Thai J. For. 17 : 105-117 (1998) วารสารวนศาสตร์ 17 : 105-117 (2541)

ECONOMETRICS MODEL FOR PLYWOOD IN THAILAND

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บทคัดย่อ

การศึกษาครั้งนี้มีวัตถุประสงค์เพื่อสร้างแบบจำลอง อุปสงค์ อุปทาน และราคาของไม้อัด ตลอดจนหาค่าความยืดหยุ่นของอุปสงค์ และอุปทานที่เกิดจากตัวแปรอิสระแต่ละตัวที่อยู่ในแต่ละฟังก์ชั่น และคาดคะเนแนวโน้มของอุปสงค์ อุปทานและราคาของไม้อัดในอนาคตของประเทศไทย ในการหาค่าสัมประสิทธิ์การถดถอยของโมเดลดังกล่าว ใช้วิธี Two stage least squares จากการศึกษาพบว่าตัวแปรที่มีผลต่ออุปสงค์ของไม้อัดคือราคาขายส่งเฉลี่ยของไม้อัดและราคาขายส่งเฉลี่ยของปูนซีเมนต์ผสม ตัวแปรที่มีผลต่ออุปทานของไม้อัดคือราคาขายส่งเฉลี่ยของไม้อัดในปีที่ผ่านมาและปริมาณนำเข้าไม้ท่อน และตัวแปรที่มีผลต่อราคาขายส่งเฉลี่ยของไม้อัดคือรายได้เฉลี่ยต่อคนและปริมาณความแตกต่างระหว่างอุปทานและอุปสงค์ในปีที่ผ่านมา ค่าสัมประสิทธิ์การตัดสินใจของอุปสงค์ อุปทานและราคาขายส่งเฉลี่ยของไม้อัดมีค่าเท่ากับ 0.848 0.809 และ 0.954 ตามลำดับ ค่าความยืดหยุ่นของอุปสงค์ อุปทานของไม้อัดที่เกิดจากการเปลี่ยนแปลงของราคามีค่าเท่ากับ 0.1713 และ 0.6404 ตามลำดับ จากการคาดคะเนแนวโน้มของอุปสงค์ อุปทานและราคาของไม้อัดในช่วงปี 2541-2450 พบว่ามีอัตราการเพิ่มขึ้นโดยเฉลี่ยเท่ากับ 11.32, 9.64 และ 5.89 เปอร์เซ็นต์ ตามลำดับ

ABSTRACT

The objectives of the study were to formulate a demand, supply, and price model of plywood; to determine the elasticities of demand and supply with respect to each exogenous variable included in the model; and to project price, production and consumption of plywood in Thailand. The regression coefficients of the models were estimated by a two stage least squares method. The study found that factors affecting the demand and supply of plywood were the average wholesale price of plywood and mixed cement; and the lag of one year of average wholesale price of plywood and quantity of imported logs, respectively. In addition, factors relating to the average wholesale price of plywood were the difference between the previous year production and consumption of plywood and per capita income. The coefficient of determination (R^2) of demand, supply and price of plywood were 0.848, 0.809 and 0.954 respectively. The elasticity of demand for plywood with respect to average wholesale prices of plywood and mixed cement were 0.1713 and 5.6395 respectively. The elasticity of supply of plywood with respect to lag of one year of average wholesale price of plywood and quantity of imported logs were 0.6404 and 0.3124 respectively. The projection of demand, supply, and average wholesale price of plywood for a ten year period (1998-

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2007) were carried out. The results of the projection show that the growth rate of demand, supply and price of plywood were 11.32, 9.64 and 5.89 percent, respectively.

INTRODUCTION

The present and future generations of the Thai people require wood products to satisfy a variety of needs. In 1990 the demand for industrial wood products was equivalent to about 20 million cubic meters of wood raw material. As both the population and the economy of the country continue to grow, and even allowing for substitution by other materials, the demand for wood products is expected to grow even more. The domestic wood-based industry is trying to meet the country's needs, but it is faced with a shortage of raw materials. (Royal Forest Department, 1993).

The plywood manufacturing process is unique in the sense that a highly variable raw material is manufactured into a product that is stronger and more versatile than the wood from the original tree. Table 1 shows the production and consumption of plywood annually for the years 1985 to 1997 inclusive. These data indicate the remarkable growth of this industry in 13 years. The highest, lowest, and average levels of plywood production were 278,000 m^3 in 1995 and 44,000 m^3 in 1986 and 145,925.07 m^3 respectively; while, plywood consumption was 371,700 m^3 in 1995, 17,400 m^3 in 1987, and 167,812.15 m^3 respectively. The production of plywood has been greater than consumption during the years 1985 to 1988, the surplus became 700 m^3 in 1985, and 34,100 m^3 in 1988. Plywood consumption has achieved a very rapid rate of growth, averaging 22.5 percent per annum, whereas plywood production increased by 11.7 percent per annum. The peak in the surplus of plywood was in 1987, with 52,600 m^3 surplus. However, since 1989 there has been a shortage of plywood, in 1996 the shortage was greatest with a deficit of 107,700 m^3. The plywood industry has been dependent on imported logs since the logging ban. In 1990 about 90% of the wood raw materials was procured by ship from Malaysia and overland from Myanmar (Royal Forest Department, 1993). Plywood is now used in structural components in buildings in competition with steel and concrete (FAO, 1983). About 75 % of the plywood consumed was used in construction, 20% in furniture manufacture, and 5% in other uses such as containers and advertising boards. (Royal Forest Department, 1993).

It is recognized that plywood always plays an important role in the Thai economy. Thus, the obtained econometric model as well as the projection of demand, supply and price of plywood would greatly facilitate sound decision making among the related entrepreneurs and government officers. In addition, this could be used as a guideline for formulating a Plywood Development Plan.

OBJECTIVES

1.To formulate demand, supply and price models of plywood in Thailand.

2.To determine elasticities of demand and supply.

3.To project price, production and consumption of plywood in Thailand.

METHODOLOGY

Data collection

The time series data for the period 1985-1997 was employed for formulating the demand, supply and price models of plywood. The information was gathered from various sources, namely, the Food and Agriculture Organization of the United Nations (FAO), Royal Forest Department, Department of Business Economics, Office of the National Economic and Social Development Board and Thai Plywood Company Limited.

Table 1. Production and consumption of plywood in Thailand, 1985-1997.

Year	Production (m^3)	Annual change (%)	Consumption (m^3)	Annual change (%)
1985	82,000	-	81,300	-
1986	44,000	-46.34	38,700	-52.40
1987	70,000	59.09	17,400	-55.04
1988	70,000	0.00	35,900	106.32
1989	70,000	0.00	74,000	106.13
1990	122,000	74.29	139,800	88.92
1991	164,000	34.43	184,900	45.51
1992	166,000	1.22	203,422	37.37
1993	260,000	56.63	279,436	-27.20
1994	220,000	-15.38	248,900	22.36
1995	278,000	26.36	371,700	49.34
1996	195,000	-29.86	302,700	-18.56
1997	156,000	-20.00	203,400	-32.80
Average	145,923.08	11.70	167,812.15	22.50

Source: (FAO, 1999)

Data analysis

An analysis of demand, supply and price of plywood were carried out in the form of aggregate models by using a two-stage least square method. The models were formulated by employing the hypothesis as follows.

$$QDA_t = f(X_{1t}, X_{2t}, X_{3t}, X_{4t}, X_{5t}, X_{6t}, X_{7t} X_{8t}, X_{9t})$$

$$QSA_t = f(X_{1t-1}, X_{10t}, X_{11t}, X_{12t}, X_{13t}, X_{14t}, X_{15t})$$

$$X_{1t} = f((QSA_{t-1} - QDA_{t-1}), X_{7t}, X_{10t})$$

where:

QDA_t = demand or consumption of plywood in year t (m^3)

QSA_t = supply or production of plywood in year t (m^3)

X_{1t} = average wholesale price of plywood in year t (baht / sheet)

X_{1t-1} = lag of one year of average wholesale price of plywood (baht / sheet)

X_{2t} = average price of lumber in year t (baht / ft^3)

X_{3t} = average mill price of fiberboard in year t (baht / cubic tons)

X_{4t} = average mill price of steel in year t (baht / cubic tons)

X_{5t} = average wholesale price of mixed cement in year t (baht / cubic tons)

X_{6t} = population in year t (million)

X_{7t} = per capita income in year t (baht)

X_{8t} = exportation value of furniture in year t (million baht)

X_{9t} = value of construction in year t (million baht)

X_{10t} = average price of imported logs in year t (baht / m^3)

X_{11t} = average wage rate in year t (baht /day)

X_{12t} = quantity of imported plywood in year t (m^3)

X_{13t} = quantity of exported plywood in year t (m^3)

X_{14t} = quantity of imported logs in year t (m^3)

X_{15t} = quantity of imported veneers in year t (m^3)

$(QSA_{t-1} - QDA_{t-1})$ = the difference between last year's production and consumption of plywood (m^3)

The regression coefficient estimation

Demand supply and price equations should be simultaneously determined because in the plywood market the seller does not only determine the equilibrium plywood prices but also by the consumer. Consequently, the quantity demanded and supplied also determines the price. Thus, demand supply and price equations should be combined as in the simultaneous equation system. In order to avoid the problem arising from the correlation between the explanatory endogenous variable and the error term, a two-stage least squares method was applied.

The procedure of the demand, supply and price of plywood analysis is shown below:

1. Demand of plywood model

$$QDA_t = a_0 + a_1X_{1t} + a_2X_{2t} + a_3X_{3t} + a_4X_{4t} + a_5X_{5t} + a_6X_{6t} + a_7X_{7t} + a_8X_{8t} + a_9X_{9t} + U_1 \quad (1)$$

2. Supply of plywood model

$$QSA_t = b_0 + b_1X_{1t-1} + b_2X_{10t} + b_3X_{11t} + b_4X_{12t} + b_5X_{13} + b_6X_{14t} + b_7X_{15t} + U_2 \quad (2)$$

3. Identities

$$QDA_t = QSA_t \quad (3)$$

4. Price of plywood model from model (1) and (2), since X_{1t} and X_{1t-1} are correlated with U_1 and U_2, the first stage is to regress X_{1t} as a function of the predetermined variables ($QSA_{t-1} - QDA_{t-1}$), X_{7t} and X_{10t} The implicit function will be :

$$X_{1t} = f((QSA_{t-1} - QDA_{t-1}), X_{7t}, X_{10t}) \quad (4)$$

The classical ordinary lest squares estimation will yield X_{1t} from equation (4). Some of the exogenous variables may be deleted from the plywood price model in order to obtain the best model that provide high significance of the regression coefficients, high value of R^2, no serial correlation, minimized mean square error and where the distribution of the error terms approach a normal distribution.

From this procedure the best plywood price model will be obtained. The estimated $\hat{X}_{1t}$ and $\hat{X}_{1t-1}$ are not correlated with U_1 and U_2, respectively. Therefore, the second stage, $\hat{X}_{1t}$ substituted for X_{1t} and $\hat{X}_{1t-1}$ for X_{1t-1} into model (1) and model (2), respectively. This will allow all the variables on the right side of the model to be uncorrelated with error terms in the model. Therefore, the demand and supply of plywood model becomes.

$$QDA_t = a_0 + a_1\hat{X}_{1t} + a_2X_{2t} + a_3X_{3t} + a_4X_{4t} + a_5X_{5t} + a_6X_{6t} + a_7X_{7t} + a_8X_{8t} + a_9X_{9t} + U_1 \quad (6)$$

$$QSA_t = b_0 + b_1\hat{X}_{1t-1} + b_2X_{10t} + b_3X_{11t} + b_4X_{12t} + b_5X_{13t} + b_6X_{14t} + b_7X_{15t} + U_2 \quad (7)$$

From the formulation of supply and demand for plywood models, some of the exogenous variables included in both models may be deleted by using the same procedure as the formulation of price model.

By the same procedure, the demand, supply and price of plywood will be formulated by SPSS 7.5 Windows program. In order to check the validity of the models, testing for serial correlation was carried out.

Testing for serial correlation

The Durbin-Watson test was used for testing the serial correlation. The null hypotheses of the Durbin-Watson test revealed that there was no autocorrelation among the error terms in the first-order condition. In other words, the null hypothesis revealed that r_a is equal to 0.

$$r_a = \frac{\sum_{t=2}^{n} \hat{U}_t \hat{U}_{t-1}}{\sqrt{\sum_{t=2}^{n} \hat{U}_t^2} \sqrt{\sum_{t=2}^{n} \hat{U}^2_{t-1}}}$$

The statistical test used was based on the following formula,

$$DW = \frac{\sum_{t=2}^{n} (\hat{U}_t - \hat{U}_{t-1})^2}{\sum_{t=1}^{n} \hat{U}_t^2}$$

where:

r_a = autocorrelation coefficient

DW = Durbin-Watson statistical test

U_t = the residuals from a fitted-least squares regression.

t = time variable (1, 2, 3,...,n)

Durbin and Watson have provided tables for testing the serial correlation. In this test, they set the lower and upper critical values d_L and d_U for various values of the number of independent variables k and sample size n. If $DW < d_L$, we reject the null hypotheses and accept the hypothesis of positive autocorrelation $r_a > 0$. If $DW > d_U$, we do not reject the null hypothesis. If $d_L < DW > d_U$, the test is inclusive. On the other hand, if $DW > 4 - d_L$, we reject the null hypothesis and accept the hypothesis at negative autocorrelation.

If $DW < 4 - d_U$, we do not reject the null hypothesis. If $4 - d_U < DW < 4 - d_L$, the rest is inconclusive.

Estimates of point elasticities of demand and supply

The plywood demand model was used to estimate the average point elasticities of demand for plywood, it is expressed as follows:

$$E_{ii} = \partial Q_{id}/\partial P_i \cdot P_i/Q_{id}$$

where:

E_{ii} = own price elasticity of demand

Q_{id} = quantity of demand

P_I = price of commodity I

Projection equation

The estimated demand, supply and price model will be used for projecting the demand, supply and price of aggregate plywood. Before projection of consumption, production, and price of plywood were made, forecasts of future values of exogenous variables included in each model had to be obtained. The principle procedure used was to examine past trends of exogenous variables plotted against time, and to extrapolate any stable trend observed. Lines were fitted by the ordinary least square method using data for the period 1985-1997. The period of projection will start from 1998-2007. The time trend models to be used for estimating the future value of independent variables including in aggregate demand, supply and price model are presented to as follows.

$$X = f(T)$$

where:

X = independent variable included in aggregate demand, supply and price model

T = time variable (1985 =1, 1986 = 2, 1987 = 3,..., 1997 = 13)

The models were valid enough to be used for projecting the demand, supply, and price of plywood.

RESULTS AND DISCUSSION

Demand of plywood

The aggregate demand model of plywood is in natural log forms. The structural coefficients of demand equation are estimated by a two-stage least square method. The results show that demand for plywood is a function of average wholesales price of plywood (X_{1t}), and average wholesale price of mixed cement (X_{5t}) (Table 2). The model shows that, the regression coefficient of variable X_{5t} was significant at the 1 percent level, while the regression coefficient of variable X_{1t}, was not significant at the 10 percent level. The coefficient of variable X_{1t} was positive, which means that when the average wholesale price of plywood increased the demand for plywood also increased. This is mainly due to the fact that the capacity of plywood production in Thailand was limited

and there is no other construction material, that is suitable as a substitute for plywood. The coefficient of variable X_{5t} was positive, which means that when the average wholesales price of cement increases it will cause the quantity of plywood consumption to increase.

R^2 is 0.848, which indicates that the deviation of the dependent variable (QDA_t) from 1985-1997 can be explained by the explanatory variables (X_{1t}, and X_{5t}), at about 84.8 percent.

From the serial correlation test, the computed DW and autocorrelation coefficient (r_a) was 1.602 and 0.107, respectively. The upper critical value (d_u) from the Durbin-Watson table, which corresponded to 2 explanatory variables, based on 13 observations at a 5 percent level of significance was 1.562. DW $>d_u$ in the case of the autocorrelation coefficient was positive indicating that there is no autocorrelation among the error terms in the first order condition or the autocorrelation coefficient was equal to zero ($r_a = 0$).

Table 2. Estimated regression coefficient of aggregate demand of plywood in Thailand, 1985-1997.

Independent variable	Constant term	Coefficient	SE	t-ratio	F	R^2	DW	r_a
	5.09188609		0.9195	5.538***	27.990***	0.848	1.602	0.107
$\ln X_{1t}$		0.17126498	0.3078	0.556ns				
X_{5t}		0.00478921	0.0014	3.326***				

*** = Significant at 1 percent
ns = Not significant at 10 percent
SE = Standard error of estimate
R^2 = Coefficient of determination
DW = Durbin-Watson statistical test value
r_a = Autocorrelation coefficient

Estimated equation:

$$LnQDAt = 5.09188609 + 0.17126498(\ln X_{1t}) + 0.00478921(X_{5t})$$

Supply of plywood

The aggregate supply model of plywood is in natural log forms. It is in linear form with two-stage least squares. The final results of the structural coefficients are given in Table 3. This shows that the supply of plywood was a function of the lagged average wholesale price of plywood (X_{1t-1}), and the quantity of imported logs (X_{14t}). In the model, the regression coefficients of X_{14t} and X_{1t-1} were significant at 1 and 5 percent levels respectively. The coefficient of variable X_{1t-1} was positive which means that when the lagged average wholesale price of plywood increases, and the quantity of plywood supply was also increases. The coefficient of variable X_{14t} was positive, which means that when the quantity of imported logs is increased, the quantity of plywood supply was also increased. This because of the logging ban in 1989.

R^2 was 0.809 indicating that the deviation of the dependent variable (QSA_t) can be explained by the explanatory variables (X_{1t-1}, X_{14t}) at about 80.9 percent.

The serial correlation test, the DW value and autocorrelation coefficient were 1.849, and -0.121, respectively. The upper critical value (d_u) from the Durbin-Watson table has corresponds to 2 of the explanatory variables based on 13 observations a 5 percent significance level was equal to 1.562. In this case, the autocorrelation coefficient was negative and DW $< 4-d_u$

(1.849 < 4-1.562 =2.438) indicated that there was no autocorrelation among the error term in the first order condition or the autocorrelation coefficient was equal to zero ($r_a = 0$).

Table 3. Estimated regression coefficient of aggregate supplies model of plywood in Thailand, 1985-1997.

Independent variable	Constant term	Coefficient	SE	t-ratio	F	R^2	DW	r_a
	10.79538638		0.1695	63.686***	21.120***	0.809	1.849	-0.121
X_{1t-1}		0.00201480	0.0005	4.231*				
X_{14t}		0.00000029	0.0000	1.936***				

*** = Significant at 1 percent * = Significant at 10 percent

Estimated equation:

$$\ln QSA_t = 10.79538638 + 0.00201480(X_{1t-1}) + 0.00000029(X_{14t})$$

Price of plywood

The average wholesale price of plywood is estimated in natural log forms with an ordinary least square. The results are presented in table 4. It shows that the price of plywood was a function of the differential quantity between lag of one year of production and consumption of plywood (QSA_{t-1}-QDA_{t-1}), and the per capita income (X_{7t}). In the model, the regression coefficient of variable X_{7t} was significant at the 1 percent level, and the regression coefficient of variable QSA_{t-1}-QDA_{t-1}, was not significant at the 10 percent level. The coefficient of QSA_{t-1}-QDA_{t-1} was negative which means that when it increases it will cause the average wholesale price of plywood to decrease. The coefficient of variable X_{7t} was positive, which means that when the per capita income increases it will cause the average wholesale price of plywood to increase.

The R^2 was 0.954 indicating that the variation in the average wholesale price of plywood can be explained by the differential quantity between the lag of one year of supply and demand of plywood ((QSA_{t-1}-QDA_{t-1}) and per capita income (X_{7t})) at about 95.40 percent.

In the test for serial correlation, the computed DW value and autocorrelation coefficients were 2.084 and -0.074, respectively. The upper critical value (d_U) from the Durbin-Watson Test table corresponding to the explanatory variables with 13 observations at 5 percent level of significance was equal to 1.562. The autocorrelation coefficient was negative and DW<4- d_U (1.853<4-1.56=2.438), indicated that there was no autocorrelation among the error terms in the first order condition or the autocorrelation coefficient was equal to zero ($r_a = 0$).

Table 4 Estimated regression coefficient of aggregate price model on the average wholesale price of plywood in Thailand, 1985-1997.

Independent variable	Constant term	Coefficient	SE	t-ratio	F	R^2	DW	r_a
	-3,846.46488993		480.1592	-8.011***	104.336***	0.954	2.084	-0.074
LnX_{7t}		395.30758519	45.7955	8.632***				
QSA_{t-1} - QDA_{t-1}		-0.00053248	0.0005	-1.082ns				

*** = Significant at 1 percent ns = Not significant at 10 percent

Estimated equation:

Estimated equation:

$$\ln X_{1t} = -3846.46488993 - 0.00053248(QSA_{t-1}-QDA_{t-1}) + 395.30758519\ln(X_{7t})$$

Table 5. Estimated demand, supply and average wholesale price of plywood in Thailand.

Year	Demand (m^3)	Supply (m^3)	Average wholesale price of plywood (Baht/sheet)
1985	55,412.56450650	57,200.26440568	71.07625594
1986	39,123.01841560	58,857.69607785	90.31764741
1987	36,141.72046112	63,538.89354380	136.24115265
1988	37,350.68576314	73,090.32269259	177.05825732
1989	53,688.95785874	98,537.44970041	250.69775850
1990	132,252.93928121	138,169.42131434	330.64453625
1991	204,897.10844126	157,669.64672245	386.50839211
1992	248,166.07138050	191,873.11753231	428.2201586
1993	224,899.96552506	171,873.28987702	478.03455310
1994	227,946.53884181	200,327.96060062	517.10962384
1995	232,033.65047246	206,249.28923267	573.65543408
1996	236,338.38915481	203,356.18908904	638.65890196
1997	409,418.08418356	229,088.66329981	659.18765766

Estimates of point elasticities of demand and supply of plywood

The aggregate demand and supply models were used to estimate the average point elasticities of demand and supply of plywood as presented in Tables 6 and 7. From table 6, the own price elasticities of demand for plywood with respect to average wholesale price of plywood (X_{1t}) was 0.1713 implying that demand for plywood is inelastic. Thus, a one percent change increase in the average wholesale price, all other factors unchanged, the quantity of demand for plywood will increase by about 0.1713 percent. The cross-price elasticities of demand for plywood with respect to wholesale price of mixed cement (X_{7t}) were 5.6395 indicating that demand for plywood was elastic. A one- percent change increase in the average wholesale price of mixed cement will result in the same direction in demand for plywood by 5.6395 percent. In this case, the mixed cement is a substitution goods for plywood.

Table 6. Estimates of average point elasticities of demand for plywood in Thailand, 1985-1997.

Variable	Average elasticities of demand for plywood
Average wholesale price of plywood(X_{1t})	0.1713
Average wholesale price of mixed cement(X_{7t})	5.6395

In table 7, the estimated elasticities of supply of plywood with respect to the lagged average wholesale price of plywood and quantity of imported logs were 0.6404 and 0.3124, respectively, indicating that supply of plywood was inelastic. A one-percent increase in both the lagged average wholesale price of plywood and the quantity of imported logs will increase the quantity of plywood supply about 0.6404 and 0.3124 percent, respectively.

Table 7. Estimates of average point elasticities of plywood supply in Thailand, 1985-1997.

Variable	Average elasticities of supply for plywood
Lagged average wholesale price of plywood(X_{1t-1})	0.6404
Quantity of log imported (X_{14t})	0.3124

Projections of demand, supply, and price of plywood

The aggregate demand, supply, and price models were employed to project the consumption, production, and price of plywood for the period 1998-2007 the results are presented in Table 8. It can be shown that in 1998 the demand, supply and average wholesale price of plywood were 366,021 m^3, 232,524m^3 and 718 Baht/sheet, respectively, and at the end of the projection period, the corresponding values are 780,417 m^3 456,777 m^3 and 1,141 Baht/sheet, respectively. The average percentage of increase in demand, supply and average wholesale price of plywood during the projection period will be 11.32, 9.64 and 5.89 percent, respectively.

Table 8. Projection of demand, supply, and average wholesale price of plywood in Thailand, 1998-2007.

Year	Quantity of demand for plywood (m^3)	Quantity of supply of plywood (m^3)	Average wholesale price of plywood (Baht/sheet)
1998	366,021	232,524	718
1999	400,322	251,865	765
2000	436,814	267,427	811
2001	475,797	285,255	858
2002	517,578	305,645	905
2003	562,476	328,885	951
2004	610,831	355,274	998
2005	663,006	385,136	1,045
2006	719,393	418,833	1,093
2007	780,417	456,777	1,141

CONCLUSION

The study found that the factors affecting the quantity of demand and supply of plywood were the average wholesale price of plywood and average wholesale price of mixed cement, and the lag of one year of average wholesale price of plywood and the quantity of imported logs. In addition, factors affecting the average wholesale price

of plywood were the differential quantity between lag of one year production and consumption of plywood and per capita income.

The coefficient of determination of demand, supply and price of plywood models were 0.848, 0.809 and 0.954 respectively, this indicated that the exogenous variables in each model could explain the deviation of demand, supply and price of plywood about 84.8, 80.9 and 95.4 percent, respectively.

The elasticity of demand for plywood with respect to average wholesale price of plywood and average wholesale price of mixed cement were 0.1713 and 5.6395 respectively. The elasticity of plywood supply with respect to lag of one year of average wholesale price of plywood and quantity of imported logs were 0.6404 and 0.3124 respectively.

The projection of demand, supply and average wholesale price of plywood in the next ten years period (1998-2007) were undertaken. This indicated that the growth rate of demand, supply and price of plywood during the projection period were 11.32, 9.64 and 5.89 percent, respectively. Based on the results of the projection the plywood demand deficit will become a severe problem of the wood industry in Thailand and the amount of the deficit will become larger and larger over time. In order to mitigate this problem, the Thai government should facilitate the entrepreneurs to increase their importation of plywood and veneer logs by decreasing the import tax on these products.

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Appendix Table 1. Explanatory variables for calculated demand supply and price of plywood model.

Year	X_{1t}	X_{1t-1}	X_{2t}	X_{3t}	X_{4t}	X_{5t}	X_{6t}	X_{7t}	X_{8t}	X_{9t}	X_{10t}	X_{11t}	X_{12t}	X_{13t}	X_{14t}	X_{15t}	QSA_{t-1}-QDA_{t-1}
1985	94.00	92.67	246.25	80.00	9,246.94	1,065.00	51.80	20,141	639.55	55.6	6,499.94	66.80	1,300	2,000	172,100	0	300
1986	86.92	94.00	246.25	76.42	9,071.11	983.75	52.97	21,157	773.15	54.3	6,233.05	66.80	1,100	6,400	152,714	0	700
1987	97.08	86.92	321.00	87.92	9,264.99	952.50	53.97	23,911	1,425.85	61.3	4,785.54	68.75	1,400	54,000	282,928	100	5,300
1988	103.75	97.08	350.50	93.00	11,148.21	950.00	54.96	28,256	2,170.68	74.4	4,541.30	69.40	4,900	39,000	466,780	800	52,600
1989	362.60	103.75	419.00	175.50	13,074.17	1,013.33	55.89	33,204	1,988.52	95.6	3,453.20	72.15	9,400	5,400	1,193,340	1,700	34,100
1990	362.50	362.60	470.00	178.88	13,637.50	1,191.67	56.30	38,613	2,582.03	116.6	3,056.89	80.70	19,700	1,900	1,847,392	2,300	-4,000
1991	386.12	362.50	470.00	180.75	12,459.08	1,277.50	56.96	43,655	3,171.21	130.5	3,900.28	90.30	23,800	2,900	1,747,201	3,100	-17,800
1992	402.33	386.12	501.25	196.92	12,278.25	1,313.84	57.79	48,311	4,016.19	138.7	3,559.65	97.95	41,079	3,657	2,036,090	9,292	-20,900
1993	447.00	402.33	560.00	235.33	12,349.16	1,289.35	58.34	53,593	4,932.74	150.7	4,323.25	112.55	24,012	4,576	1,366,719	11,798	-37,422
1994	529.91	447.00	700.00	276.00	12,293.77	1,289.35	59.10	60,612	5,821.63	172.1	4,782.79	122.70	30,700	1,800	1,548,899	14,000	-19,436
1995	554.33	529.91	805.00	280.00	12,195.28	1,289.35	59.46	69,047	6,624.25	184.8	7,276.91	127.60	95,000	1,300	1,377,869	20,500	-28,900
1996	621.10	554.33	805.00	292.74	11,700.65	1,289.35	60.12	74,585	6,980.05	196.0	6,739.75	134.80	109,900	2,200	936,300	15,500	-93,700
1997	689.77	612.10	805.00	319.00	12,394.38	1,402.35	60.82	77,093	8,355.44	152.5	6,069.37	143.20	53,400	6,000	895,545	17,400	-107,700

Appendix Table 2. Time trend function for exogenous variable included in aggregate demand, supply and price model of plywood.

Source	Time trend model	R^2	SE	DW	r_a
Average wholesale price of mixed cement	$LnX_{4t} = 7.15439691 + 0.00936798T - 0.33163954(1/T)$ 95.607^{***} 1.061^{NS} -3.429^{**}	0.886	0.0472	1.935	-0.019
Per capita income	$LnX_{7t} = 7.67777209 + 0.72124951(1/T) + 1.51305475(T^{1/3})$ 115.090^{***} 14.679^{***} 49.865^{***}	0.998	0.0206	1.624	0.019
Quantity of imported logs	$LnX_{14t} = 18.71009181 - 0.26881584T - 19.85050477(1/T)$ 22.878^{***} -4.690^{***} -7.162^{***} $+13.49980283(1/T^2)$ 6.407^{***}	0.938	0.2612	1.868	0.038
Different between last year's production and consumption of plywood	$QSA_{t-1} - QDA_{t-1} = -2,700.85543989 + 27.597.91984520\ln T$ -0.159^{ns} 1.894^{ns} $-1.006.27556732T^2$ -5.056^{***}	0.822	20,416.57	1.691	0.150

*** = Significant at 1 percent ** = Significant at 5 percent * = Significant at 10 percent ns = Not significant at 10 percent