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THE FORESTRY SYSTEM AND THE TIMBER MARKET IN CHINA

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THE FORESTRY SYSTEM AND THE TIMBER MARKET IN CHINA

Abstract

In the past two decades, China has achieved a spectacular success in its economic growth. As a basic input for the production process, the forest resource has been one of the fundamental factors propping up the expansion of China's economy. When China is absorbing imports of timber products in the global market, studies of China's forestry system and its timber market incite greater interest. This paper represents a systematic approach to probe into the comprehensive realities of China's forestry system and its timber market. Econometric methods are applied in analyzing the demand and supply patterns. The empirical analysis is used to forecast the quantity demanded for timber products in China.

Key words: China, forestry, timber market

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1. INTRODUCTION

Forest resources are a basic input of production. In many countries, the forestry sector makes a significant contribution to the economy. Wood is used widely in construction and related industries, as well as paper and paperboard making. Also, as a fundamental natural resource, forests provide the essential function of environment protection. Forest resources are distributed unevenly in the world. Countries with abundant forest resources, such as Russia, Brazil, Canada, Sweden, and some tropical countries, produce timber products and export to countries whose forest resources are insufficient to meet their demand. Before the late 1970s, China's influence in the global timber market was minimal, and it was autarkic in timber production. With the launch of the economic reforms, China started to import timber products in 1978. During the 1980s and early 1990s, China's timber imports supplemented its domestic timber production, increasing moderately, but declining in some years. However, from the late 1990s, China's timber imports have skyrocketed, and China started to play a key role in the global timber market. In 2002, China became the second-largest timber importer, only behind Japan. It is commonly believed that China's scorching economic growth has caused the demand for timber products to rise. However, the inside workings of China's forestry system and timber market are still not fully researched. Not only the timber exporters want to predict China's timber demand, but scholars try to learn more about the functioning of China's forestry system and the timber market.

Forestry economics has been developed for decades in some Western countries.

Economic theories have been applied to the analysis of the forestry systems and timber markets in these countries. But are these theories adequate to explain the situations in China's forestry system and timber market? China has the different culture with that in the West; China keeps some vestiges from its former command economic system; China is a big country with the highest populations. Putting all these factors together, China's forestry system and timber market are very complicated. Therefore, to understand the situations in China, systematic perspective is essential for researchers. Figure 1 shows the hierarchy and interrelationships of China's economy, China's forestry system, China's timber market, and the global timber market. Obviously, only with the thorough understanding of institutional settings in China, can studies of China's forestry system and timber market make sense. Also, China's timber market needs to be considered as a part of both China's economy and the global timber market. The market mechanism formally started to function in China in 1978 when the Chinese government launched an economic reform leading to market economy. Although timber production and business behavior were still irrational during the early period of the economic reform, China's timber market gradually has become predictable since then. The quantity demanded for timber products and the capacity of timber production is not only of interest in China, but also of interest by global timber-export countries. How to apply the economic theories in describing and predicting the behaviors in China's timber market is a big challenge. Within an economic framework, quantity demanded for timber products can be forecasted by an econometric regression model. However, the complexity lies in the fact that the level of timber quantity demanded and produced can be influenced by many factors. Some of them are common economic variables, while some others are not always common different countries. In this paper, I try

to model China's timber market by identifying those factors which have significant influences, and the true relationships between them. Since the history of China's timber market is short, empirical analysis is constrained by insufficient time series data. Nevertheless, the result of the model is still powerful in predicting. And the econometric model gives a sound quantitative analysis, helping to explain the demand and supply patterns in China's timber market.

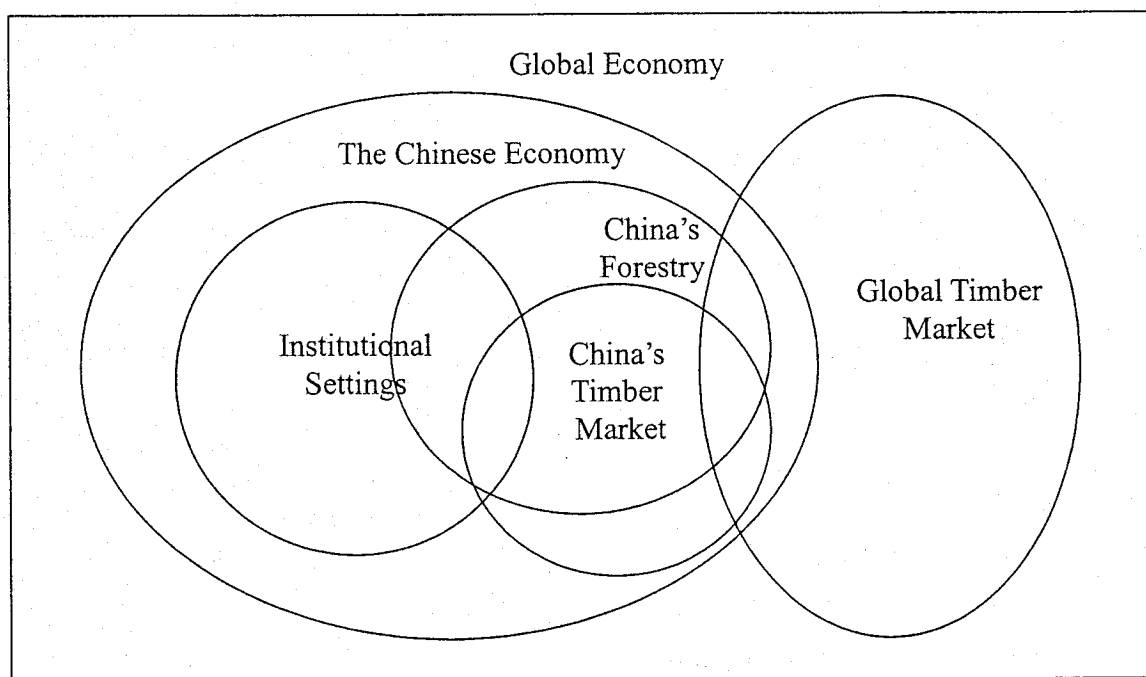


Figure 1. – System Structure of Research Field

The paper is organized as follows. Section 2 presents a comprehensive review of China's forestry sector. Section 3 surveys the previous relevant studies. China's timber market is analyzed in Section 4, and an econometric model is formulated. Also in this section, the model is estimated with annual data. Some concluding remarks and the

prospects for future works are given in Section 8. The data used in the econometric estimation are listed in the appendix.

2. A REVIEW OF CHINA'S FORESTRY SECTOR

There are not many countries experiencing numerous significant changes as much as China has in the past several decades. The situation in China is very complex, and good background knowledge does not exist. Here is a comprehensive review of China's forestry sector. Institutional settings of China's forestry system and timber market are introduced.

2.1. An Overview of China's Economic System

The People's Republic of China (PRC) was established on 1 October 1949. As a communist country under the Soviet model, China had a nearly pure command economic system until 1978. Meanwhile, the Chinese economic development was not successful. Even worse, the Cultural Revolution launched in 1966 brought China's economic development to a rapid halt, eventually shutting China off to the outside world. In 1978, the Chinese government launched the economic reform and "Open Door" policy, which made China's economy start the transition to market economy. Since then, China has made massive economic progress over the last two decades and is now the world's sixth largest economy – second largest on a purchasing power parity basis. In 2002, China's gross

domestic product (GDP) reached 10.2 trillion yuans – about 1.23 trillion U.S dollars.¹ China’s scorching economic growth also lets China play a more and more important role in the international trade. In the 1990s, China’s trade growth was three times faster than global trade. China was the fourth-largest merchandise trader in 2002, if the European Union is counted as a single unit, according to International Trade Statistics (2003). The entrance to the World Trade Organization (WTO) in 2001 was a milestone, which indicated China’s economy and market became a part of the global economic system.

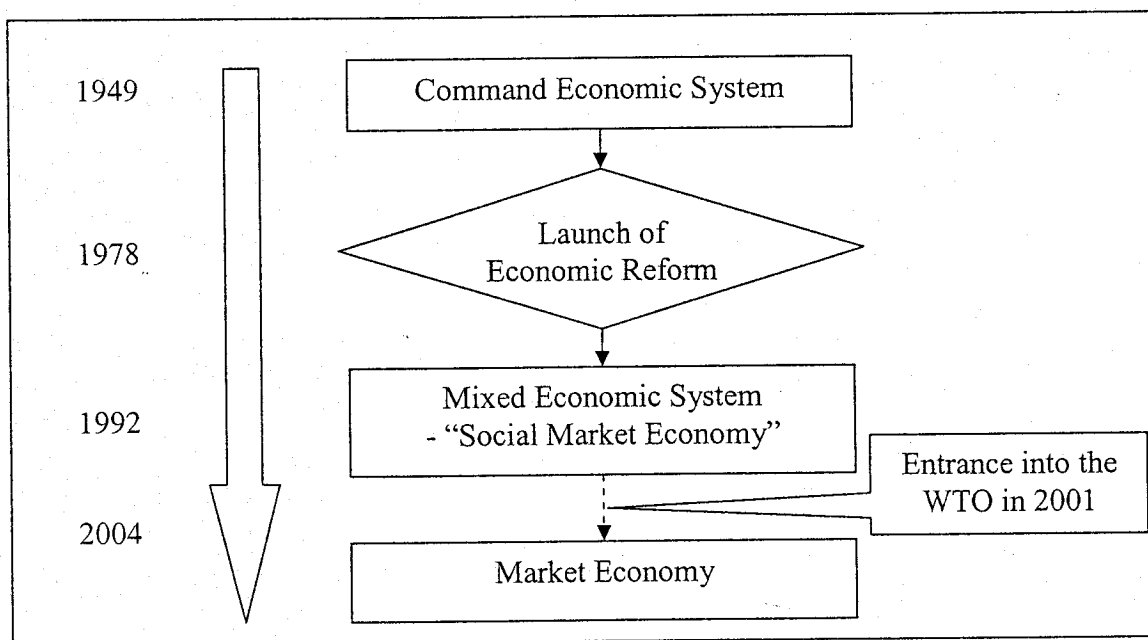


Figure 2. – Transition of the Chinese Economy

As showed in Figure 2, today, China’s economy is a mixed economic system, called a “socialist market economy” by the Chinese government. Although China’s economy has adopted the main principles of a market economy, many vestiges of the

¹ Source: National Bureau of Statistics (2003)

command economic system still exist, which presents not only a distinct characteristic of the Chinese economy, but also a challenge for foreigners to learn how to conduct business in China.

Since the economic reform was launched in 1978, China's centrally planned economy began to disintegrate. Commodity, capital, labor services, and technology markets developed one after another. In order to enhance the functioning of the market, the government gradually reduced the categories of products governed by central production planning, and abolished the price fixing system. Furthermore, the wholesale and retail commercial systems have been restructured, and the private sector has been allowed to engage in commercial activities. Under the reform, the public sector's monopolized pattern of commercial activities has been gradually broken up, and the market-oriented pattern of diversified economic elements and operational forms has been established. According to this new model, efficiency is promoted through the expansion of markets in the allocation of resources and a greater role for the private sector. Before 1978, most commodities were produced and allocated according to the State's production and distribution plan. With the progress of the reform, most commodities, including forestry products, have been subjected to market forces. Before the economic reform, the prices of most commodities in China were fixed by government agencies and were not changed very frequently. Because prices did not change when production costs of a commodity or its demand shifted, they often failed to reflect the true values of goods, causing many kinds of goods to be misallocated, resulting in a price system that the Chinese government itself referred to as "irrational." Since the economic reform was launched, the prices of most commodities

have gradually been allowed to be determined by market forces. As a part of the economic reform, an open-door strategy was implemented. Foreign investments and international trade were encouraged by a welcoming business environment. China has emerged as the fifth largest trading power in the world, from virtually ground zero in 1978, and has been the second largest recipient of foreign direct investments, after the United States. With the entrance into the World Trade Organization (WTO) in 2001, China ascended to a new level of multilateral economic development. Since then, China has gradually reduced tariffs on imports, including most timber products.

2.2. Forest Resource and Administration

The People's Republic of China is the world's third largest country in terms of area after Russia and Canada. It ranges from sub-arctic regions in the north and west to tropical lowlands in the south; from fertile plains in the east to deserts in the west. In absolute terms, the large territory and diverse ecological conditions bring China abundant forest resources. According to an announcement made by the State Forestry Administration (SFA) in June 2000, the land used for forestry in China is 263.395 million hectares, of which forest area is 158.941 million hectares, ranking China fifth in the world, after Russia, Brazil, Canada, and the United States in terms of forest area. However, relative to its large territory and huge population, China is not rich in forest resources. According to the SFA (2000), in 2000, China's per capita forest area was only 0.128 hectares, about one fifth of the world average, and the forest coverage rate was 16.55%, about 60% of the world average.

Geographically, China is made up of six large regions: the Northeast, North, Northwest, East, South, and Southwest regions. China's natural forests are primarily distributed in three regions: the Northeast, the Southwest, and the Southern ten provinces. According to Zheng et al. (2001), these three regions account for 81% of the total forested area in China and 87% of the commercial timber area. The forests of China have some of the most diverse wood species in the world. More than 500 species are unevenly distributed among the hilly lands and mountains in the Northeastern, Southwestern, and Southern regions. Forests in the Northeastern and Southwestern regions are mainly natural growth, while forests in the Southern regions are predominantly plantations scattered in small blocks throughout the ten provinces. China's forests are identified at three geographical levels. The top level is the "region level," described by topography and landform. The second level is the "zone level," identified with the regional distribution of heat intensity. The third level is the "division level," which is classified according to distribution of forest types and dominant species. The main three forest regions cover 16 main forest divisions in all eight zones. Although the three major forest regions account for most of the total forest area in China, the forest coverage is not even within each division. Some areas are thickly covered, while others are scattered. Not all forests in the major production regions are commercially available for harvesting due to various reasons. A forest might not be exploited for commercial gains because of poor accessibility or because it houses a mixture of different tree species with different age classes and thus different types of commercial value. Also, a forest might be excluded from commercial harvest because of some special government policies for soil and water conservation or because the forest has been designated as a wildlife reserve to protect some endangered species.

Official forest land in China is either owned by the State or by collectives. According to FAO (2002), in terms of standing volume, state forests, which are concentrated in the northeast and southwest, account for 70% of the total, while collectives own 55% of the forest land. Collectives dominate the area and volume of plantation forests, while state forests have traditionally been primarily composed of old-growth natural forests. State forests are owned by the central government on behalf of the citizens of China. Local townships and villages, i.e., collectives, own collective forests. The central government has devolved state forest utilization and management responsibilities to state forest enterprises, including state forestry industry bureaus and state forest farms, while collectives have traditionally retained direct local control of their forests.

To achieve effective management of forest utilization in such a large country, the Chinese government operates a complex and extensive hierarchy of administrations, which are established at five levels, namely the State Forestry Administration (SFA) at the central government level; Forestry Departments in provinces, autonomous regions and municipalities; forestry bureaus in prefectures and cities; forestry bureaus in counties, banners and small cities; and forestry stations in towns and townships. The SFA has responsibility for coordinating all protected areas located on forest land and operates at the national level. It is also responsible for research - through the Academy of Forestry -, education - at three universities and four colleges -, and the administration of state forestry throughout China. Forestry development relies on the participation of a gamut of stakeholders. Identifying the main players and their functions is necessary to understand the institutions of China's forestry sector. Table 1 provides an overview of the key actors

involved and their different functions.

Table 1

Key Stakeholders Involved in China's Forestry

| Function | Stakeholder | Objective |
|-----------------------------------|--------------------------------|--|
| Forestry sector administration | SFA | Ensure sustainable forest management |
| | Provincial forestry department | Protect and cultivate forest resources and promote forestry sector development |
| | Forestry bureaus in cities | |
| | Forestry stations in towns | |
| Forest ownership | State | All forest land is publicly owned |
| | Collectives | |
| | Households, private entities | Individuals have the right to own planted trees |
| Forest utilization and management | Collective farms | Harvesting; protection of soil and water resources; fuelwood |
| | State farms | Harvesting; environmental protection; and natural landscape and historical site protection |

To carry out its mandate, the SFA works with provincial, prefecture, county, and towns/township authorities. The authorities at the provincial level include municipalities and autonomous regions, such as Inner Mongolia. All forests are managed according to

Forest Law enacted in 1998, which, however, allows for significant flexibility in interpretation, and provincial regulations, with approval from the SFA, may be introduced to suit local conditions. Although the SFA supervises the implementation of central government forestry laws and policies, it does not have the authority to enforce these policies and laws directly. While local authorities receive some project funds from the SFA, they depend on local treasuries as well as their own revenues from local charges and taxes to cover recurrent costs, such as staff salaries. In certain instances, however, the central government, through the SFA, will fund large-scale programs, such as afforestation or infrastructure developments. Moreover, the SFA has technical supervisory powers, which enable it to recommend action where lower levels of government are failing to implement national policies and laws. In addition, the SFA controls the State Forestry Technical Extension Centre, which also supervises provincial technical extension entities. Ultimately, enforcement is implemented through local level by executives that direct the local Forestry Department at the provincial level or Forest Bureau at the county level.

While this centrally administrative and technical extension system continues to function, notable changes have occurred in recent years. Prior to the establishment of the SFA, the Ministry of Forestry had lost control over markets and prices of raw and processed forestry products in the early 1980s. In addition, provincial and lower level authorities have gradually reduced their direct involvement in forest utilization and management. While in some areas the functions of the SFA have been curtailed, in others they have increased. Most notably, the SFA retains key regulatory and monitoring roles, although these measures must be implemented through lower level authorities. As

responsibility for forest utilization and management has been decentralized to non-government actors, forestry departments have had to intensify their supervision of the management standards.

2.3. Timber Market in China

Flows of trade and investments between countries have risen so dramatically that it is now common to speak of the “globalization” of the world economy. Today, it is no longer possible to study any economy without taking into account the developments in the rest of the world. China had been relatively closed to trade with the most western countries for several decades because of the ideological difference. However, the Chinese government launched economic reform and an open-door policy two decades ago. These policies have brought China not only great success in economic development, but also unprecedented opportunities to the rest of the world. The capital investment contributes a large part to China’s economic growth, which causes the boom in construction and related industries. In the last twenty years, countless public projects, factories, and commercial and residential buildings have been built, and this trend is anticipated to continue. These projects have generated great demand for timber products, which are the basic material for constructions and related industries. At a deeper level, the construction boom has been the source of enormous changes in China’s forestry economy, and has even exerted profound influences on many aspects of the Chinese society. Economically, the great demand for forest products requires the efficiency of resource allocation, which has resulted in the formation of China’s timber market and which has also changed the supply pattern of

China's timber production. In its attempt to meet the rising demand, the mass timber production has caused serious deforestation. The mass timber production has not only degraded the environment, but also brought catastrophic disasters, such as flood and desertification. To pursue the goal of sustainable development, the Chinese government has formulated policies to encourage reforestation and restrict domestic timber production. At the same time, the Chinese government has also reduced tariffs on import timber products to bridge the gap between demand and domestic supply. China's timber market is not the market for only domestic players any more; foreign competitors are now welcome to participate in this market.

2.3.1. General Mechanism of the Timber Market

Because China's timber market is a part of China's market system, it is embedded in the institutional setting of the Chinese economy. It is also a part of the global timber market. Thus we start with a discussion of the general mechanism of the world timber market. Commodity circulation starts with production, so it is necessary to know how timber products are produced. When trees have been harvested, they are in the form of roundwood, which refers to the natural state of the trees as felled, with or without bark, round, split, roughly squared, or in other forms, for example, stump, etc. Commodities included are sawlogs and veneer logs, pulpwood, other industrial roundwood, and fuelwood. Sawlogs, veneer logs, and most other industrial roundwood are used as materials in construction and other related industries, such as decoration, furniture, joinery, etc. They

are sent to sawmills and wood processing factories to be transformed into intermediate timber products, such as sawwood, plywood, veneer, etc. Usually, small-sized wood is used as pulpwood, which is sent to pulp mills to make pulp, for use in paper and paper board production. Fuelwood is used for fuel or making charcoal, an energy source in rural areas. Figure 3 shows this production process.

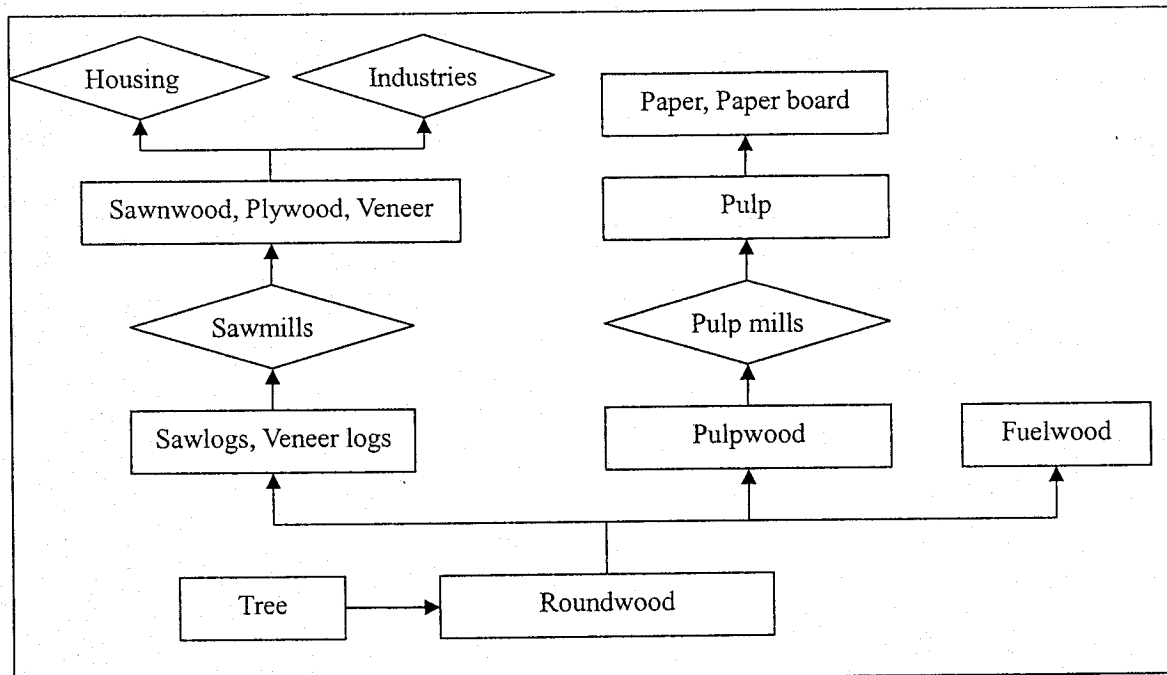


Figure 3. - Wood Production Flow

After all these wood products have been produced, they are traded in the market. The wood products market has not only a wide range of product categories, but also hierarchical levels corresponding to the production procedures. Here, I demonstrate the hierarchical

market structure only of timber products². In many countries, especially in most countries in the West, the timber market consists of three vertical levels: the forest resource level, the wood-processing industry level, and the end-use industry level. Figure 4 illustrates the structure of timber market.

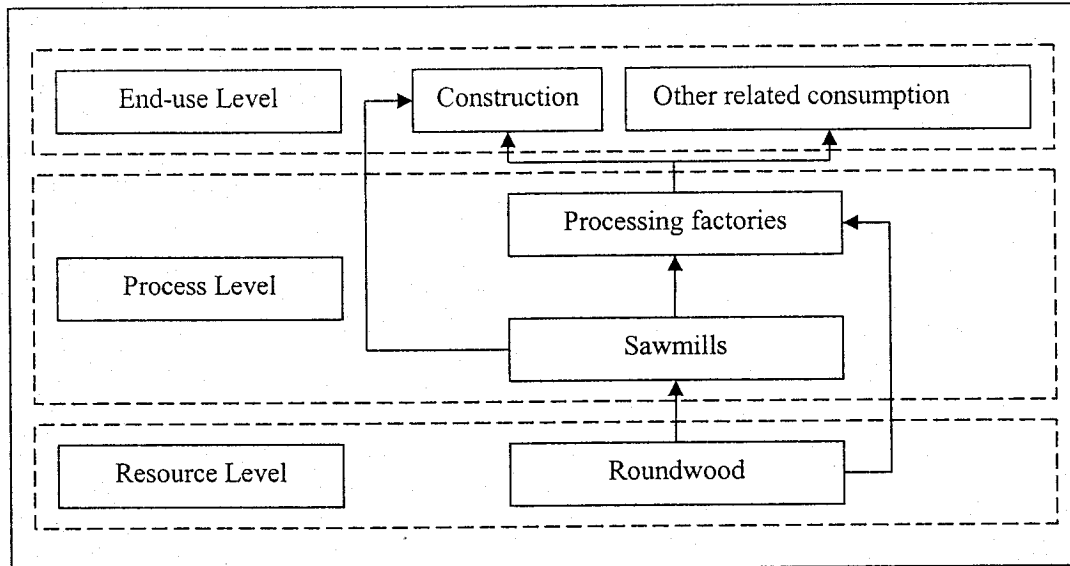


Figure 4. - Structure of Timber Market

The first level is the forest resource level at which the participants are the forest owners, who own forest farms. They sell wood to the second-level participants, namely the wood processing industry. The wood processing enterprises, which include sawmills and wood panel factories, produce sawnwood, plywood, veneer, or other kinds of engineered wood products. These timber products will be provided to the third level, the end-use level, as intermediate inputs in construction and other related industries. Trades primarily exist

² The concept of timber refers to “the wood of trees cut and prepared for use as building material” (WoodNet, University of Princeton), which is applied in this paper.

between two adjacent levels, which give the timber market a hierarchical vertical structure. However, some wood-processing enterprises also have their own forest farms. That means the firms have the options to use wood from their own forest land or to buy wood from the market. If roundwood can be bought and sold in a competitive market at a given price, it does not matter whether the firms buy wood in the market or use their own. If they use a unit of their own wood, they lose the revenue from the sales of that one unit of wood. And if they choose to sell the unit, one additional unit of wood has to be bought in the market for use as an input in production. If the roundwood market is imperfect, i.e., if the selling price of roundwood differs from the price which has to be paid when roundwood is bought in the market, the situation is clearly different. If the buying price exceeds the selling price, it is reasonable to use all of the wood owned by the firm before anything is bought or supplied to the roundwood market. If the buying price is less than the selling price, then the entire stock of wood should be sold in the roundwood market. In a few words, the firm's objective is to maximize profit, so it must be aware of the price of roundwood in the market.

2.3.2. Description of China's timber market

As I have already mentioned, the Chinese economy is quite distinct from the economies in the West, and this distinction is also found in its timber market. Before the economic reform period, the production of all the forest products was planned by the government. The market had not yet been formed, and the distribution was also operated by the government. This situation has changed after the economic reform launched in 1978.

Under the reform, the Chinese government adopted the market mechanism in the forest sector and allowed a real market for forest products to be established. Nowadays, the structure of the Chinese timber market and the products bought and sold in this market are almost the same as those found in a market in the West. Nevertheless, the Chinese timber market still retains many vestiges of its former command structure. The most significant characteristic of the command economy system left in China's forestry is that the property right to forest resources still belongs to the State. At the resource level, since the ownership of forest land has not changed, logging is still controlled by state forest farms and collective forest farms. This gives the government the ability to affect domestic timber production through its policies.

At the wood-processing industry level, significant changes have taken place since the economic reform. Although state wood processing enterprises still constitute a significant part of the industry, private enterprises and foreign investors have widely participated. These wood-processing enterprises do not depend on the government's distribution system any more, and only buy their wood from the market. Also, when timber products have been produced, competition is fierce among sellers in the end-use consumption market. Construction firms, furniture factories, joinery companies, and many other consumers at the end-use level, buy timber products freely from the market. And, of course, brokers exist at all three levels as the glue that keeps the market together.

Because China is a large country, timber products are bought and sold in many local markets. Although the paper refers to these markets as China's timber market and

treats these markets as a single market at the aggregate level, it is still helpful to understand the spatial distribution of China's timber markets. After the centrally planned wood distribution system was dismantled, timber products became completely free market goods. Timber products can be directly shipped from production areas to manufacturers or to the retail market through wholesalers. There are thousands of wholesalers, ranging from state-owned trading corporations with hundreds of employees, to one-person privately owned businesses.

When we talk about the "timber market," it is not only a geographical location, but any arrangement that enables timber buyers and sellers to get information and to do business with each other. However, the "timber market" is also a physical gathering place for wholesalers and retailers of different timber products. These markets are located in many cities across the country, and they are localized. Since China is a large country in terms of area, the timber market is also regarded as being made up of several regional submarkets. The division of these submarkets is in accordance with the economic diversity, surrounding regional business centers. Roughly speaking, China's timber market can be subdivided into Eastern, Southern, Western, and Northern markets. Some major cities, such as Shanghai, Guangzhou, Chongqing, and Beijing, are regarded as the regional central market places for these submarkets. In these important market places, the prices reflect the trend in China's timber markets. Prices of major timber products from these main markets are published in network newsletters, and act as guide for lower-level local markets. Communications among these main markets is perfect, and the price differentials among these markets reflect the differences in transportation costs from the forest farms

and different pressures from demand. However, communications between the main and small markets are infrequent and imperfect, and the prices of a similar timber product are often different, especially between a major market and a small market. Because Southern China has experienced faster economic growth, while Western China is less developed than other regions, the prices of timber products are higher in Southern China than in Western China.

2.3.3. The Demand Side of China's Timber Market

Demand drives production and the activities in the market. It is thus necessary to study the demand pattern and understand the factors that affect demand and the extent that these factors play in the market.

Wood is a kind of essential raw material with broad uses. Timber products are widely used in construction and related industries. When the economy expands, the consumption of timber products will also rise. Macroeconomic indicators, such as GDP, are strongly correlated with the demand for timber products. In the last two decades, China's real GDP grew annually at an average rate of about 7% to 9%, and the demand for timber products also exhibited an upward trend. Figure 5 depicts the rising trend of China's real GDP.

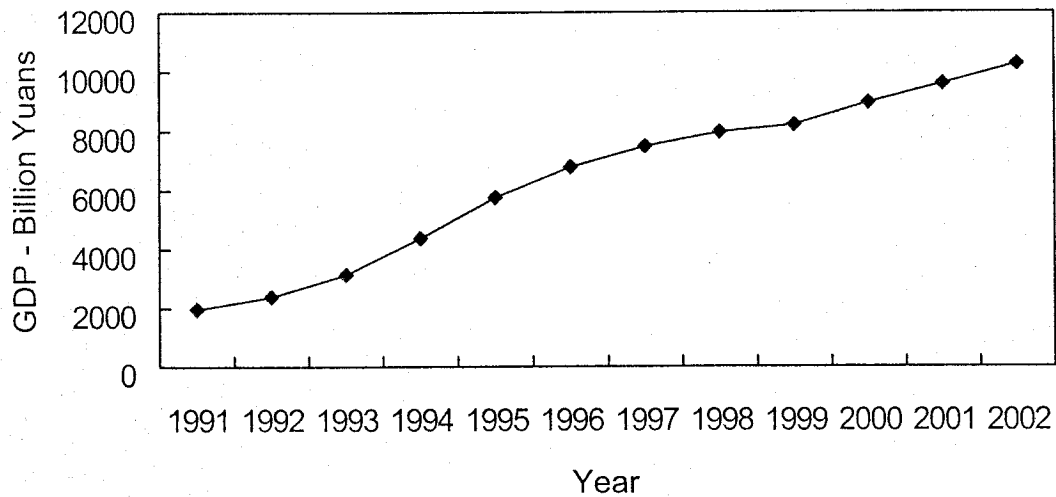


Figure 5. - Growth Trend of China's Real GDP³

From the end-use side, the demand for timber products is primarily derived from the expansion of construction and related industries. In the last twenty years, the construction industry in China has experienced unprecedented growth. Cities have changed their appearance every year with new buildings, while rural areas have witnessed the emergence of new factories. More significantly, the boom in residential construction and decoration has induced a rise in demand for timber products.

As a socialist country, China adopted a public housing system before the economic reform. Most of the residential houses and apartments belonged to the State. Residential construction was carried out by municipalities and state enterprises, then assigned to individual families or employees; however the property rights to these residential houses were still in the hands of the State. Furthermore, these residential houses were constructed according to a government's plan and did not reflect the incentives

³ Data source is NBS annual report (1991-2003)

created by the rising demand. Because the population had grown continuously and because not enough housing had been built, living conditions were poor during that period. In urban areas, it was common for a large family to live in a small apartment. With the implementation of economic reform, the Chinese government abandoned the public housing system. The publicly held apartments were sold off to private citizens, and the State ended the public housing program. Real estate developers were allowed to build and sell apartments and houses, and private citizens were encouraged to buy their own homes. Farmers in rural areas were also allowed to build their own houses at designated locations. Once private purchasing power was released, China's housing market entered a new era. Because average household income in China has been rising steadily, it is now possible for Chinese families to buy their own homes. When young people grow up and get married, they need their own homes, and this generates a huge demand for residential constructions, especially in a country like China with a large population. Figure 6 shows this rising trend in China's residential construction.

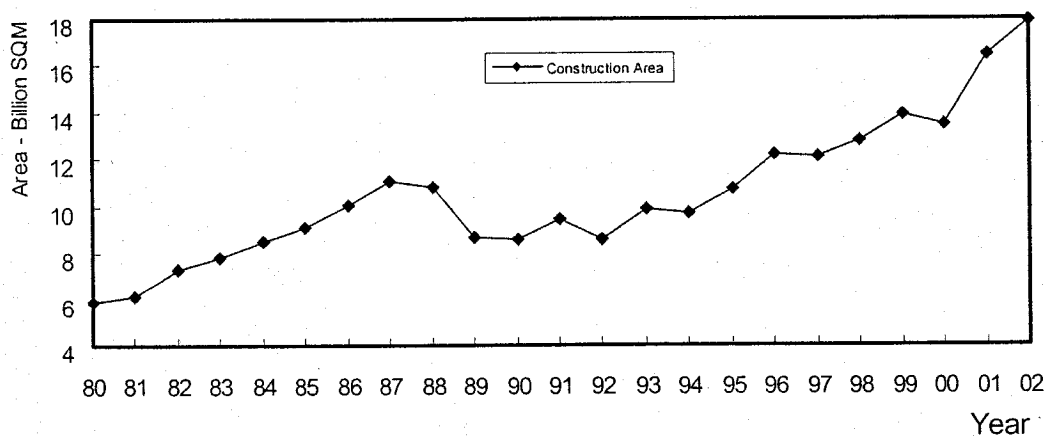


Figure 6. - Annually Finished Residential Construction Area

Booming construction activities in China have been the major forces which drive the rising demand for timber products. Furthermore, the booming construction industry also has stimulated some other related industries, such as furniture, joinery, and decoration, and the growth of these industries also increases the demand for timber products. There are also some other factors which affect the demand for timber products. For instance, the Chinese government has welcomed imports of timber products in recent years; it has also significantly reduced the corresponding tariff, and the tariff reduction encouraged domestic demand.

2.3.4. The Supply Side of Timber Market

Basically, the supply in China's timber market is comprised of domestic supply and import supply. The domestic supply of timber products depends on the production quantity of roundwood, i.e., the number of trees harvested. Before the economic reform, logging was carried out according to the production plans made by government departments at different levels. The state forest farms produced roundwood under the quota allocated by the Ministry of Forestry, and the production of collective forest farms was administrated by local governments. A centrally planned system, which is called the Unified Procurement System and administered by the then Ministry of Forestry, was used to organize about a quarter of total timber production, and the rest was used locally. Under this system, state and collective farms sold roundwood to state wood-processing enterprises at prices fixed by the State. Then these state wood-processing enterprises

produced sawnwood products, which were sold to end-use industries at prices also fixed by the State. Although prices were linked to costs of production, they did not take into account most of forest management costs, and were normally well below market prices. Altogether, the domestic supply of timber products was totally centrally planned at that time.

Since 1978, the market has been gradually liberalized, and private producers have been increasingly permitted to participate freely in the wood processing industry. In the early 1980s, the Unified Procurement System was officially abolished. Timber products were traded in the market at prices determined by the interplay between demand and supply forces. Although the state forest farms were still under government control, they began to participate in the market as private players. To satisfy the increasing demand, domestic production of timber products had to be raised. This helped to achieve the economic goal, but caused serious ecological and environmental problems. As I have described, China's forest resources relative to its area and population are not abundant. Although China has the fifth largest area of forest land in the world, it is not rich in forest resources. Since the establishment of the People's Republic of China, forests had been excessively cut for economic purposes, especially after the launching of the economic reform. The ensuing deforestation caused serious disasters - flooding, drought, desertification, etc. - and the extinction of many rare wild species. Although the Chinese government had noticed the shortage of forest resources, and had undertaken a successful afforestation campaign for a long time, the number of trees afforested was well below that had been harvested previously. In 1998, China was hit by the greatest flood in 100 years. The flood brought disaster to Eastern China, and this environmental problem delivered a

great shock to the Chinese government, which prompted it to institute a national forest conservation program (NFCP). The plan called for the cessation of logging in many watersheds and a reduction in others. It also called for ambitious planting of forests for future harvest. This strategy has a profound impact on China's timber products market. With the implementation of the NFCP and related policies, China's domestic timber supply has been significantly reduced, and the trend will continue.

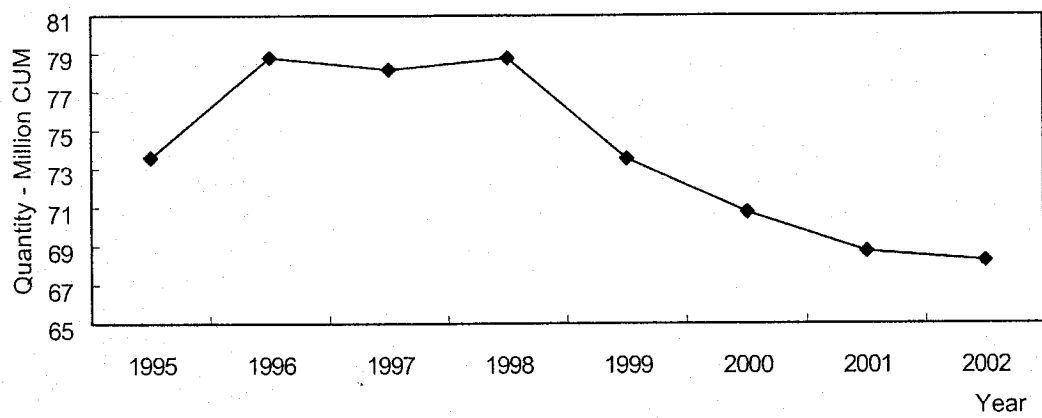


Figure 7. - China's Domestic Timber Production

Since China's domestic timber supply has been insufficient to meet demand, it has started to import timber products since the late 1970s. During the 1980s and the early 1990s, timber imports were a supplement to domestic production. Timber imports had been moderately increasing and had even declined in some years. While demand was growing along with the Chinese economy, the domestic production capacity had not increased, and imports became more and more significant in China's timber market. Then in 1998, the implementation of the NFPP imparted a momentous change to import supply. According to

this policy, China's domestic timber production has shrunk, while demand has expanded. Therefore, China had no choice but to import more, and this trend would continue. In 1998, if all timber products imported were converted into round wood, the total import volume would exceed 50 million cubic meters, which was about one quarter of the total consumption of China's industrial round wood. In 2002, the share of import timber products reached 35%, and China was the second largest timber import country, only behind the U.S., according to FAO (2003). One can say that the NFPP has greatly affected not only China's domestic timber market, but also the international timber markets.

In order to encourage timber imports and also to uphold commitments of entering the WTO in 2001, the Chinese government has reduced the tariff to zero on most timber products. There is also no other trade barrier for import timber products; foreign supply is just treated in the same manner as domestic supply. At the present time China has many trade partners throughout the global timber market. It imports tropical timber products from Indonesia, Malaysia, the Philippines, and Gabon. China also imports non-tropical timber products from Russia, the U.S, Canada, and New Zealand. Sufficient imports of timber products have effectively solved the problem of domestic supply shortage. With the fierce competition among all these domestic and foreign suppliers, China's timber market is now very competitive.

3. PREVIOUS STUDIES

Here I review some relevant studies, which fall into two categories: econometric studies of timber market, and studies about China's timber market.

3.1. *Econometric Studies of Timber Market*

Most of the previous econometric studies of timber markets were about North America and Europe. The most typical econometric analysis uses the trade scenario between forest owners and the wood process industry to model the timber market. The behavior and decisions of forest owners determine the supply, while the amount of roundwood bought by wood process enterprises is the actual demand for timber in the market. In an econometric analysis of Sweden's timber market, Johansson and Lofgren (1985) adopted a partial equilibrium model of the sawtimber market. In this model, the supply of sawtimber is determined by the price of sawtimber and the price of pulpwood, as well as the cutting cost. The reason behind the use of the pulpwood price as a separate argument is that some of the small wood could be used either as sawtimber or transferred from the timber market to the pulpwood market. There is, in addition, an effect which stems from the fact that a higher price for pulpwood makes thinning more profitable, which induces some of the forest owners to carry out a thinning instead of a final felling, which in turn decreases the supply of sawtimber and increases the supply of pulpwood, and vice versa. Practically, the product flows also involve the factors related to the paper industry.

At the resource level, roundwood could be divided into large roundwood and small roundwood. Large roundwood is sent to sawmills to produce sawtimber and chips, which would be sent to pulp mills to make pulp for paper production. Small roundwood could be sent either to sawmills or pulp mills, depending on the relative profitability of these two actions. The cutting cost here is a vector of variables consisting of logging labor cost and management cost of forest. On the demand side, the demand for sawtimber is decided by the price of sawtimber, the ability to pay for sawtimber, and lagged sawnwood production. The argument of “ability to pay for sawtimber” is made up of the difference between the price of sawnwood products and the wage rate in the wood-processing industry, and it actually measures the profitability of the wood processing industry. A high ability to pay for sawtimber means the wood-processing industry can earn more profits from buying sawtimber to produce sawnwood products. It provides the incentive, which generates demand for sawtimber. In this model, the price of sawtimber is endogenous, while all the other variables in the right side of the theoretical equations are exogenous. Similarly, Sedjo and Lyon (1996) adopted the same approach in their developed model. They also identified the interrelationship of demand for pulpwood and demand for sawntimber. They asserted some analysts made the mistakes of trying to assess the pulpwood market without recognizing its relationship with total wood supply. They extended the research to analyze the supply and demand for timber of the entire global market, by subdividing the global timber market into eight regions and modeling them respectively.

Baudin (2003) also modeled the demand for sawnwood in a few Western Europe countries. He believed that the traditional analysis, which he deemed to be based on the

aggregate relationship between sawnwood consumption and GDP, could not clearly represent the consumption pattern of sawnwood in a variety of sectors. To account for the specific characteristics of end-uses sectors in his analysis, he applied an end-use approach in modeling demand for sawnwood in Sweden, Norway, United Kingdom, and Germany. The methodology he adopted is to undertake sector classification, with a data base being constructed, and specify econometric models for the activities in these sectors. In the analysis of the demand for sawnwood in the United Kingdom, he classified the end-use sectors into five categories, which are construction, joinery, furniture, packaging, and DIY (do it yourself). Each category is comprised of a few sub-categories. Thus, the classification is fairly complete, and most of the end-use sectors for sawnwood consumption are covered. The author found no time series data base existed for these countries regarding quantities of sawnwood consumption by sector. Cross sectional studies may exist for some years that provide quantitative information about sawnwood used in various sectors. Hence, a methodology was developed to construct a consistent time series data base for end-uses of sawnwood. Existing cross sectional end-use studies constitute one piece of information necessary for construction of approximate historical data. The other source is time series data from available construction and industry statistics for the country studied. By combining these different data sets, an annual data base was set up that covers the period. The econometric model was derived from a twice differentiable production function. A log-linear function was deduced, where coefficients are directly interpreted as elasticities. For the United Kingdom, 11 sectors were selected to estimate the equation. Baudin's study provided an alternative approach in analyzing the demand for sawnwood - from the end-use perspective. One complication, however, is that for a given

country, sector classifications in cross-sectional studies are often inconsistent over time, and data collection from the end-use sectors are often infeasible.

3.2. Studies about China's Timber Market

It was only two decades ago that the timber market in China was formed. Therefore, China's forestry economy has only received the attention of researchers in recent years, and extant literature on the subject is limited. A majority of these studies were focusing on the introduction of the institutional settings of China's forestry system. Several studies contained a descriptive analysis of China's timber market. Zheng et al. (2001) gave a comprehensive description of China's forestry sector. The authors reviewed China's forest-related laws and policies, including the legal framework of forestry, policies concerning environment protection, and tax policies for forestry sector. They also introduced the industrial structure of China's forestry sector, including timber production and trade in timber products. An equilibrium analysis of China's timber market and ecological protection was also presented in this study. The recommendations given by these researchers were to develop strategies in protecting the forest resource, and encourage more flexible timber trade policies. Waggener (2001) carried out a descriptive analysis on both the demand and supply sides of China's timber market. He introduced the influence of China's current forestry policies on the change of supply capacity, and compared China's timber production before and after the implement of the National Forest Conservation Program (NFCP). He anticipated that China's timber products consumption

would keep on increasing, and that China would rely more on imports. Cohen (2000) focused his research on the assessment of the timber trade between Canada and China. He adopted a systematic approach in the analysis of China's timber market, with comprehensive introduction of China's timber industry, the timber market, and trade opportunities. His conclusion was that China's timber market would provide more opportunities to global timber exporters, including Canada. There are also some other studies describing China's forestry system and timber market in a general manner, like Yamane (2001) and Braden (2002). Taking a different approach, Zhang (2002) proposed an empirical model to analyze optimal forestland allocation in Hainan province. In his paper, he analyzed the relationships between economic development, institutional changes, and resources and environment. In the context of forest sector, China's major environmental issues were briefly described. Forest development was analyzed with the change of relative scarcity of forests and institutional revolutions. Hainan province was used to empirically examine their relationship. The estimation results indicated that higher timber prices promoted forestry investment in a managed forest, as measured by plantation forest cover, and the agricultural product price had a positive impact on both managed and natural forest cover.

4. ECONOMETRIC ANALYSIS OF CHINA'S TIMBER MARKET

In Section 3, I described China's timber market from both the supply side and demand side. In this section, we formulate an econometric model to analyze China's timber market.

4.1. *Statement of Research Objectives*

Although China's timber market is commonly expected to continuously thrive, people still are curious about the quantity of timber products demanded and supplied in the future. Also, the factors which affect and determine the demand and supply in China's timber market is still not clear. To answer these questions, my research is devoted to quantitatively modeling China's timber market, and forecasting timber quantity demanded by empirical analysis. Econometric approach was applied in many previous studies of timber markets in Western countries. However, econometric analysis has not been applied to research of the demand and supply of China's timber market. In this paper, classic forest economic theories are applied in an empirical analysis of China's timber market. Modifications of theoretical model are conducted according to the characteristics of the demand and supply patterns in China's timber market. The result of this research will provide significant benefits. When the quantity demanded for timber products is projected, this information will help the Chinese government to carry out appropriate forestry policies, coordinating the tradeoff between economy growth and environment protection. For the timber exporters in global market, it is also essential to figure out the quantity demanded and supplied in China's timber market, in order to try to fill the gap.

4.2. Modeling China's Timber Market

Here I start with a discussion of the modeling approach used in this paper. Basically, economic modeling approaches fall into two categories: general equilibrium and partial equilibrium. Each approach has its own particular uses, advantages, and disadvantages. General equilibrium (GE) models provide answers to questions at the level of entire sectors and economies, and they are built from functional relationships between supply and demand for all products and aggregate supplies and demands for inputs to production. The strength of GE models is that because all sectors are allowed to be affected by all other sectors, the modeled market can be described more accurately and completely, and the results can be measured in terms of aggregate national economic welfare. However, the primary weakness of GE models is their lack of model resolution on specific sectors or products. Partial equilibrium models, on the other hand, assume that the feedbacks from sectoral changes to aggregate macro variables, such as GDP growth, national investment, wages, etc., are negligible, and that assumption allows modelers to quantify the specific commodity markets, like the timber market. So, in this paper we model China's timber market using the partial equilibrium approach.

The methodology of econometrics consists of specifying, estimating, and verifying an economic model. An econometric model is specified by expressing an economic theory in the form of mathematical equations. When an economic variable in which we are interested has some relationship with several other economic variables, a multiple regression equation is used to express the relationship between these variables. In

particular, the regression equation indicates the extent to which we can predict some variables from the knowledge of others, or the extent to which some variables are associated with others. In understanding China's timber market, it is essential to find out which factors affect the demand and supply, and to what extent. Also, because supply and demand simultaneously determine the equilibrium price and quantity in a market, both a supply and a demand equation must be specified in order to describe a market. Price and quantity are interdependent, jointly determined, and are called endogenous variables. A multiple-equations model is required.

In a broad sense, the pulpwood market and the fuelwood market both belong to the wood market. In their study of Sweden's timber market, Johansson and Lofgren, *op. cit.*, pulpwood was an important factor which affected the supply of timber; see the theory in Section 5 of Chapter 9 of their work. However, things are different in China. According to Lin, *op. cit.*, nearly 90% of China's pulp production and the 80% of paper production have relied on straw, reed, and grass inputs, not on wood pulp. Even when China has produced advanced paper products with wood pulp in recent years, the wood pulp is imported directly from other countries. Since there has been no actual demand for pulpwood in China, pulpwood has no effect on China's timber market. On the other hand, fuelwood does have an impact on timber supply, and we will verify its influence in the model.

As we have described, the structure of the timber market is hierarchical, and can be subdivided by product categories. In our effort to model China's timber market, I choose "industrial roundwood" - which covers most categories of timber products used in

construction and related industries - as the modeling object, and the trade between the resource level and the wood-processing industry as the modeling scenario.

The supply in China's timber market consists of domestic supply and foreign imports. From the early 1980s, there have been no trade restrictions other than the tariff on imported timber products, and even the tariff on most timber products has been reduced to zero in recent years. There is not much difference between domestic supply and import supply, except for the price differential due to difference in quality. Therefore, we do not differentiate between domestic supply and import supply, but consider them together as a single variable representing the supply side. The market supply function is assumed to be given by:

$$(1) \quad Q_t^s = \alpha_0 + \alpha_1 \underset{(+)}{P_t^r} + \alpha_2 \underset{(-)}{P_t^c}$$

In (1), Q_t^s is the supply of roundwood in year t ; P_t^r is the price of roundwood in year t ; and P_t^c is the price of charcoal in year t .

On the supply side, incentive comes from the profits of suppliers. The higher the price of industrial roundwood, the more profits the forest farms could make, and the more quantity of wood they would like to supply. So the price of roundwood P_t^r is the indicator for the suppliers' incentive. The reason behind the use of the price of charcoal P_t^c as a separate argument is as follows. In many areas of China, especially in rural areas, fuelwood has been the major fuel source. According to Lin, op. cit., 32% of total forest

wood output was used as fuelwood in 2002, since some of the small wood could be used either as sawlog in timber production or as fuelwood. If the coal price is high, more fuelwood will be supplied for charcoal production, which in turn will decrease the supply of timber and increase the supply of fuelwood, and vice versa.

Theoretically, almost all supply functions include a cost variable. In most previous studies, the variable of labor input, which represents the cost of processing timber, was included in the supply functions of many Western countries' timber markets. According to Johansson and Lofgren, *op. cit.*, the wage rate of logging workers was used to represent cutting cost when they modeled Sweden's timber market. However, the cost variable is inappropriate to be included in the supply function of China's timber market. The reason is mainly attributed to the employment and salary system in China's forestry sector. As the Chinese economy was a command system 20 years ago, the employment and salary system was totally coordinated by the government. Therefore, the employment was not allocated by demand pressures, and the salary level was not proportioned to the business profits. At that time, a standard wage rate system was adopted, even in different industries and sectors. Since the state and collective enterprises were public owned, only the government had the power to adjust the wage rate. In the most recent 20 years, with the progress of China's economic reform, this situation has gradually changed to be compatible with market economy, but in some state-dominant sectors, e.g. forestry, this change was kind of slow to occur since the 1980s and the early 1990s. During that period, in the state and collective forest farms, the wage rate of logging workers was not much related to the timber production and business profits. As a result, adopting the wage rate as a cost variable in the

supply function does not make any sense here. The real data of wage rate in China's forestry sector from 1980 to early 1993, which are obtained from the NBSC, also prove this point, as the wage rate is just steadily increasing, regardless the variations of timber supply in each year. Due to the data constraint, other agents for cost variable are also infeasible in this case. For the above reasons, the cost variable is not included in the supply function.

Next, I look at the demand side of the market. Economic growth in China has brought increasing demand for timber products. In many previous studies, GDP has been used as a variable which influences the demand for timber. However, since the demand for timber products derives more directly from the construction and related industries, it is more appropriate to include an argument which quantitatively represents China's construction industry. Thus, we use the annually finished residential construction area (C_t) as this argument. Also, we include the price of roundwood in the demand function, which is assumed to affect the demand for roundwood. Therefore, the market demand function is assumed to be given by

$$(2) \quad Q_t^D = \beta_0 + \beta_1 P_t^r + \beta_2 C_t$$

(-)
(+)

In (2), Q_t^D is the demand for roundwood and C_t is the annually finished residential construction area, both in year t .

Finally, the market-clearing condition is

$$(3) \quad Q_t^S = Q_t^D$$

Together, (1), (2), and (3) constitute the econometric model of the Chinese timber markets.

The signs under the parameters denote the expected signs of the coefficients.

4.3. *The Data*

The data are annual time series data covering the period from 1980 to 2002. China's economic reform started in 1978, and before then the Chinese economy was a command economy. Thus we actually study the Chinese timber market since its inception up to the present time.

China's statistics system is imperfect, especially for sectoral historical statistics. It is even more difficult to obtain data from official sources. The data used in this paper are from various sources. Most descriptive data are from the forestry department of the Food and Agriculture Organization of the United Nations (FAO). The quantities of China's domestic industrial roundwood production and imports are also from FAO. The statistical term is "industrial roundwood," which includes all industrial wood in the rough. I do not include pulpwood in our model. The data of annually finished residential construction area come from National Bureau of Statistics of China. Since China is a large country and has a huge market, there are no data on the list of prices for the whole country. Also, we cannot find price data on all timber products or all tree species. The price data on roundwood prices are the average prices of typical conifer logs in the market of eastern China. The roundwood price in this region is higher than those in northern and western China, but lower than that in southern China. Hence, it is reasonable to consider the price data in this

region as representative of the price of timber products in China. The data on roundwood prices come from the newspaper Chinese Construction. The data on the coal price come from China Energy Information Network, and represent the price of fuel coal in eastern China. The original price data have been converted to the constant price, with 1990 as the base year, and adjusted with the price index of National Bureau of Statistics of China.

Table 2 gives the descriptive statistics of the variables in the model

Table 2

Variables and their Descriptive Statistics

| Variable | Variable Description | Mean | Standard Deviation | Minimum Value | Maximum Value |
|-----------------|--|--------|-----------------------|------------------|------------------|
| $Q_t^s (Q_t^D)$ | Total industrial roundwood consumption in $10^6 m^3$ | 76.24 | 9.99 | 55.7 | 94.1 |
| P_t^r | Real price of roundwood in yuans per m^3 | 764.48 | 71.95 | 600 | 826 |
| P_t^c | Real price of coal in yuans per ton | 121.21 | 7.26 | 107 | 132 |
| C_t | Annual finished residential construction area in $10^9 m^2$ | 1.041 | 0.304 | 0.592 | 1.788 |

4.4. *The Result of the Estimation*

The simultaneous-equation model consisting of equations (1), (2), and (3) has been estimated by the technique of Two-Stage Least Squares (2SLS). The software, Statistical Package of Social Science (SPSS), was used to carry out the estimation.

The 2SLS estimates of the demand and supply of roundwood equations are presented in Table 3. As can be seen from the table, the model has a good fit. All the coefficients in the supply curve are statistically significant and have the expected signs. A rise in the price of roundwood (P_t^r) will increase the quantity supplied of roundwood, while an increase in the price of coal (P_t^c) will decrease the supply of roundwood. The coefficients in the demand curve also have the expected signs. An increase in the price of roundwood (P_t^r) will decrease the quantity demanded for this product, while an increase in construction activity will raise the demand for roundwood. The only problem is that the coefficient of the price of roundwood, P_t^r , in the demand curve is not statistically significant. This could imply that although the price has a negative effect on the quantity demanded, this effect is not significant enough in China's timber market. Thus, when the economic activities, for example, construction, were booming in some periods, demand did not decline, in spite of the of price increase; that is, demand for roundwood is quite inelastic. Also, the imperfect collection of price data could cause this problem.

Table 3

Estimation Result for Supply and Demand Functions

| | Q_t^S | Q_t^D |
|----------------------|------------|----------|
| $\alpha_0 (\beta_0)$ | 130.993 ** | 72.848** |
| P_t^r | 0.340** | -0.0327 |
| P_t^c | -2.596** | |
| C_t | | 2.704** |
| R^2 | 0.793 | 0.793 |

** Significant at the 1 per cent probability level

Figure 8 shows the predictive power of the model. The prediction of the quantity of roundwood bought and sold for the period 1980-2002 has been obtained by making use of the corresponding reduced form equations.

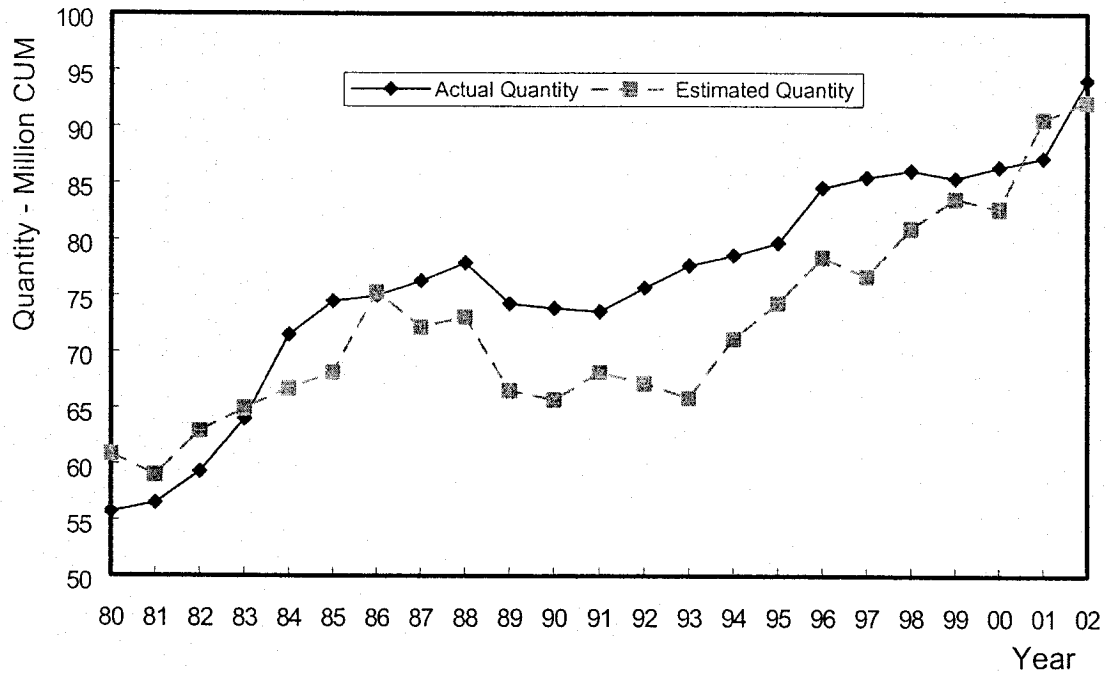


Figure 8. - Actual and Estimated Timber Quantities

To see the significance of the estimate result and the goodness of fit, t test and F test are applied in hypothesis test. The calculated t values of both the coefficients are 7.208, which are far higher than the critical value of t at the 5 percent level with 21 degrees of freedom. Also, the calculated F value is 38.325, which is far higher than the critical value of F at the 5 percent significant level. These statistical tests demonstrate the estimate result of the model fits enough, and the regression relationship in this model is significant.

The model is able to describe the fluctuations in the quantities of roundwood bought and sold in a satisfactory manner. The largest gap between the actual quantity and estimated quantities occurs for the year 1993. This is because the inflation rate reached a

peak at 18% in 1993, due to the immoderate economic expansion⁴. Demand was climbing in 1993, when the prices of timber products rocketed.

One possible problem with the estimation is that it did not take into account the effect of the quota on domestic roundwood production. Since the implementation of the NFCP in 1998, China's domestic timber production has been restricted by production quotas. The change on the supply side is depicted in Figure 9.

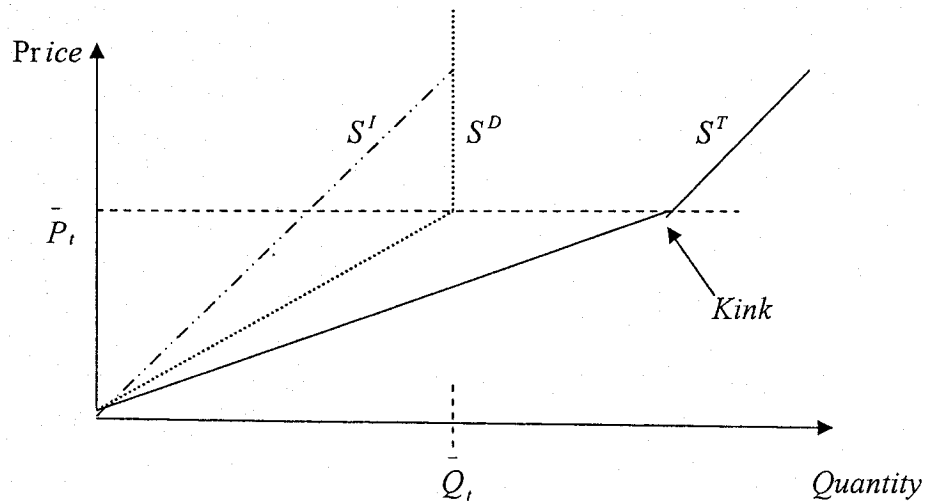


Figure 9. - Supply and Demand of China's Timber Market

In the figure, the domestic timber supply is represented by S^D ; the import timber supply by S^I ; the total timber supply in China's market by S^T . The total timber supply, S^T , is obtained by horizontally summing S^D and S^I . The domestic timber supply rises

⁴ NBS, annual report 1994.

continuously with the price of timber until the latter reaches \bar{P}_t , at which the domestic timber supply reaches its annual quota \bar{Q}_t . After that, the domestic timber supply stops growing even when the price of timber products continues to rise, i.e., the domestic timber supply curve becomes vertical after \bar{P}_t . Thus total supply S^T becomes less elastic when the price of timber rises above \bar{P}_t , because the increased total timber supply comes only from foreign producers, and domestic supply ceases to grow. Therefore, the supply curve should be estimated separately before and after the turning point. However, it is believed that more foreign suppliers of timber products – encouraged by the Chinese government – will enter the market. Thus the total supply curve might be less inelastic than the situation depicted in Figure 7. Actually, when I look at the total timber supply in the market after 1998, we cannot detect any significant impact of the quota on the total supply. While the domestic supply is curbed by the quota, more imported timber products are supplied at a same price level. Figure 10 shows the supply quantities – domestic and imported – in the timber market after 1998. Obviously, the total supply of timber products has not been much affected. Thus I did not modify the theoretical model to incorporate the influence of the quota on total supplies.

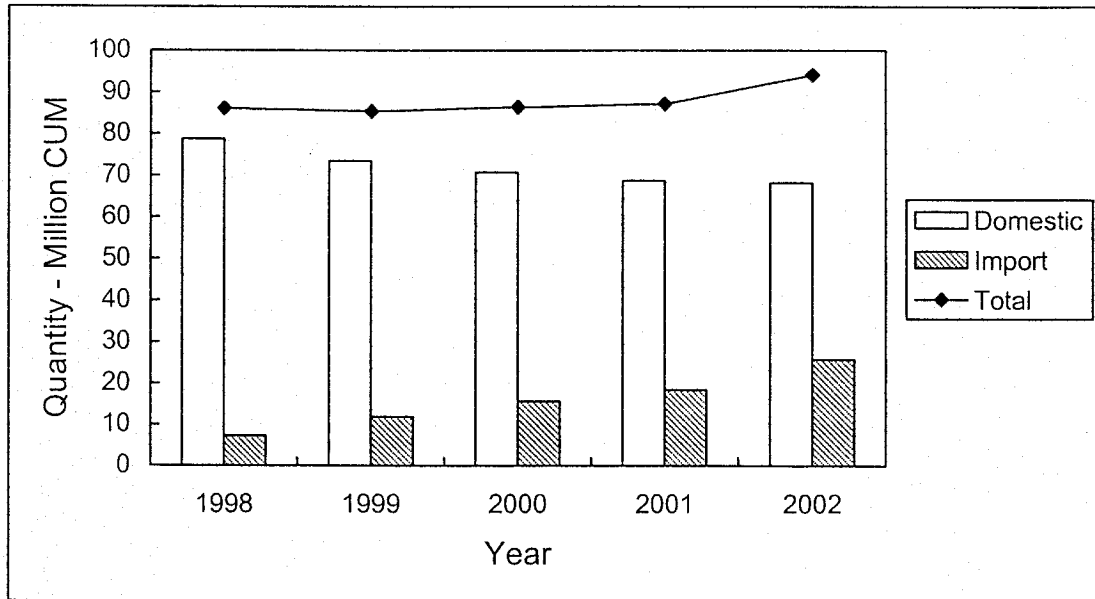


Figure 10. - Timber Supply After 1998

5. SUMMARY AND CONCLUSIONS

In this paper, I studied China's forestry sector, which is a complex system, from a systematic perspective. I not only presented a comprehensive investigation of China's forestry system, but also applied an econometric approach to analyze the timber demand and supply, which is the first application of such an analysis of China's timber market. The investigation of China's forestry sector highlights the role that economic institutions play in shaping economic outcomes in the Chinese economy, and in particular this sector. The empirical result of econometric model confirms the relationships among the economic variables that are expected to characterize the demand for and supply of timber in China. The model also provides the ability of forecast.

As expected, Construction activities doubtlessly have a positive and significant influence on the demand for timber. It is commonly believed that China's construction industry will still be flourishing in the near future, and reaching a record level in 2008, when China hosts the Olympic Games in Beijing. Hence the demand for timber is anticipated to keep on rising. However, China has been looking for a substitute for wood for use in construction and has carried out R&D programs with this aim for years. With technological progress, the pattern of demand for and supply of timber products may change, and should be considered in future studies.

The empirical results also indicate that the price of timber products has a significant impact on the Q_t^S of timber, but its influence on the Q_t^D of timber is weak, which implies that the suppliers have relatively more power in the market. If demand is inelastic, a price increase will not cause any significant decrease in quantity demanded. In that case, China will pay more for timber imports. Thus to mitigate the rising costs of timber imports, the Chinese government could coordinate economic activities to prevent extreme and irrational periodic expansions in construction.

According to the results of the estimation, the price of coal has a significant effect on timber supply. Because the price of coal is a proxy for the prices of substitutes for wood, from which timber is produced, the estimation results indicate that if it is more profitable to use wood in other ways, the supply of timber will significantly decrease. In recent years, China has started to establish mass production lines, making superior paper and paperboard products from wood pulp. This means that in addition to the demand for fuelwood, the

demand for pulpwood needs to be considered in future studies of the timber market.

There are some peculiar characteristics of the Chinese timber market the model fails to capture. First of all, we have modeled China's timber market as a competitive market, but in some aspects this market has been imperfect, especially in the early 1980s. For example, the Chinese government caused wide fluctuations in the price of timber, and the behavior of the state enterprises were sometimes irrational in the market. For these considerations, improved modeling needs to be conducted when such data are available.

APPENDIX: THE DATA

The data are time series data, covering from 1980 to 2002. The data source of quantity of timber consumption is the database of FAO; the data of annually construction area come from database of NSB; the data on roundwood prices and coal prices come from the Chinese Construction and China Energy Information Network, respectively.

| Year | $Q_t^S = Q_t^D$ ($10^6 m^3$) | P_t^r (yuan/ m^3) | C_t ($10^9 m^2$) | P_t^c (yuan/ton) |
|------|--------------------------------|------------------------|----------------------|--------------------|
| 1980 | 55.7 | 769 | .592 | 123 |
| 1981 | 56.5 | 765 | .613 | 132 |
| 1982 | 59.3 | 786 | .734 | 129 |
| 1983 | 64.0 | 806 | .780 | 125 |
| 1984 | 71.5 | 816 | .852 | 125 |
| 1985 | 74.5 | 813 | .910 | 125 |
| 1986 | 75.0 | 810 | 1.006 | 125 |
| 1987 | 76.3 | 826 | 1.107 | 128 |
| 1988 | 77.9 | 811 | 1.085 | 122 |
| 1989 | 74.3 | 819 | .873 | 128 |
| 1990 | 73.9 | 810 | .864 | 130 |
| 1991 | 73.6 | 807 | .946 | 128 |
| 1992 | 75.7 | 784 | .859 | 124 |
| 1993 | 77.7 | 825 | .789 | 122 |
| 1994 | 78.6 | 739 | .975 | 119 |
| 1995 | 79.7 | 649 | 1.074 | 116 |
| 1996 | 84.6 | 615 | 1.223 | 115 |
| 1997 | 85.5 | 600 | 1.212 | 120 |
| 1998 | 86.1 | 643 | 1.276 | 110 |
| 1999 | 85.4 | 690 | 1.393 | 110 |
| 2000 | 86.4 | 800 | 1.346 | 110 |
| 2001 | 87.2 | 805 | 1.647 | 107 |
| 2002 | 94.1 | 798 | 1.788 | 115 |

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