of individual privately owned mode in scrap recycling industry, and gradually does it occupied the scrap recycling market, which brought diversification on sector and operating pattern to the market.

With the concept “renewable resource” been put forward in the later period of 80s in 20th century, renewable resources recycling activities taken charged by commercial circulation administration have drawn more attention. In 1987, 『notice about problems in advancing the renewable resources recycling process』 is issued by government, not only did it put forward the concept of "renewable resources", but also illustrates relevant regulations and instructions about tax and price policies, operation and management of renewable resource enterprises about renewable resource industry.

With the growing concern on environmental protection field of nation, renewable resource industry which was included in environmental protection category has caught the opportunity of deep progress. Firstly comes the encouraging policy about the comprehensive recycling of "the three waste" in industrial category, then followed by encouraging policy about comprehensive recycling of solid waste and "environmental protection industry", "clean technology industry". For example, 『Environmental Pollution Prevention and Control Law of Solid Scraps』 and『The clean production propel law』 encourages the enterprises to make use of advanced technology and facilities on comprehensive recycling process about resources, as a result promotes the recycling and technology developing of renewable resource recycling.

As entering the 21st century, "recyclable economy" arises. Renewable resource industry, as an important part, has benefited from the opportunity. With the gradually integration of ideas about recycling economy into national development strategy, recycling of renewable resources begins to show up in national developing plan. 『The 10th five year plan about recycling of renewable resources』 is the only plan focused on renewable resources, it emphasizes "implement these economic policies nation issued about recycling of renewable resources", including the policies of exemption on value added tax of renewable resources recycling enterprises and tire retread, refundable for resources comprehensive recycling product while imposed, reductions on enterprise income tax of resources comprehensively recycling enterprises. In the national standards 『classification of domestic economic industry』 (GB/T4754) amended on 2002, the major category "waste resources and scrap recycling industry" has been added in, which means the official statistics about the industry is to expose in China statistical yearbook from then on. Otherwise, the 『instruction about “11th five year” comprehensive recycling of resources』 issued in the end of 2006 and the 『instruction about “12th five year” comprehensive recycling of resources』 has again highlighted the important position of renewable resource industry, and again reflect the nation’s policy orientation about encouraging the progress of renewable resource industry.

3.2 Overall situation of the renewable resources industry

3.2.1 Current situation of the development of renewable resources industry

Development of renewable resources industry is an effective and important way to solve China’s resource depletion, energy shortages, environmental pollution and many other problems. As a basic national policy of China, the development and utilization of renewable resources has achieved success, and the industry keeps expanding and recycling system is improved gradually, especially after the development of renewable resources industry was set as the major strategic task of China "Eleventh Five-Year" period in 2006. At present, the number of China's renewable resource recycling enterprises has reached more than 10 million, the number of recycling outlets is over 30,000 and the employees are about 18 million people.

According to data of China Statistical Yearbook (2004-2014), the number of “all state and non-state-owned industrial enterprises above designated size”[1] of China’s renewable resources industry increased to 1274 in 2013 from 107 in 2003, and gross value of industrial output rose from 4.994 billion Yuan (2003) to 330.66 billion Yuan (2013) (Fig.3-1, Fig.3-2). Affected by macroeconomic, China’s total recycling volume of renewable resources and recovery value declined to different extents after 2012. In 2013, the total recovery volume of China’s major renewable resources (ferrous metal scrap, non-ferrous metal scrap, scrap plastics, scrap paper, scrap tire, electronic scrap, scrap car, scrap ship) reached 160 million tons, fell by 0.2% and 2.6% when compared with figures of 2012 and 2011 respectively; and recovery value of major

[1] Non-state-owned industrial enterprises above designated size refer to enterprises whose main business income is above 5 million Yuan.

resources (487.11 billion Yuan) decreased by 11% and 6% from 2012 and 2011 respectively (Table 3-1). Total domestic recycling volume of ferrous metal scrap, non-ferrous metal scrap, scrap plastics, and scrap paper reached 148.752 million tons in 2013. Divided by years, domestic recovery volume of these main four renewable resources can be ranged, from the highest to the lowest, as ferrous metal scrap, scrap paper, scrap plastics and non-ferrous metal scrap respectively (Fig.3-3). In 2013, the import of this four kind of renewable resources were 47.788 million tons, and the total import of scrap paper (221.01 million tons) was the biggest between 2005 and 2013, followed by scrap plastics (66.05 million tons) and non-ferrous metal scrap (64.28 million tons), while the figure of ferrous metal scrap was the smallest, only 57.59 million tons (Fig. 3-4).

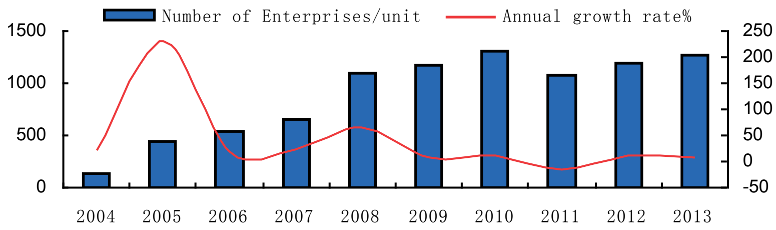

Fig.3-1 Number of industrial enterprises above designated size (2004-2013).
Sources: [105].

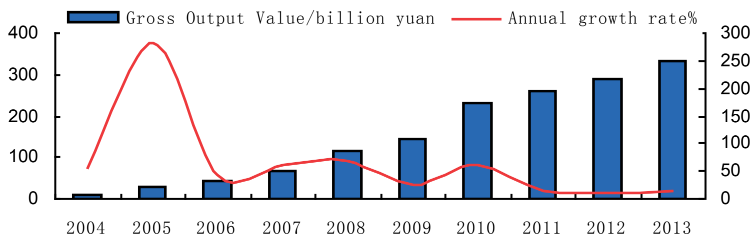

Fig.3-2 Gross industrial output value of recycled resources (2004-2013).
Sources: [105].

Table3-1 Main renewable resources recycling in Volume and Value (2011-2013).

Year	2011	2012	2013	2011	2012	2013
Category	Volume（million tons）			Value（billion Yuan）		
Ferrous Metal Scrap	9100	8400	8570	274.1	222.6	192.8
Non-Ferrous Metal Scrap	455	530	562	88.9	102.7	99.6
Scrap plastic	1350	1600	1366	92.0	105.6	88.8
Scrap paper	4347	4472	4377	86.9	83.0	74.4
Scrap tire	329	370	375	7.9	8.9	7.6
Electronic scrap	371	191	264	11.9	5.7	7.0

Scrap Ship	225.2	255	250	6.3	6.4	6.0
Scrap Car	285	249	274	8.3	6.4	5.5
Total（ton）	16462	16067	16038	576.4	541.3	481.7

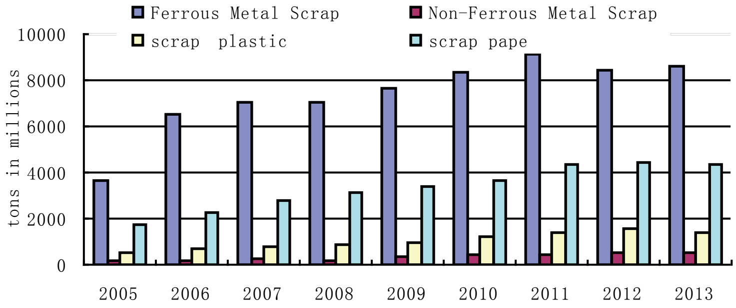

Fig.3-4 Total volume of main renewable resources recycling (2005-2013). Sources: [106-108].

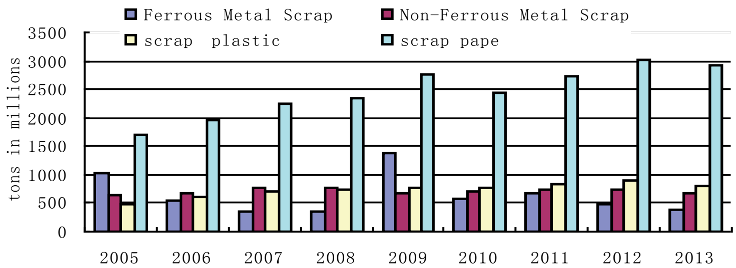

Fig.3-5 Main import renewable resources in volume (2005-2013). Sources: [106-108].

3.2.2 Industrial scale of renewable resources industry

Most of the enterprises of China's renewable resources industry are self-employed and small enterprises. 94.4% of more than 100,000 enterprises are self-employed, and the number of enterprises whose annual sales are over one billion Yuan is less than 100. Next, we take three kinds of enterprises ("the state-owned and state-holding industrial enterprises", "private industrial enterprises" and "'foreign' industrial enterprises") as the research object and analyze from the industrial scale, economic efficiency and performance levels, in order to avoid the limitations and drawbacks of a single indicator and reflect the performance of China's renewable resources industry more comprehensively. The results are as follows.

In the 21st century, the industrial scale of the three kinds of enterprises that have different ownership structures has increased significantly. As can be seen in Fig. 7, between 2003 and 2013, total number of state-owned, private and foreign-funded enterprises increased from 127 in 2003 to 918 in 2013, with an average annual growth rate of 19.7%. The annual average percentage of private enterprises is about 74.7%, reflecting that private enterprises are main force of renewable resources industry (Fig.7). It is shown in Fig. 8 (a) that private enterprises have the largest industrial output. They are followed by foreign-funded enterprises, and the figure of state-owned enterprises is the smallest. Fig.8 (b) shows that the annual average percentage of private enterprises' industrial output was up to 65% with a gradual increase. In contrast, the figure of foreign-funded enterprises was roughly 27% and declined in recent years. State-owned enterprises accounted for only a little part with a slight increase.

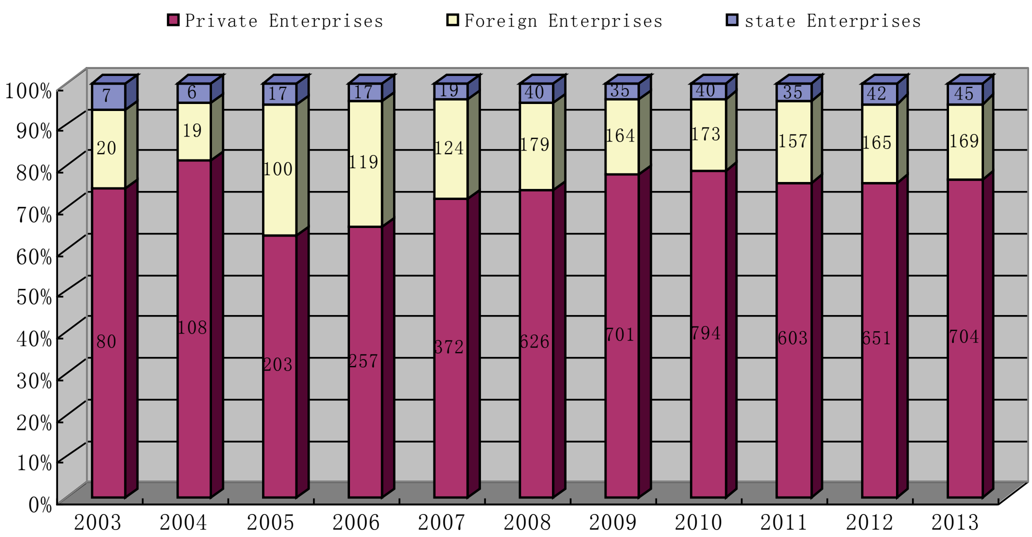

Fig.3-6 Percentages of state-owned, private and foreign-funded enterprises (2003-2013)
Sources: http://www.stats.gov.cn/ 105].

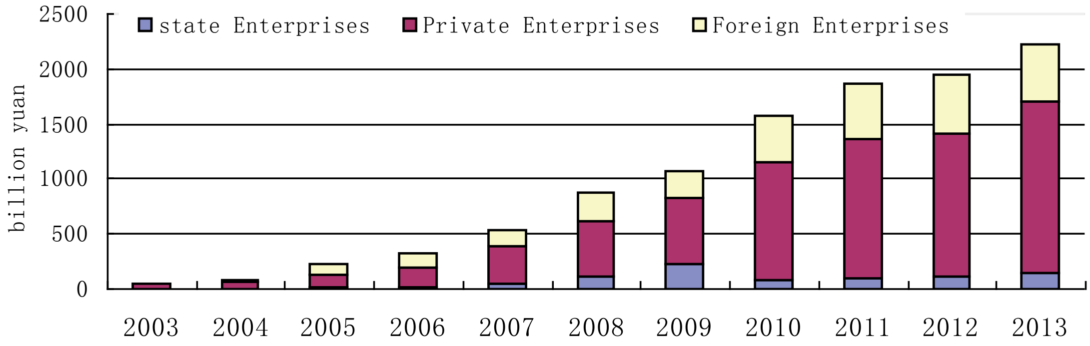

Fig.3-7 (a) Industrial output of state-owned, private and foreign-funded enterprises (2003-2013)
Sources: http://www.stats.gov.cn/ [105].

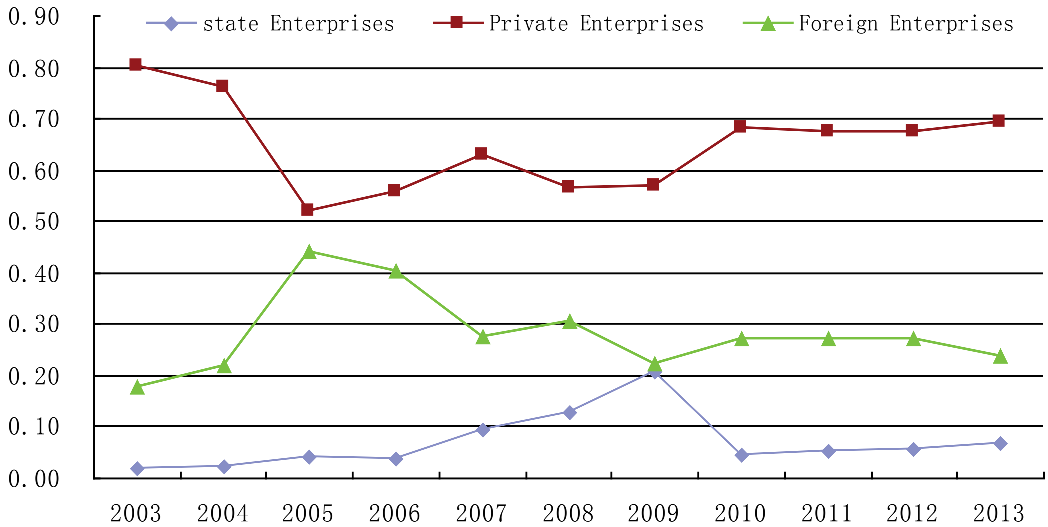

Fig.3-7 (b) Fluctuation of the share of state-owned, private and foreign-funded enterprises

3.2.3 Economic benefit of renewable resources industry

First, examine the overall operating efficiency of renewable resources industry. The following are the major economic indicators of industrial enterprises above designated size.

Table 3-2 Major economic indicators of industrial enterprises above designated size

(One hundred million Yuan)

Sources: [105].

Year	Prime operating revenue	Total profits	Total assets	Total Liabilities
2003	50.89	0.84	26.03	17.76
2004	79.50	1.19	30.67	21.57
2005	281.67	8.13	126.37	81.90
2006	429.33	14.23	195.88	134.65
2007	682.51	24.44	272.27	180.66
2008	1158.33	40.31	548.95	370.43
2009	1453.06	66.29	746.30	507.41
2010	2381.77	114.88	923.56	613.19
2011	2645.28	160.57	1311.79	836.35
2012	2920.55	162.66	1412.02	678.74
2013	3340.04	132.08	1561.07	953.45

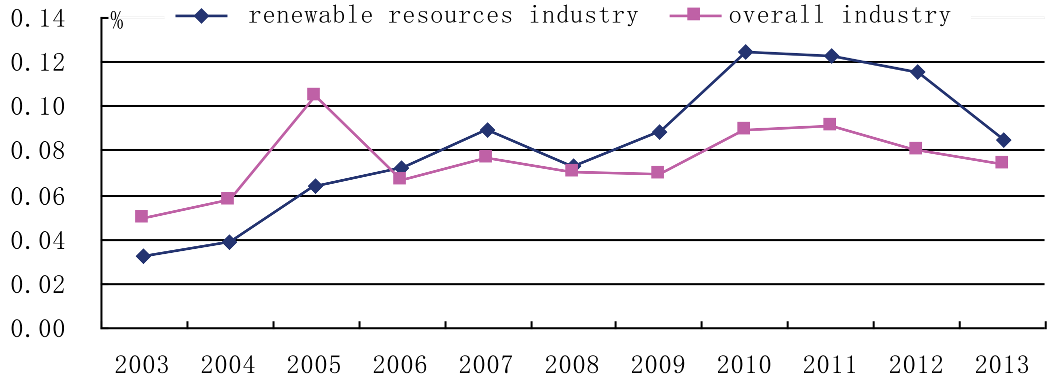

Fig.3-8 Average returns on assets of renewable resources industry and overall industry
Sources: sorted out by the authors

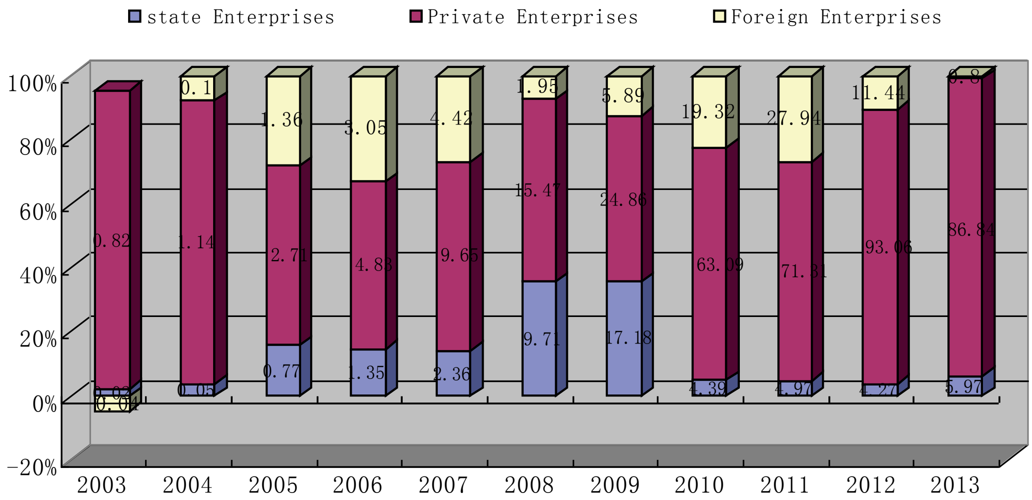

Fig. 3-9 Profits of state-owned, private and foreign-funded enterprises
Sources: [105].

As we can see from Table3-2, the four indicators of renewable resources industry increased year by year from 2003 to 2013, except that the gross profit of 2013 declined. This indicates that the industry keeps a good development trend (Table 3-2). Fig.3-8 shows that renewable resources industry has the same average return on assets as overall industry between 2003 and 2013, and these two figures declined to their bottoms in 2008 while reached their peaks in 2010, after which they both had a downward tendency. This change reflects the fact that 2008 financial crisis led to the Chinese economy stalling, and the government conducted a large-scale "4000000000000" public investment in order to stimulate economic growth, contributing to the temporary China's economic recovery in 2009 and 2010. Return on assets of renewable resources industry rose gradually and exceeded that of overall industry in 2006, after which it maintains the high profit rate. This is mainly the result of the publishment of China's renewable resources industrial policies (Table 3-2).

It can be seen in Fig. 3-9 that the profit of private enterprises got a significant increase, growing from 2.486 billion Yuan in 2009 to 6.309 billion Yuan in 2010, while the figure of state-owned enterprises dived to 439 million Yuan in 2010 after it peaked at 1.718 billion Yuan in 2009. Such a huge difference among enterprises with different ownership is led to the fact that after the government canceled the VAT exemption policy on renewable resources industry in 2009, the negative effects of the policy gradually influence the outcome of corporate profits (Table 2). This also, to some extent, plains why the return on assets of this industry declined faster than that of the overall industry after 2011 (Fig. 3-8).

3.2.4 Performance of renewable resources industry

The total asset contribution rate and the ratio of profits to cost are important indicators to reflect industrial performance. The total asset contribution rate is the core indicator of evaluating and assessing profitability of enterprises, and it is also the reflection of enterprises' performance and management. From the total asset contribution rates of 2003-2013, we can see that private enterprises had the strongest profitability, followed by state-owned enterprises, while foreign-funded ones were the weakest. Private enterprises remained the strongest position after their profitability exceeded that of state-owned enterprises in 2005. From 2010 to 2013, The annual average total asset contribution rate of private enterprises was over 25%, the figure of state-owned enterprises dropped gradually from 24.03% in 2010 to 14.06% in 2013, and that of foreign-funded enterprises also witnessed a 12.74%-to-5.90% decline during this period (Fig. 3-10). These changes indicate that under a competitive market mechanism, reasonableness of private enterprises' renewable resources inventory as well as the precise control of product sales markets fasten the cash flow and enhance the asset investment efficiency.

The ratios of profits to cost reflect not only the economic benefits of production costs and expenses enterprises invest but also the economic benefits of cost reduction.

As can be seen in Fig. 3-11, private enterprises exceeded state-owned enterprises in the ratio of profits to cost and ranked the first after 2010; in contrast, that of state-owned enterprises fell sharply after then . Cancellation of VAT exemption policy has a huge effect on large-scale state-owned enterprises, while most private enterprises are small-scale and have a cost advantage in competition with state-owned enterprises. Also, in renewable resources industry, state-owned enterprises and private enterprises manufacture similar products to some extent, which contributes to the intense competition in the industry. In addition, state-owned enterprises have advantages in scale, technology, capital and talent, but the competition is only involved in low-level homogeneous products, eventually resulting in "Gresham's law", namely the situation that big companies do worse than small businesses and was expelled from the market.

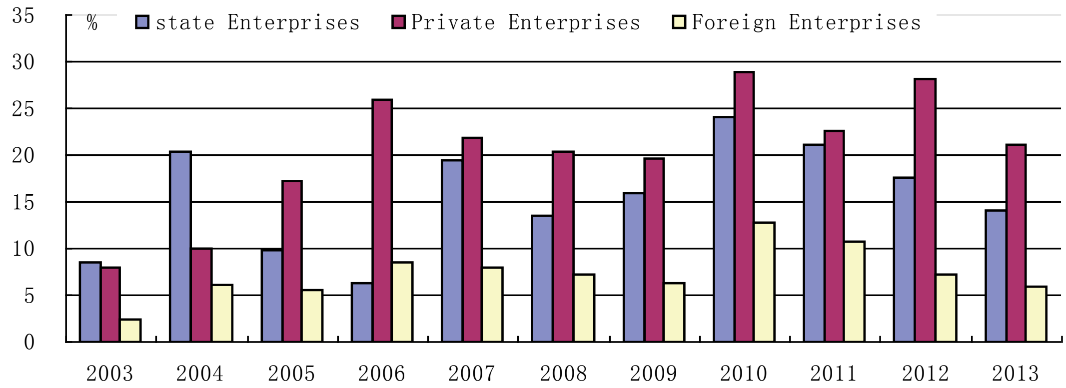

Fig.3-10. Total asset contribution rate of renewable resources industry (2003-2013)
Sources: http://www.stats.gov.cn/ [105].

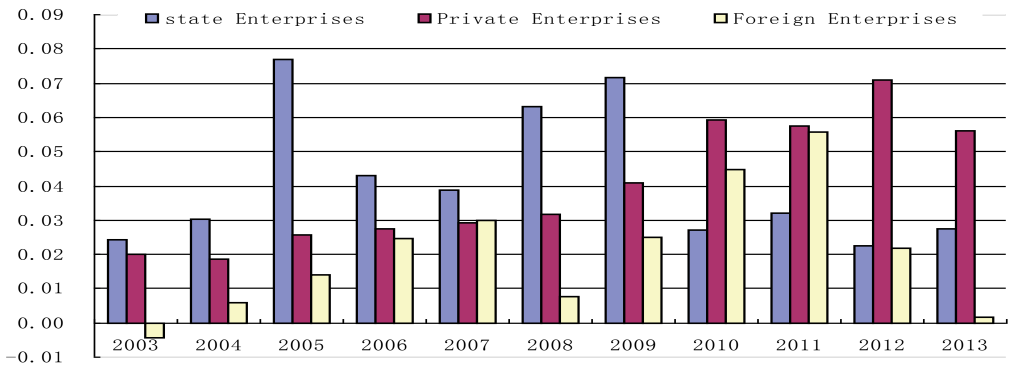

Fig.3-11. Ratio of profits to industrial cost of renewable resources industry (2003-2013)
Sources: http://www.stats.gov.cn/ [105].

The qualitative analysis of the performance indicators of renewable resources industry above clearly shows: renewable resources industry that considers private enterprises as an important part develops rapidly, but the whole performance is affected largely by the external macroeconomic environment and policies.

3.3 The constitution of the renewable resource industry chain and problems existed

3.3.1 The constitution of renewable resource industry chain

Renewable resource industry makes use of the scrap generated in social production and consumption process as its raw material, then repurchase and machining and recycling in the condition that economic and technological factors is permitted. With the renewable resource industry market generally released, an integrated process ranged as stationary purchasing website, mobile purchasing website, scrounger, recycling processing worker (or enterprise) etc. together screening and classifying, finally conveying to the user enterprise has been formed in China. Renewable resource industry chain majorly concludes three phases: scraps recycling, resourcezation process, and reuse.

1. Recycling

Recycling of renewable resource is the first phase of renewable resource industry chain. Residents, production enterprises, commercial enterprises and administrative institution is the production source of scraps. So, recyclers takes the responsibilities to recycle the scraps from its source, then resell it to specialized recyclers or sell it directly to the merchants in distribution market for differentials between purchase and sell. The whole process is realized by market trading. Through this phase, the distribution condition of scraps becomes centralized rather than dispersed in every area of production and consumption process.

2 .Resource utilization

Resource utilization is the second phase of renewable resource industry chain. Also it is the bond and bridge between the upstream and downstream of renewable industry chain. After preliminary classification of recycled scraps, portions which lost its original value of use were sold directly to renewable resource distribution market.

Portions which still have remained value of use partly will be sold to flea markets, and then, a part of them will be resold to customers as second hand goods after repairing and fabricating, another part with no sense to be repaired will be sent into scraps distribution market. Every scrap entering into distribution market will go through further processing of classification, disassemble, smashing and packing. After that, a part of them will be further machining in trading market which was more normative in managing, bigger in scale and better in technology construction. Another part will be sent to enterprises specialized in Resource utilization, and will be sold to enterprises as raw material after processing into renewable material. Currently, the principal part of Chinese Resource utilization is individual workers and small or medium sized enterprises. These subjects faced problems such as shortage of funds, rough technology and facilities, backward means of processing, which caused ineffectively and unreasonable processing of scraps and waste of resources in one hand. In another, subjects in the phase are all working individually and separately, which causes benefit from scale economics being hard to access.

3. Reuse

The third phase of renewable resource industry chain is the process that renewable materials been processed into various kinds of renewable products and get to consumers by circulation market. This phase is realized majorly by two sorts of enterprises: the first sort is enterprises originally specialized in every processing industry; the second sort is enterprises which was newly-built specially for reusing renewable resources. Problems in this phase majorly lie on: (1) as the recycling and processing part are connected loosely, resources will flow into some informal small enterprises or small workshops. They make simple disassemble and processing for scraps in low level, causes resources been insufficiently utilized, and also causes severe pollution, while standard enterprises have to let the facilities to be unused because of the lack of supply. (2) Because of the small scale and dispersion of resourcezation, the concentrated utilize is disadvantageous. For example, many big recycling enterprises turns into import scraps from abroad because of incapability in accessing large sum of coessential renewable resources from domestic market sustainably.

In general, an integrated, well-bedded industrial chain structure has been formed in Chinese renewable resource industry. Lots of specialized body with small scale is ranged in every phase of the industry chain. A growing increasing trend by the direction of material flow is to be seen in the investing scale and profitability of subjects in industry chain. What's more, through the resourcezation phase which completed the activities of scraps classification, package, disassembling etc., scraps turns into materials accessible for production enterprises. Scraps turns into resources, marked the important part in industry chain.

3.3.2 Analysis concerning operating mechanism of renewable resource industry chain

1. Operating mechanism of renewable resource industry chain

Renewable resources and renewable products are coming from natural resources. With the process of production enterprises, natural resources turn into various kinds of protogenous products directed to every consumer's need. They lose their value of use after been consumed, then become scraps instead of vanish. The part of scraps with no value will be led out to natural ecological system, meanwhile other scraps with existed value will be collected through various channels into the renewable resource industry chain, and then turns into renewable products and again returns back to consumers through circulation market (Fig.3-12). In this process, the mechanism of power that keeps renewable resource industry chain operates normally majorly comes from two aspects: first is the inherent price and competition mechanism in industry chain pulls the renewable resources industry, second is the pushing effect towards renewable resource industry from capital, technology and policy factors outside the industrial chain.

The operating of renewable resource industry chain is, substantially, the material flow process of renewable resources. But, the material flow process of renewable resource in China is completed by a set of transaction, and finally formed the so called value chain. It is the value chain that guides the material flow, including the float direction and intensity. Currently, the basic power that operates Chinese renewable resource industry is to influence the supply and demand of renewable resource through the internal transmission mechanism dominated by market mechanism. As for renewable resources, if renewable products are rejected by consumers, then renewable resources utilization enterprises will lose faith in using renewable resources in production process, which directly causes the recyclers not to recycle, and material flow of renewable resources will fail to enter the next phase. Or if any of the phases couldn't generate acceptable profit, the value chain will crack.

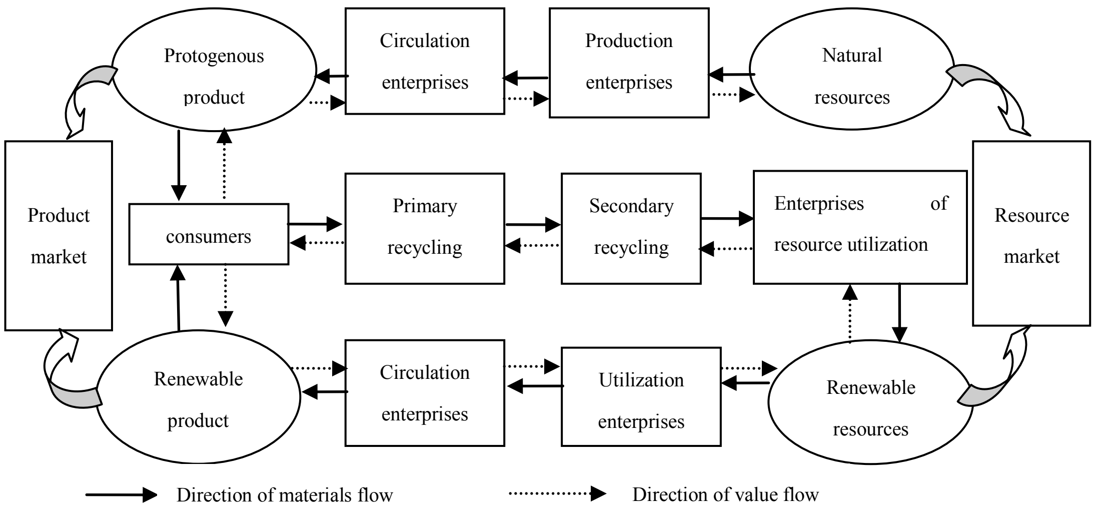

Fig.3-12 Sketch map about the relationship between directions of material flow and value flow in two markets

The mode that value flow guides material flow will otherwise bring another effect. It will attract capitals which run after profit that enter, and further it will push material flow forward, as well as it controls the direction of technology exploitation. So, if renewable resource industry chain could realize the smooth movement under the guidance of value chain, capitals and technology will be appealed and entering this field, which reversely pushing the progress of renewable resource industry and furthermore forming a virtuous cycle. However, renewable resource value chain will easily affected by various factors and break down, which causes the renewable resource industry chain to break down. The situation that renewable resource industry chain breaks down normally lies below: (1) there are no price advantages for renewable resources against natural resources. Utilizing enterprises will lose the enthusiasm on utilizing the renewable resources, which causes the industry chain to break down. (2) The unreasonable structure of renewable resource industry market. Excessive competition leads to profit space elimination in some phases, consequently causes the industry chain to crack. (3) Reduction of recycling profit in every part of industrial chain induced by uprising energy price and logistics cost etc. will also leads to the cracking of industrial chain. (4) The industrial policies that enhance the environmental standards and tax burden of recycling causes relevant costs to rise, and make some subjects on industrial chain to have no profit, which ultimately causes industrial chain to crack.

2. Problems analysis

It can be seen from analysis above that the value chain of Chinese renewable resource industry formed in transactions is very fragile. In purpose of ensure the fluent operation of renewable resource industry, as well as keep an enough space of profit in every subjects of industry chain through the pulling force inside industry chain and pushing force outside industry chain, two matters is to be concerned: one lies on the end of the industry chain and enforce the demand for renewable resources, another is to reduce the operation cost of renewable resource industry.

When aiming at current Chinese renewable resource industry, it can be seen that the promotion on profit space of subjects spread over the industry chain is quite limited because of the feature of renewable resources and the influence of other external factors, which majorly reflected on these aspects: first, when seen inside the industry chain, neither the quality nor the quantity of renewable resources can support the operating scale enlargement or the reduction on costs of subjects spread on industry chain. In sight of quality factor, as the complexity in scraps ingredients, for there are elements which are of value or that without value or even poisonous and harmful ones, extracting costs will rise because of the low level and dispersiveness about elements of value. Also, insight of quantity factor, the economic requirement that fulfills the minimum amount of raw material to attain scale effect is hard to reach for the amount of renewable resources accessible for resourcezation because of the widespread feature of generating source. Therefore, feature on quality and quantity about renewable resource has limited the further reduction of industry chain cost.

Second, seeing outside the industry chain, an approach that could increase the price of renewable resource or the profit space is nearly inexistent. In the aspect of renewable resource demand, the lack of price advantage about renewable resources against natural resources, as well as the lack of consumer's demand on renewable products because of risk aversion, compresses the increasing space of renewable resource price. And, in another aspect, funds outside the industry chain as an important urge that pushes the industry chain to operate is nearly inexistent in our country. The reason of which lies in the nonparticipation towards industry chain of interest subjects especially subjects who generates the scraps and the commodity production enterprises. Not only the funds necessary for operation of industry chain is impossible to be offered, but the operation of industry chain has been pinned, which increase the operating cost of subjects located in downstream of renewable resource industry chain. In the aspect of policies that urges the progress of industry chain, though a set of supporting policies has been issued by nation towards the industry, but on account of the lack of enough theoretical and practical bases, problems in operation of industry chain couldn't be clearly studied out. Therefore, in actual effect, these policies haven't got remarkable effect, some of them even block the healthily progress of the industry. In the aspect of technology that urges the industry chain to progress, many renewable resource technologies in our country have fallen behind the developed country, and has increased the cost of recycling.

Generally speaking, no matter inside or outside the industry chain, the pushing and pulling force are lacked in the renewable resource industry of our country. This makes the energy that pushes the total industry chain to operation be insufficient, which is the major problem in the operation of the renewable resource industry chain of our country. Therefore, how to find the energy source that pushes renewable resource industry chain to operate proceeded from analysis concerning on relevant factors influencing and restricting the operation of industry chain is an important thing for the regulation and perfection of renewable resource industry of our country.

Although there still remains the problem of insufficient power in the renewable resource industry chain of our country, we discovered in actual survey that some of the subjects on the industry chain have a vast space of profit. So, why does the renewable resource industry of our country keeps operating instead of the industry chain to be cracked under various disadvantages?

(1) According to analysis above, the power that keeps the subjects on industry chain to operate normally is that every subject has enough profit space. To enhance the profit space, either increasing the price of renewable resource, or reducing the costs. However, influenced by advantages such as the quality, the quantity, demand, technology and capital of renewable resources, the profit space is limited for renewable resource industry of our country. So, only reducing operating cost can profit space been increased. To reduce costs, first way is externalities of enterprise internal cost; second way is to sacrifice the social welfare of workers, considering the advantages of labor force in our country. That is to say, the reason that renewable resource industry of our country could runs normally under the lack of power in industry chain is that enterprises can take the advantage to externalize the internal costs caused by pollution in recycling process and sacrificing the social welfare of workers and the public in exchange for profit space. Also it is the main reason that self-regulation mechanism could operate under various disadvantages in renewable resource industry of our country.

(2) Another sight. For some renewable resources, even the internal costs could be externalized, recycling enterprises couldn't realize enough profit to avoid letting scraps into emission channel because of the limitations of utilization cost. This will cause resources to be wasted and also causes pollution. However, renewable resources, which have comparative advantages towards natural resources, operate inefficiently under the basis of second pollution and loss of worker's welfare. So, for renewable resources in our country, whether to recycle or not could bring big problems.

3.3.3 Problems of renewable resources industry

There are lots of problems about renewable resources industry in China, including: recycle system is not sound, management norms, processing and using technology is relatively backward, and legalization and standardization degree is not high. These problems not only involve the industrial development itself, but also include the problems in management, mainly reflected in the following respects:

1. Low utilization efficiency of renewable resources and serious secondary pollution

The recovery rate of China’s renewable resources is low. According to estimation, the value of resources that can be recycled but are not recycled is up to a trillion yuan, and the rate of resources utilization is less than 40%, while waste recovery rates of developed countries are often above 70%. In particular, recycling enterprises have only a little interests in low-profit renewable resources, such as glass, used batteries and construction waste, resulting in serious loss of resources. A lot of renewable resources that are not recycled are thrown away, filled or incinerated, causing serious actual or potential contamination of air, soil and groundwater. Because the industry concentration is not high, most of recovery enterprises are diverse and dispersed, many companies mainly process primary products with low added value, the recycled amount of scale enterprises accounts for only 10%-20%, and the degree of scale operation need to be improved, the recovery rate of China’s renewable resources is low.

2. Renewable resources industry lacks market power.

Most of China’s renewable resources enterprises gathered in the recycling, dismantling and simple manufacturing processes that have low added value. Their production and supply depend on the needs of downstream resource utilization industries to a certain extent, but in the long run, they stand at a more disadvantage position than downstream industries. The renewable resources market structure is close to perfect competition, and renewable resources enterprises have smaller scale than downstream resource utilization enterprises, so renewable resources products are constrained by the latter in sales volume and price, prices of renewable resources are much lower than that of initial resources, and scope of profits is narrow.

3. The market mechanism is not perfect, and it lacks effective regulation

Most varieties of renewable resource recycling industry lack production technical standards, quality classification standards and testing standards. With no clear, unified market access conditions, some small-scale enterprises with low technology and resource utilization rate enter the market and have a serious impact on the overall development of renewable resources industry. The recycling, dismantling and processing of renewable resource industry chain develop fast, while sectors such as research and development and consulting services develop toughly, and many technological achievements can not be transformed into productivity. Division of government administration sectors that related to renewable resources is not reasonable, and there are problems such as separations of departments, overlapping functions and institutional overlap. For example, recycling and comprehensive processing of waste and sound processing enterprises belong to different sectors; they lack unified management, and cannot establish regional specialization and integrated market system in accordance with the need of industrial development.

4. The legal system is not perfect, and the country lacks stable preferential fiscal policies and funding

From a legislative perspective, China has not had any basic laws about recycling of renewable resources since it systematically launched renewable resource utilization. The legal system lags behind. From the perspective of the renewable resources industry development policy, at present, China lacks comprehensive laws about comprehensive utilization of renewable resources and special regulations for various products, and the dismantling of waste materials, processing and re-manufacturing technology is not complete, so industrial development cannot get clear policy guidance and support. Although “Renewable Resources Recycling Management Methods”, “Circular Economy Promotion Law”, “Regulation of Waste Electrical and Electronic Equipment Recycling”, “scrap automobile recycling management approach” and other laws and regulations have been implemented in recent years, many provisions are useless because of the lack of supporting norms, standards and policies. Meanwhile, the entry limitation of enterprises and staff employed, market access system, EPR, the government green procurement system, product green design system and so on have not been established or improved. Tax policy was also flawed. “Notice from Ministry of Finance and the State Administration of Taxation on waste recycling business VAT policy” stipulates that domestic renewable resources recycling companies without VAT can open a waste materials invoice that can deduct 10% VAT. However, although imports of scrap copper and aluminum do not have to pay tariffs since 2006, the value-added tax has always been 17%. The existence of "dual track" between importing waste and domestic waste recycling is the root of many problems. In short, China's laws and regulations on the renewable resources industry needs to be speeded up.

Technology and industrialization level of renewable resources industries determine the degree of resource utilization. China invest a little in resource utilization projects, and there is no special funds supporting resource utilization and no long-term investment or equipment construction investment. Because of funding problems, it is hard to carry out some resource utilization projects with advanced technology and high economic and social benefits.

5. Unclear understanding hinders the healthy development of renewable resources industry

Affected by resource awareness, environmental awareness, and funds, technologies, equipments, talents, markets and so on, governments' investment in recycling technology is insufficient and the recycling processing of renewable resources is still not mature. Some of people's understanding of the development of this industry is still vague. Some wastes that can be used as raw materials are considered as "foreign garbage" and are restricted or prohibited importing. Renewable resources are often seen as “rubbish” or “scrap”, and it is common that some relevant recycling staff receive some degree of prejudice and discrimination. Some people believe that it is too early to develop renewable resources industry in China, and some people, who are not familiar with “re-create”, consider the products as poor-qualified when these products are known as "re-create" or "recycled material production". All of these things impede the development of renewable resources industry. In addition, the national statistical systems requires for enterprises above designated size, but many of enterprises of renewable resources industry are below designated size, causing distortion of utilization of renewable resources.

3.4 Industrial policy of renewable resources industry

As a sunrise industry, renewable resources industry has its own vulnerability and commonweal, which determine that the development of this industry must rely on policy support. “The Law on Energy Conservation”, "Cleaner Production Promotion Law" (including revisions) and the "Circular Economy Promotion Law" are the foundation and guiding ideology of China’s current renewable resources industrial policy. Table 3-3 summarizes laws and regulations relevant to Chinese renewable resources industry (Table 3-3). Next, industrial policy will be described in terms of policy of fiscal subsidies, tax policy and regulation policy.

Table 3-3 Laws and regulations relevant to Chinese renewable resources industry

NO.	Time	Laws and regulations	Policy types	Policy points	Management objects
1	1998.1.1	The Law on Energy Conservation	Guiding Policy	Save energy, improve energy efficiency, and protect and improve the environment	The whole industry
2	2001.5.1	Notice on VAT policy of waste recycling business	Tax Policy	Waste recycling companies are exempt from VAT	Recycling Systems
3	2003.1.1	Cleaner Production Promotion Law	Guiding Policy	Carry out the minimization and harmless of solid waste at the production stage	The whole industry
4	2005.4.1	Laws on the Prevention and Control of Environmental Pollution by Solid Wastes (Revision)	Regulation Policy	Clearly restrict the import of wastes, and ban importing solid wastes that cannot be used as raw materials or cannot be used harmless	Environmental protection areas
5	2006.4	Notice on the Implement of Constructing Pilots of Renewable Resources Recovery System[2]	Regulation Policy & Fiscal Policy	Achieve the industrialization of renewable resources recycling	Recycling Systems
6	2006 .4.27	Pollution Control Technology Policy of Waste Household Appliances and	Regulation Policy	Propose the "3R" principle of WEEE (Waste Electrical and Electronic Equipment),	Recovery and utilization systems

[2] Complete the construction of renewable resource recycling system pilots by three times in five years, and the followed two times, respectively, were implemented in 2009 and 2011.

		Electronic Equipments		and implement the principle of "polluter responsibility"[3]	
7	2006.12	Guidance on Comprehensive Utilization of Resources during the Eleventh five-year Plan	Regulation Policy	Improve the industrialization level of renewable resources, and include the construction demonstration of recycling system in the key projects	Resource utilization systems
8	2007.5.1	Renewable Resources Recycling Management Methods	Regulation Policy	It is the first national regulation about the standardized management of the renewable resources recycling industry and it is an important policy basis specifically for the management of the recycling industry	Recovery and utilization systems
9	2009.1.1	Circular Economy Promotion Law	Guiding Policy	Promote “minimization, reuse and recycle”, and establish extended producer responsibility	The whole industry
10	2009.1.1	Notice on Renewable Resources Value-added Tax Policy	Tax Policy	Cancel VAT exemption policy for waste recycling and sales enterprises and implement VAT refund policy	Recycling Systems
11	2010.5	Notice on the Construction of “City Minerals” Demonstration Bases	Regulation Policy & Fiscal Policy	Built about 30 "City Minerals" demonstration bases. Promote the utilization of renewable resources.	Resource utilization systems
12	2011.1.1	Regulation of Waste Electrical and Electronic Equipment Recycling	Regulation Policy & Fiscal Policy	Forbid importing waste electrical and electronic equipments that the country has made a ban on, and prohibit the establishment of "waste electrical and electronic equipments special fund"	Recovery and utilization systems

[3] Producers, sellers and consumers share the responsibility for pollution prevention of waste products lawfully.

13	2011.12	Guidance on Comprehensive Utilization of Resources during the Twelfth five-year Plan	Regulation Policy	Enhance the comprehensive utilization of industrial wastes and the recycling of renewable resources level	Resource utilization systems
14	2012.7.1	Cleaner Production Promotion Law (Revision)	Guiding Policy	Improve resources utilization efficiency, reduce the generation and emission of pollutants in the production process, and strengthen the funding of clean production and its technology	The whole industry
15	2015.1	Medium and Long-term Plan of Construction of Renewable Resources Recovery System (2015-2020)	Regulation Policy & Fiscal Policy	Establish recycling systems, strengthen supervision of the industry and improve the recovery management systems	Recovery and utilization systems

3.4.1 Policy of fiscal subsidies

Since the ministry of commerce launched a renewable resources recycling system pilot (No. 5) in 2006, three batches of 90 pilot cities have obtained support from central government special funds, and the ministry of commerce has constructed, renovated and expanded 51,550 outlets, 341 points sorting centers and 63 distribution markets, and has supported the construction of 123 renewable resources recycling processing bases. The policy of fiscal subsidies plays a significant role in regulating renewable resources recovery markets, improving renewable resources recycling rates and accelerating the construction of renewable resource recycling system.

Chinese government launched appliance trade-in policy in Beijing, Tianjin, Shanghai and other nine pilot provinces and cities in June 2009. This policy not only provides consumers subsidies when they trade appliances, but also helps appliance sales enterprises, recycling companies and dismantling enterprises gain appliance subsidies, freight subsidies and dismantling subsidies, respectively. Carrying out this policy expands domestic consumption demand, and it also increases regular recycling enterprises' recovery volume of electronic waste (WEEE), thus enhancing those enterprises' competitiveness, significantly improving the operating state of dismantling enterprises, improving efficiency of energy resources and reducing environmental pollution. Sales volume of new appliances and recovery volume of old appliances during the period of policy implementation can be seen in Table 3-4.

Table 3-4 Outcomes of Appliance trade-in policy (2009.6-2011.11)

Time	Cumulative sales of home appliances / ten thousand units	Sales amount /a hundred million yuan	Recycled volume of old home appliances / ten thousand units	Dismantling volume of old home appliances / ten thousand units
2009.6.1-2009.12.30	360.2	140.9	402.6	/
2009.12.31-2010.5.31	1 409.3	539.8	1 479.8	865.5
2010.6.1-2010.12.9	3 002.6	1 126.9	3 110.9	/
2010.12.10-2011.4.15	4500	1700	4 660	3 000
2011.4.16-2011-11.30	8 129.6	3 004.2	8 373.3	6 621

Sources: Ministry of Commerce of the People's Republic of China

3.4.2 Tax policy

Value-added tax policy is an important part of economic polices related to supporting renewable resources industry. In May 2001, Chinese waste recycling enterprises' sales of waste materials are exempt from VAT. The implementation of this policy stabilizes the development of recycling industry (Table 3-3, No. 2). However, due to tax loopholes issues on management, "Notice on renewable resources value-added tax policy" implemented in January 2009 abolished renewable resources value-added tax preferential policy, but there is a two-years transition period, during which recycling companies that meet certain conditions are treated value-added tax refund policy according to certain percentage (70% in 2009, 50% in 2010) of their VAT sales of renewable resources (Table 3-3, No.10). The implementation of this policy has a big impact on renewable resources industry, particularly on larger scaled regular waste processing enterprises. The reason is that small companies can evade VAT by paying a fixed tax, while waste source of larger regular enterprises are "scavengers officer" who do not have qualifications to invoice, non-operating agencies and organizations and small salvage stations. For large-scale regular enterprises, no VAT invoices means no deduction of input tax, and the purchase companies will need to pay the full VAT of 17%. Increase of cost severely restricts the performance of regular large-scale enterprises. In the future, constantly improving the waste materials recycling of VAT policy remains a challenging area.

3.4.3 Regulation policy

As the main law-making and administration, the government plays an important role in industry regulation means. China's current management policies on renewable resources industry can be grouped into five main aspects: (1)comprehensive regulations about renewable resources recycling and utilization, (2)specialized management about renewable resources recycling system, (3)solid waste management in the field of environmental protection, (4)resources utilization and(5) waste import management. Wherein (1) standardize and synthetically manage the two aspects of recovery and utilization of renewable resources. This kind of guiding ideology has a positive effect on the development of all aspects of this industry. Especially, we should lay emphasis on the market management of renewable resources, make the preferential policies of renewable resources enterprises clear and extend it to public finance and credit areas. After 2002, with the recommendation of circular economy, the comprehensive management of recycling and utilization of renewable resources was incorporated into management areas of "comprehensive utilization of resources", while provisions about recycling and utilization of renewable resources decreased. After 2010, the industries see the processing as the key area to achieve the goal of providing high-quality resources for community. Policies that were introduced in recent years play a leading role in regulating the market of renewable resources, improving resource recycling and comprehensive utilization systems, establishing industrial development technology systems and making standards for admittance into industries. (2) Waste recycling management is mainly about the construction of recycling industry system and the commercial circulation department is responsible for regulating. Except the administration content for enterprises and business scope in the 1980s, management policies in this area mainly includes the series of tax policy evolution, at the core of VAT, as well as the highlighted renewable resource recycling system and demonstration of management in recent years. (3) Policies in the field of environmental protection are related to resource recycling and reuse, and their correlation is mainly manifested in the aspect of solid waste management. Early policies were aimed at comprehensive utilization of industrial waste. Thereafter, comprehensive utilization of solid waste expanded to "green industries" and "clean production". Because it is one of industries that are encouraged by our country, it enjoys corresponding preferential policies. Clearly, researches on renewable resources policies should pay attention to the close connection between these policies and environmental protection policies, especially in the recycling process of waste production and comprehensive utilization of resources. The cross-cutting policy in this regard needs to be analyzed comprehensively. (4) After the 1980s, the State Council and relevant ministries issued a series of rules and regulations regarding to comprehensive utilization of waste. In1985, Provisional rules of comprehensive utilization of resources was introduced, identifying comprehensive utilization of resources as major technical and economic policies and determining the scope of the preferential treatment with "comprehensive utilization of resources directory". In 1996, the concept of comprehensive utilization of resources gradually extended to recycling of renewable resources and preferential policies about VAT and income tax were clear. Before and after 2006, with the proposition of circular economy, the importance of renewable resources recycling was further highlighted, and the renewable resource management was integrated into the resource utilization policies system, developing rapidly. In the future, "resource utilization" policy will still dominate the development of China’s renewable resources industry. (5) China's management for imports of waste started in the 1990s. With the increase of imports of waste, departments of environmental protection, quality inspection and customs gradually introduced a series of laws, regulations, standards and normative documents and formed a system that covers approval, inspection, clearance and some other aspects. The establishment of this kind of system has a positive effect on prevention of imported waste environmental pollution after China joint in WTO.

In recent years, renewable resource policies specifically for specific categories are introduced unceasingly. For example, policies about waste electrical and electronic products continuously enriched and improved China’s renewable resources policy system. Generally speaking, most of management tools of China’s renewable resources industry are command and control type, including a large number of laws and regulations, regulatory policies, standards and management systems, while incentive policies about investment, credit, prices, finance, taxation and foreign trade are rare. Among them, most economic policies that promote the development of of China's recycling industry are various types of preferential tax policies, value-added tax particularly. Other economic policies are seldom used. Roles of policies like income tax, consumption tax, imports VAT are not significant because the preferential ranges of these policies are limited. In addition, national macro-industrial policy, environmental protection industry policy and hi-tech industry policy also have relevant regulations about renewable resources industry.

However, studies show that policies in these macro areas help guide investment and enhance the level of industrial technology, but the reason why renewable resources industry was included in the national macro-support programs is usually that this industry belongs to "resource utilization", and "resource utilization" included a lot areas, in which contents about recycling industry are a few. Therefore, the effect of these incentive policies on recycling industry is very limited.

Considering the main formulation and implementation departments of all kinds of renewable resources management policies, China's renewable resources management system has the characteristics that many departments make decisions and manage the system. “Commercial sectors attach importance to recycling, industrial sectors pay attention to use, and environmental protection sectors take charge of governance” that was formed in the traditional China still existed in many reforms of government institutions. Commercial circulation departments and industrial planning departments are always responsible for the recycling industry and the using industry, respectively, while environmental protection departments are responsible for the renewable resources industry pollution control. The author thinks that this management system brings two kinds of problems: firstly, cross-function appears in the management of recycling system. At present, the ministry of commerce is responsible for the formulation and implementation of industrial policies and regulations of renewable resources recovery as well as the pilot program about the standard of recycling and the recycling system construction. In the circular economy pilot program and guidance of resources comprehensive utilization in the period of "11th five-year plan", the national development and reform commission takes the construction of renewable resources recovery system as one importance. Secondly, recycle management and reuse management are disjointed. Recycling and reuse are two closely related industry in the recycling industry chain, and separated management not only increases the coordination costs and transaction costs as well as reduces the efficiency of management, but also dose harm to the industrial development. Varieties and quantities of renewable resources recovery is restricted by the demand of industry for renewable resources. Driven by profits, recycling sectors determine to purchase specific goods in accordance with sales and recycle few resources that are hard to be sold or low-profited. Enterprise of recycling and reuse, in turn, is also affected by the number and quality of recycling. Industrial departments are reluctant to low-recycled renewable resources and no use results in no recycling of commercial departments.

Disconnected management between recycle and reuse is harmful to the two industries. Besides, the recycling sector has its own recovery system; it is difficult to manage them separately. Therefore, the author proposed that the management system of resource recycling industry in China should pay attention to industrial sectors and involve the management of recycling industry to form the comprehensive management of recycling industry and reuse industry and to strengthen the coordination function of environmental protection departments.

4. the empirical analysis of renewable resource price

Renewable resource and original resource are different ways and channels of resource supply. But both are faced with the same consuming market, and the relationship between them is competitive and substitutional. The relevance of two industries is connected through the market, in which the most important variable is price. Which kind of relevance there is between the price of renewable resource and natural resource? How does the price variation conduct in the two and further influence the market structure and competitive structure, in the dynamic perspective? These questions are included in research contents of this chapter.

This chapter illustrates the unbalanced substitutionary relationship between renewable resources and original resources theoretically, and inferring the relationship between the price of the two based on it. Then, quoting the statistics of weekly price of original resources and renewable resources from January 2014 to May 2015, this chapter makes an empirical research on the relevance between two groups of renewable resources price and natural resources price: scrap tire (ST), natural rubber (NR), scrap copper (SC) and primary copper (CU). The result shows that there are long run co-integration relationship between price of natural resources and renewable resources. The price of primary copper is the Granger causality of scrap copper.

4.1 literature review

Chinese and overseas scholars' study renewable resources and original resources majorly focused on the relevance, the conducting mechanism about the price of them and factors that causes price of renewable resources to fluctuate etc.

Overseas scholars' study includes: Stollery (1983) proved from empirical analysis that price of steel scrap is in direct proportion of price of raw steel. John E.Tilton (1999) pointed out that recycling production is sensitive to cost and price. It is possibly profitable from the rise of resource price, but technology innovation will bring about reduction of real price of resources which surpassed the rise on price brought by resource exhaustion. Therefore, recyclers should reduce its costs through technology innovation, instead of expecting the reduction of real price. Nongnrad

Sunthonpagsit, Micheal R.Duffey (2004) pointed out that the production activities of scrap tire and scrap rubber is influenced by potential investors and government sector, which causes recyclers have to face not only the reduction of real price, but also the uncertainty of market and competition with enterprise supported by government. Irene M. Xiarchosa, JeraldJ. Fletcherb (2009) researched the linkage effects between the price virgin metal and nonmetal, and pointed out that there are influence between price of scraps and raw material, but won't last long. Kentaka Aruga, Shunsuke Managi (2011) pointed out that in long run, the market price of bronze futures and spots is relevant. Anna Mansikkasal, Robert Lundmark (2014) pointed out through the calculation of the price elasticity of supply of recycled paper that this will contribute to the explanation towards the fluctuation on market price of recycled paper.

Domestic scholars' study includes: YongJian Pu, DeMin Chen (1996) pointed out that there are dynamic relevance between the price of renewable resources and original resources; also they deduced the optimal dynamic allocation model of resource according to renewable resources. WenDong Li (2008) pointed out that the price of primary renewable resources will fluctuates in a certain range, and the time series of price has durability. FeiFei Zhang (2009) pointed out from the perspective of product substitution that the price of renewable resources bears the uni-directional fluctuation caused by the price of original resources. Therefore the substitutional relationship between the two is unbalanced. MingXi Lu, Hao Zhang (2011) pointed out after researching on factors that influence the price of steel scraps that the price of steel scraps has a substitutional relationship with different relevancy between the price of various original resources that replaceable. Zibo Yang, Gang Zong (2013) pointed out that there are comprehensive substitution effects in renewable resource market. In the condition that prices won't change, the rise or fall of the price of a substitution of one renewable product will leads to the demand for that product varies toward the same direction as the price of substitution varies. YiBo Yang (2013) discovered that the fluctuation of most renewable resource price is influenced by seasonal factor, and put forward an advice about price monitoring mechanism to ensure the relatively stability of renewable resources price. JianBo Huang (2013) pointed out from the empirical analysis focused on domestic market that the price in domestic market of primary copper and copper scrap is relevant in long-run, and also pointed out the long term and short term causality between them.

4.2 Analysis on the relevance of price of renewable resources and original resources

4.2.1 The unbalanced substitution among resources

As is known to all, the renewable resources produced through the recycling and processing of scraps could, to some degree, substitute original resources. This kind of substitution is faced with two aspects of limitations: first, the technological feasibility of turning scraps into renewable resources. Normal production and consumption process turns raw material into commodities, and then becoming scraps. But the reverse of this process, however, is hard or even impossible in terms of technology. Second, whether economic or not the substitution towards natural resources by renewable resources is. The recycling process of scraps cost energy and resources as well as it pollutes instead. All of those bring about costs. Otherwise, as differences existed for the consumers of resources when using these resources in many aspects such as facilities, technology and soon, huge sunk cost will be generated in the substitution towards natural resources by renewable resources. So, the substitution towards natural resources by renewable resources currently still left with lots of limitations. That is to say, the substitution towards original resources by renewable resources is limited. Because of the limited substitution towards original resources by renewable resources, renewable resources has “natural” upper limit for price. Only when price are lower than the upper limit can the effective demand for renewable resources be generated. Renewable resource also faced with the “price restriction” of natural resources; therefore the demand market renewable resource enterprises faced is limited.

Compared with renewable resources, original resources weighed much heavier in the proportion of Chinese resource consuming. For a long time, the resource production sector plays a dominant role in Chinese economy. A stable structure embraces the using of original resources has been formed by existing technology, capital, talents and regime factors. To replace original resources by renewable resources, the old tradition must be got rid of. This involves problems such as technological innovation, talents cultivation, digestion of sunk cost and replacing of capital etc. and will generate huge mass of substitutional cost which limits the expanding of demand range for renewable resources. So, in the sight of resource substitution, original resources are in the positions of perfect substitution towards renewable resources in long run.

4.2.2 The restrictive factors towards price of renewable resources

Theoretically, if there are two kinds of product which is equally replaceable mutually, then reduction on price of one kind of product makes enterprises producing this kind of product to take the lead in market. While substitution producer enterprises will predict the price variation direction of opponent and make positive correlated decision. Then, the price of substitutions will vary in the same direction. However, this kind of price variation law is not completely allocable for natural resources and renewable resources market. The unbalanced substitutional relationship between natural resources and renewable resources determines the difference in competitive position of enterprises produces these two kinds of products respectively. Because of the huge mass of substitutional costs, natural resource enterprises could get the monopoly position in competition with renewable resources. As soon as natural resource enterprises reduce its price, it will soon conquer the whole market. So, it is available to assume that when natural resource enterprises adjust prices, renewable resource enterprises will immediately act in the same direction, which can be expressed as: $dp_r/dp_v\rangle\boldsymbol{0}$; however, when renewable resource enterprises adjust its price, natural resource enterprises won't act correspondingly, which can be expressed as: $dp_v/dp_r=\boldsymbol{0}$. While p_v and p_r represents the price of natural resources and the price of renewable resources respectively.

Otherwise, the upper limit of price renewable resource enterprises faced with will draws great influence on the equilibrium output after market adjustment. The existence of price toplimit will compress the space for price to adjust, and even press the price closer to cost and lead enterprise to be bankrupted. Based on analysis above, below will study the decision making activities of enterprises and price variation under situations with price toplimit and without price toplimit respectively.

(1) The variation trend of resource price with no consideration on price toplimit

In the condition of no price toplimit, the revenue of renewable resource enterprise in market could be expressed as:

$$\pi_r = P_r q_r - C_r(q_r) \tag{4.1}$$

Condition that maximize the revenue:

$$\frac{d\pi_r}{dp_r} = q_r + (p_r - C_r')\left(\frac{\partial q_r}{\partial p_r} + \frac{\partial q_r}{\partial p_v}\frac{dp_v}{dp_r}\right) \tag{4.2}$$

π_r represents the revenue of renewable resource enterprises, p_r is the price of renewable resources, q_r is the production, C_r is the cost.

Because $dp_v/dp_r = \boldsymbol{0}$, it can be inferred that:

$$q_r = (C_r' - p_r)\frac{\partial q_r}{\partial p_r} \tag{4.3}$$

Also, because of the production and profit of renewable resource enterprises are not only related to the price of renewable resources, but related to the resource price of natural resources. So, the supply of renewable resources product could be expressed as:

$$q_r = \alpha + \beta P_r + \delta P_v \tag{4.4}$$

When $dp_r/dp_v \rangle \boldsymbol{0}$, it can be inferred from equation (4.3) and (4.4):

$$P_r = \frac{C_r'\left(\beta + \delta\frac{dP_v}{dP_r} - \frac{\partial q_r}{\partial p_v}\frac{dP_v}{dP_r}\right) - \alpha - \delta P_v}{\boldsymbol{2}\beta + \delta\frac{dP_v}{dP_r} - \frac{\partial q_r}{\partial q_v}\frac{dP_v}{dP_r}} \tag{4.5}$$

When $dp_v/dp_r = \boldsymbol{0}$,

$$P_r = \frac{C_r'\beta - \alpha - \delta P_v}{\boldsymbol{2}\beta} \tag{4.6}$$

Assuming that the marginal cost is 0, it can be seen that the price speculated under the condition of $dp_r/dp_v\rangle \boldsymbol{0}$ is greater than that speculated under condition of $dp_v/dp_r = \boldsymbol{0}$. It reveals that if the price of natural resources has varied, renewable resource enterprise will immediately adjust the price towards the same direction. Finally new market equilibrium will be formed at higher (or lower) level of price. In short, renewable resource industry is affected by price fluctuation of natural resource industry.

(2) The variation trend of resources price in the case of upper limit of price

When resources price falls sharply, original resource enterprises will offer the resource product in lower price level to reduce the market loss caused by contraction in demand. Even renewable resource enterprises lower its price also to keep the same proportion with original resource price; the equilibrium price level reduces however. In lower price level, as the substitutional relationship is unbalanced, consumers will increase consuming on original resources and reduces the utilization of renewable resources instead. Otherwise, because of the limited substitution towards original resources by renewable resources, renewable resources are born with upper limit of price. Once faced with the rapid compress of price toplimit and sharply fall of renewable resource price, the production price will draw closer to production costs. If enterprises are lack in consciousness and emergency plan for risk, then products will overstock, funds will be difficult to flow, and furthermore, many enterprises will gone bankrupt.

4.3 Renewable resources price analysis based on VEC model

The VEC model is used for the empirical analysis to find the price correlations between recycled resources and original resources .Firstly, after using unit root test and establishing VAR model, we examine the co-integration relationship between variables. Secondly, using granger causality tests totest the long-term equilibrium relationship between variables and establishing VEC model, and then analyzes the effects and the price correlations of recycled resources and primary resources by using the impulse response functionFinally; we can draw some corresponding conclusions.

4.3.1 Variable selection and data description

This paper selects two groups of price weeks data sample for empirical analysis and inspection from January 2014 to April 2015, in order to analyze the basic characteristics of prices correlation between Chinese recycled resources and primary resources, all price index data are from zhuo chuang information website http://www.sci99.com/.

(1) Scrap tire (ST) and natural rubber (NR)

ST price index can reflect the general price changes and operation condition of Chinese domestic scrap tire comprehensively and objectively.the main market of ST price index data acquisition is : shandong zouping, hebei yutian, henan jiaozuo,shanxi pingyao and jiangsu nanjing market .NR price index can reflect the general price changes and operation condition of Chinese domestic natural rubber market comprehensively and objectively.The specifications of the natural rubber is given priority to domestic and imported standard natural rubber ,the main market of price collection is: shandong market, hengshui, tianjin, jiangsu market, zhejiang, Shanghai and guangdong market .the relationship between ST and NR are shown in figure 1.

(2) Copper scrap (SC) and native copper (CU)

SC price index can reflect the general price changes and operation condition of Chinesedomestic copper scrap comprehensively and objectively.the main market of copper scrap price collection is :Shandong, hebei, jiangsu market, guangdong market .the market of native copper price collection is north China spot market, east China spot market, north-east China spot market, south China spot market.

Fig. 4-1 and fig.4-2 reflect the relationship between scrap tire (ST) and natural rubber, copper (SC) and native copper (CU) respectively. Fig. 4-1 and fig.4-2 all show that the recycled resources price index and primary resources price index have a certain correlation and the trend is down.

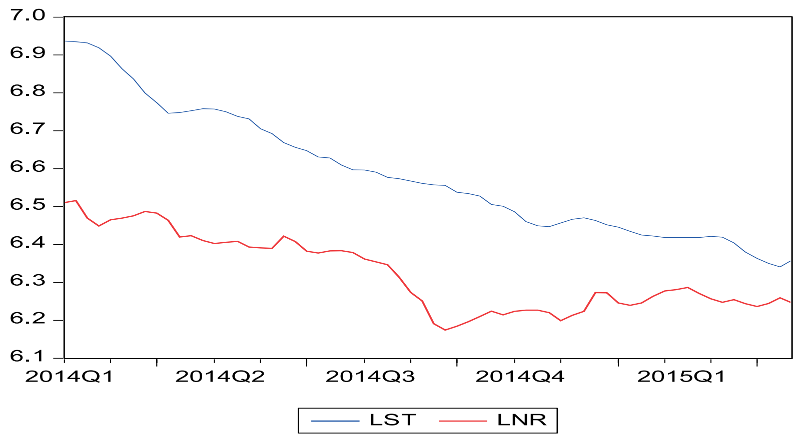

Fig. 4-1 scrap tire (LST) and natural rubber (LNR) price index time trend

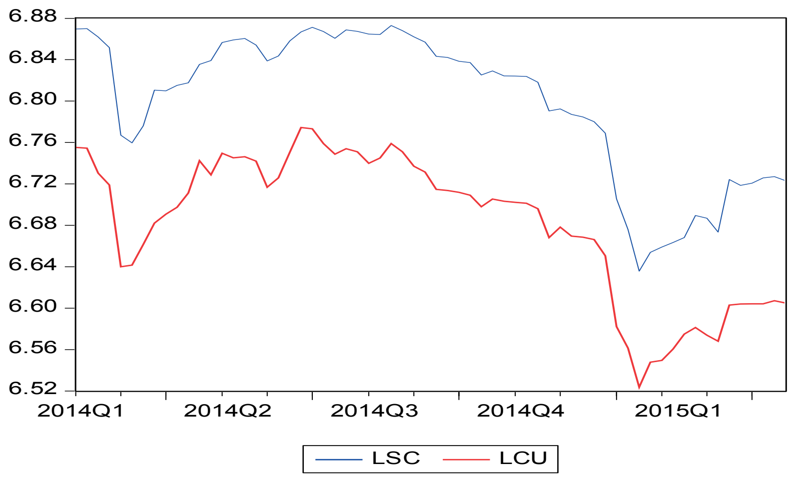

Fig.4-2 scrap copper (LSC) and original copper (LCU) price index time trend figure

4.3.2 the empirical analysis

(1) Unit root test

In order to eliminate possible problems of heteroscedasticity and serial correlation in the model,and to better analyze the relations between the recycled resources and primary resources prices ,the data is taken the natural logarithm, respectively expressed as: the scrap tire (LST) and natural rubber (LNR), copper scrap (LSC) and native copper (LCU) .To test the stationarity of time series data, after doingthe unit root test to LST, LNR, LSC, LCU usingeviews6.0, we found that all variables are not satisfy the stationarity test, Then doing ADF test to their first order difference , we found that all the data come intostationary time series, the results are in the following table.

Table 4-1 unit root test

Variable	Level data		Critical value		First difference	
	ADF	Probability	1%	5%	ADF	Probability
LST	-3.39	0.015	-3.55	-2.91	-3.81	0.00
LNR	-1.95	0.31	-3.54	-2.91	-5.60	0.00
LSC	-1.02	0.74	-3.55	-2.91	-6.24	0.00
LCU	-1.06	0.72	-3.54	-2.91	-6.37	0.00

Note: All the unit root tests for the level and first differences.

The above results show that the ADF values of the first order difference of the variables is less than the critical level at the 5% confidence level, which means that these variables are the first-order single whole sequence. In other words, all the variables are non-stationary first-order single whole sequence, and there may be some linear combination, which can maintain a long-term stable equilibrium relationship between variables, namely the cointegration relationship.

(2) The determination of VAR (P) model lags order

The mathematical expressions for the VAR (P) model

$$y_t = A_1 y_{t-1} + \ldots + A_p y_{t-p} + Bx_t + \varepsilon_t \quad t=1,2, \ldots, T \qquad (4.7)$$

Among them: yt is k dimension endogenous variable vector, xt is d dimension exogenous variables vector, p is lag order, T is the number of samples. A1, Ap, B is the coefficient matrix respectively, epsilon is k dimension disturbance vector .According to the aforementioned formulas, establish two groups of VAR model about scarp tire (LST) and natural rubber (LNR) as well as copper scrap (LSC) and native copper (LCU) .The establish of VAR (P) model need to determine the maximum number of lag order p. Using statistic information LR, AIC criterion and rule of SC, the results are as follows.

Table 4-2 VAR Lag Order Selection Criteria of DLST and DLNR variables

Lag	LogL	LR	FPE	AIC	SC	HQ
0	335.0670	NA	3.52e-08	-11.4851	-11.4140	-11.4574
1	352.7365	33.5111*	2.20e-08*	-11.9564*	-11.7433*	-11.8734*
2	353.4179	1.2453	2.47e-08	-11.8420	-11.4868	-11.7036
3	356.5156	5.4478	2.55e-08	-11.8109	-11.3135	-11.6172
4	360.9318	7.4619	2.52e-08	-11.8252	-11.18580	-11.5762

* indicates lag order selected by the criterion

LR: sequential modified LR test statistic (each test at 5% level)

FPE: Final prediction error

AIC: Akaike information criterion

SC: Schwarz information criterion

HQ: Hannan-Quinn information criterion

Table 4-3 VAR Lag Order Selection Criteria of LSC and LCU variables

Lag	LogL	LR	FPE	AIC	SC	HQ
0	275.1438	NA	3.81e-07	-9.1048	-9.0350	-9.0775
1	376.8672	193.2745*	1.47e-08*	-12.3622*	-12.1528*	-12.2803*
2	377.7820	1.6771	1.63e-08	-12.2594	-11.9103	-12.1229
3	379.3533	2.7759	1.77e-08	-12.1784	-11.6898	-11.9873
4	380.6965	2.2835	1.93e-08	-12.0899	-11.4616	-11.8441

Figure 4-2 shows that the lag order of the VAR model based on DLST and DLNR is 1 which means we can establish the VAR model (1) .Table 4-3 shows that the optimal lag order of the VAR model based on the copper scrap (LSC) and original copper (LCU) are 1 , which means VAR (1) model can be established.

(4)Johansen cointegration test

When modeling non-stationary time series, the co-integration relationship between variables need to be considered and should be test. When there exist more than one co-integration relationship between variables, Johansen cointegration test provides a good testing method. Table 4-4 is the results of the Johansen cointegration relationship test.

Table 4- 4 Johansen cointegration test results between variables

Variables	Hypothesized No. of CE(s)	Trace Statistic	0.05 Critical Value	Prob.**	Max-Eigen Statistic	0.05 Critical Value	Prob.**
DLST、DLNR	None *	19.8778	15.4947	0.0102	16.8828	14.2646	0.0188
	At most 1	2.9949	3.8415	0.0835	2.9950	3.84147	0.0835
DLSC、DLCU	None *	22.8661	15.4947	0.0032	21.0289	14.2646	0.0037
	At most 1	1.8372	3.8415	0.1753	1.8372	3.8415	0.1753

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

The table 4-4 shows that there respectively exists onecointegration relationship between the scarp tire (DLST) and natural rubber (DLNR), copper scrap (LSC) and native copper (LCU) under the 5% significant level

(5)The establishment of the VAR model

After the unit root test, the determination of lag order, and Johansen cointegration relationship test, the final two groups of VAR model are determined as follows

DLST=0.5613*DLST (-1) - 0.0041*DLNR (-1) - 0.0039 (4.8)

DLSC=0.6038*DLCU(-1) - 0.3617*DLSC (-1) - 0.0017 (4.9)

(6) The establishment of error correction model (VEC)

Vector Error Correction Model (Error Correction Model) is a VAR model with cointegration constraints, on the basis of above analysis, the VEC Model can be established as follows:

$$\Delta Y_t = \gamma ecm_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta Y_{t-i} + \varepsilon_t$$

Each equation of the fomula is an error correction model. ecm_{t-1} is a vector error correction, reflecting the long-term equilibrium relationship between variables, γ is adjusted factor, Γ_i mainly reflects the short-term effects of relationship between variables.

the concrete form of VEC model is:

D(DLST)=-0.036*(DLST(-1)-3.4452*DLNR(-1)-0.0047)-0.2385*D(DLST(-1))-0.1363*D(DLNR(-1)) + 0.0003 (4.10)

$$ecm_{t-1} = (\text{DLST}(-1) - 3.4452 * \text{DLNR}(-1) - 0.0047$$

D (DLSC) = 0.8285*(DLCU (-1)-0.9945*DLSC (-1) + 9.8107e-05) - 6.8715e-05 (4.11)

$$ecm_{t-1} = (\text{DLCU}(-1) - 0.9945 * \text{DLSC}(-1) + 9.8107\text{e-}05 \quad (4.12)$$

$$\text{DLSC}(-1) = \mathbf{1.0055} * \text{DLCU}(-1) + 9.8649\text{e-}05 + \mathbf{1.0055} ecm_{t-1} \quad (4.13)$$

The estimating result (4.10) from the VEC model shows that the differential item reflects the influence of short-term volatility in the error correction model of the scarp tire price index (DLST).In the short term, changes in the natural rubber price index (DLNR) has an influence on scarp tire price index (DLST) with the one phase lag effect. Natural rubber price index increases by 1%, making the one period lag of scarp tire price index reduced by 0.1363%. The adjustment coefficient is -0.036 in the formula 4.10; meet the error correction mechanism of reverse correction. This means that when the short-term fluctuations deviated from its long-term equilibrium, it will pull the non-equilibrium state back to equilibrium with the adjustment of -0.036.In the short term, the price of scarp tire (LST) and natural rubber (LNR) may deviate from long-term equilibrium level with scarp tire (LST), namely the previous real price of scarp tire (LST) and natural rubber (LNR) to scarp tire is higher than the long-term equilibrium price i, so in the next period, it should pull the non-equilibrium state back to equilibrium with the adjustment of -0.036 to modified the price deviation of scarp tire.

(4.11) shows that in the short term, original copper (LCU) prices had no effect on copper scrap (LSC) price index; Long-term relationship suggests that if original copper price index rises 1%, scrap copper price index will rise 1.0055%

(7)Granger causality test

Cointegration test only illustrates the long-term stable relationship between variables, but did not indicate the direction of this relationship. To illustrate the causal relationship between variables, we use the granger causality analysis method for inspection.

Table5-5 Granger causality test results output

Null Hypothesis	Obs	Lags	F-Statistic	Prob.
DLST does not Granger Cause DLNR	61	2	1.5655	0.2180
DLNR does not Granger Cause DLST	61	2	0.5197	0.5976
DLCU does not Granger Cause DLSC	61	1	1.5401	0.2233
DLSC does not Granger Cause DLCU	61	1	4.5642	0.0146

Table 5-5 shows that there is no granger causality relationship between scarp tire (DLST) and natural rubber (DLNR) ; but original copper (DLCU) price index is Granger cause of copper scrap (DLSC) price index fluctuation at 5% significance level impulse response function analysis

Using the Eviews6.0 to analyze the impulse response function of VAR model of scarp tire (DLST) and natural rubber (DLNR), and VAR model of copper scrap (LSC) and original copper, selecting the time lag for 10. First giving a response standard error deviation to scarp tire (DLST) and natural rubber (DLNR) , we can get the impulse response function of figure4-3 that scarp tire (DLST) for itself and for natural rubber (DLNR) as well as natural rubber (DLNR) for themselves and for scarp tire (DLST) the impulse response function of figure 4-4. Figure 4-3 shows when the scarp tire (DLST) gives a response standard error deviation to itself, DLST immediately has a positive response, and the value is 0.010% (maximum), then rapidly reduces in stage 2, and stabilizations around 0.0069% from stage3; While scarp tire (DLST) gives a response standard error deviation to itself, the natural rubber (DLNR) does not immediately respond, then it has a slowly positive response and stabilizations around 0.0021%.

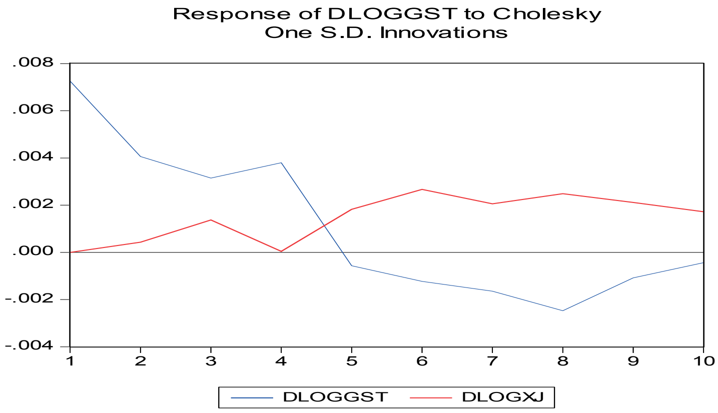

Fig.4-3 Impulse response of LnST to LnST and LnNR

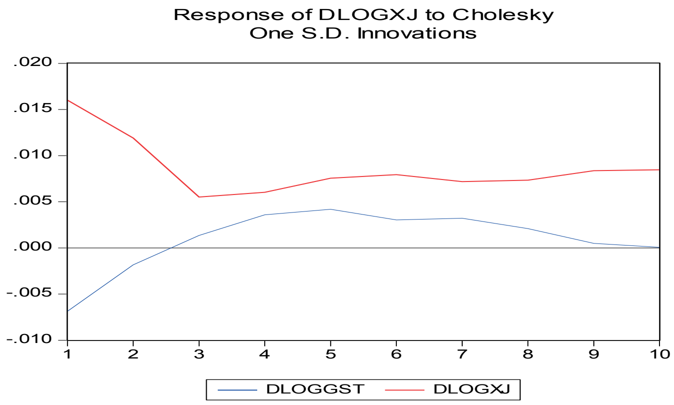

Fig.4-4 Impulse response of LnNR to LnNR and LnST

Figure 4-4 shows when natural rubber (DLNR) gives a response standard error deviation to itself, DLNR immediately has a positive response ,and the value is 0.0153% (maximum), then it decreases rapidly to 0.0008% and maintains the basical stability.While natural rubber (DLNR) gives a response standard error deviation to itself, scarp tire (DLST) responses immediately , the value is-0.0061%,but then the negative response decreases, it reaches 0.0024% (maximum) in state 3 and then the fluctuation is controlled within 0.0020% until to stage 10.

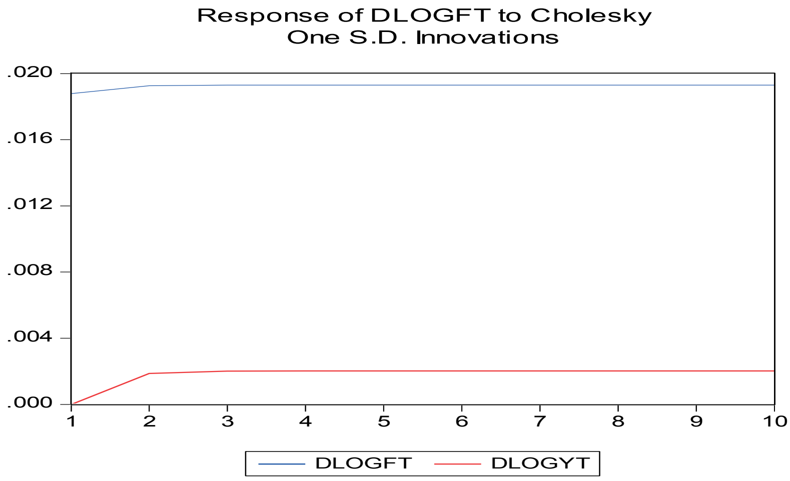

Fig.4-5 Impulse response of LnSC to LnSC and LnCU

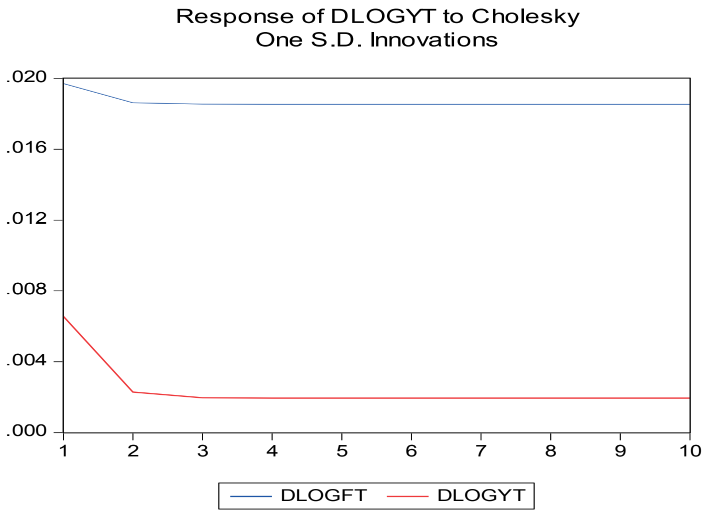

Fig.4-6 Impulse response of LnCU to LnSC and LnCU

Figure4-5 shows when copper scrap (LSC) gives a response standard error deviation to itself, LSC immediately makes the positive response 0.0067%, then it staying above the positive response 0.0017% on a sustained basis from the stage3; while copper scrap (LSC) gives a response standard error deviation to itself, original copper (LCU) immediately makes the positive response 0.0221%, then it has a positive response 0.0240% and keep it stability from stage2.

Figure4-6 shows when original copper (LCU) gives a response standard error deviation to itself, LCU immediately makes the positive response 0.0246%, then it remains a steady at the levels of slightly lower than the first stage; while original copper (LCU) gives a response standard error deviation to itself, copper scrap (LSC) does not respond immediately, then it has a positive response 0.0017% and keeps stability from stage3 to stage 10.

4.3.3 Conclusion and thinking

Based on the above research, the following conclusions can be obtained:

(1)From the view of resource consumption, renewable resources and native resources has a common alternative , this substitutional relation makes the relevance between the native resources price and renewable resource prices, and changes toward the same direction .In the context of the fluctuations of international resources price,price of renewable resources are influenced by the price of native resources conduction effect, which brings risks to the renewable resources industry.Therefore, to promote the healthy and stable development of the renewable resources industry, we can not only focus on the change of renewable resources product market supply and demand, but also pay attention to other resources price fluctuation and the change of the whole resource market

(2)The substitution effectbetween renewable resources and native resources is unbalanced which leads to the unidirectional price fluctuation from the native resources to renewable resources , renewable resources industry comes into a passive subordinate position, lack of the reponsemechanism of absorbing shocks .In addition, because of the existence of the price ceiling,the resources consumption market structure changes follows the changed of resource price,and the original market of renewable resource industry is damaged

(3)In the case of a corresponding system environment which is far from perfect, exposing the renewable resources industry directly to price fluctuations and market risk will makes immature renewable resources industry suffer a hard hit and come to a premature end .As an important source of resources consumption, expand the scale of the use of renewable resources can alleviatethe native resource scarcity to some extent.Keeping the proportion of renewable resources fairlyand maintaining reasonable resource consumption market structure is of great importance. The development of renewable resources industry can not only rely on market regulation, but also need the improvement and perfection of related system environment.

5. Empirical analysis of renewable resources industrial performance

5.1 Theory of industrial organization

The theory of industrial organization is an applied economics that uses microeconomic theory to analyze the relationship of the enterprise, market and industry, so as to analyze and guide the industrial organization policy. Industrial organization refers to organization and market relations among enterprises within the same industry, reflecting competition and monopoly among these enterprises. Researches on the relationship between market structures and industrial performance are core issues of industrial organization researches. Through the study of industrial organization, it is reasonable to organize the relationship between the enterprises in the industry and market, which realizes effective competition of the industry, optimizes the allocation of resources, and ensures good development. Among them, the industry performance is an important part of researches on industry development and factors influencing industry performance are important part of researches on the industry economics.

Traditional industry economics analyzed industry performance and its factors based on the theory of industrial organization that was set up by Mason and Bain (1951,1956) from Harvard University. This theory used “S-C-P” paradigm and emphasized that industry structure (Structure) is the basic determinant, different industry structure determines different corporate conduct (Conduct) and corporate conduct determines industry performance (Performance).

In the research of the theory of industrial organization, a core problem is the relationship between market structure and industry performance. Industry economists focus more on the analysis of industry structure and industry performance because they think that industry conduct is the inevitable choice of industry structure leading to industry performance. Industry structure is the characteristic and form representing the relationship among markets within the industry and the determinant of the competitive nature of industrial organization. Competition and monopoly relationships within the industry and the corporate conduct influenced each other, so studying market structure is of great significance to industry development. Important determinants of market structure include the market concentration, product differentiation as well as barriers to entry and exit. When it comes to market structure and performance, Harvard school holds the view that large firms with higher market concentration have larger market power and seem more likely to obtain monopoly profits, and the industry concentration and profit margins have a positive correlation. Industry performance refers to the final economic results of prices, outputs, costs, profits, product quality and varieties formed by a certain market conduct, under certain market structure. Market performance is subject to both market structure and market conduct and it can measure the degree of resource allocation and whether market structure within the industry is mature.

Xie Le (1970) revealed the relationship between the market conduct and market performance. He thought that the influence of market conduct such as the formation of price, advertising campaigns and researches on industry performance made up for the deficiency of Bain’s discussion on market conduct, therefore promoting the development of industrial organization theory from Harvard school and forming the paradigm: market structure– market conduct – market performance. The analytical paradigm of the school is shown in the figure below:

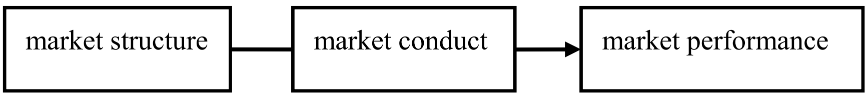

Fig.5.1 Traditional SCP paradigm

Joe. Bain (1951) made a lot of researches on the relationship between market structure and the rate of yields. The result shows that with the increase of concentration, the industry's long-term profits improve. Mann (1966) found in researches on many industries that the average profit margin of concentrated industries that have high barriers to entry is higher than that of industries that have no such barriers.

In 1968, the publication of “Author of Industrial Organization” from Stigler marked the mature of Chicago school in theory. Stigler believed that constant high profit margins in an industry may be the result of high efficiency and innovation in the industry, not the monopoly power in the industry. Since 1970, Chicago school, which represents by Stigler, Tamu Seitz and Baumol, supplied the market structure of Harvard school and developed it to be a new theory of industrial organization. This theory analyzes industrial organization with the rigorous economics theory, and emphasizes the two-way interactive relationship among market structure, market conduct and market performance. One of the key points of debating of Harvard school and Chicago school is whether the high profit in high-concentrated market structure comes from monopoly power or from high efficiency of big enterprise.

5.2 Literature review

Researches on S - C - P paradigm focus on the relationship between market structure and market performance. As it is difficult to qualify the market conduct, most studies mainly use observable variables such as concentration, barriers to entry, scale economy to analyze market performance.

A lot of scholars studied on the causes of market performance. Demsetz (1973) did empirical study and found that the positive correlation between market concentration and profitability is conditional. Only when the concentration is over 50%, they are positively correlated. He also pointed out that the high profit margin in high-concentrated industries is the result of the production efficiency. Baumol, et al., (1982) established competitive market theory from market entry and exit freedom, and thought that as long as we keep the complete freedom of market enter; we can have good production efficiency and technological efficiency. Gale and B ranch (1982) studied the effect of market share and market concentration on profit margins, concluding that the former is more connected with profit margins. Pedro Mar in and Georges Siotis (2008) argued that promoting industrial technology innovation is an important content of market performance.

Domestic scholars began to pay close attention to researches of market structure, concentration and performance since the middle of 1980’s. They carried on empirical tests of the relationship between the market structure and market performance in our country from different angles. The results of these studies show big differences. Some show that structure lead to performance, while others supported Chicago school of efficiency determining market structure.

Ma Jiantang (1993) studied empirically market structure, concentration and profit margins of main industries in our country. The conclusion is: "the reason why industry concentration and industry profit margins in China have no absolute relations is that China has relatively strict price control on highly centralized industries. Thus in the industry, the price is not decided by the market that has monopoly structure but by the government. Therefore, the chain of market structure and enterprise price behavior is interrupted, and the absolute relation of market structure and performance in market economy didn’t exist any more". Ma Jiantang (1993) further proved that in China, "enterprise market share and profit margins have a positive correlation”

Yin Xingmin (1996) confirmed that economic benefits of most manufacturing sectors would increase with the increase of enterprise scale, and industrial concentration and the economic benefit have a positive correlation.

Qi Yudong (1998) studied the relationship between industrial concentration and economic performance of industries in China. It shows that within a certain range, industrial concentration has a significant positive correlation with economic performance indicators such as sales tax rate and capital tax rate; the higher the concentration, the better industrial economic performance.

Xu Zhilin etc. (2005) used multi-use performance indicators and correspondence analysis method to study the relationship between industrial structure and performance of our country, finding that there were obvious relationships; different industrial structures result in different industries performance and productivity.

Li Shiying (2005) did empirical analysis on the relationship between entry barriers and market performance of China's manufacturing market and argued that there existed an inverse relationship while corporate researches have a positive effect on market performance.

Tang Yaojia (2004) did empirical analysis on factors of industrial performance in China’s industry and found that the main factors are industrial market concentration and density of cost of sales, while the company's R & D intensity and economies of scale could not affect or promote industrial financial performance.

Lu Qibin etc. (2004) used structural equation model to study the relationship between market structure and market performance, from the consumers' point of view. The results show that in China which is under the process of transition, mostly, market performance determine market structure, rather than market structure determine market performance.

As for researches on relationship between ownership and industry performance, Oliver Hart et al. (1997) and Andrei Shleifer (1998) noted that, generally, private ownership is more suited to a competitive market than public ownership. Megginson et al. (1994) ，Boubakri and Cosset (1998) as well as Juliet D'Souza and William L. Megginson (1999) pointed out that financial and operational efficiency will enhanced after the ownership changed from public ownership to private ownership. However, Wortzel and Wortzel (1989) argued that market discipline and management incentives have a greater responsibility to enhance the efficiency than ownership itself. Scott E. Atkinson, Robert Halvorsen (1986) and Kole, Mulherin (1997) pointed out that ownership is not the determinant of corporate performance. Zuobao Wei ,Oscar Varela, M. Kabir Hassan (2002) calculated and found the reduction of output shares of Chinese state-owned enterprises and the increase of that of non-state enterprises. The rapid expansion of non-state enterprises dramatically changed the industrial production structure, and non-state enterprises have become the driving force of the rapid growth of China's industrial output. Alex Ng, Ayse Yuce, Eason Chen (2009) found the inverted u-shaped relationship between state ownership and performance. Not only is ownership structure found to affect performance, but also ownership concentration affects performance.Vickers and Janin (2006) analyzed the mechanism of action of industrial ownership structure in industry performance and held the view that assume industry enterprises could be classified into state-owned enterprises and private ones, the industrial ownership structure would change according to the "state-owned enterprises → private enterprises " direction, and this kind of change would firstly significantly improve the efficiency of resource allocation and then improve industry performance. Anzhela Knyazev etc. (2013) did empirical analysis and found that in the short-term, privatization of enterprises has a negative effect on performance, but the effect is positive in the long-term. Mei Yu (2013) analyzed data of listed companies from 2003 and 2010. The results show that state ownership has a U-shaped relationship with firm performance, and a firm profitability ratio of state-owned ownership is greater than that of a dispersed ownership structure because of the support from government policies.

Liu Xiaoxuan (2003) pointed out that state-owned enterprises are closely related to market structure that lacks competition, while competitive market structure are closely related to the structure of non-state-owned property or private property. Empirical analysis shows that non-state-owned enterprises get good performance in a competitive market, and the structure of state-owned property has a negative effect on industrial performance while industry concentration and size variable have positive effects.

Sun Zao (2011) studied the impact of changes in China's ownership structure on industry performance, concluding that the change of the proportion of enterprises above designated size has a negative correlation with industry performance, and the increase of the proportion of private enterprises has a positive effect on the overall industry performance.

To sum up: industry performance is affected by many factors. Characteristics of different industries enable market structure, corporate conduct; ownership structure and ownership structure affect industry performance differently.

5.3 Analysis of renewable resources industry performance based on the view of industry

5.3.1 Indices and models

According to the literature review, "structure - conduct - performance" paradigm can explain the change in industry performance. Market structure and corporate conduct plays an important role for industry performance.

For China, which is experiencing the adjustment of industry structure, the influence of the ownership structure on industry performance can not be ignored. Competitive market structure is a prerequisite for the positive effect of the change of ownership structure. A large number of studies have shown that when China's industrial ownership structure evolutes along with the "diversity" direction, he proportion of non-public economic companies continues to increase, industrial performance is continuously improved and industrial competitiveness is significantly improved. Therefore, when constructing models of factors affecting industry performance, people should not only consider market structure and corporate conduct, but also test the industrial ownership structure variables, that are the real effect of the proportion of private enterprises on industry performance.

Data of renewable resources industry first appeared in China Statistical Yearbook in 2003, which means that there are only a few time series data. In order to increase the sample size and further analyze the effect of ownership structure (state-owned enterprises, private enterprises and foreign investment enterprises) on overall industrial performance, we took the state-owned enterprises (denoted as STATE), private enterprises (denoted as PRI) and foreign-funded enterprises (denoted FOR) as cross-sectional data when selecting explanatory variables and explained variables. The cross-sectional data together with the 2003-2013 time-series data constitute panel data for analysis of industrial performance.

In order to test the decisive factor affecting the industrial performance of China's renewable resources industry, the main variables and indicators in the analysis are selected as follows (according to the theory of industrial organization):

(1) Select the most two representative indices for measuring industrial performance (Pr): return on assets (PR1) and return on sales (PR2). The former reflects the ability of per unit of assets to create profits, while the latter mainly reflects the profitability of per unit of sales in market competition.

(2) Select MES to describe the economies of scale of market structure. Given that the scale of state-owned enterprises of China's renewable resources industry is not the result of market competition efficiency choice, the large scale is not necessarily based on efficiency and cost advantages; instead, in spite of the small

scale, many private enterprises have lower operating costs than large state-owned enterprises. We chose the indicator of enterprises' average size, namely respective original prices of fixed assets of state-owned, private and foreign enterprises ratio overall number of enterprises of renewable resources industry.

(3) According to the analysis in section 3, we chose indicator OWN, which has a significant impact on industrial performance. The ratios of actual capital and total industrial capital of three kinds of enterprises' respective companies were used to characterize the proportion in the industry, and the higher proportion means more extensive distribution in this industry.

(4) According to the theory of industrial organization, enterprises business behaviors have an important role in industrial performance, so we select ratio of profits to cost, that is the ratio of total profits and total costs (selling expenses, management expenses and financial expenses), reflecting the economic benefits of enterprises' investment.

According to the analysis above, the panel data model was employed:

$$\Pr_{it} = C + \alpha_1 MES_{it} + \alpha_2 OWN_{it} + \alpha_3 RPC_{it} + \varepsilon_{it} \quad (1)$$

where for i=1,2…, N cross-section units and periods t=1,2,…,T; C is the constant term; ε it is a random disturbance term; Prit is the performance of enterprise i in year t; MES represents the minimum economies of scale; OWN denotes the industrial ownership structure; and RPC reflects the contribution of per unit of operation costs to performance.

5.3.2 Results and analysis

(1) Panel unit root test. In order to avoid spurious regression, we selected individual intercept and trend and did panel unit root test on raw data, finding that all the series are non-stationary except for OWN. Hence, do 1st difference on all variables and results of the test show that the series are stationary, which means we can do co-integration test (Table 5-1).

Table 5-1 Unit root test results

Variable	PR_1		PR_2		MES		OWN		RPC	
Testing methods	Statistic	Prob.	Statistic	Prob.	Statistic	Prob.	Statistic	Prob.	Statistic	Prob.

LLC	-4.98	0.00	-3.90	0.00	-9.41	0.00	-4.98	0.00	-4.15	0.00
IPS	-2.82	0.00	-1.84	0.033	-5.13	0.00	-2.82	0.00	-2.47	0.01
ADF	19.39	0.00	14.18	0.028	30.38	0.00	19.39	0.00	18.79	0.00
PP	19.53	0.00	10.60	0.101	34.08	0.00	19.53	0.00	22.41	0.00

(2) Panel co-integration test. After all variables were stationary at 1st difference, we did co-integration test to test whether there was long-term stable relationship among variables. We used Kao Residual Co-integration test to test relevant variables. In the case of containing the individual intercept term but no trend term and lag fixes in one, Kao Residual Co-integration test rejected the original hypothesis that cointegration relationships do not exist among variables, under the significant level of 1%. Therefore, we can do regression on panel data.

(3) The set of panel data model. First, use the F-statistic to help select mixed effects models or pooled regression models. The general expression of panel model is as follows:

$$y_{it} = \alpha_{it} + \beta_{it} x_{it} + \varepsilon_{it} \qquad (2)$$

Where i=1,2,⋯,N cross-section units and periods t=1,2⋯,T, αit and βit are 1×1 and 1×K vectors of constants that vary across I and t, respectively, Xit is a row 1×K vectors of exogenous variables, and εit is the error term, K is the number of variable.

The null hypothesis was:

$$H_2: \quad \alpha_1 = \alpha_2 = \ldots = \alpha_N$$

$$\beta_1 = \beta_2 = \ldots = \beta_N$$

Under the condition of hypothesis H2, statistics F2 =2.66. When the number of cross section N=3, the number of explanatory variables K=3, the time series T=11 and significance level was 5%, the computed statistics F (8.21) =2.42. Because F2=2.66>2.42, it rejected H2, which means rejecting hybrid model. Therefore, we could only choose from Random intercept model and Random Effect mode. This paper finally chose Fixed Effect Random intercept model, based on the following two considerations: 1. the empirical analysis directly analyzed the sample data, rather than inferring overall effect through sampling data, so we usually choose fixed effect regression model; 2. when N is not greater than K, we cannot use Eviews6.0 to set random effect models. Hence, the fixed effect random intercept model can be represented as follows:

$$y_{it} = \alpha_i + \beta x_{it} + \varepsilon_{it} \qquad (3)$$

(4) Panel regression results. Empirical analysis results of the fixed effect model are as (4) and (5).

$$Pr_{1i} = -\mathbf{0.0034} + C_i + \mathbf{0.0627}MES_i + \mathbf{0.0265}OWN_i + \mathbf{0.0148}RPC_i \qquad (4)$$

（-0.9492）（2.2994）（2.3639）（5.3934）

R^2=0.9279 D.W. =1.9018

$$Pr_{2i} = -\mathbf{0.0014} + C_i + \mathbf{0.0443}MES_i + \mathbf{0.0109}OWN_i + \mathbf{0.0058}RPC_i \qquad (5)$$

（-0.9663）（4.1458）（2.4679）（5.3639）

R^2=0.9470 D.W. =1.8739

where i is the number of panels, and Ci is the common coefficient intercept. From the fixed effect model (4) and (5) we can see that the three indicators (coefficients of minimum economies of scale, the ownership structure and cost contribution rate), which have a important impact on industrial performance, were all significant under the significant level of 5%. Take model (4) as an example and analyze the indices above: the elastic coefficient of minimum economies of scale to industrial performance is 0.063. That is to say, industrial performance increases 0.063% when minimum economies of scale increase 1%. Similarly, industrial performance increases 0.03% and 0.01%, respectively, when the ownership structure and cost contribution rate increase 1%. In a word, both of model (2) and (3) show that minimum economies of scale makes the greatest contribution to industrial performance, followed by the ownership structure and cost contribution rate.

C11 (state-owned enterprises) = -0.0063, C12 (private enterprises) =0.01276, C13 (foreign-funded enterprises) =-0.0064; C21 (state-owned enterprises)=-0.0025, C22 (private enterprises) =0.0055, C23 (foreign-funded enterprises) = -0.0030. In model (4) and (5), the sum of intercept term of these three kinds of enterprises and constant term reflects each fundamental, which is known as the amplification effect of the increase of minimum economies of scale, the ownership structure and cost contribution rate on the return on assets of renewable resources industry. In other word, the larger the intercept term, the larger the amplification effect, and vice versa. The analysis results of fixed effect intercept term indicate that private enterprises make the greatest contribution to renewable resources industry.

5.4 Analysis of renewable resources industry performance based on listed companies

5.4.1 Profile of DEA model

DEA (Data Envelopment Analysis) is usual when evaluating efficiency. Its biggest advantage is that it can work on multi-input and multi-output decision unit without knowing the specific form of the production function.

The most basic model of DEA method is CCR model:

min θ

$$s.t. \sum_{j=1}^{n} \lambda_j x_j \leq \theta x_0$$

$$\sum_{j=1}^{n} \lambda j y_j \geq y_0, \quad \lambda_j \geq 0, \quad j = 1,2...n$$

Xij≥0 represents the first i input of the first j decision-making unit DMUj; yij≥0 indicates the first I output of the first j decision-making unit DMUi.

Chames, Cooper, Rhodes (1978) pointed out that when returns to scale were constant, overall efficiency (OE) is the product of technical efficiency (TE) and allocative efficiency (AE), that is CCR mode. Banker，Chames, Cooper (1984) note that when returns to scale were variable, technical efficiency (TE) can be resolved into scale efficiency (SE) and pure technical efficiency (PTE). Scale efficiency is efficiency affected by scale and it can reflect the gap between the actual production scale and the optimal production scale; pure technical efficiency is efficiency caused by management and production technology. Technical efficiency is the product of scale efficiency and pure technical efficiency, that is TE = SE * PTE. Since BBC model separates the two causes (not in the best size and low efficiency of production technology) of manufacturers technical inefficiency and pure technical efficiency can better reflect the management level of study objects than technical efficiency in CCR mode, this article will use the BCC mode.

5.4.2 Samples and indicators

Taking into account the availability of data and trade restrictions of listed companies, this analysis selected 19 domestic listed companies4 (Hong Kong-listed companies are not selected because the reporting period and the form of annual reports are different from those of Shanghai Stock Exchange and the Shenzhen Stock Exchange). Among them, there are Grammy, whose main job is to recycle secondary metal and e-waste, and leading enterprises of renewable resources industry such as Sound Environmental, which focuses on the disposal and recycling of city garbage and industrial solid waste. The overall efficiency of these companies reflect the overall performance of China's renewable resources industry.

Selection of input-output variables. This paper selected 4 inputs indicators and 2 output indicators. Input indicators are: total assets, operating costs, total liabilities and employees; Output indicators are: revenue and net profit. The total assets indicator means all assets that can bring economic benefits, so it can be seen as an input indicator. The operating cost is critical to evaluate the efficiency of an enterprise's production and business activities; the total liability is closely related to profitability; and the number of employees reflects the input of enterprises human capital. The revenue is an important indicator to evaluate the business operation results and profitability, and the net profit is able to evaluate the enterprises performance more comprehensively.

5.4.3 Empirical results and analysis

The study uses the input-output data of 19 listed companies over the period of 2009-2013 in order to measure the total factor productivity of Chinese renewable resources industries by using the DEA Malmquist index model. The results are as follows in table5-2.

Table 5-2 Malmquist productivity index of renewable resources industry and its decomposition (2009-2013)

[4] Data of these 19 listed companies are derived from the annual reports of listed companies on Sina.com (2009-2013)

Year	TE	PTE	SE	TC	MI
2010-2009	0.998	0.995	1.003	1.069	1.067
2011-2010	0.974	0.994	0.98	0.972	0.947
2012-2011	0.941	0.945	0.996	0.958	0.901
2013-2012	0.956	1.009	0.948	1.222	1.168
average	0.967	0.985	0.982	1.055	1.020

TEC: technical efficiency change; PEC: pure technical efficiency change; SEC: scale efficiency change; TC: technical progress change. The technical efficiency change can be further decomposed into the pure technical efficiency change and scale efficiency change, namely TEC=PEC*SEC.

As can be seen in Table 5-2, the average growth rate of renewable resources industry's total factor productivity was 2.1%, and the average growth rate of technical progress was positive, 5.5%; the average growth rate of technical efficiency was -3.3%, and the rates of pure technical efficiency and scale efficiency are -1.5% and -1.8%, respectively. The results show that the positive growth of technical progress not only make up the decline of the rate of technical efficiency (including pure technical efficiency and scale efficiency), but also is far greater than the negative growth of technical efficiency, leading to the high positive growth rate of the total factor productivity between 2009 and 2013. That is to say, the high rise of the renewable resources industry's total factor productivity in recent years is due to the rapid development of technology. Technology innovation means "hard" technical progress is greater than "soft" technical progress including management, systems and policies. The figure5-2 further shows that the fluctuations of total factor productivity and technological progress are significant, while those of technical efficiency, pure technical efficiency and scale efficiency are obviously small. The following things result in this situation: the renewable resources industry is a fast development sunrise industry in 21st century; under the condition of low degree of market regulation, imperfect institutional measures and low management level, technical progress has much space to improve, while pure technical efficiency (accumulation of management efficiency and production experience) and scale efficiency (the ability and knowledge of formation and management of large enterprises) have to go through the accumulation of time and practice and then increase slowly.

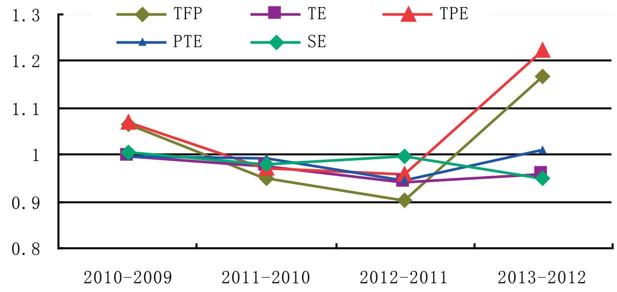

Fig.5-2 Total factor productivity of renewable resources industry and its decomposition trend (2009-2013)

5.4.4 Summary

This chapter firstly reviews the theory of industrial organization, and then summarizes factors affecting industry performance. These factors are market structure, industry concentration, barriers to entry and economies of scale. Meanwhile, a large number of studies have shown that: in China, ownership structure is another important structural factor affecting industry performance in addition to the market structure.

Based on a large number of results of Chinese and foreign scholars researches, this chapter does empirical analysis on the renewable resources industry performance, from the industrial perspective (meso), in order to find factors affecting the performance. The results shows: minimum economies of scale makes the greatest contribution to industrial performance, followed by the ownership structure and cost contribution rate. The reason why the ownership structure has a positive effect on industry performance is that the change of ownership structure must lead to the configuration change of resources in different ownerships, and configuration produces different efficiencies, inevitably promoting resources to flow to the ownership structure with higher allocation efficiency. Therefore, the allocation change of resources further promotes the adjustment of the ownership structure.

Also, this chapter uses DEA mode to do empirical analysis on this performance from the listed companies' perspective (micro). The results show that the high rise of the renewable resources industry's total factor productivity from 2009 to 2013 is due to the rapid development of technology. Technology innovation means "hard" technical progress is greater than "soft" technical progress including management, systems and policies. This conclusion points out the direction for the enhancement of renewable resource industry performance. We should keep developing technology transfer to increase productivity, and focus on the improvement of the management level and explore optimal production scale.

6. Conclusion and policy recommendations

6.1 Conclusion

Based on the perspective of industry, this paper investigates the fundamental factors influencing the progress of renewable resource industry according the definition and feature description, current developing situation, monetary and tax policies towards renewable resource industry through the methodology of industrial organization theory and empirical analysis, makes a comprehensive and thorough research about the performance of renewable resource industry, and trying to reveal the growing pathway, inner driving force, potential of development and direction of progress concerning renewable resource industry in our country.

This paper concludes a basic point of view through the research on renewable resource industry as below:

(a)As an important way to get resources, renewable resource in recycling process is a valid matter to attain the sustainability of economy. Promoting the recycling of domestic renewable resources could not only reduce the consuming of energy and improve the situation of pollution, but can also attain visible economic profit.

(b)The relationship between renewable resources and natural resources is homogenous and substitutional. The limited substitutions of natural resources by renewable resources lead to the limited demand space faced by renewable resources. The homogeneity of renewable resources makes the cost to be the crucial factor in competition, and also cause the situation under market economic system that small enterprises in renewable resource market has greater competitiveness and adaptability than big enterprises with rich capital and advanced technology and facilities.

(c)Two reasons that the development of renewable resource industry is supported by policies are listed below: first, more and more does the nation focus on pollution. Together with the rising of "recyclable economy" that makes the promotion of renewable resource industry to be necessary; second, the fragility and non-profitability of renewable resource industry itself determines that the developing of the industry has to be supported by policies. The regulatory measures in Chinese renewable resource industry areas are majorly commanding measures, including lots of laws and regulations, policies, criterions and supervisory regime. But the number of economic encouraging policies towards investing, credit, price, finance, tax, import and export etc. is not enough. Among them, economic policies that promoting the development of Chinese renewable resources industry is constitute by every type of tax preference policies majorly, especially the preferential policies of value added tax. Except for value added tax, other policies are barely used. Policies such as Income tax, consuming tax, and import VAT policies involve only a narrow field, the range of its profit is limited, so the function of which is not remarkable.

(d)The limited substitution of natural resources by renewable resources makes the renewable resources to have a “natural” price toplimit. It leads to the one-sided fluctuation influence from natural resources towards renewable resources. Meanwhile, empirical analysis indicates that there are long-term co-integration relationship between the price of natural resources and renewable resources.

(e)It is verified through empirical analysis that, factors influencing the performance of Chinese renewable resource industry includes another important structural factor other than market structure: ownership structure. Among the ownership structures, private enterprises makes the greatest contribution towards the performance of renewable resource industry, and state owned enterprises are much weaker in competitiveness than private enterprises.

(f)Do empirical analysis on renewable resources industry from the listed companies’ perspective (micro). The results showed that the high rise of the renewable resources industry’s total factor productivity from 2009 to 2013 is due to the rapid development of technology. Technology innovation means that “hard” technical progress is greater than “soft” technical progress, including management, systems and policies. The results noted that the performance of renewable resource industry still can be improved significantly

6.2 Policy suggestion on renewable resource industry

Renewable resource industry is commonweal industry, and also an industry that gains little profit. Therefore, to raise up the comprehensive utilizing efficiency and the level of industrialization of renewable resources, government should built up a sound law and regulation system about renewable resources, and makes financial tax preferential policies that was sustaining and stable. Also, government should increase the input of research, reinforce the public advertising and education of the development of renewable resources, encourages enterprises to carry out technological researches, prompt the technology of resource recycling to transform, improve the efficiency of industry technology. And also improve the imitation of advanced management method of foreign countries, and built up the evaluation system of industry performance in multiple perspectives such as social, economic and environmental. The specific advices are as below:

(a)Accelerating the building of legal system, establishing more perfect law and regulation system

Government and related departments should build up perfected regulatory system about renewable resource market. Relevant laws should be established. Reduce the use of temporary instructions; replace it by compulsive laws or regulations so that long-term and stable instructive and supervisory work could be carried out. Strict entrance standard and environmental standard should be built up to prevent the pollution generated in recycling, reproducing and processing procedure. Meanwhile, the legislation experience of developed country in the field of recycling of renewable resource could be imitated, in order to accelerate the establishing of legal system on comprehensive utilization of renewable resource and its supporting measures.

(b)Enhancing the guidance of technology developing, built up the technological system of industry development

The supporting towards the research on renewable resource technology and theoretical study should increase. Government should encourage enterprises to carry out technological research, to lift up the level of technology, pushing the transformation of technology about resource recycling. The building of industry development technology system should be accelerated, including the scrap recycling technology, and safety disposal technology. Promoting the cooperation between enterprises and packaging companies, material companies, institutions and other scientific research institutions. The technology speciality of the recycle of renewable resources is high, so technology support has to be strong in the development of industry. Capitals should be invested to the research and development of industrial technology, to build up preliminarily the industrial technology researching and developing system. Meanwhile, the import of advanced technology and facilities abroad and cooperate of whom has to be enhanced. The spatial arrangement of industry should be adjusted, and the economic profit of industry agglomeration should be developed.

(c)Carry out the policies of government reward and preferential tax

Renewable resource industry is belongs to industries with little profit. Government should enhance the policy supports towards renewable resource industry, and should accelerate the development of renewable resource industry by any accessible means such and establish encouraging policies and reducing tax. When focused on taxes, government could make use of subsidies or tax concessions to reduce the general tax burden of enterprises. And when focused on encouraging policies, relevant experience from abroad could be imitated, such as government subsidizing new technologies and techniques of renewable resource industry. Government should also supporting in financing, tax in every segment of renewable resource industry should be reduced, and infrastructure construction of renewable resources should be supported either.

(d)Built up demonstration bases and industrial parks, realizing the development of industrial cluster gradually

Building a typical large recycling demonstration base to drive the development of such industry. To build a renewable resource industrial park, make the renewable resources in industrial park to be formally traded and deeply machined, to form a distributing processing and trading base. Meanwhile, carry out regionalizational regulation toward enterprises worked on processing of renewable resources to raise up the recycling rate of resources, and reduce or prevent the influence that waste water and scraps draws towards the environment. Built up an industrial park is the future horizon of development of renewable resource industry. The industrial park which integrates the regulation, trading, processing and sewage & solid waste management could not only make intensive use of land resources, but also share the resources, furthermore, it could protect environment and cultivate the market to regulate surplus and deficiency. These are beneficial for relevant department to make unified regulation and promoting the green environmental protecting industry to developing persistently and healthily.

(e)Raise up the consciousness of public, guarantee the source of fund

Aiming at the problems of residents that lack of recognition about scraps recycling and classification and recycling of wastes, nation should press the advertisement to enhance the consciousness of public. And, all kinds of advertising activities should be launched in order to advertise the significance of the recycling and management of renewable resources.

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