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Causality of Forest Inventory and Roundwood Supply in Korea

Dong-Jun Kim[1]* and Eui-Gyeong Kim[2]

[1]*Chungbuk National University, Cheongju 361-763, Korea*
[2]*Gyeongsang National University, Jinju 660-701, Korea*

Abstract : This study confirmed econometrically the causality of forest inventory and roundwood supply using Korean data. In general, forest inventory is included as explanatory variable in roundwood supply function. We checked whether each series is stationary or not before using it in the model, and determined whether the combination of the series is cointegrated. The relationship between forest inventory and roundwood supply was represented by bivariate vector autoregressive model. The causality of forest inventory and roundwood supply was measured by the causality test of Granger. There appeared to be no evidence of the causal relationship between change in forest inventory and change in roundwood supply in Korea. That is, change in forest inventory does not cause change in roundwood supply in Korea. It seems reasonable not to include forest inventory as explanatory variable in roundwood supply function in Korea.

Key words **:** *forest inventory, roundwood supply, vector autoregressive model, causality test*

Introduction

Forest inventory has increased steadily since 1975 owing to the maintenance of forestation policy in Korea. However, most of raw material for building and construction is imported from foreign countries. Roundwood production increased in the 1980's, but decreased in the 1990's. Especially, it decreased abruptly because of economic recession in 1997. It decreased in the 2000's.

Change in forest inventory is regarded as the cause of change in roundwood supply. So, forest inventory is, in general, included as explanatory variable in roundwood supply function.

There are a few causality studies using Korean data. Son (1991) analyzed the causality of land value and macro-economic variables using Granger causality test. The results showed that GDP, construction product, price index, and interest rate caused land value change. Kim *et al.* (2003) estimated the impacts of currency value change on forest products import quantities using Korean data. The results by Granger causality test showed that currency value change caused softwood roundwood import quantities in Korea. And Kim (2001) estimated the impacts of building permit area change on forest products import quantities using monthly data. The results by Granger causality test showed that building permit area change caused fiberboard import quantities in Korea.

*Corresponding author
E-mail: kdj63@chungbuk.ac.kr

It is meaningful to confirm the causality of forest inventory and roundwood supply econometrically. The objective of this study is to confirm econometrically the causality of forest inventory and roundwood supply using Korean data. The causality provides an indication of whether forest resource variable can explain roundwood supply efficiently. The result of this study may contribute to the roundwood sector model specification.

Data Collection

Data collected are as follows:
1) Korean forest inventory
2) Korean roundwood production

Data for the period of thirty years from 1975 to 2004 were used. The data used are at the yearly level. This produced thirty observations for forest inventory and roundwood production.

Methods

The relationship between forest inventory and roundwood supply was represented by bivariate vector autoregressive model. The causality of roundwood supply with forest inventory was measured by the causality test of Granger.

1. Unit root test

An implicit assumption underlying regression analysis involving time series data is that such data are stationary.

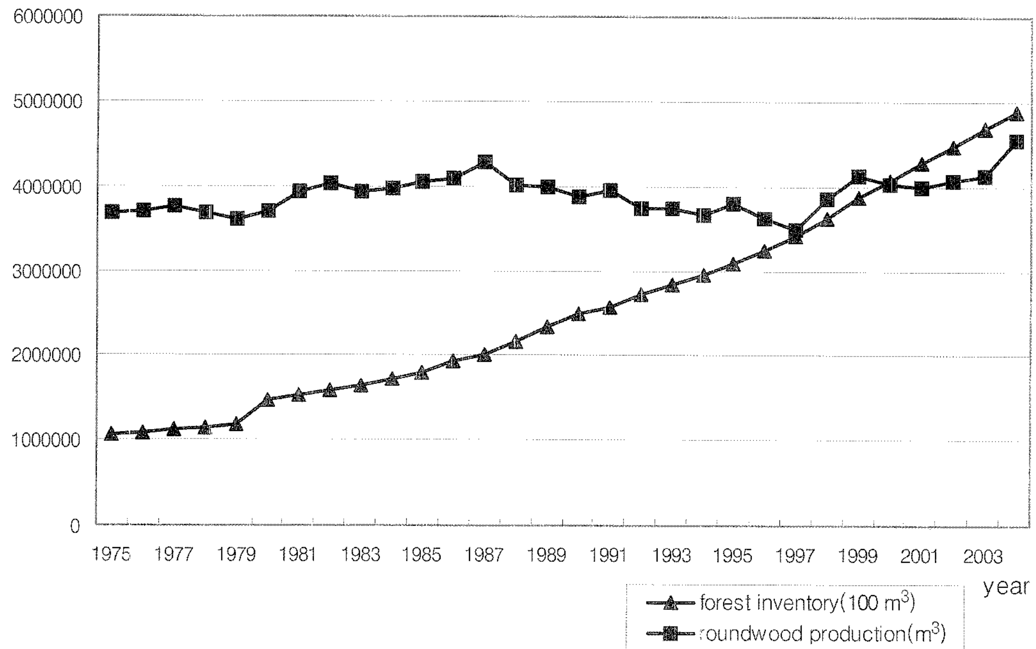

Figure 1. Change in forest inventory and roundwood production.

Stationarity means that the mean and autocovariances of a series do not depend on time. Standard estimation procedures cannot be applied to the model that contains a nonstationary dependent variable or explanatory variables (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 the unit root test.

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

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

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

where y_t is forest inventory, and x_t is roundwood production.

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-mentioned 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[1] 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 forest inventory and roundwood production 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 forest inventory, and x_t is roundwood production.

If we find that the error term, u_t, is stationary, then we say that forest inventory and roundwood production 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 autore-

[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).

gressive 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

Our goal is to confirm econometrically the causality of forest inventory and roundwood supply.

The relationship between forest inventory and roundwood supply was represented by bivariate vector autoregressive model, both treated as endogenous variables.

The model of this study is

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

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

where y_t is forest inventory, x_t is roundwood production, 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 (4) and (5) were 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.

4. Causality test

Although regression analysis deals with the relationship of one variable to others, it does not necessarily imply causality. The causality test of Granger was done to test the presence of causal relationship between change in forest inventory and change in roundwood supply. That is, an F test of the hypothesis that forest inventory change does not cause roundwood supply change was performed. And, assuming that there is the causality between change in forest inventory and change in roundwood supply, the test values were compared.

Table 1. Result of unit root test.

Variable	Original data	First differenced data
Forest inventory	-0.72	-4.36**
Roundwood production	-1.32	-3.89**

The values represent augmented Dickey-Fuller test statistics.
The critical value at 5% significance level is -2.98.
**Reject the null hypothesis that the time series is nonstationary at 5% significance level.

Results and Discussion

Table 1 shows the result of unit root test. 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 year-to-year differencing in the original level.

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

The results of model estimation are as follows(LFI: forest inventory, LRP: roundwood production).

The significance level of F-statistic in the equation rejected the hypothesis that all coefficients are zero. And the coefficient sign of forest inventory variable was as expected.

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 result suggested that the error term in the equation appeared free of serial correlation.

Table 4 shows the result of the causality test between

Table 2. Result of cointegration test.

Variable	Forest inventory
Roundwood production	4.04

The value represents 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 production with the forest inventory at 10% significance level.

Table 3. Result of model estimation.

Explanatory variable		LRP(-1)	LFI(-1)
Coefficient		0.77	0.02
T-statistic		4.81***	1.18
Adj. R^2		0.54	
F-statistic	15.17	Prob(F-statistic)	0.00
Q-statistic	0.71	Prob(Q-statistic)	0.70

Table 4. Result of causality test.

Variable	Forest inventory
Roundwood production	0.24

The value represents F test statistic.
*Reject the null hypothesis that the forest inventory change does not cause the roundwood production change at 10% significance level.

change in forest inventory and change in roundwood supply. There appeared to be no evidence of the causal relationship between change in forest inventory and change in roundwood supply. That is, change in forest inventory does not cause change in roundwood supply in Korea. It seems reasonable not to include forest inventory as explanatory variable in roundwood supply function in Korea.

Conclusion

Change in forest inventory is regarded as the cause of change in roundwood supply. So, forest inventory is, in general, included as explanatory variable in roundwood supply function.

This study presented a first attempt to confirm econometrically the causality of forest inventory and roundwood supply using Korean data. The causality provides an indication of whether forest resource variable can explain roundwood supply efficiently.

There appeared to be no evidence of the causal relationship between change in forest inventory and change in roundwood supply in Korea. That is, change in forest inventory does not cause change in roundwood supply in Korea. It seems reasonable not to include forest inventory as explanatory variable in roundwood supply function in Korea.

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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