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Development of the Roundwood Import Prediction Model

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Abstract : This study developed the Korean roundwood import prediction model using vector autoregressive (VAR) method. The roundwood was divided into softwood and hardwood by species. The VAR model of roundwood import was specified with two lagged endogenous variables, that is, roundwood import volume and roundwood import price. The results showed that the significance levels of F-statistics in the softwood and hardwood roundwood import equations rejected the hypothesis that all coefficients are zero. So, we concluded that roundwood import volume can be explained by lagged import volume and lagged import price in Korea. The coefficient signs of all variables were as expected. Also, the model has good explanatory power, and there is no autocorrelation.

Key words **:** *Roundwood import; prediction model; VAR model*

Introduction

Roundwood is used as the raw material of wood-based industry. Korea depends most of roundwood consumption on import from foreign countries. Korean roundwood import increased before the economic shock of 1997, and abruptly decreased in 1998. Since the recovery from the shock, it has increased. If dividing roundwood into softwood and hardwood by species, softwood roundwood import increased and hardwood roundwood import decreased.

There are a few studies on roundwood import modeling in Korea. Joo and Lee (1998) and Park and Youn (2000) estimated the Korean roundwood import model by species and countries. Both studies used econometric model. Park and Youn (2000) included lagged endogenous variable in the model. The vector autoregressive (VAR) model has never been used. Finnish Forest Research Institute (2001) estimated roundwood import using VAR model.

It was considered important to analyze whether the systems approaches, such as vector autoregressive and vector error correction methods, could provide better forecasts than the partial approach.

This article tried to develop the roundwood import prediction model using VAR method. The objective of this article is to confirm whether the VAR method can be used to predict the roundwood import in Korea.

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Research Methods

1. Data collection

Import volume and price were collected and calculated from the Statistical Yearbook of Foreign Trade by Korea Customs Service. Import price was deflated.

Data for the period of twenty-six years from 1980 to 2005 were used. The data used are at the yearly level. This produced twenty-six observations.

2. Model specification and estimation

1) Unit root test

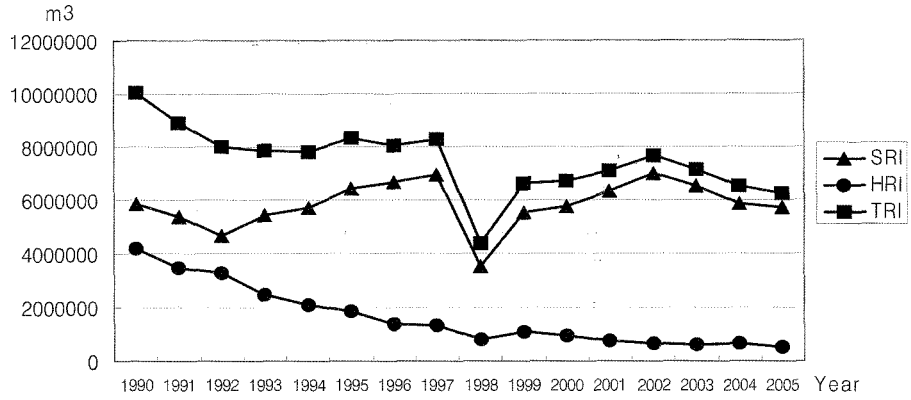
An implicit assumption underlying regression analysis involving time series data is that such data are stationary. Stationarity means that the mean and autocovariances of a series do not depend on time (Hamilton, 1994). Therefore, we should check whether a series is stationary or not before using it in a model. The formal method of testing the stationarity of a series is unit root test.

To find out if the series is stationary, the regression was run on

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

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

where y_t is roundwood import volume, and x_t is round-



* S(H)RI: softwood(hardwood) roundwood import, TRI: total roundwood import

Figure 1. Roundwood import trend by species.

wood import price.

And, we found out 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 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 year. The above process was repeated until a stationary series was achieved.

2) Cointegration test

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

To find out if roundwood import volume and roundwood import price 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 roundwood import volume, and x_t is roundwood import price.

If we find that the error term, ut, is stationary, then we say that roundwood import volume and roundwood import price are cointegrated. To find out if the error term is stationary, the error term was subjected to the unit root test explained above.

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 estimation

The idea underlying the VAR model is first to summarize the dynamic correlation patterns among observed data series and then use this summary to explain and predict likely future values for each series. Mathematically, a VAR expresses the current value of each of series as a weighted average of the recent past of all the series plus a term that contains all the other influences on the current values.

A VAR representation of p order can be expressed as

$$Y_t = a_0 + a_1 y_{t-1} + \ldots + a_p y_{t-p} + \mu_t \quad (4)$$

where Y_t is the $m \times 1$ vector of roundwood import volume for year t, and μ_t is a vector of innovations.

The innovations measure the extent to which y_t cannot be determined exactly as a linear combination of the past values of y_t with weights given by the constant coefficients a_0 and a_p t=1, ···, p. It is assumed that μ_t is a random vector with zero mean and error covariance matrix positive definite, and that is uncorrelated with lagged values of y_t. The VAR can be rewritten as

$$\Delta y_t = \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + b x_t + \varepsilon_t \quad (5)$$

where $\Pi = \sum_{i=1}^{p} a_i - I, \Gamma_i = -\sum_{j=i+1}^{p} a_j$,

and x_t is the $m \times 1$ vector of variable influencing roundwood import volume for year t (Hall, 1999).

The relationship between roundwood import volume and roundwood import price was represented by bivariate VAR model, both treated as endogenous variables.

The model of this article is

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

where y_t is roundwood import volume, x_t is roundwood import price, and u_t is uncorrelated with its own lagged values and all of the right-hand side variables.

All variables are in the form of natural logarithm. The logarithmic transformation decreases the impact of any residual heteroscedasticity (Uusivuori and Buongiorno, 1990). And, the lag length of the model was set on the criterion of Akaike.

Equation (6) was estimated by ordinary least squares (OLS) method using 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, OLS estimation can produce efficient estimates.

Results and Discussion

1. Unit root test

Table 1 shows the result of unit root test. All the absolute estimated values in the third 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.

Table 1. Result of unit root test.

	variable	original data	first differenced data
softwood roundwood	import volume	1.74	4.00**
	import price	2.28	5.96**
hardwood roundwood	import volume	1.79	3.20**
	import price	1.55	4.17**

The values represent augmented Dickey-Fuller test statistics.
The critical value at 5% significance level is -2.99.
**Reject the null hypothesis that the time series is nonstationary at 5% significance level.

Table 2. Result of cointegration test.

	variable	import price
softwood roundwood	import volume	11.72
hardwood roundwood	import volume	9.89

The values represent augmented likelihood ratio test statistics.
The critical value at 5% significance level is 15.41.
*Reject the null hypothesis of no cointegration of the roundwood import volume with the roundwood import price at 5% significance level.

For the first differenced data, the fourth 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 year-to-year differencing in the original level.

2. Cointegration test

Table 2 shows the result of the cointegration test of roundwood import volume with roundwood import price. All the absolute estimated values did not exceed the absolute critical value at 5% significance level. That is, roundwood import volume does not have cointegration with roundwood import price. So, vector autoregressive model can be used with differenced data.

3. Model estimation

The result of model estimation is as follows(SRI: softwood roundwood import volume, SRP: softwood roundwood import price, HRI: hardwood roundwood import volume, HRP: hardwood roundwood import price).

Roundwood import volume was explained by the import volume and import price in the previous period. The significance levels of F-statistics in the softwood and hardwood roundwood import equations rejected the hypothesis that all coefficients are zero. So, we concluded that roundwood import volume can be explained

Table 3. Result of model estimation.

dependent variable		
softwood roundwood import volume	14.56 + 0.70 SRI(-1) - 1.08SRP(-1) (3.83)*** (7.69)*** (-3.44)***	F-statistic=64.44 Prob(F-statistic)=0.00 Adjusted R-squared=0.78 Q-statistic=0.25 Prob(Q-statistic)=0.69 RMSE= 0.15
hardwood roundwood import volume	6.41 + 0.94 HRI(-1) - 0.58 HRP(-1) (2.49)*** (12.38)*** (-2.83)***	F-statistic=105.11 Prob(F-statistic)=0.00 Adjusted R-squared=0.82 Q-statistic=0.29 Prob(Q-statistic)=0.67 RMSE= 0.12

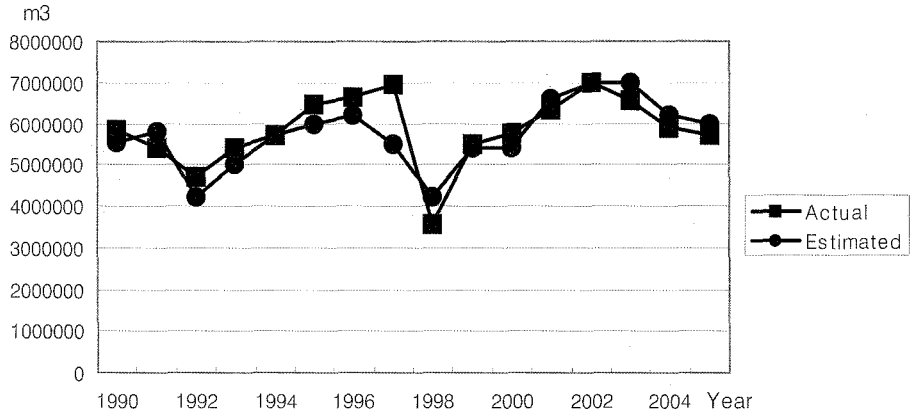


Figure 2. Comparison of the actual and estimated values of softwood roundwood import.

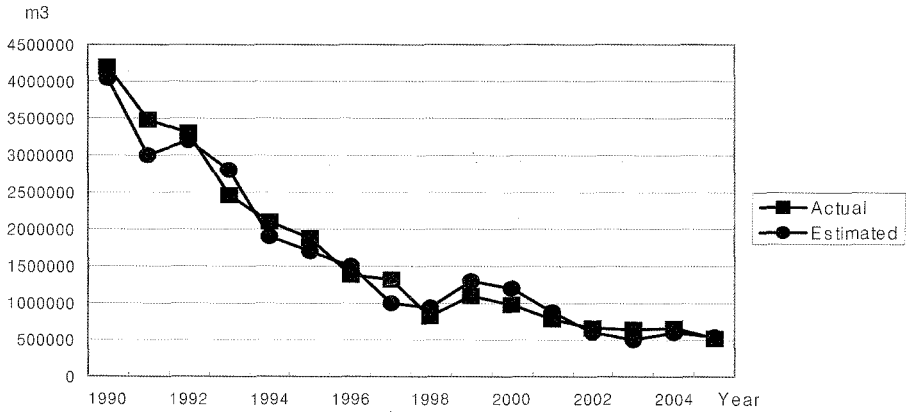


Figure 3. Comparison of the actual and estimated values of hardwood roundwood import.

by lagged roundwood import volume and lagged roundwood import price in Korea.

The result showed that the coefficient signs of all variables were as expected. T-statistics are in parentheses below the coefficients. All the coefficients were statistically significant at the one percent significance level. The VAR model has good explanatory power.

The Q statistic is from Ljung-Box Q test to test the presence of serial correlation. Durbin-Watson statistic cannot be used in the model when lagged respondent variable is used as explanatory variable. The results suggested that the error terms in the equation appeared free of serial correlation.

The actual values of roundwood import volume and the estimated values from the VAR model are shown in Figure 2.

Conclusion

This study presented a first attempt to develop the roundwood import prediction model using VAR method. The roundwood was divided into softwood and hardwood by species. The VAR model of roundwood import was specified with two lagged endogenous variables, that is, roundwood import volume and roundwood import price. The significance levels of F-statistics in the softwood and hardwood roundwood import equations rejected the hypothesis that all coefficients are zero. So, we concluded that roundwood import volume can be explained by lagged import volume and lagged import price in Korea. The coefficient signs of all variables were as expected. Also, the model has good explanatory power, and there is no autocorrelation.

The result of this study is limited. The use of vector autoregressive model is justified by using asymptotic distribution theory. Coefficients are asymptotically normal only if they are of a variable that is stationary and which does not appear in any of stationary linear combinations (Alavalapati *et al.*, 1996). If any linear combination is stationary, vector error correction model should be used.

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