Projection of Timber Supply and Demand Trends in China Based on an Econometric Model

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Abstract

This study provides an overview and analysis of China's timber market trends over the last two decades, along with projections to the year 2020. An econometric model (simultaneous equations regression) is applied to estimate China's timber supply and demand. Key variables influencing China's timber market are identified. Corresponding coefficients are estimated and can be applied to other studies and sophisticated timber market models. Results show that timber supply in China increases at a slightly higher rate than timber demand, but timber consumption is projected to triple between 2008 and 2020, which will result in significant growth of timber imports (also nearly tripling by 2020).

China's forest products market became a more significant part of the world market over the past decade, with both domestic timber consumption and forest products exports rising quickly in a very short period. Nevertheless, domestic timber production in China was nearly constant during the period from 1988 to 2006. Since the late 1990s timber imports have increased significantly (more than tripled from 1998 to 2006), while timber consumption expanded. Currently China is the world's second largest timber importing country behind Japan (Sun et al. 2004, White et al. 2006).

The annual value of imported forest products in China was more than US$10 billion in recent years, and they have become the third largest foreign exchange commodity behind oil and steel. At the same time, China is a large forest products exporter as well. At present, with the rapid export growth of wood-based panels, China has become the world's second largest panel-producing country after the United States. In a comparison of export volume in 2002 and 2005, plywood exports increased more than three times and fiberboard exports increased more than 17 times. In addition, furniture exports experienced a 30 percent annual rate of increase in the past 10 years, and the total value of furniture exports reached US$14 billion in 2005 (White et al. 2006). China seems to be on its way to becoming the largest furniture-exporting country in the very near future. In the context of economic globalization, China's wood production and demand is an influential factor for world forest resource protection and timber price fluctuation. Therefore, the dynamics of China's timber market have been of major interest for scholars and international conservation organizations (Sun et al. 2004, Zhu et al. 2004, White et al. 2006, Bao and Cao 2008).

Although it is generally held that China's import of wood products places much pressure on the forests of neighboring and tropical nations, such as Russia, Indonesia, and a number of nations in Africa (Liu and Diamond 2005, Mayer et al. 2005, Zhang 2007), we know very little about the trends of China's wood supply, demand, and import. What are the determinants of China's wood supply and demand? To what extent are these factors affecting China's timber market, and where is China's wood import going? Answers to these questions are important, not only for China, but also for the world. However, not enough academic work has been done to address them. The purpose of this study was to analyze China's past and present timber market, determine major influencing variables, and develop a comparatively simple method to project China's prospective timber supply and demand and hence capture timber import trends.

This study used standard and straightforward economic methods to analyze supply, demand, and trade in China's forest products market to make projections on timber imports in the coming decades. The following sections provide an overview of China's forest products market in the past two decades, introduce the methodology and

empirical frameworks in the analysis, and present projection results and conclusions.

Division of Market in China and Overview of Market Trends in the Past Two Decades

According to official statistics (State Forestry Administration 1989 to 2006), China's domestic timber production[1] declined during the period 1997 to 2002 (Fig. 1). This decline can be explained in part by the Natural Forest Protection Program (NFPP) implemented by the Chinese government in 1998. Harvesting of natural forests has been strictly prohibited in western China and restricted in northeast China under NFPP regulations. After 2002, timber production increased slightly, but for a number of years it remained lower than the highest production level before NFPP. In the meantime, China's demand for timber, as indicated by the trend in timber consumption (Fig. 1) has been steadily rising along with rapid economic growth. The gap between growing demand and limited domestic production is one reason for accelerating growth of timber imports (Fig. 1).

For the convenience of modeling, we divide China's territory into three broad regions. Region 1 constitutes provinces in the north China plain and the northwest, with relatively scarce forests and weak forest industrial tradition. Provinces in this region are considered net timber consumers. Region 2, the northeast timber production region, constitutes four provinces in the northeast with forest predominately owned by the state: Heilongjiang, Jilin, Inner Mongolia, and Liaoning. Region 3, the southern timber production region, includes provinces in the southeast, south, and southwest, where productive and collective forests dominate.[2] Figure 2 illustrates forest cover conditions and the regional divisions used in our analyses.

Analyzing timber production trends based on our regional classification, we can see that timber production or supply trends of the central consumption region (Region 1) and northeast state-owned forest region (Region 2) were initially stable and then declined after the mid-1990s (Fig. 3). Meanwhile, in the southern timber supply region (Region 3), timber production has increased significantly since 2000, and this region has replaced the northeast region as the main domestic supplier. Two factors have led to this change. First, the decline of timber production in the northeast state forest region was persistent over the past two decades due to resource degradation and reforestation failure. Second, since

2000, the NFPP has imposed strict logging restrictions and further reduced allowable cut in the region. On the other hand, afforestation in the southern timber production areas (Region 3) has been rather successful since the early 1980s, especially after the implementation of forest production responsibility reform (individualization of forest tenure) in the majority of the collectively owned forest areas. Forest volume in south China as a whole has grown significantly in recent years and so has the timber production capacity. Therefore, timber production in the southern areas has increased year by year and has accelerated in the past several years (Fig. 3).

Analyzing timber consumption trends based on our area classification, we can see that timber consumption in the northeast state-owned forest areas (Region 2) has been relatively stable. Meanwhile, in southern areas (Region 3) and central areas (Region 1) the volume of timber consumption demonstrates apparent upward trends, especially the consumption in central consuming areas where it has maintained, on average, a 5 percent annual growth rate since 2001 (Fig. 4).

Sawnwood production in China has experienced more dramatic changes than timber production. In 1995, sawnwood production volume reached 40 million m^3. In 2000, however, the volume decreased to 6.34 million m^3 (Fig. 5). This process paralleled diversification of the forest products industry away from simple, single-use products toward more market demand–driven product mixes.

The growth of wood-based panels in China reflects this complicated process. The production of wood-based panels in China can be roughly divided into three stages. The first stage was the period of 1988 to 1994 when the forest products industry was still under the shadow of a planned economy. The market in that period was not yet fully opened up, and production volume was relatively stable. The second stage was from 1995 to 1999, when market liberalization picked up speed. The market was not as stable as before. Production fluctuated, with a somewhat upward trend. The third stage, when the forest products industry entered a golden age, started in 2000 and continues to the present. Unlike timber production, wood-based panel production has not been affected as much by the implementation of NFPP. As a matter of fact, the production volume increased rapidly. From 2002 to 2006, the production of plywood and particle board has doubled, and fiberboard production has experienced an astonishing quadrupling in growth (Fig. 6).

We can see that China's timber production and processed timber product markets have moved out of a planned economy and matured progressively in the past 20 years. Consequently, China's forest products industry has become one of the major suppliers to the world market. It has also become the biggest consumer of the world's forest resources, especially those from the Russian temperate forests and from tropical forests. In the era of global efforts to attempt to curb climate change by helping tropical developing countries stabilize forest resources, the dynamic of the Chinese forest products market is of great significance. Understanding future trends of the Chinese forest products market and the determining factors will help the world and Chinese policy makers to make prudent decisions on forest products trade, domestic forest resource conservation, and global trade regulations.

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[1] Timber production here includes both industrial roundwood and fuel wood. Wood-based panels belong to secondary production and will not be discussed in this article. Data in this study do not include the Hong Kong Special Administrative Region, Macao Special Administrative Region, and Taiwan Province.

[2] The south timber production region includes the provinces of Jiangxi, Fujian, Hunan, Yunnan, Guangxi, and Sichuan. Yunnan and Sichuan are labeled as state forest regions and have been under the influence of the Natural Forest Protection Program (largely a logging ban). However, collectively owned forest areas are bigger than those owned by the state in these two provinces. Other provinces are net timber consumption areas. The criterion to group these areas is the average net production (production less consumption): the average net production in a production area is positive, while the average net production in a consumption area is negative. The original data of average net production are listed in Appendix Table 1.
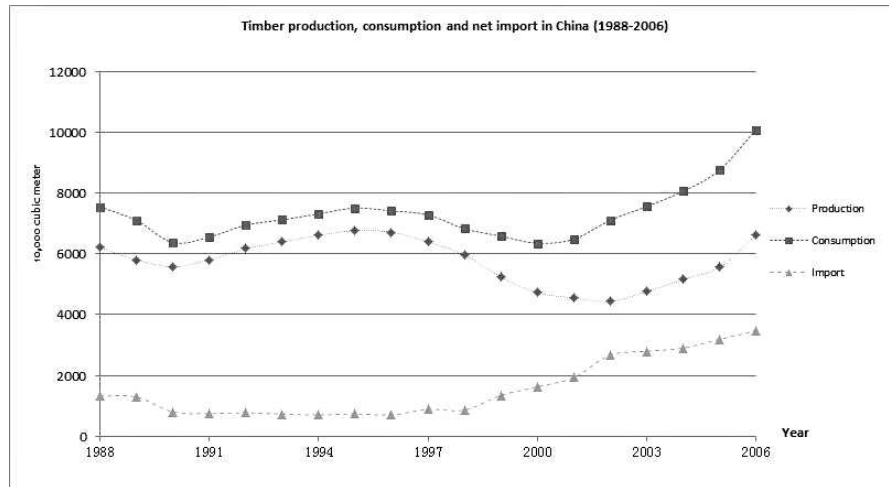
Figure 1.—Timber production, consumption, and net import in China (1988 to 2006).
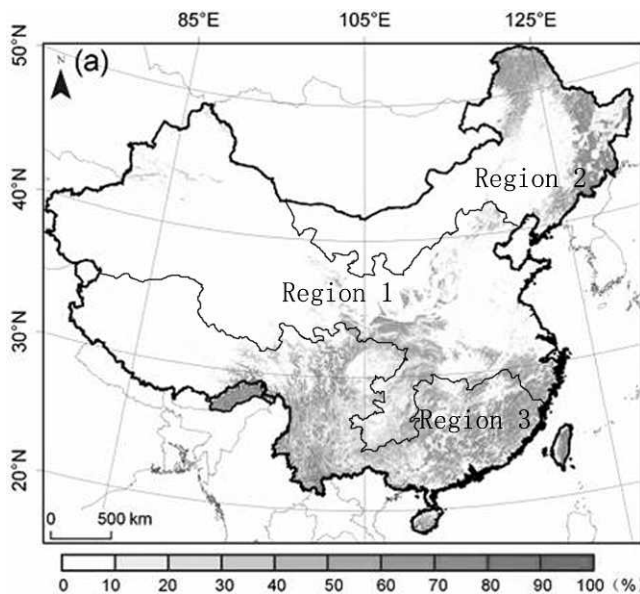

Figure 2.—Forest cover in China and classification of three regions. Source of forest cover: the sixth National Forest Resources Inventory (1999 to 2003).

Description of Methodology and the Model

Econometric estimation is a general approach to study timber markets (Gregory 1966, Luppold 1984, Daniels and Hyde 1986). Even today, when a number of sophisticated forest sector models are available to project future trends in timber markets, econometric approaches are widely adopted to isolate variables that influence the market and to provide needed parameters for such models (Adams and Haynes 1996, Sohngen and Sedjo 1998, Kallio et al. 2004).

In this article we also adopted an econometric method to make projections of China's future timber supply and demand. The econometric approaches can identify the major influencing variables for China's timber supply and demand, and also statistically quantify their relative influence. Based on expected changes of the major variables, the projected

trends of China's timber supply and demand can be determined. The gap between prospective supply and demand is the prospective import or export in our analysis. Similarly, the gap between regional supply and demand illustrates internal trade among different regions.

The econometric method is based on estimations of domestic timber supply and demand in China as well as in particular supply regions. From the perspective of econometrics, since timber price is endogenously determined in either the demand function or supply function, demand and supply equations should be simultaneously estimated in order to obtain consistent results. Therefore, we applied a simultaneous equations regression model combining supply and demand to estimate the influence of macroeconomic variables and other market characteristics on China's timber market. Specifically, the following model is used in our analysis:

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\begin{cases}
D_{it} = f(P_{it}, \Phi, \varepsilon_{1it}) \\
S_{it} = f(P_{it}, \Theta, \varepsilon_{2it}) \\
D_{it} = S_{it} = Q_{it}
\end{cases} \tag{1}
$$

where S_{it} is the timber supply or production[3] in province i of year t and D_{it} is the timber demand in province i of year t. Θ is a vector that denotes the determinants of domestic timber supply.

Newman (1988) made a comprehensive review of the theoretical models of forest management, in which timber production is a balanced decision based on economic and biological criteria. The key factors that influence timber supply in theory include biophysical productivity of forests, the economic environment, and prevailing social values (see William 1994). To examine timber supply on the scale of a country also requires full consideration of these possible determinant variables, as well as local policies that influence timber supply. Thus, we hypothesize that regional timber supply in China is a function of the price of timber (P), a

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[3] Following Luppold (1984) and Daniels and Hyde (1986), timber supply is the same as timber production in our analysis. Since there is no strategic reserve plan for timber in China so far, it is reasonable to assume that all domestic produced timber can be sold in the market.
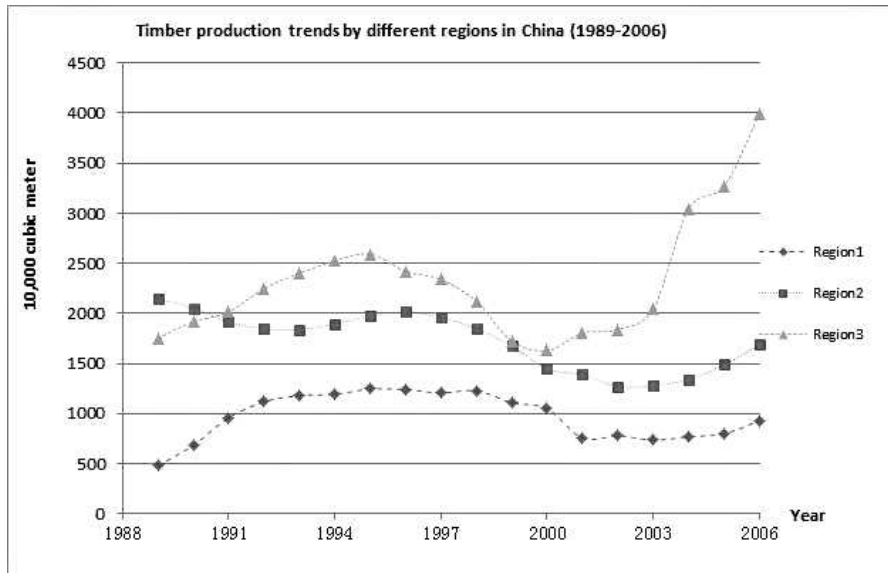
Figure 3.—Timber production trends by different regions in China (1989 to 2006).
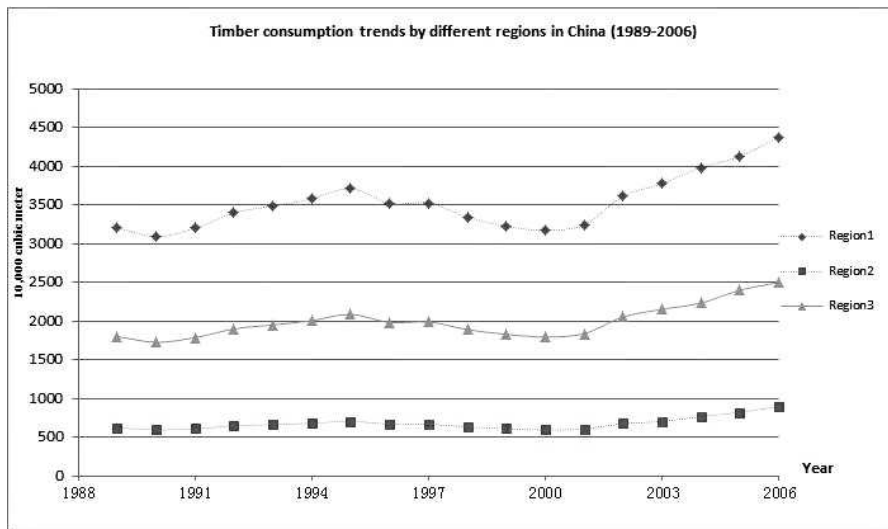

Figure 4.—Timber consumption trends by different regions in China (1989 to 2006).

dummy variable representing introduction of the NFPP in 1998 (NFPP), the logging quota allocated to the forest (L), the ratio of the area of state-owned forests to that of collectively owned forests (SC), forest inventory volume (I), average wage of forest workers (W), and ratio of average wage of forest workers to local average wage (R). The econometric specification of timber supply or production is thus set up as the following equation:

$$\ln S_{it} = \alpha + \beta_1 \ln P_{it} + \beta_2 \mathrm{NFPP}_{it} + \beta_3 \ln L_{it} + \beta_4 \mathrm{SC}_{it}$$
$$+ \beta_5 \ln I_{it-1} + \beta_6 \ln W_{it} + \beta_7 R_{it} + \mu_i + \varepsilon_{it} \qquad (2)$$

where i denotes the province and t denotes year.

Φ is a vector that denotes the determinants of domestic timber demand or consumption including average timber price (P), gross domestic product (GDP), price index of metal industry (PIM), housing area under construction (H), rural income per capita (RI), urban income per capita (UI), and an urbanization index (U). We controlled for autocor-

relation by using 1-year lagged timber consumption (TC). This also helps mitigate the omitted variable problem.[4] The demand function takes the following form:

$$\ln D_{it} = \alpha + \beta_1 \ln \mathrm{GDP} + \beta_2 \mathrm{PIM} + \beta_3 \ln H + \beta_4 \ln \mathrm{RI}$$
$$+ \beta_5 \ln \mathrm{UI} + \beta_6 U + \beta_7 \ln \mathrm{TC} + \mu_i + \varepsilon_{it} \qquad (3)$$

Some justifications are useful for the selected variables in demand function. As early as the mid-1960s, Gregory (1966) developed a consumption model and empirically showed that income and wood availability are two major variables correlated with the variance in industrial wood consumption. Numerous subsequent studies confirmed that

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[4] Including lagged timber consumption in our model corrects for autocorrelation and improves the explanatory power without significantly changing the remaining substantive coefficients of other regressors.
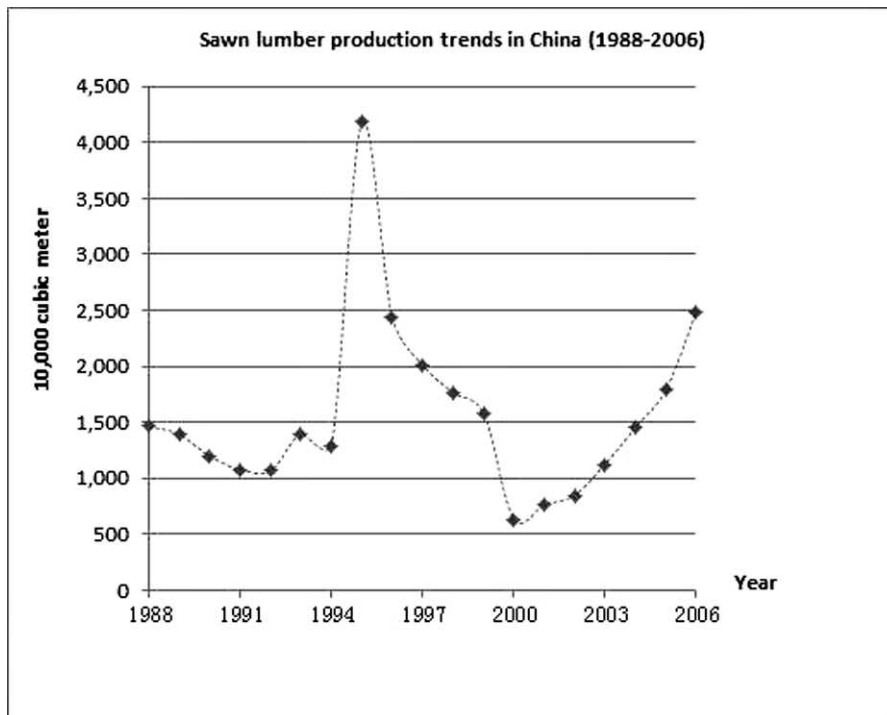
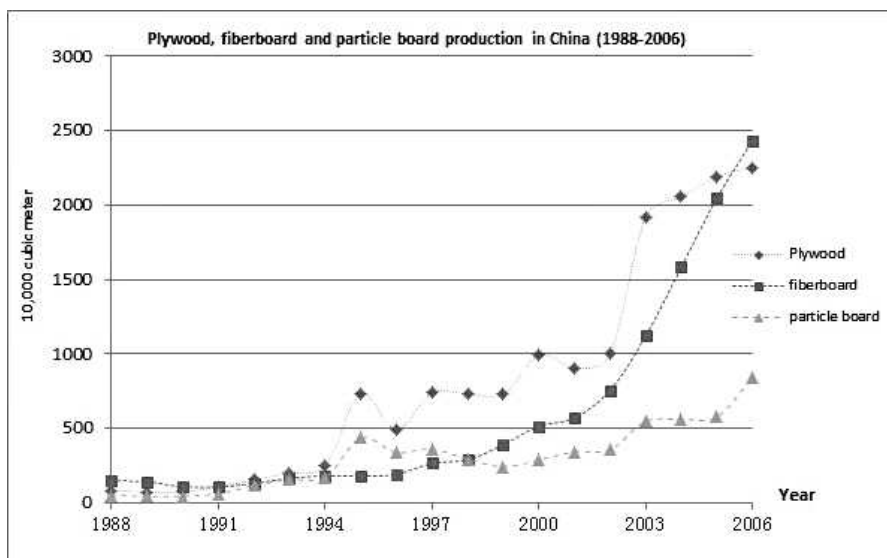Figure 5.—Sawn lumber production trends in China (1988 to 2006).

Figure 6.—Plywood, fiberboard, and particle board production in China (1988 to 2006).

price is another key explanatory variable for timber demand. Turner and Buongiorno (2004) summarized price and income elasticities of import demand for forest commodities in published studies. To model timber consumption at a regional or national level, GDP is commonly included to represent economic development levels (Zhang et al. 1996). We controlled both rural and urban income per capita to capture possible nonconstant income elasticity. Housing area under construction and urbanization index are also included since construction and internal decoration consume more than half of China's timber (Tian et al. 2003). These

two variables also improved the explanatory power in terms of R^2 of our model in the bottom-up modeling process.

Table 1 lists the variables used in the timber supply Equation 2 and timber demand Equation 3.

In our analysis, the proxy for timber demand is equilibrium consumption.[5] In estimation, we transformed the structural form, Equation 1, into reduced form, and then adopted the seemingly unrelated regression (SUR) method to avoid biased estimation. With the panel data of 30

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[5] The details on construction of timber demand are listed in the Appendix.

Table 1.—Descriptions of variables used in Equations 2 and 3.

Variable	Description
Timber supply, Equation 2	
P	Trade price of timber in local markets
NFPP	Policy dummy which is 1 when logging of the province was restricted by Natural Forest Protection Program (NFPP) (first introduced in 1998)
L	Logging quota allocated to a province
SC	Ratio of the area of state owned forests to that of collectively owned forests
I	Forest inventory
W	Average wage of forest workers
R	Ratio of average wage of forest workers to local average wage
Timber demand, Equation 3	
GDP	Provincial gross domestic product
PIM	Price index of metal industries
H	Housing area under construction
RI	Rural income per capita per year
UI	Urban income per capita per year
U	Urbanization index
TC	One year lagged timber consumption

provinces from 1989 to 2006, we estimated the supply and demand functions of timber for China as a whole (All China) as well as separately for each of our three regions. Results are shown in Table 2.

Theoretically, treating timber price as endogenous should improve the consistency of the estimation results. As shown in Table 2, timber price is negatively related to timber demand but positively related to timber supply, which is consistent with economic theory; this result is consistent across regions. Some other exogenous variables, like forest inventory, average forestry wage, logging quota, and the NFPP dummy variable also consistently influence timber supply in China. For example, supply is positively correlated with inventory, as expected. It is worth noting that NFPP strongly hampers timber production and the logging quota is positively related to timber supply, which indicates that China's timber supply largely complies with logging quota restrictions and forestry policy does have a strong impact on the timber market. In addition, average forestry wage shows a subtle influence on timber supply. On the one hand, average forestry wage as a part of timber production costs is negatively related to timber production. On the other hand, compared with average social wage, the higher the forestry wage, the larger the amount of timber produced, which indicates that higher forestry wage may encourage timber employment and hence increase timber output.

Influences of demand determinants, like GDP, urbanization index, and income per capita, are generally consistent with theory as well. The price index of the metal industries shows a positive influence on timber demand, which indicates substitution effects among heavy metals and timber in China. Moreover, rural income per capita is negatively related to timber demand, while the influence from urban income per capita is positive. Since urban income in China is higher than rural income, this implies a U-shaped relationship between income per capita and timber demand. Where income per capita is comparatively low (e.g., rural areas), timber demand decreases as income

Table 2.—Estimation of China's timber production and consumption system.[a]

	All China		Region 1		Region 2		Region 3	
Variable	Demand	Supply	Demand	Supply	Demand	Supply	Demand	Supply
P	-0.061 (1.82)*	0.370 (2.16)**	-0.147 (2.05)**	0.439 (2.00)**	0.004 (0.09)	0.371 (2.09)**	-0.078 (2.77)***	0.334 (1.46)
GDP	0.094 (2.90)***		0.136 (2.30)**		0.061 (0.57)		0.111 (2.01)**	
PIM	0.039 (1.71)*		0.085 (1.68)*		0.074 (1.88)*		0.073 (2.88)***	
H	0.019 (5.95)***		0.021 (5.07)***		0.036 (4.35)***		0.031 (5.42)***	
RI	-0.199 (8.73)***		-0.205 (6.76)***		-0.238 (3.42)***		-0.221 (3.72)***	
UI	0.099 (3.46)***		0.111 (2.57)**		0.076 (0.64)		0.115 (2.42)**	
U	0.024 (2.24)**		-0.015 (0.98)		-0.120 (1.85)*		0.050 (3.25)***	
TC	0.641 (14.33)***		0.651 (10.15)***		0.497 (3.64)***		0.323 (4.29)***	
NFPP		-1.092 (10.74)***		-1.143 (8.66)***		0.069 (0.97)		-1.700 (9.85)***
L		0.256 (3.46)***		0.267 (2.82)***		0.271 (6.02)***		0.445 (2.66)***
SC		0.022 (1.42)		0.001 (0.01)		0.002 (0.52)		-0.821 (2.92)***
I		0.159 (1.64)*		1.558 (4.61)***		0.809 (1.55)		0.079 (1.09)
W		-0.323 (2.63)***		-0.620 (3.84)***		-0.371 (3.61)***		0.202 (1.04)
R		0.008 (3.67)***		0.007 (2.05)**		0.006 (3.92)***		0.026 (5.94)***
No. of samples	392	392	238	238	56	56	98	98
R^2	0.73	0.43	0.73	0.49	0.72	0.72	0.87	0.75

[a] Abbreviations are explained in Table 1. Regional estimations are obtained by a separate regression run for each region. Values in parentheses are t statistics. * = significant at the 10 percent level; ** = significant at the 5 percent level; *** = significant at the 1 percent level.
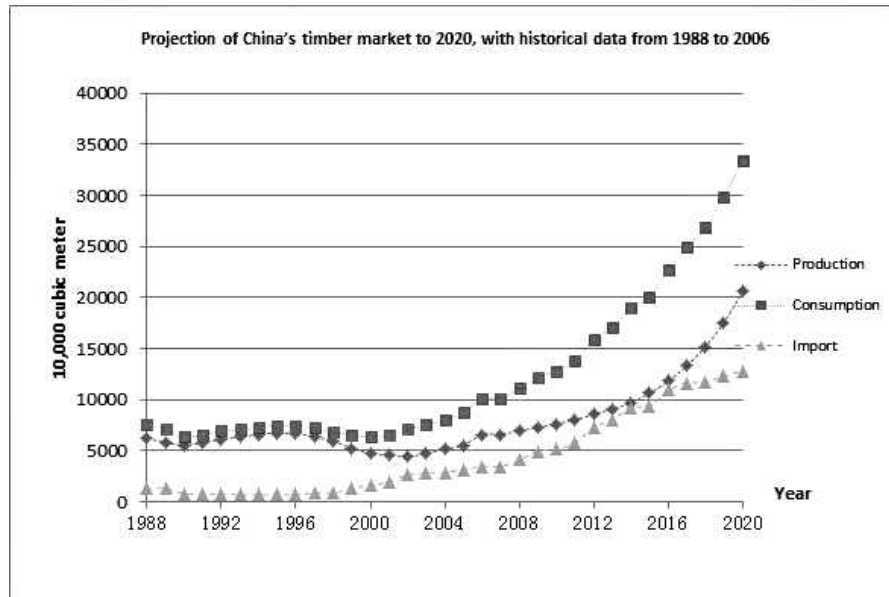
Figure 7.—Projection of China's timber market to 2020, with historical data from 1988 to 2006.

increases, but in urban areas, where income per capita is higher, timber demand increases as income grows. The regression result fits China's situation, where rural families would apply construction materials like cement instead of wood as their income increases. But urban families would use more wood floorings or furniture as their income grows.

In this section, we have estimated timber supply and demand equations for China as a whole and by region, and in the process we have identified key influencing variables for China's timber market. The coefficients of these variables were estimated by the SUR method in order to address the endogeneity of timber price. The results were robust across three regions and will be used to project China's future timber supply and demand in the next section.

Demonstration of Results

Based on the estimated equations for timber production (supply) and consumption (demand) of China's timber market (All China equations), some projections of China's timber markets can be made with a few assumptions about China's economy from now until the year 2020. China's GDP is assumed to grow at an annual rate of 8 percent, while both forest inventory and average forestry wage will grow at the rate of 5 percent.[6] Other determinants are set at the same rates of change as in 2006. The results of this scenario are illustrated by projections of timber consumption, production, and import to the year 2020 (along with historical data until 2006) in Figure 7.[7] The assumption of 8 percent GDP growth is based on the central government GDP growth target in the "12th Five-Year Plan."

In this simple but reasonable scenario, China would still rely on imported timber in the next decade. The difference

between domestic timber production and demand would stabilize by 2015. The difference, however, would be three times larger than that in 2005, meaning imports would increase by threefold (as shown in Fig. 7). To cover the shortage of domestic timber production without higher imports, China may have to find a way to further improve forest productivity. Given existing conditions, the projected quantity of timber production, consumption and import is shown in Table 3.

Admittedly, the projection here did not take into consideration some complex but crucial factors that may significantly change projection results, such as technology innovation that could result in changes in wood demand, or significant changes in social values, such as the growing public awareness of forest protection and the social preference of leaving resources for future generations rather than consuming them now. Therefore, the projection is probably more reliable in the near term rather than further into the future. In general, we focused on primary economic determinants (variables such as price, GDP, wages, and

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[6] Five percent is the average growth rate of average forestry wage and forest inventory during 1989 to 2006.

[7] For simplicity, import here is equal to consumption less production, which is also the net import (the real import would be the projected net import plus real export).

Table 3.—Projected quantity of China's timber production, consumption, and import.

	Projected quantity (10,000 m³)		
Year	Production	Consumption	Import
2007	6,611.8	10,084.0	3,472.2
2008	6,997.1	11,108.1	4,111.0
2009	7,268.6	12,236.2	4,967.5
2010	7,653.1	12,853.4	5,200.3
2011	8,079.8	13,850.5	5,770.7
2012	8,556.9	15,920.3	7,363.4
2013	9,094.3	17,098.5	8,004.2
2014	9,703.7	18,990.4	9,286.7
2015	10,654.5	19,994.5	9,340.1
2016	11,836.0	22,789.4	10,953.3
2017	13,317.2	24,968.5	11,651.3
2018	15,187.7	26,921.6	11,734.0
2019	17,563.7	29,876.4	12,312.8
2020	20,596.6	33,458.2	12,861.6

income) since they are more visible and can be quantified, but this is not to say that other variables would not become important in the future.

Conclusion

In this study, we developed an econometric model to estimate a simultaneous system of equations representing China's timber supply and demand. First, in estimating the supply and demand, we identified important variables influencing China's timber market. We then obtained statistically significant and theoretically consistent estimates of supply and demand equations, and used the equations to make projections of China's timber supply and demand (production, consumption, and net imports) to 2020 based on simple trend assumptions about major variables.

Our study confirms that China's forestry policy restricts China's timber supply in two major ways: one is the NFPP and the other is the logging quota system. Because NFPP will continue to be in effect for another 10 years, its impact will remain. Average forestry wage is negatively related to timber production, while the ratio of average forestry wage to average social wage represents the comparative advantage of forestry in the labor market and is hence positively related to timber supply. On the demand side, some microeconomic indicators, like GDP, housing area under construction, and urbanization rate, have positive influences on timber demand as expected.

For the projections, we assumed that China's GDP will grow at an annual 8 percent rate, and both forest inventory and average forest sector wage will grow at an annual 5 percent rate until 2020. Using these assumptions we projected China's timber supply and demand based on our econometric equations. The projected result suggests that China's import of timber would continue to expand in the decade ahead, but its growth would stabilize around 2015. To lessen the gap between domestic timber demand and supply as well as mitigate the reliance on foreign timber, the Chinese government is looking for effective policy tools. Besides tenure reform and some follow-up measures aiming at increasing forestry productivity in southern collective forests, improving performance in the state forest sector has the potential to make a large difference. Because the government is determined to continue its investment in natural forest protection, pressure to reform—namely, to modernize state forest enterprise management, adopt better forest tenure scheme to enhance individual incentive, and reduce social policy burden—is mounting. The upcoming 10 years will be crucial for the reform and transformation of the state forest sector. If successful, forest productivity will grow at even higher rates. We will see much less pressure on international forest resources.

On the demand side, our results imply that timber demand and income per capita have a U-shaped relationship, with a positive correlation to urban income per capita. Therefore, we expect that China will remain as one of the major importers in world timber markets in the decade ahead because of the strong upward trend of timber demand associated with rising income per capita. This upward trend in timber demand is combined with the fact that present strict logging controls are not likely to be reduced in the near future.

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Appendix: Description of Data Used in the Econometric Model

Provincial timber production data from 1988 to 2006 is from *Statistical Yearbook of China's Forestry* 1989–2007 (State Forestry Administration 1989).

Provincial timber consumption data are derived through the following steps:

1. calculating national consumption, which equals the sum of domestic timber production and net import (import less export);
2. calculating the sum of the production value of wood-processing industry, housing industry, and paper industry for each province and assigning weights 1 to 3 as the proportion of each industry to the sum;
3. ranking weights 1 to 3 among the provinces;
4. calculating weights 4 to 6 as the contribution of each province in each of the three industries;
5. finding the final weight of each province in the national timber consumption: weight 1 × weight 4 + weight 2 × weight 5 + weight 3 × weight 6; and
6. calculating provincial consumption: national consumption × final weight.

Provincial net production (production minus consumption) is listed in Appendix Table 1. Some of the explanatory variables data in the econometric model—GDP, price index of metal industry, house area under construction, rural and

Appendix Table 1.—Average net production of each province.

Province	Net production (10,000 m^3)
Beijing	−1,027.2
Tianjin	−715.4
Hebei	−4,004.9
Shanxi	−1,409.2
Inner Mongolia	5,167.0
Liaoning	−1182.4
Jilin	5,757.3
Heirongjiang	8,718.7
Shnaghai	−1,534.5
Jiangsu	−4,295.5
Zhejiang	−787.1
Anhui	−344.8
Ningxia	−131.3
Xinjiang	−602.3
Fujian	4,358.7
Jiangxi	1,775.5
Shandong	−3,945.1
Henan	−2,975.7
Hubei	−1,977.0
Hunan	1,273.8
Guangdong	−1,813.5
Guangxi	2,510.7
Sichuan	−71.1
Guizhou	−894.0
Yunnan	1,488.2
Shan'anxi	−824.4
Gansu	−742.6
Qinghai	−184.1

urban income per capita per year, average social income, average social wage—are from *Statistical 50 Years of New China* (National Bureau of Statistics 2005); some explanatory variables data—dummy variable of NFPP, logging quota—are from official documents issued by State Forestry Administration; and other determinants data—average forestry wage, forests inventory—are from *Statistical Yearbook of China's Forestry* (State Forestry Administration).

Import and export data are from *Statistical Yearbook of China's Forestry* 2007 (State Forestry Administration).

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