

Chapter 2 KOREAN TIMBER MARKETS AND POLICY

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Contents

1. Policy Study
 - 1.1 Historical overview of Korean timber markets
 - 1.2 Korean policy changes
2. Econometric Study
 - 2.1 Survey of Korean timber models
 - 2.2 Modeling of Korean timber demand and Supply
 - 2.3 Estimation results and discussion
 - 2.4 Simulation of forest resources and timber trade in Korea
 - 2.5 Concluding remarks

1. POLICY STUDY

1.1 HISTORICAL OVERVIEW OF KOREAN TIMBER MARKETS

1.1.1 Economic development

Republic of Korea (ROK hereafter) has experienced rapid economic growth for the last three and half decades. The economic growth rate has been relatively high (more than 5 percent per year) except during two periods as shown in Figure 1. There were two periods when economic recessions occurred, in 1980 and 1998. In 1980 the domestic political environment was unstable, while the country experienced a financial crisis in 1998.

The most important component of economic development of ROK has been the export industries. The exports of goods and services accounted for 29 percent of the national gross product in 1993. This means that the international competitiveness of industries is key to economic development.

The economic development has been the ground for importing materials for building capital stocks like housing and roads. The building construction sector has grown 53 times during the 32 years between 1962 and 1994 while the length of roads has grown 2.2 times during the same period. The economic growth has transformed the land cover and the life style of Korean people. More forestlands have been converted into other land uses, as the country has become more industrialized and urbanized. People now consume more of such goods and services as fiber products and outdoor recreation.

1.1.2 Forest resources

Forestlands cover nearly two thirds of ROK land area. As of 1997, there were 6.441 million hectares of forestlands in ROK. This was 0.366 million hectares less than that of the year 1946. The reduction in forestland is mainly due to the land conversion into agricultural and urban land uses. The main force of conversion of forestland into other uses has changed over time: first from agriculture (until 1970s) and followed by urbanization since the 1980s. The average forestland acreage per capita has declined continuously as the population has increased nearly threefold since 1945. However, the growing stock per capita has increased continuously ever since the Korean War ended. (see Table 1)

There were many treeless “forestlands” in ROK until the 1960s when the government’s reforestation policy became effective. By the 1980s when the reforestation was completed, nearly four million hectares of lands were planted by work forces (Yoo, 1997). Today there are about 2 million hectares of plantation forests established. The main species of forest plantations include Japanese larch (*Larix leptolepis*), Korean pine (*Pinus koreansis*), pitch pine (*Pinus rigida*), hybrid populus (*Populus*

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euramericana, *Populus alba x grandulosa*), black locust (*Robinia pseudoacacia*) and *Alnus spp.*, among others.

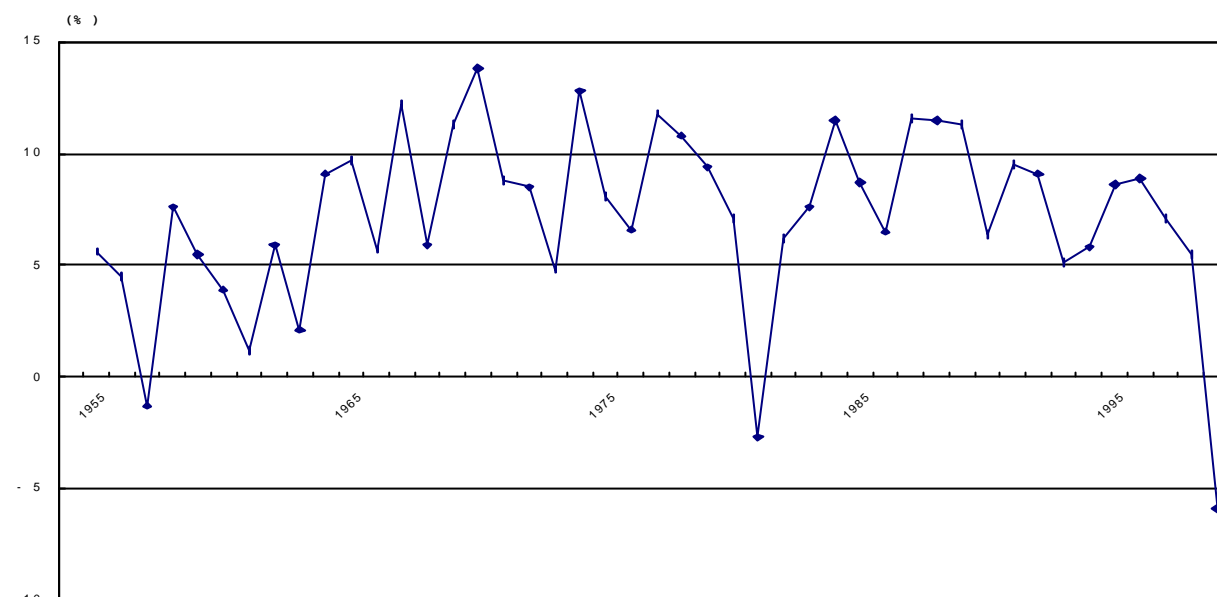


Figure 1. Real GDP Growth Rate

Table 1. The changes in forest resource of ROK over the last five decades

Category	Unit	1946	1952	1960	1970	1980	1990	1996	
Forestland	Mil ha	6.814	6.469	6.701	6.611	6.568	6.476	6.448	
Growing stock	Mil m ³	54.000	30.826	63.995	68.773	145.694	248.426	340.824	
Average stock	m ³ /ha	7.92	4.765	9.55	10.40	22.18	38.36	50.21	
Population	Mil	19.369	20.527	24.989	31.466	37.436	43.411	45.991	
Forest Per capita	Acreage	Ha	0.352	0.315	0.268	0.210	0.175	0.149	0.140
	volume	m ³	2.788	1.502	2.561	2.187	3.892	5.723	7.411

The forestland is divided into three categories by ownership: namely, national, private and owned by public bodies such as provincial municipalities. The national government owns 21 percent of the nation's forestland while individuals and private corporations own 71 percent (4.6 million hectares). National forests are usually located in upper ridges of mountains in the remote areas while most of urban forests are owned privately.

There are 2.1 million individuals who own their own forests, giving the average forestland holding only 2.2 hectares per individual owner. In most cases, the main purpose of owning forests is to keep the graveyards for their ancestors. This provides the explanation for the relatively high land price of forestland compared to the productivity.

Forests of ROK are composed of young stands, which have grown at the rate of 5 to 6 percent per year by volume for the last three decades. The average growing stock at the current time is just over 50 cubic meters per hectare. The forests are normally composed mainly of mixed hardwood if there are no human disturbances. Due to the historical human disturbances, there are more coniferous forests than hardwood forests in ROK at the moment. However, due to the low level of forest disturbances over the last three decades, there is an evident trend of transition from conifers back to hardwood forests. The Table 2 shows the current status of forest composition in ROK.

Table 2. The current status of species composition of ROK forests

Category		conifers	Hardwood	Mixed	Total
Acreage	Mil ha	2.788	1.686	1.779	6.441
	%	43.3	26.2	27.6	100.0
Volume	Mil m3	151.0	94.6	95.3	340.8
	%	44.3	27.6	28.0	100.0

Source : Forestry Administration

1.1.3 Stumpage and log production

The stumpage market in ROK is dominated by the log-producing merchants, who buy the stumpage from forest owners and harvest timber to supply the domestic logs for saw mills and pulp mills. The stumpage is usually small in volume and scattered in a large area so that the price paid to forest owners is low. Only one quarter of the log price is paid to the stumpage owner with variations in log size and usage. The trend in stumpage price of national forests is shown in Figure 2.

The forest owner had to get permission for harvesting his or her timber until 1995 when the timber harvest regulations were eased; harvesting permission was replaced by reporting if he or she operates according to a forest management plan. Even with such a change in timber harvest regulation, the forest owner is subject to the governmental regulations such as forest planning. This means the Korean stumpage market has been fairly regulated by the government.

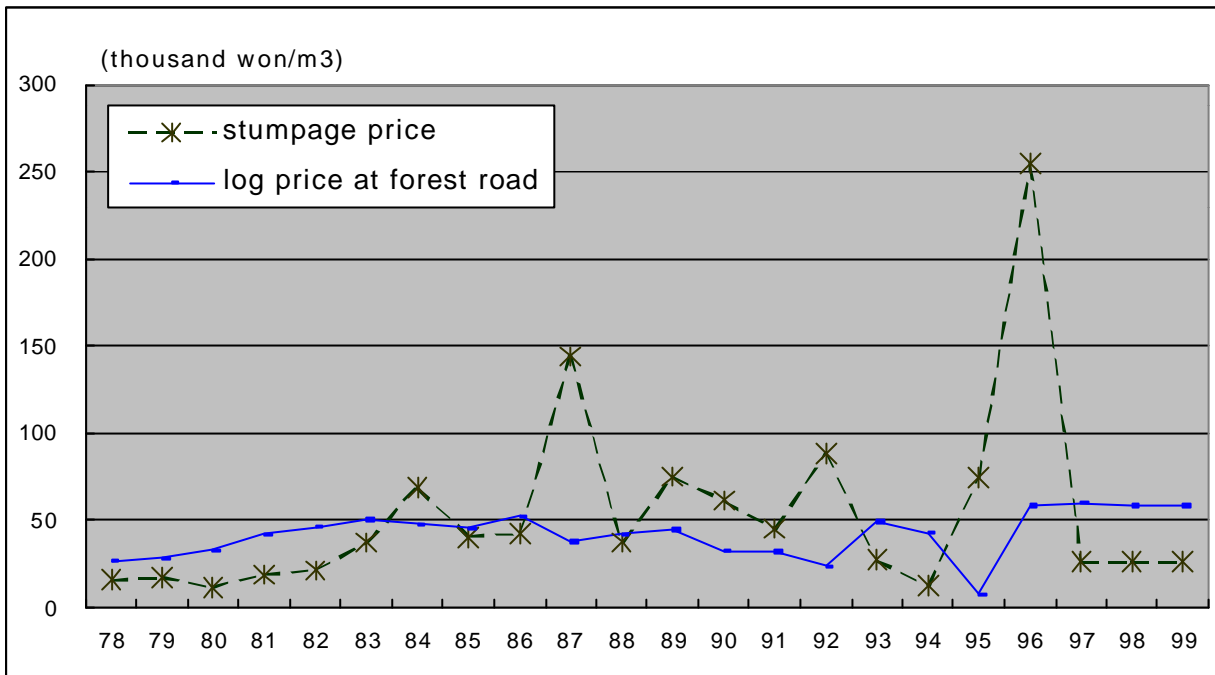
Among the stumpage permitted for harvesting, only 20 percent was from final harvests while the rest is from thinning, salvage harvests from stands damaged by insects and species conversion for stand improvement. The share of final harvest was 87 percent in 1985. The change in stumpage structure is largely due to the change in market demand for domestic timber. From the late 1980s, the demand for pit props declined sharply while the demand for domestic pulpwood has increased. The composition of domestic timber by usage is shown in Figure 3.

The demand for logs exceeds the supply potential from domestic forests in ROK. The excess demand is be met by imports from foreign suppliers. In 1997, the total demand for logs in ROK was 9,328,000 cubic meters while the domestic supply was only 1,062,000 cubic meters. The balance (8,266,000 cubic meters) was imported. The trend in log supply is shown in Figure 4.

The source of imported logs has changed remarkably over the last twenty years. In 1978, Indonesia supplied 54.7 percent of total logs imported into ROK while New Zealand supplied 41.5 percent of total log imports. The most prominent feature is the substitution of tropical hardwood with radiata pine logs from New Zealand and Chile. (See Table 3) The most powerful factor in the change in Korean log market was the relative price of logs. For example, the relative price of Malaysian tropical hardwood to New Zealand pine logs was 0.59 in 1977 while it had risen to 2.53 in 1997.

The end-use of logs has changed dramatically over the last three decades. In 1967, logs for plywood to be exported accounted 43 percent of total logs consumed while sawlogs for domestic construction accounted for more than 60 percent in 1997.

Figure 2. Stumpage price of national forests for the last two decades



Source: Forestry Administration

Figure 3. Timber supplied from domestic forests by usage (unit: thousand m³)

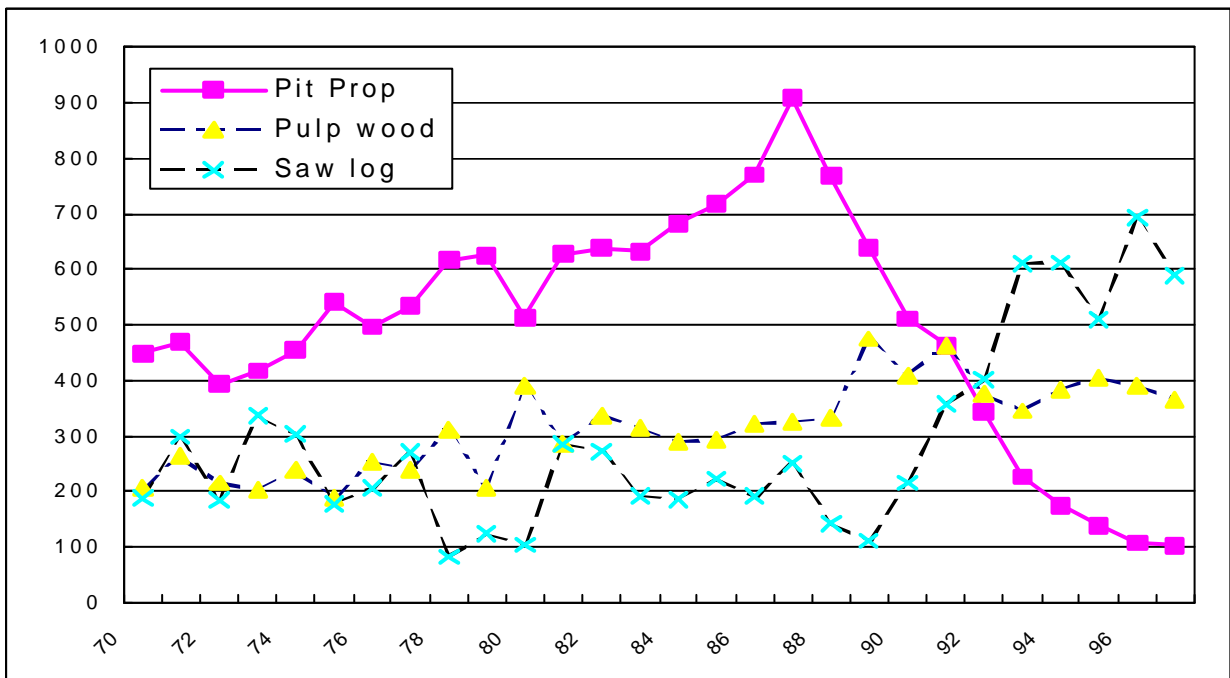
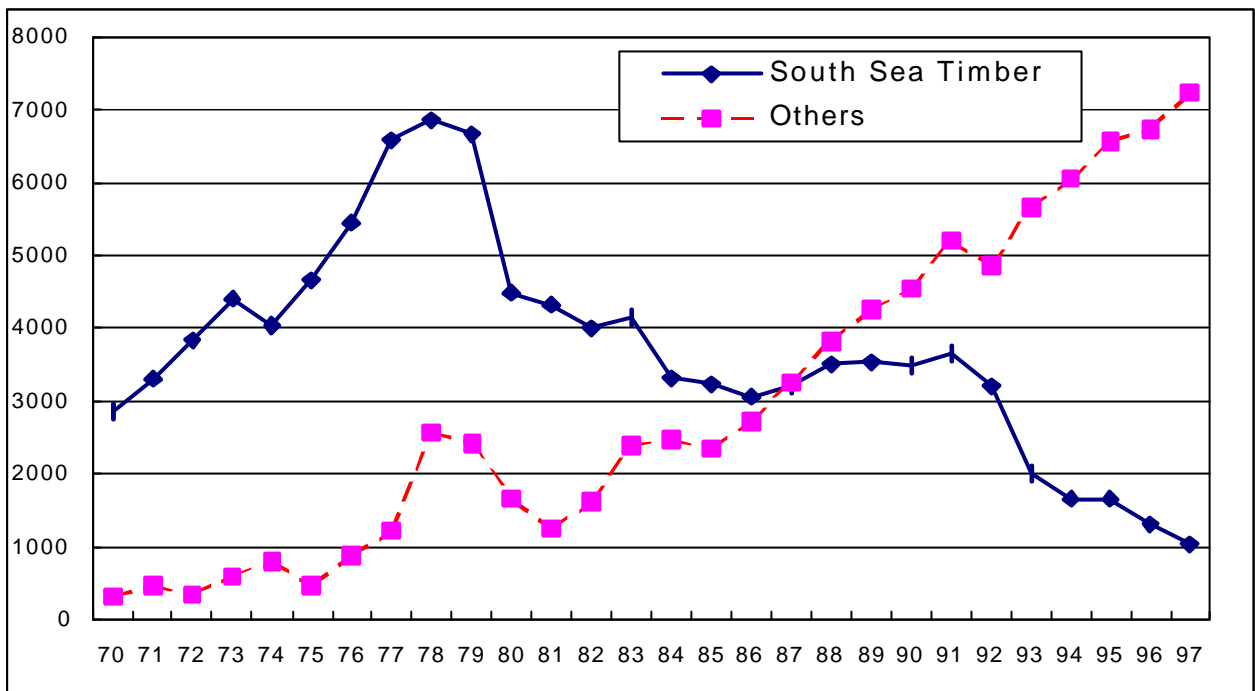


Figure 4. Imported logs by source of supply (unit: thousand m³)



1.1.4 Processed timber (lumber, plywood, pulp and paper)

The number of sawmills and lumber production capacity has declined remarkably in the last decades as the international competitiveness has eroded due to increased wages and shortages of raw materials supply. There were 936 sawmills with production capacity for about 6.5 million cubic meters of logs in 1996 while there were over 2,000 sawmills with capacity of 7.7 million cubic meters of logs in 1985. The lumber production in 1995 was 3.440 million cubic meters, with a 72 percent capacity utilization ratio. The demand for lumber exceeded the domestic production by 985,000 cubic meters in 1997, which was filled by imports. Only 20,000 cubic meters of lumber were exported in 1997 compared to 376,000 cubic meters in 1980.

The utilization of waste wood from sawmills increased remarkably in recent years as the medium density fiberboard (MDF) mills increased their production capacity. However, the declining competitiveness of Korean sawmills worries the MDF mills.

Plywood industry has also declined in the recent years, as its international competitiveness becomes weak. The number of plywood mills saw its peak with 88 in 1985 and decreased to 7 in 1997. The type of plywood produced by domestic mills has evolved into a few very specialized products such as thick plywood for container flooring and concrete framework, from thin plywood for furniture manufacturing in the early period. The production capacity accordingly followed the trend in number of mills. Table 3 shows the production capacity and level of plywood production.

The export of plywood has declined steadily from the peak in 1977. (See Table 4) As a result of the declining competitiveness of the Korean plywood industry, imported plywood has gained in market share in the last decade. In 1997, the imported plywood captured 48.3 percent of the Korean plywood market. Indonesia has been the biggest exporter to the Korean plywood market followed by Malaysia.

The demand for plywood in the domestic market has steadily increased due to the growth of the construction sector and the number of households. The construction sector accounts for 35.7 percent of plywood consumption while furniture manufacturing accounts for 37.2 percent. The growth of plywood consumption would have been larger if MDF and particleboard manufacturing industries have not penetrated the plywood market. The production capacity of MDF alone is equal to that of plywood.

Table 3. Plywood production and production capacity in ROK (Unit : m³)

	1970	1975	1980	1985	1990	1995	1996	1997
Production	1,067,261	1,808,621	1,574,930	1,227,213	1,123,625	974,237	895,979	1,014,054
Capacity	1,449,275	2,425,864	2,516,908	2,408,770	1,329,371	1,031,871	991,000	1,032,000

Source: Forestry Administration

Table 4. Export and import of plywood (unit: thousand m³)

	1970	1975	1980	1985	1990	1995	1996	1997
Export	1,055	1,304	953	127	76	104	89	44
Import	-	-	23.0	11.0	735.0	1,307	1,081	970

Source : Forestry Administration

There are three kinds of pulp mills in ROK; namely four ground wood pulp mills, a thermo-mechanical pulp mill, and a chemical mill. The production capacity has increased from 35,600 tons in 1960 to 852,000 tons in 1997. The chemical pulp mill with production capacity of 400,000 tons per year consumes mainly hardwood chips while the other mills consume pine logs and chips. The domestic pulp mills supplied only 22.7 percent of total pulp requirement in the Korean paper industry in 1997. Pulp imported from overseas in 1997 was 1.981 million tons, of which 1.798 tons was chemical pulp (FAO 1999). The source of pulp imported includes USA, Canada, Indonesia, Brazil, Chile and New Zealand. The Korean paper industry relies heavily on recycled paper for its raw material supply. The ratio of recycled paper in the paper supply has grown from 35.1 percent in 1970 to 69.3 percent in 1997. The relative price again played a critical role in the substitution between virgin pulp and recycled paper (Youn, 1988). The domestic supply of recycled paper accounts about three quarters of the total requirement while the balance is imported. The main source of recycled paper imports is United States, which accounted for more than 90 percent in 1995. Table 5 shows the structure of raw material markets for the Korean paper industry.

The Korean paper industry has experienced extraordinary growth over the last four decades. The production of paper and paperboard increased to 7.75 million tons in 1998 from 54,825 metric tons in 1960. The growth rate of paper and paperboard production in ROK was 14 percent per year over the last four decades. The growth was based on the population and economic growth of the nation, which experienced a rapid growth of economy with doubled population over the last four decades.

Table 5. Supply of raw materials for Korean paper industry (unit: metric ton)

	1970	1975	1980	1985	1990	1995	1996
Pulp	239,695 (65.1%)	325,250 (45.6%)	620,264 (36.7%)	834,611 (35.5%)	1,457,612 (30.4%)	2,218,158 (31.0%)	2,526,447 (31.9%)
Wastepaper	128,748 (34.9%)	388,542 (54.4%)	1,071,964 (53.3%)	1,518,459 (54.5%)	3,342,121 (69.6%)	4,945,323 (69.0%)	5,391,306 (68.1%)

1.2 KOREAN POLICY CHANGES

1.2.1 Forest management policy

The social unrest during and just after the Second World War and the Korean War caused the forest resources to be unregulated and over exploited. Thereafter, the forest management policy in ROK has been focused on rehabilitation and reforestation of damaged forest ecosystems coupled with tight protection measures. Since the early 1960s, total planted area approaches about 4 million ha while about one half has failed to become plantations.

Major species planted include pine (*Pinus koreansis*, *Pinus rigida*), larch (*Larix leptolepis*), poplars (*Populus euroamericana*, *Populus alba x grandulosa*), black locust (*Robinia pseudo-acacia*), and chestnut (*Castanea crenata*). The hardwood species are fast growing species planted for rehabilitation and fiber production while pine and larch are planted for long term rotations. The coniferous species have been planted heavily except during two periods, one prior to 1968 and one in the middle of the

1970s when fast growing species were given higher priority.

The government has been the key player in forestry investment in ROK. It provides subsidies to forest owners for planting trees and improvement of forest stands. The rationale for providing subsidies to forestry activities is mainly based on the public benefits of forestry to the society in general. Activities in forestry which are eligible for subsidy include tree planting, pruning, thinning, and construction of forest roads and recreational facilities within forested areas. The income of forestry is specially treated in tax law such that forestry income can be deferred until harvest time.

The road building in forested areas started in the 1980s as a strategic measure for improving the forest management environment. The forest road density has increased from nearly nil in 1980 to 1.9m per ha. The national forests have 2.5m of forest roads per ha while non-national forests have 1.7m per ha on average. The national government has a plan of lengthening forest roads until the density reaches 10 m per ha by 2030.

Timber harvesting have been strictly regulated by the authorities according to forest and environmental laws in ROK. Every forest has been managed based on a forest management plan, which is approved by the authorities. From this year, due to the new government's policy of freeing the governmental regulations in business, the forest management plan becomes not mandatory but optional. It is expected to see more timber harvesting sites near roads from next year. Since the public interests in environmental functions of forests are increasing, the conflicts between timber-oriented forestry sector and environmental conservationists could appear more often in the future.

1.2.2 Forest Industry Policy

The Korean forest industries largely rely on the forest resources overseas as the domestic forest resources are at the early stage of development. The logging industries are composed of small harvesters who operate only seasonally during the autumn and winter. They do not have a coordinated channel to express their views to the forest policy decision making of government while there is a growing citizen's movement against logging in the natural forests near urban areas and scenic view points. However, thinning of planted stands is promoted both by the government and non-governmental organizations.

Most of Korean saw mills process mainly imported logs while some small ones located near forest areas process domestic logs. The saw mills processing domestic logs receive more policy attention than those processing imported logs. There is a growing demand for wooden housing though the magnitude is still limited.

The international competitiveness of the Korean plywood industry has eroded since early 1980s. The major factor affecting the competitiveness of the Korean plywood industry is the cost of raw material supply. The log producing countries' policies, which restrict log export and promote production of plywood domestically, and international environmental politics against tropical deforestation have raised the price of tropical hardwood logs. The Korean government has been supporting the plywood industry to substitute tropical hardwood with softwood logs for their raw material supply. In 1999, Korean plywood manufacturers supplied about 40 percent of plywood raw materials with softwood logs, which were nearly nil until late 1980s.

The environmental policy has become more concerned of reducing wastes and recycling resources since the UN Conference on Environment and Development (UNCED) in 1992. The use of wooden chopsticks in the restaurants was condemned while recycled paper was collected more for re-use in paper-making.

The timber or forest certification is not yet discussed in the public while only academia investigates the implication on the forest-based industries if it is introduced.

As income and leisure time become larger, the number of visitors to forested areas is increasing. There are 20 national parks and 67 recreational forests, which are major destinations of forest recreationists. The number of visitors to national parks saw its peak in the early 1990s while visitors to recreation forests are growing continuously. Table 6 shows the trends of forest recreation in Korea. The government provides subsidies to forest owners who develop a recreational forest in order to internalize the social benefits of forest recreation. In the recent years there are growing numbers of people participating in ecotour trips involving forest areas.

Table 6. Trend in forest recreation in ROK

	1989	1990	1991	1992	1993	1994	1995	1996
Number of recreational forests	4	8	14	21	31	37	52	53
Number of visitors (1000 persons)	44	624	815	1,025	1,170	1,461	2,079	2,471

Source : Forestry Research Institute

The government holds the production of non-wood forest products, such as mushroom and chestnuts at as high priority of its forest policy since local forest villagers can make earnings out of forests from these non-wood products. The production of bed-logs for mushrooms is promoted while the pest control for chestnut plantations is given high priority.

1.2.3 Timber trade policy

Since joining the World Trade Organization, the ROK government has been reducing trade barriers. The tariff rates of forest products imported have been declining as shown in Table 7. As a result of the reduction of tariffs, a large part of Korean forest products markets have been captured by foreign suppliers. The case of plywood market is one of the most well known examples.

The government has shown its interests in supporting forest related industries which can utilize domestic forest resources. The forestry associations are usually given priority as recipients of governmental financial support.

1.2.4 An Overview of the Korean Timber Market

The major end-users of timber in Korea are construction and furniture industries. Therefore, the level of demand for timber is heavily influenced by the performance of these sectors. In recent times the demand for composite wood-based panels such as medium density fiberboard has increased due to the development of new applications of these products in construction and furniture manufacturing. Since 1990 the demand for timber has increased steadily until 1997 when the Korean economy crumbled.

According to the official forestry statistics of the Korean government, the consumption of timber products has grown from 22,275,000 cubic meters in roundwood equivalent measure to 27,404,000 cubic meters in 1996. The number decreased a little bit to 26,452,000 cubic meters in 1997. (see Figure 4) This is equivalent to a growth rate of 3.9 percent per year for the 1992-97 period. On the other hand, the domestic production of timber has not increased for the same period, remaining at the level of about 1.1 million cubic meters per year. Thus the self-sufficiency in timber products has been declining from 6 percent in 1992 to 4 percent in 1996 and 1997. This means that the Korean timber market is dominated by imported timber and heavily influenced by conditions in international timber markets. As of 1995, the total amount of domestic timber consumed was 1,335,000 cubic meters. (Note that there is a discrepancy between the amount produced and amount consumed of domestic timber: The figure in consumption was calculated from the statistics of timber-based products while the statistics of domestic timber production is the one reported by the government). The largest amount of domestic timber (29.2 percent) was used for pulp, followed by construction (25.0 percent), chips for wood-based panels (13.8 percent), mushroom bed-logs (12.0 percent), and pit-props (9.7 percent), in descending order. Among these end-use sectors, only the construction sector consumes sawlogs while the others use pulp logs. In the case of imported timber, out of the total amount consumed (14,697,000 cubic meters in roundwood equivalent volume in 1995), the construction sector consumed the largest amount (62.5 percent), followed by furniture manufacturers (21.9 percent), and packaging (5.8 percent). One of noticeable trends in timber consumption in Korea is that the share of processed wood is increasing in the consumption of wood by the construction sector.

Table 7. Tariff rates of wood products imported into ROK over the last two decades(Unit : %)

Item	1980	1988	1989	1990	1991	1992	1993-97	1998	1999
Log (excl. tropical logs)	5-10	5	2	2	2	2	2	2	2
Tropical logs	5-20	5	1.5	1.5	2	2	2	1	1
Sawnwood	20-30	20	10	10	9	7	5	5	5
Veneer	30	20	10	10	9	7	5	5	5
Processed wood (excl. plywood)	30	20	15	13	11	9	8	8	8
Plywood	30	20	20	15	11	9	8	8	2
Pulp	10	5	2	2	2	2	2	2	2
Recovered paper	10	5	2	2	2	2	2	2	2
Paper and paperboard	20-40	20	15	13	11	9	8	8	8

Source: Customs Office (ROK). Tariff schedules of Korea 1980, 1988, 1989, 1998, 1999.

Figure 5. The trend of timber consumption (roundwood equivalent)

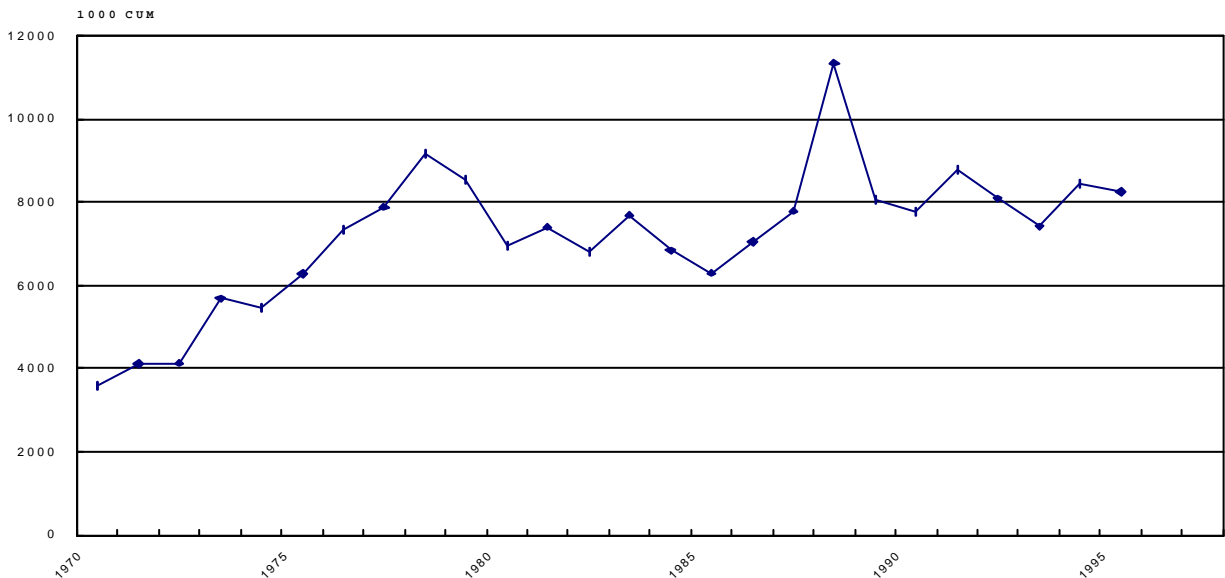


Table 8. Timber consumption and supply by category 1992-1997 (unit: thousand m³)

Category	1992	1993	1994	1995	1996	1997
Total consumption	22,275	26,648	24,178	25,325	27,404	26,452
As logs	9,182	8,832	8,883	9,284	9,225	9,328
Domestic logs	1,123	1,184	1,173	1,055	1,195	1,062
Imported logs	8,861	7,648	7,710	8,229	8,030	8,266
Imported processed timber	12,138	15,816	15,295	16,041	18,179	17,124
Self-sufficiency in timber (%)	6(12)	5(13)	5(13)	4(11)	4(13)	4(11)

Note: the figure in parenthesis is self-sufficiency in roundwood.

Source : Forestry Administration.

In the five years since 1992, the trend emerged of restrictions against the timber production in major timber producing countries. This was echoed by a new trend in Korean timber importation; that is, import of tropical roundwood has been declining while that of processed tropical wood and softwood logs is increasing. The import of roundwood has been declining while that of processed wood is increasing as shown in Table 9. Especially, the import of sawnwood is increasing at a rapid rate reflecting the declining international competitiveness of Korean sawmill industry.

The reasons for declining import of tropical hardwood logs are also similar to the case of sawlogs. The Korean plywood industry has substituted a part of its traditional raw material - tropical hardwood logs with softwood logs imported as a reaction to the uncertain supply potential of tropical hardwood logs due to international environmental pressures. Among the imported tropical hardwood logs, two species of Malas and Kerueing constitute more than 60 percent while in the case of softwood logs radiata pine from New Zealand and Chile constitute 58.5 percent in 1995.

2 ECONOMETRIC STUDY

2.1 SURVEY OF KOREAN TIMBER MODELS

Although the study of econometric analysis of timber markets started in the mid-1970s in Korea, most studies so far have been confined to forecasting the long-term demand for timber. In most cases, the purpose of such studies was to assist the long-term investment planning by the Government which is concerned with a secure timber supply in the future.

The studies on supply of timber in Korea have been in two directions: one is only concerned with the biological potential of timber supply and the other econometric estimation of supply functions of domestic timber. The supply side of the timber market has been less analyzed relative to the demand side. This may be due to the fact that the amount of domestic timber production is small and has been regulated by the Government. The fragmented ownership of Korean forestlands has probably also been a limiting factor for studies on the supply side.

Oh and Lee (1980) estimated the biological potential of timber supply from domestic forests by applying an *a priori* factor (1% of growing stock) to the total growing stock estimated based on yield tables. Lee and Youn (1992) estimated the biological timber supply potential from national forests in the next 50 years by applying policy scenarios of rotation ages and harvesting ratios. However the estimates can hardly match the actual harvest levels of national forests which are determined not only by the government's policy, but also by the prevailing market conditions. Yum (1993) estimated the domestic timber supply function by assuming that the elasticity of timber supply with respect to growing stock is

Table 9. Trend of Korean log imports by source (Unit: thousand m³)

		1970	1975	1980	1985	1990	1995	1996	1997
Hardwood	Sub-total	2,852	4,661	4,486	3,228	3,483	1,656	1,302	1,028
	Philippines	888	264	82	67	-	-	-	-
	Malaysia	1,487	1,628	2,474	2,308	2,912	656	495	376
	PNG	-	-	133	841	571	997	802	650
	Indonesia	477	2,769	1,817	12	-	3	5	2
Softwood	Sub-total	303	458	1,655	2,350	4,550	6,573	6,728	7,238
	USA	236	448	1,043	1,494	2,971	803	794	754
	New Zealand	56	-	185	99	1,290	3,003	3,225	3,417
	Others	11	10	427	757	541	2,767	2,709	3,067
Total		3,155	5,119	6,141	5,578	8,285	8,229	8,030	8,266

Source: Customs Administration

1%. It is a rather unrealistic assumption since the forest growing stock is composed mainly of small diameter trees less than 30 years in age.

As mentioned, there have been more studies on the demand for timber in Korea compared to those on supply. In most cases demand studies aimed to forecast timber demand in the future by end-use sector. Kim et al (1980) and Cho et al (1989) are typical timber demand studies, utilizing time series to estimate aggregate timber demand. Youn and Kim (1992) first divided the timber market by species -- softwood and hardwood. They utilized dummy variables to improve regression results. Seok and Jang (1992) applied a time-series analysis called Box-Cox parametric transformation in timber demand forecasting. Jun Sun Kim (1998) assumed that the prices of previous periods would affect the demand for timber in the current period. Perez-Garcia and Joo (1990) analyzed the impact on Japanese and Korean timber markets of changes in North American forest policies. In their study, they argued that the restrictions of logging in the Pacific Northwest would increase the harvesting costs in the region and thus the timber harvest in other regions. Joo and Lee (1998) developed an econometric model composed of a system of equations, which was applied to estimate the impact of changes in international financial markets on the Korean timber market.

2.2 MODELING OF KOREAN TIMBER DEMAND AND SUPPLY

2.2.1 Theoretical framework

Timber is consumed as an input to various sectors of industrial production, such as construction and furniture manufacturing in Korea. Thus, the demand for timber should be basically understood as a derived demand of general economic activities. This leads the theoretical model as specified below”

$$Q_d = f(P, GDP)$$

where Q_d is the quantity of timber demanded at the price conditions (P) and the level of economic activity represented by gross domestic product (GDP). The price conditions include the price of timber as well as of other goods.

The supply of timber is divided into two sources: domestic and foreign. The quantity of domestic timber supplied is assumed to be a function of domestic timber price and the level of growing stock 31 years old and more. Domestic timber is assumed to be a perfect substitute for imported timber. The supply of timber from abroad is assumed to be perfectly elastic, considering Korea's share of imported timber in the international timber markets not to be significant. So the supply of domestic timber is assumed to be a function of international timber prices and levels of growing stock; namely

$$Q_s = f(P, GS30)$$

where Q is the quantity of domestic timber (roundwood) supplied in the given year and $GS30$ is the growing stock over 30 years old.

2.2.2 Methods

Korean domestic demand and supply cannot affect the market price, which is usually determined in the international market and is accepted by importers in Korea, which has an open economy. The demand and supply of commodities can be estimated using the ordinary least squares method. The model was employed to estimate the supply of logs from domestic forests and timber processing industries and the demand for processed timber. The demand for logs is driven from the supply function of processed timber, i.e. lumber, plywood and other wood-based panels, and pulp.

The model was used to simulate the effects of domestic forest resource policy and international environmental policy on the Korean forest sector. The simulation was based on the following scenario: First, the Korean Government will maintain its forest conservation policy of restricting the harvest at the current level; second, the international hardwood price will increase at the rate of 1 percent per year while the softwood timber price will remain at the current level; third economic growth will continue at the rate of 4 percent a year until 2015, with exception of a decrease of 5.3 percent in 1998.

2.2.3 Data

To analyze the market structure, yearly time series data were used for the period 1970-97. The round-wood equivalent volumes were calculated by applying yield factors to the level of outputs such as lumber and wood-based panels (0.6 for plywood and fiberboard, 0.65 for particleboard, and 0.58 for medium density fiberboard). The consumption of pit props and pulpwood were treated as exogenous due to the limited number of buyers who have not paid enough attention to the prices of logs. Because the amount of softwood roundwood consumed for plywood manufacturing is small and unknown to the public, so it was not accounted in this study.

The data on production of domestic timber were classified by species using the official harvest reports by the Forestry Administration. Among the general use category which does not distinguish the species, 82 percent was assumed as coniferous and the rest hardwood. The growing stock of mixed forests was divided into coniferous and hardwood by simply assuming 63.5 percent to be coniferous. The prices of timber were calculated by dividing the total value of timber import by the total amount, by species. The current prices were deflated by a producers' price index to obtain real prices.

Dummies were created for a period when the market was affected by an unusual factor. The year 1988 was the year of Olympic Games in Korea, which affected the construction and labor market in the year and the following year. The period 1976-80 was when the Korean plywood industry exported their products in large quantity. The period 1978-80 was when the Korean economy in general was affected by external and internal influences such as oil crisis and political disruptions.

2.3 ESTIMATION RESULTS AND DISCUSSION

2.3.1 Estimation of Equations

The equations were estimated using a log-log form, which allows us to find the elasticities of demand and supply with respect to prices, GDP and growing stocks. The equations were estimated by ordinary least squares regression method, assuming that both Korean timber consumers and producers are price-takers in international timber markets. All signs in the equations estimated are as expected. Table 3 shows the results of regression estimation.

2.3.2 Discussion

As shown by the international prices of timber in Figure 6, the rises and falls of timber prices are closely related to the changes in forest policies in major producing countries and international energy prices. The first two peaks in price of coniferous timber imported from North America reflect the first and second oil crises while the later ones in the 1990s are due to the restriction of logging in the Pacific Northwest affected by the emergence of the biodiversity conservation movement. The price of tropical hardwood has been steadily increasing since the early 1990s due to the dwindling timber supply affected by tropical rainforest conservation movement.

The price increase of North American softwood has caused Korean timber consumers to substitute North American timber with radiata pine from New Zealand and Chile. The demand for radiata pine has been increased partly by substitution of hardwood in plywood manufacturing with softwood. This means that the international environmental policy for protecting tropical forests has been affecting the Korean timber market. Global environmental policy has favored the consumption of softwoods rather than hardwoods, at least in Korea.

The equation coefficients of log-log functional form can be useful in providing the magnitude of responsiveness of demand and supply with respect to the independent variables. The coefficients estimated from the log-log form equations are summarized in Table 10 below. According to the coefficients, the demand for timber in Korean log markets is not elastic with respect to its own price and economic activity. The demand for coniferous logs is more responsive to its own price and economic activity than that of non-coniferous logs. The supply of roundwood from domestic forests is elastic with respect to price. The level of inventory of over-30 years old stands is influential to the domestic supply of coniferous logs, but not very much in the case of non-coniferous log supply.

Table 10. Estimated equations of timber demand and supply functions

[1] Demand for coniferous timber (log equivalent)

$$\ln QDC = 4.3896 - 0.4045 \ln(RPC) + 0.5504 \ln(GDP) + 0.6488 D88$$

$$(1.8065) \quad (-1.5428) \quad (-7.2828) \quad (3.6452)$$

$$R^2 = 0.8695 \quad \bar{R}^2 = 0.8518 \quad D - W = 0.5317$$

[2] Demand for non-coniferous timber (log equivalent)

$$\ln QDNC = 6.1442 - 0.2571 \ln RPNC + 0.2469 \ln RPC + 0.1875 \ln GDP + 0.3688 D7680$$

$$(3.1700) \quad (-1.3756) \quad (0.8984) \quad (2.4081) \quad (5.5103)$$

$$R^2 = 0.6133 \quad \bar{R}^2 = 0.5397 \quad D - W = 1.4910$$

[3] Supply of domestic coniferous logs

$$\ln QSDC = -18.2891 + 1.3846 \ln RPC + 0.8514 \ln IC - 0.4855 D7880 - 0.9334 D8889$$

$$(-377515) \quad (3.31925) \quad (5.5308) \quad (-2.0199) \quad (-4.3243)$$

$$R^2 = 0.7572 \quad \bar{R}^2 = 0.7131 \quad D - W = 1.3883$$

[4] Supply of domestic non-coniferous logs

$$\ln QSDNC = -7.8922 + 1.3972 \ln RPNC + 0.1422 \ln INC - 0.9046 D7880 - 0.7656 D8889$$

$$(-4.7061) \quad (6.8753) \quad (1.5549) \quad (-5.2680) \quad (-4.4421)$$

$$R^2 = 0.8469 \quad \bar{R}^2 = 0.8191 \quad D - W = 1.4044$$

QDC: coniferous consumed (log equivalent)

RPC: price of coniferous logs imported

QDNC: non-coniferous consumed (log equivalent)

RPNC: price of coniferous logs imported

QSDC: domestic coniferous logs supplied

IC: coniferous inventory over 30 yr

QSDNC: domestic non-coniferous logs supplied

INC: non-coniferous inventory over 30 yr

GDP: gross domestic product

D88: dummy for year 1988

D7680: dummy for the period 1976-80

D7880: dummy for the period 1978-80

D8889: dummy for the period 1988-89.

Figure 6. The trend of real prices of softwood and hardwood (unit: won in 1990)

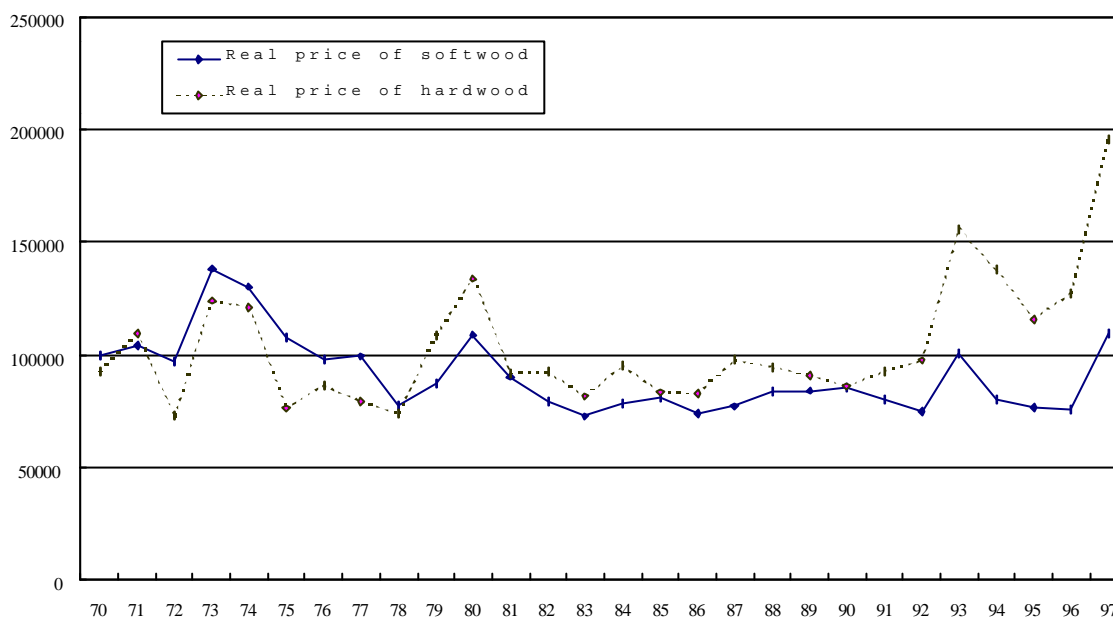


Table 11. Elasticities of timber demand and supply with respect to each variable

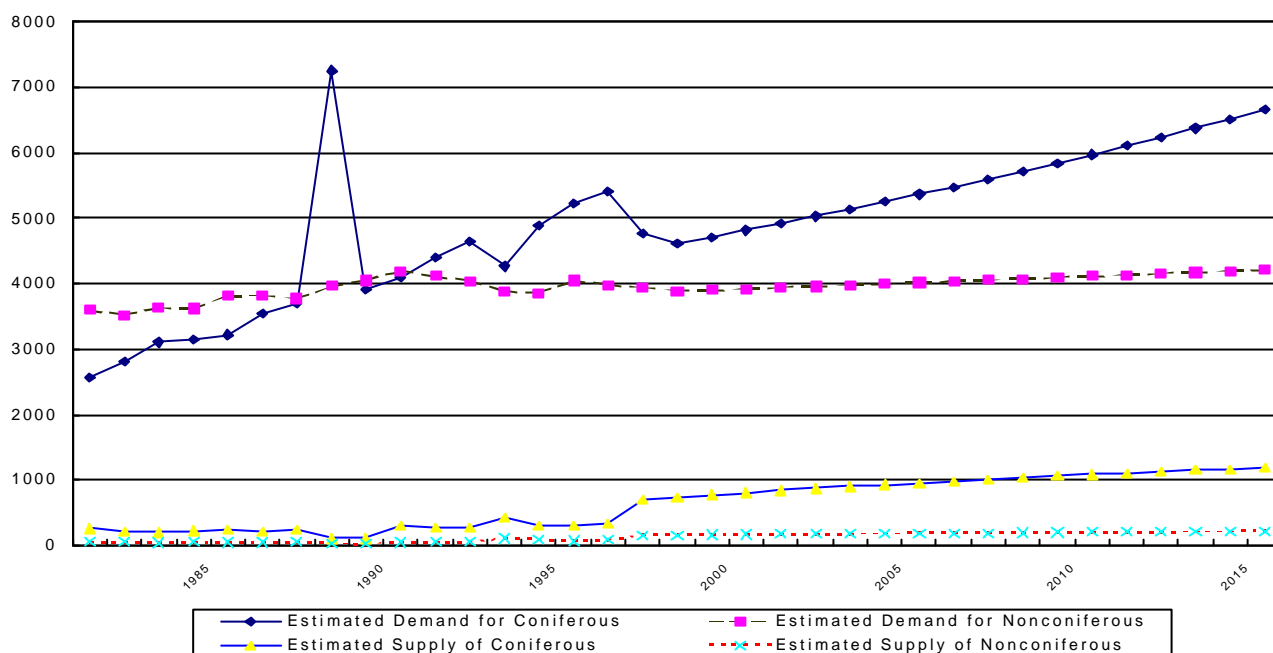
	Price of coniferous logs	Price of Non-coniferous logs	GDP	Inventory coniferous	Inventory non-coniferous
Demand for Coniferous logs	-0.4045		0.5504		
Supply of Coniferous logs	1.3846			0.8514	
Demand for non-coniferous logs		-0.2571	0.2469		
Supply of non-coniferous logs		1.3972			0.1422

2.4 SIMULATION OF FOREST RESOURCES AND TIMBER TRADE IN KOREA

Korea is a net timber importer due to its low productivity of forestlands and the distribution of forest stands skewed toward its younger generations, even though 65 percent of her land is covered with forests. It is very important that the country pays its attention to any changes in international timber markets in order to be responsive to the changes.

A model was used to predict the future demand and supply of roundwood in ROK based on the scenario explained earlier. The result of scenario simulation shows that the consumption of coniferous roundwood will grow from 4,198,000 cubic meters in 1995 to 5,975,000 in 2010 and 6,656,000 in 2015. The consumption of non-coniferous roundwood is predicted to increase slightly from 4063 cubic meters in 1995 to 4113 cubic meters in 2010, and 4213 cubic meters in 2015. The domestic production of roundwood is expected to increase steadily, mostly from coniferous forests, even though the absolute amount is not much.

Figure 7. Projection of demand and supply of roundwood in Korea (unit: thousand m³)



The emergence of global environmental problems has been affecting forest policies of major timber countries such as the United States of America and Indonesia. Such changes in forest policies have been affecting the production and trade of forest products. One such change is the restriction of logging in the national and state-owned forests in the Pacific North West of the U.S. The pressure of environmentalists who wanted the protection of old growth forests resulted in a policy change to protect forests for biodiversity conservation. Changes in a national forest policy can affect the prices of international forest products markets. Since Korean forest product markets are to a large extent open to the international suppliers, the demand and supply of timber in Korea will be directly affected by changes in international environmental or forest policies.

2.5 CONCLUDING REMARKS

The changes in North American forest policy for biodiversity conservation reduced the supply of coniferous logs to the international market and it induced an increase in international coniferous log prices. The consumers in Korean log markets changed their source of log import from North America to New Zealand and Chile subsequently. The consumption of timber in Korea will continue to rise, while the domestic production of logs will likely increase slightly. Therefore, the supply of timber from foreign countries will continue to be important for Korea.

The import of tropical hardwood timber has been also affected by international environmental policy, which stressed the conservation of tropical forests. The conservation of tropical forests reduced the supply of tropical timber, raising the price. The relative (to that of softwood) price of tropical timber effectively reduced the demand of tropical timber in Korea and induced the increase of demand for softwood. The higher relative price of hardwood, which is considered to be the case in the coming decades, implies that the long-term forestry investment should be changed from the present softwood-oriented one to one for hardwood production.

This study has not paid enough attention to the potential of timber certification as an incentive for sustainable forest management. As being discussed in the international forest policy forums, the impact of timber certification systems on the timber market should be addressed in future studies.

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