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Impacts of the Interest Rate Change on the Forest Products Import Quantities in Korea[1]

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利子率의 變化가 林產物輸入에 미치는 影響[1]

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ABSTRACT

This study estimated the impacts of the interest rate change on the forest products import quantities in Korea. The first objective is to analyze whether there is any causal relationship between change in the interest rate and changes in the import quantities of forest products in Korea. And the second objective is to evaluate the dynamics of the impacts of the interest rate change on the forest products import quantities in Korea. The relationship between the interest rate and the import quantity was represented by bivariate vector autoregressive model. Whether there is any causal relationship between change in the interest rate and changes in the import quantities of forest products was analyzed by the causality test. And the dynamics of the impacts of the interest rate change on the forest products import quantities were evaluated by variance decomposition analysis and impulse response analysis.

The import quantity of forest products can be explained by the lagged interest rate variables and the lagged import quantity variables in Korea. Change in the interest rate causes change in the plywood import quantity in Korea. In the bivariate model of the plywood import quantity, after three months, the interest rate change accounts for about twenty percent of variation in the import quantity, and its own change accounts for about eighty percent of variation in the import quantity. On the other hand, the impact of a shock to the interest rate is significant for about six months on the import quantity of plywood in Korea. That is, if the interest rate change had an impact on the import quantity of plywood in Korea, it was only of a short-term nature.

Key words : Forest products market, Vector autoregressive model, Causality test, Variance decomposition analysis, Impulse response analysis

要 約

이 연구는 이자율의 변화가 임산물수입량에 미치는 영향을 우리나라 시장을 대상으로 분석하였다. 첫번째 목적은 이자율의 변화가 임산물수입량 변화의 원인이 되는지, 즉 인과관계를 파악하는 것이고, 두번째 목적은 이자율의 변화가 임산물수입량에 얼마만큼 얼마동안 영향을 미치는지, 즉 동태적 영향을 추정하는 것이다. 이자율과 임산물수입량의 관계는 자기회귀모형에 의해 만들어졌다.

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인과관계 파악은 인과성검정을 이용하였고, 동태분석은 분산분해분석과 충격반응분석을 이용하였다.
결과에 의하면 이자율의 변화는 임산물 중에서 합판수입량 변화의 원인이 되었다. 합판의 경우에 어느 시기의 수입량은 그 시기 이전의 이자율에 의해 20%, 그 시기 이전의 수입량에 의해 80% 가량 설명되었다. 또한 이자율의 변화는 합판수입량에 6개월까지 영향을 미쳤다. 즉 이자율의 변화가 합판수입량에 영향을 미쳤더라도 단기간에 불과했다.

INTRODUCTION

Korea recently experienced an economic crisis, particularly a monetary problem. The financial crisis can be defined as the abrupt increase in interest rate. Actually, the interest rate increased abruptly during the first quarter of 1998 in Korea.

The interest rate impacts the forest products sector. The impact is on the demand for forest products. Because forest products are intermediate inputs consumed in producing final products, the demand for forest products is a derived demand for final products. The high interest rate decreases the domestic production and consumption of final products that use forest products as raw material, and it decreases the demand for forest products (Klemperer, 1996).

Actually, in 1998 when Korean interest rate abruptly increased, the import quantity of forest products decreased 17% from 1997.

Because Korea experienced instability in its interest rate, and the Korean forest products sector depends on imports, it is important to estimate the impacts of the interest rate change on the forest products import quantities in Korea. The impact provides an indication of how the forest products sector responds to the financial problem. The results may contribute to an improved understanding of sector linkage and, hence, forest products sector model specification. And, the results can be used to establish the policy or planning of the forestry sector.

OBJECTIVES AND SCOPE

The first objective is to analyze whether there is any causal relationship between change in the interest rate and changes in the import quantities of forest products in Korea. And the second objective is to evaluate the dynamics of the impacts of the interest rate change on the forest products import quantities in Korea.

Ten forest products commodities were considered : hardwood roundwood, softwood roundwood, hardwood lumber, softwood lumber, plywood, particleboard, high-density fiberboard, medium-density fiberboard, mechanical pulp, and chemical pulp.

DATA COLLECTION

Data collected are as follows :

1) Korean money market interest rate

2) Korean forest products import quantities for hardwood roundwood, softwood roundwood, hardwood lumber, softwood lumber, plywood, particleboard, high-density fiberboard, medium-density fiberboard, mechanical pulp, and chemical pulp

Data for the period of eight years from 1992 to 1999 were used. The data used are at the monthly level. This produced 96 observations for the interest rate and each commodity.

METHODS

1. Unit root test

An assumption underlying regression analysis involving time series data is that such data are stationary. A time series is said to be stationary if the series does not have an upward or downward trend over time. Standard estimation procedures cannot be applied to the model that contains a nonstationary dependent variable or explanatory variables (Hamilton, 1994). Also, the nonstationary time series has the possibility of spurious regression. Therefore, we should check whether a series is stationary or not before using it in a model.

The formal method of testing the stationarity of a series is the unit root test. To find out if the interest rate or any import quantity is stationary, the regression was run on

$$y_t = c + \sum_{i=1}^{n} \alpha_i y_{t-i} + u_t \quad (1)$$

$$x_t = c + \sum_{i=1}^{n} \beta_i x_{t-i} + v_t \quad (2)$$

where y_t is the Korean import quantity of forest products, x_t is the Korean interest rate, α_i and β_i are the parameters, and u_t and v_t are the error terms.

And, we tested if the absolute value of any α_i or β_i is statistically equal to one on the basis of t-statistic. The estimated coefficient was divided by its standard error to compute the statistic, and referred to the Dickey-Fuller table. If the absolute computed value exceeded the Dickey-Fuller absolute critical value, then the hypothesis that the given time series is nonstationary was rejected. If, on the other hand, it was less than the absolute critical value, the time series was found to be nonstationary.

If the series was nonstationary, it was transformed by taking the first differences over one month. The above process was repeated until a stationary series was achieved.

We had to specify the number of lagged terms to add to the regression. The usual advice is to include lags sufficient to remove any serial correlation in the residuals. A lag length of four was found to be sufficient.

2. Cointegration test

Even if both time series are nonstationary, the linear combination of those two series[1] may be stationary.

If such a stationary linear combination exists, the two nonstationary time series are called cointegrated. The stationary linear combination is called cointegrating equation and may be interpreted as a long-run equilibrium relationship between the variable (Hall et al., 1999). Therefore, given a group of nonstationary time series, we should check whether any combination of the series is cointegrated.

To find out if the interest rate and any import quantity are cointegrated, the regression was run on

$$u_t = y_t - c - \sum_{i=1}^{n} \alpha_i y_{t-i} - \sum_{i=1}^{n} \beta_i x_{t-i} \quad (3)$$

where y_t is the Korean import quantity of forest products, x_t is the Korean interest rate, and u_t is the error term.

If we find that the error term, u_t, is stationary, then we say that the interest rate and the import quantity are cointegrated.

To find out if the error term is stationary, the error term was subjected to the unit root test explained above. The lag length was set at four.

If the two variables are not cointegrated, vector autoregressive model can be specified using differenced data. If, instead, the two variables are cointegrated, vector error correction model should be used.

3. Model specification and estamation

The relationship between the Korean interest rate and the Korean import quantity of forest products, both treated as endogenous variables, can be represented by bivariate vector autoregressive or vector error correction model.

The vector autoregressive model of this study is

[1] The two series should be integrated of the same order. A differenced stationary series is said to be integrated, and is denoted as I(d), where d is the order of integration. The order of integration is the number of unit root contained in the series, or the number of differencing operation it takes to make the series stationary (Gujarati, 1995). In this study, all the variables were I(1).

$$y_t = c + \sum_{i=1}^{n} \alpha_i y_{t-i} + \sum_{i=1}^{n} \beta_i x_{t-i} + u_t \quad (4)$$

where y_t is the Korean import quantity of forest products, x_t is the Korean interest rate, u_t is the error term. Equation (4) captures the impact of the interest rate change on the import quantity.

All variables are in the form of natural logarithm. The logarithmic transformation decreases the impact of any residual heteroscedasticity (Uusivuori and Buongiorno, 1990).

The lag length of the model was set at four months. The lag length of VAR or VEC model is often selected somewhat arbitrarily, with a standard recommendation suggesting that we set it long enough to remove any serial correlation in the error terms. However, if we choose the lag length too long, the estimates become imprecise (Hall, et. al. 1999).

Equation (4) was estimated for each commodity using monthly data on the Korean interest rate and the Korean forest products import quantities.

Equation (4) was estimated by ordinary least squares (OLS) method using the software EViews 3.1. The lagged values of endogenous variables appeared only on the right-hand side of each equation. So, there was no simultaneity. Therefore, the OLS estimation can produce efficient estimates. with each other.

4. Impact analysis

Whether there is any causal relationship between change in the interest rate and changes in the import quantities of forest products was analyzed by the causality test. And the dynamics of the impacts of the interest rate change on the forest products import quantities were evaluated by variance decomposition analysis and impulse response analysis.

1) Causality test

The causality test of Granger was done to test the presence of causal relationship between change in the Korean interest rate and changes in the Korean forest products import quantities. An F test of the hypothesis that the interest rate change does not cause the import quantity change was performed.

2) Variance decomposition analysis

Interpreted together with the impulse response, the variance decomposition can provide valuable insight into the dynamics of the model under investigation (Jennings et al., 1991).

The error variance of the model includes the variation in dependent variable to the shock in explanatory variable. It provides a measure of the explanatory strength of each explanatory variable at different horizon. Also, it gives information about the relative importance of each explanatory variable to dependent variable (Hall et al., 1999).

In this study, the variance decomposition provides the relative importance of the lagged interest rate variable and the lagged import quantity variable to the current import quantity at different horizons.

The autoregressive representation can be written as

$$y_t = c + \sum_{i=1}^{n} \alpha_i y_{t-i} + u_t \quad (5)$$

where y_t is vector of the import quantity and the interest rate, and u_t is vector of the error terms.

It is not possible to divide the impact of the interest rate on the import quantity using the autoregressive representation.

However, the moving-average representation expresses the levels of the import quantity as a function of the error terms. Inverting the autoregressive representation into the moving-average representation resulted in

$$y_t = c + \sum_{i=1}^{n} \alpha_i u_{t-i} \quad (6)$$

where y_t is vector of the import quantity and the interest rate, and u_t is vector of the error terms.

The variance decomposition of the import quantity was calculated from the parameters of equation (6).

The decomposition was done for the horizon of 24 months. This is judged sufficiently long to capture most of the dynamics of interest rate change impact.

3) Impulse response analysis

Although the variance decomposition measures the explanatory strength of each explanatory variable at different horizon, it does not indicate the expected time path of dependent variable's response to the shock to explanatory variables. The impulse response function estimates the impact of one single shock to explanatory variable on dependent variable for several periods in the future (Alavalapati et al., 1996).

In this study, the impulse response function provides the response of the import quantity to a standardized one-unit shock in the interest rate.

To assess the impact of a shock over a 24-month period, the impulse response was obtained from

$$y_t = c + \sum_{i=1}^{n} \alpha_i u_{t-i} \quad (7)$$

where y_t is vector of the import quantity and the interest rate, and u_t is vector of the error terms, called impulse in the language of vector autoregressive model.

The error term was supposed to increase by a value of one standard deviation. Such an increase changed the interest rate and the import quantity in the current as well as future periods through the dynamic structure of the vector autoregressive model. The mean responses and variances of the import quantity were obtained for 24 future months.

Changing the order of variables can change the impulse responses. The economic reasoning for the ordering of variables is not unique. Alternative explanations can be provided to change the places of variables (Alavalapati et al., 1996). Therefore, the impulse responses were obtained with the alternative ordering of the variables to see whether the results changed significantly.

RESULTS AND DISCUSSION

Table 1 shows the result of unit root tests. All the absolute estimated values in the second column did not exceed the absolute critical value at 5% significance level. That is, all the time series are nonstationary, and therefore have systematic trends, which may be eliminated using differenced values.

For the first differenced data, the third column shows that all the absolute estimated values exceeded the absolute critical value at 5% significance level. That is, all the time series are stationary in the first differenced level. It means that stationary series were obtained by using month-to-month differencing in the original level.

Table 1. Result of unit root tests.

Variable	Original data	First differenced data
Interest rate	- 1.4593	- 3.2671**
Hardwood roundwood	- 1.0361	- 5.4899**
Softwood roundwood	- 2.7123	- 4.8320**
Hardwood lumber	- 2.1814	- 4.6919**
Softwood lumber	- 2.0588	- 7.5339**
Plywood	- 1.8051	- 4.4682**
Particleboard	- 1.9694	- 4.7642**
High-density fiberboard	- 1.5565	- 6.3612**
Medium-density fiberboard	- 1.5444	- 3.3688**
Mechanical pulp	- 0.0111	- 4.5896**
Chemical pulp	- 1.6891	- 4.4287**

The values represent Augmented Dickey-Fuller test statistics.
The critical value at 5% significance level is -2.89.
** Reject the null hypothesis that the time series is nonstationary at 5% significance level

Table 2 shows the result of cointegration tests of the import quantities with the interest rate. All the absolute estimated values did not exceed the absolute critical value at 5% significance level. That is, all the import quantity variables do not have cointegration with the interest rate. So, vector autoregressive model can be used with differenced data of the import quantities and the interest rate variables.

Table 2. Result of cointegration tests of the import quantities with the interest rate.

Variable	
Hardwood roundwood	6.6355
Softwood roundwood	12.5271
Hardwood lumber	12.9568
Softwood lumber	11.7224
Plywood	10.3894
Particleboard	14.8076
High-density fiberboard	11.6050
Medium-density fiberboard	12.5189
Mechanical pulp	10.3950
Chemical pulp	11.8909

The values represent likelihood ratio test statistics.
The critical value at 5% significance level is 19.96.
* Reject the null hypothesis of no cointegration of the import quantity with the interest rate at 10% significance level

Table 3 shows the result of model estimation. The structural model places strict interpretation on the parameters of the equation, while the vector autoregressive model interprets the system as a whole. With several lags of the same variables, each estimated coefficient may not be statistically significant, possibly due to multicollinearity (Gujarati, 1995). The significance levels of F-statistics in all equations rejected the hypothesis that all coefficients are zero. So, we concluded that the import quantity of forest products can be explained by the lagged interest rate variables and the lagged import quantity variables in Korea.

The Q values in the seventh column are from Ljung-Box Q test to test the presence of serial correlation. Durbin-Watson statistic cannot be used in the model when lagged dependent variable is used as explanatory variable. If there is no serial correlation in the residuals, all Q-statistics at all lags should be insignificant with large p-values (Gujarati, 1995). The results suggested that the error terms in all the equations appeared free of serial correlation.

Table 3. Result of model estimation.

Dependent variable	Observation number	Lag length	F-statistic	P>F	Adj. R^2	Q	P>Q
Hardwood roundwood	78	4	5.26**	0.00	0.31	0.23	0.99
Softwood roundwood	75	4	5.41**	0.00	0.32	1.93	0.75
Hardwood lumber	78	4	10.05**	0.00	0.48	0.49	0.98
Softwood lumber	84	4	4.82**	0.00	0.27	2.21	0.70
Plywood	84	4	6.55**	0.00	0.35	0.39	0.98
Particleboard	84	4	2.05*	0.05	0.09	0.40	0.98
High-density fiberboard	78	4	4.96**	0.00	0.29	1.47	0.83
Medium-densityfiberboard	84	4	2.58**	0.02	0.13	0.87	0.93
Mechanical pulp	53	4	8.01**	0.00	0.52	0.43	0.98
Chemical pulp	84	4	4.72**	0.00	0.26	0.41	0.98

** Reject the null hypothesis that all coefficients are zero at 5% significance level
* Reject the null hypothesis that all coefficients are zero at 10% significance level

Table 4 shows the result of the causality tests between change in the interest rate and changes in the forest products import quantities in Korea. There appeared to be evidence of the causal relationship between change in the interest rate and change in the import quantity of plywood in Korea. That is, change in the interest rate causes change in the plywood import quantity in Korea.

One possible explanation for such a result may be that the domestic plywood is a good substitute for the imported plywood. That is, the imported plywood may not be different in quality from the domestic plywood in Korea.

Also, change in the interest rate does not cause changes in the import quantities of hardwood roundwood, softwood roundwood, hardwood lumber, softwood lumber, particleboard, high-density fiberboard, medium-density fiberboard, mechanical pulp, and chemical pulp in Korea.

Table 4. Result of the causality tests between change in the interest rate and changes in the import quantities.

Dependent variable		P>F
Hardwood roundwood	0.92	0.46
Softwood roundwood	1.13	0.35
Hardwood lumber	1.49	0.22
Softwood lumber	0.64	0.64
Plywood	4.50**	0.00
Particleboard	1.04	0.39
High-density fiberboard	1.29	0.28
Medium-density fiberboard	1.42	0.23
Mechanical pulp	0.50	0.74
Chemical pulp	0.64	0.63

The values in the second column represent F test statistics.

** Reject the null hypothesis that the interest rate change does not cause the import quantity change at 5% significance level

Table 5 shows the result of the variance decomposition of the plywood import quantity for the horizon of 24 months. The decomposition divided the variance into parts explained by each explanatory variable in the model.

The standard error in the second column is the forecast error of the plywood import quantity for each forecast horizon. The source of this forecast error is the variation in the future values of the plywood import quantity to a shock in the model. The remaining columns give the percentages of the variances of the plywood import quantity due to each explanatory variable. The values in the third column represent the percentages of the variances of the plywood import quantity explained by the interest rate. And, the values in the fourth column represent the percentages of the variances of the plywood import quantity explained by its own. The third column and the fourth column of each row add up to 100.

In the bivariate model of the plywood import quantitiy, after three months, the interest rate change accounts for about twenty percent of variation in the import quantity, and its own change accounts for about eighty percent of variation in the import quantity.

Table 5. Result of the variance decomposition analysis of the plywood import quantity.

Month	Standard error	Explanation percentage (%)	
		Interest rate	Import quantity
1	0.7968	0.0000	100.0000
2	0.9104	6.6959	93.3041
3	1.0050	21.5881	78.4119
4	1.0298	21.0182	78.9812
5	1.0300	21.0088	78.9912
6	1.0338	20.8678	79.1322
7	1.0360	21.1690	78.8310
8	1.0382	21.2295	78.7705
9	1.0389	21.2042	78.7958
10	1.0391	21.2287	78.7713
11	1.0391	21.2290	78.7710
12	1.0391	21.2339	78.7661
13	1.0392	21.2315	78.7685
14	1.0392	21.2323	78.7677
15	1.0392	21.2334	78.7666
16	1.0392	21.2333	78.7667
17	1.0392	21.2333	78.7667
18	1.0392	21.2333	78.7667
19	1.0392	21.2333	78.7667
20	1.0392	21.2333	78.7667
21	1.0392	21.2333	78.7667
22	1.0392	21.2333	78.7667
23	1.0392	21.2333	78.7667
24	1.0392	21.2333	78.7667

Figure 1 shows the response of the plywood import quantity to one standardized impulse equal to one standard deviation of the interest rate estimator for 24 future months. That is, Figure 1 shows the impact of a one time and one standard deviation shock to the interest rate on the import quantity of plywood over time.

One hundred draws were made from the parameters of the vector autoregressive model of the plywood import quantity to establish the impulse response. The middle line is the mean value of the impulse response, that is, the standardized magnitude of the response. And the dotted lines are the two plus/minus standard deviations of the response.

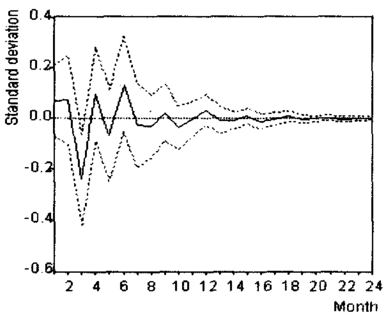

Figure 1. Response of the plywood import quantity to one standard deviation shock to the interest rate.

The impact of a shock to the interest rate is significant for about six months on the plywood import quantity in Korea. That is, the impact of a shock to the interest rate on the plywood import quantity is shown to disappear after about six months. One possible explanation for such a result may be that Korean plywood importers have short-term contracts with exporters.

Changing the order of variables did not change the impulse response. So, only result with the order of the interest rate and the import quantity was presented.

CONCLUSION

This study presents a first attempt to estimate the dynamic impacts of the interest rate change on the forest products import quantities in Korea. There appeared to be evidence of a causal relationship between change in the Korean interest rate and change in the Korean import quantity of plywood. That is, change in the Korean interest rate causes change in the Korean plywood import quantity. One possible explanation for such a result may be that the domestic plywood is a good substitute for the imported plywood. That is, the imported plywood may not be different in quality from the domestic plywood in Korea.

Similarly, changes in the interest rate do not cause changes in the import quantities of hardwood roundwood, softwood roundwood, hardwood lumber, softwood lumber, particleboard, high-density fiberboard, medium-density fiberboard, mechanical pulp, and chemical pulp in Korea.

In the bivariate model of the plywood import quantitiy, after three months, the interest rate change accounts for about twenty percent of variation in the import quantity,and its own change accounts for about eighty percent of variation in the import quantity.

The impact of a shock to the interest rate is significant for about six months on the plywood import quantity in Korea. That is, the impact of a shock to the interest rate on the plywood import quantity is shown to disappear after about six months.

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