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Sustainable Forest Management and West Malaysian Sawntimber Supply Analysis

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Abstract

This paper examines the dynamic effects of sustainable forest management (SFM) on the West Malaysian sawntimber supply. Both short-run and long-run effects on sawntimber supply are studied using a multivariate cointegration analysis. The proxy of SFM variable is permanent forest reserve. It is expected as an exogenous negative shock in the sawntimber supply. In general, given the fact that West Malaysian sawntimber supply is decreasing since 1990s, the results show that sawntimber supply is statistically influenced by SFM practices. Furthermore, reducing of harvested area of forest has significant effect on sawntimber supply decreases. While in the short-run, the results suggest that there are negative impacts of SFM practices on sawntimber supply at 10 percent significant level, in the long-run, the result is significant at 1 percent level. This may to some extent pull down the West Malaysian sawntimber supply together by bringing the forest harvests to sustainable level.

Keywords: Sustainable forest management, Sawntimber supply, Cointegration analysis

1. Introduction

The calculation of the allowable cut was an important element of forest management. It is expressed in term of forest area of wood volume to be harvested. The goal was to obtain a sustainable yield of the best possible yield. Mohd Shahwahid & Awang Noor (2002) revealed that the annual coupe was lower than the official approved annual coupe by 34%. In fact, in Peninsular Malaysia, annual coupes have been steadily declining and this is part of the conservation strategy to ensure sustainable timber production. Hence, the sustainable yield has been one of the basic views of forest management for a considerable length of time. Initially, the only goal or at least the main goal in mind of forester was usually wood production.

Recently, the forest conservation in West Malaysia was evaluated (with respect to quality as well as quantity) from a biological point of view, and a substantial increase in area of forest reserve was recommended (Salahuddin, 1996). This does not have just negative impacts to supply of logs but also to the wood-based products in particularly is sawntimber. Based on the Forest Department Peninsular Malaysia (FDPM) Statistics (2005), the supply of logs increased gradually with a slight fluctuation from 6.5 million m^3 in 1970 to 13.0 million m^3 in 1992 with an average growth rate of 4.5 percent per year and then decreased to 4.4 million m^3 in 2005 with an average reduction rate of -5.1 percent per year. This decline in log production was mainly due to the reduction of annual coupes resulting from the Rio Convention and Malaysia's need to achieve ITTO objectives 2000 and international certification standard in attaining SFM (Lim, 2002). In the case of sawntimber supply from natural forest, almost the same pattern is indicated as well as log production. The supply of sawntimber has increased from 2.3 million m^3 in 1970 to 6.2 million m^3 in 1990 with an average rate of growth annually of 8.5 percent and then gradually decreased to 3.2 million m^3 in 2005 with an average reduction rate of -3.2 percent per year. In general, we can say that, timber and timber products particularly sawntimber have faced the same impact of decreasing its productions since 1990s.

There exist a large number of studies on costs connected to forest conservation, but only a few studies address consequences on the timber and forest products markets. Perez-Garzcia (1993), Sedjo *et al.*, (1994), Sohngen *et al.*, (1999) are among the exceptions in this regards. At the national level, Barbier *et al.*, (1995) analysed economic effects of imposing sustainable forest management in Indonesia using simulation approach. The econometric analysis of forest conservation on timber price and harvest level were examined empirically by Linden & Uusivuori (2002), based on historical data from Finland. In addition, local studied done by Mohd Shahwahid (1995), concluded that, in the event of reduce logging hectarage (due to strict conservation measures), price should provide an adequate incentive to encourage further extraction of log. The incentive should be enough to cover the marginal cost of extraction, transportation and royalty payment. Another study concludes that in Finland, annual timber-selling income was unchanged after the increased of conservation since the decreased harvest and increased price were of the same relative magnitude. Finally, Leppanen *et al.*, (2005) study the market impacts of increased forest conservation in Finland using a dynamic econometric model. The results confirm that conservation increases timber prices and decreases the harvest, but the impact on forest industrial output and timber imports were projected to be less than the *a priori* expectation (Leppanen *et al.*, 2005).

There are several studies have used the cointegration method to analysed their studies. For example, Silvapulle & Jayasuriya (1994) analysed the Philippines rice market integration by using multiple cointegration approach. Kugler & Lenz (1993) used multivariate cointegration analysis to test the long run validity of purchasing power parity and Bahmani-Oskoose & Mohsen (1986) used the same method to analysed the international trade flows in developing countries.

Hence, the purpose of this paper is to analyse the economic consequences on sawntimber supply from natural forest in term of domestic price, import price, area open for harvest and specifically on the different extents of permanent forest reserve in West Malaysia.

2. Methodology and Data

2.1 Production of Sawntimber Model

$LnSTSS_t^s = \beta_0 + \beta_1 \, LnSTDP_t + \beta_2 \, LnSTMP_t + \beta_3 \, LnHA_t + \beta_4 \, LnPRF_t \, \mu_t$

$\beta 1 > 0, \quad \beta 2 \quad > 0, \beta 3 < 0$ and $\beta_4 < 0$

where LnSTSS is the quantity of sawntimber production, LnSTDP is domestic prices of sawntimber, LnSTMP is import price of sawntimber, LnHA is the annual harvested area and LnPRF is the permanent reserve forest, μ is error term, and superscript *s* refers to supply and *t* for periods annually of that endogenous and exogenous variables. All the variables are log-transformed. The coefficient of domestic prices of sawntimber, β_1, is expected to be positive and it is also expected that the import price of sawntimber is positive sign because as domestic supply of sawntimber decrease, local industry will find substitute for sawntimber products from import market, annual harvest area is positively related to sawntimber supply; an increase in harvest area would spur the supply for Malaysian sawntimber and vice versa. Taking into consideration of the permanent reserve forest as proxy of SFM is generally expected to be negative. This would slightly diminish the sawntimber supply when the permanent reserve forest area is increases to be in line with the objective of SFM.

2.2 Unit Root Tests

In the long-run, unit root tests in autoregressive time-series models have received considerable attention in the econometric literature. The unit roots test is testing for the order of integration. The basic idea is that, the order of integration of a series is given by the number of time a series must be differentiated in order to produce stationary series. If a non-stationarity was detected in a series it is eliminated by differentiating the series until stationarity is obtained. In time series jargon, a non-stationary series which can be transformed to a stationary series by differentiating *d* times is said to be integrated of order *d* denoted by I~(d). If the first differentiated variable achieves stationarity, that variable is integrated of order one, I~(1). On the other hand, if the level of a variable is already stationary, that variable is integrated of order zero, I~(0). This stationarity can be verified by finding out if the time series contains a unit-root, that is, a non-stationary situation.

2.3 Johansen and Juselius (JJ) maximum likelihood test

Johansen & Juselius (1992) procedure posses several advantages over Engle and Granger method in testing for cointegration:

i. No prior assumption regarding the number of cointegrating vector;

ii. Assumes all variables as endogenous;

iii. Provides a unified framework for estimating and testing cointegration relations within the vector error correction model (VECM) formulation; and

iv. Unlike EG cointegration test, which use bivariate framework, ARDL bounds test allows a multivariate framework that enable us to include other relevant variables to avoid simultaneity and specification problems.

The procedure developed by Johansen which involves the identification of rank of the *m* by *m* matrix Π in the specification is given below:

$$\Delta Y_t = \delta + \Pi Y_{t-k} + \sum_{i=1}^{k-1} \Gamma_i \Delta Y_{t-k} + \nu_t$$

where X_t is a column vector of the *m* variables, Π and Γ are coefficient matrices, Δ is difference operator, k denotes the lag length, and δ is a constant. There are two tests provided, namely trace and maximal eigenvalue tests. The main importance of these two tests is that both tests have no standard distributions under the null hypothesis, although approximate critical values are tabulated by Osterwald-Lenum (1992). Nevertheless, Johansen & Juselius (1990) suggest that the maximal eigenvalue test is more powerful than the trace test.

Trace test:

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^{n} \ln(1-\hat{\lambda}_i)$$

Maximal eigenvalue test:

$$\lambda_{\max}(r, r+1) = -T \ln(1-\hat{\lambda}_{r+1})$$

where r is the number of cointegrating vector, $\hat{\lambda}$ is the estimate values of the characteristics roots obtain from the estimated Π matrix, T is the number of usable observations.

2.4 Vector Error Correction Model (VECM)

Vector autoregression (VAR) has been used primarily in macroeconomics. Early in their development, it was argued by some authors (i.e. Sim, 1980) that VARs would forecast better than the sort of structural equation models. One could argue that as long as the error term (μ) includes the current observations on the (truly) relevant exogenous variables, the VAR is simply an overfit reduced form of some simultaneous equations model (Hamilton, 1994). One of the virtues of the VAR is that it obviates a decision to what contemporaneous variables are exogenous; it has only lagged (predetermined) variables on the right-hand side, and all variables are endogenous. In addition to forecasting, VARs have been used for two primary functions, testing Granger causality and studying the effects of policy through impulse response characteristics (Engle & Granger, 1987).

2.5 The Data

This study was used the secondary data which represented the whole Peninsular Malaysia. All data were compiled from published sources of Malaysian Government publications, namely from the Annual Reports of the Forestry Department of Peninsular Malaysia, the Ministry of Primary Industries, the Malaysian Timber Industry Board and various issues related to all the publication by Malaysian Forestry Department. All of the data are time series annual basis from 1970 to 2005 and are in absolute value. These values are expressed in terms of Ringgit Malaysia (RM), meter cubic (m^3) and hectare (ha). The data set consists of four variables. The variables are production of sawntimber, domestic price of sawntimber, import price of sawntimber, annual harvest area and permanent forest area. All of the variables in the data set are transformed into natural logarithms for usual statistical reasons.

3. Results

This part presents and discusses the empirical analysis on the relationship between sawntimber supply and the several of independent variables including PRF the main factor that need to be analysed. PRF is a proxy of a factor of SFM practices. The complete analysis involves unit root test and Johansen & Juselius (1990) multivariate cointegration procedures. Regression analysis based on time series data implicitly assumes that the underlying time series are stationary. This analysis can be checked by finding out if the time series contain a unit root. The Augmented Dickey-Fuller (ADF) and Phillips Perron (PP) tests can be used for this purpose.

3.1 Unit Root Test

Table 1 shows the result of ADF and PP tests at level and first different. All of the independent and dependent variables are integrated of first order I(1). Given that all time series are stationary in first differentiate, we proceed to test for cointegration between sawntimber supply and other independent variables in examining the long run relationship between both of them.

3.2 Multivariate Cointegration Test

The results of the cointegration tests are presented in Table 2. The traced statistics indicate long-run relationship among the variables, where the null hypothesis of no cointegration at $r = 0$, $r \leq 1$ and $r \leq 2$ are rejected at 5 percent level where it is indicated that at least three (3) cointegrating equation(s) occurred. The maximum Eigen value statistics, on the other hand, indicate only one (1) cointegrating vectors where it is significant at 5 percent level. Since both the trace and maximum eigen value statistics reject the null hypothesis of no cointegration at r=0 and another two (2) null hypothesis in the trace statistic, we in this study, therefore assume that there exists at least one (1) and not less than three (3) cointegrating vector. We shall use this relationship to analyse the long-run behavior of the sawntimber supply.

The result of long-run analysis reveals that the domestic price of sawntimber, the import price of sawntimber and the permanent forest reserve are significant at 5 percent level in determining the sawntimber supply. While the annual harvested area shows that there is an empirically insignificant impact on sawntimber supply. From this result, it is clear that the West Malaysian sawntimber supply has negatively significant impact from the implementation of SFM practices. It is consistent as mentioned earlier that the sawntimber supply reveals the decreasing rate since 1990s at -3.2 percent annually until 2005 (FDPM, 2005).

The behaviour of the sawntimber supply is examined by estimating the vector error-correction model (VECM). Two (2) lags are chosen as it is sufficient to achieve white noise in the error term. The results of VECM showing the short-run dynamics of the sawntimber supply equation and the diagnostic tests are given in Table 3. The diagnostic tests indicate that the VECM is adequately specified. The Jarque-Bera statistic (JB) suggests that the residuals are normality distributed, the Breusch-Godfrey LM statistics indicate that there is no autocorrelation in the residuals by two (2) lags. The value R^2 of 0.7464 indicates that about 74.64 percent of the variation in the sawntimber supply is explained by all the independent variables. Furthermore, Chow's forecast test suggests that there was no structural break during the period of study.

Table 4 shows most of variables could not affect the sawntimber supply, except HA and PRF which are significant at 5 and 10 percent level respectively. The ECT in the model was also negatively significant which is good for the model. In the domestic price of sawntimber equation, none of the variables could affect the price of sawntimber and the ECT in the model was positively significant. In the import price of sawntimber equation, only domestic price is significant. In the annual harvested forest equation, none of the variables were influenced. Finally, the only significant variable in permanent forest reserve equation is annual harvested area at 1 percent level while the rest are not significant including error correction term.

4. Conclusion

In this study, we have examined the long-run and short-run relationships between the West Malaysian sawntimber supply with the domestic price of sawntimber, import price of sawntimber, annual harvested area and permanent forest reserve as a proxy of SFM practices. A cointegration analysis is carried out to identify the long-run relationship among the variables. The results show that by complying with SFM criteria, there is a disruption in the sawntimber supply. Furthermore, in the long-run, an increase in domestic price of sawntimber would help to compensate for lost volumes these days. On the other hand, the short-run dynamics of sawntimber supply is by referring to the ECT. The VECM results show that a substantial portion of the adjustment to the long-run equilibrium takes place and there are insignificant impacts on sawntimber supply in the short run except by the annual harvested area. Furthermore, the results obtained in Granger causality tests indicate that the domestic price of sawntimber and import price of sawntimber do not stands as an important determinants of sawntimber supply in the short-run except annual harvested area and permanent forest reserve. Hence, we can conclude that, West Malaysian sawntimber supply has been affected in the short-run as well as in the long-run as a result of complying with the sustainable forest management policy.

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Table 1. Results of Unit Root Test

Variable	Level (trend & intercept)		First difference (trend & intercept)	
	ADF	PP	ADF	PP
LnSTSS	-2.2558	-2.2693	-5.7010***	-5.6998***
LnSTDP	-1.2715	-1.4104	-4.7401***	-4.7457***
LnSTMP	-2.3257	-2.2350	-7.6161***	-7.7133***
LnHA	-1.9574	-2.0701	-6.3378***	-6.4078***
LnPRF	-1.6415	-1.7942	-2.9323*	-2.9097*

Notes: ***Significant at 1 percent: Critical value = -3.6394, **Significant at 5 percent: Critical value = -2.9511, *Significant at 10 percent: Critical value = -2.6143, LnSTSS (Production of Sawntimber), LnSTDP (Domestic Price of Sawntimber), LnSTMP (Import price of Sawntimber), LnHA (Annual harvested area) and LnPRF (Permanent Reserve Forest).

Table 2. Johansen's Test for the Number of Cointegrating Vectors (VAR with 2 Lags)

Null	Trace		Maximal Eigen value	
	Statistic	5% critical value	Statistic	5% critical value
R = 0	87.57**	69.82	35.79**	33.89
R ≤ 1	51.78**	47.86	21.45	27.58
R ≤ 2	30.33**	29.80	19.12	21.13
R ≤ 3	11.21	15.49	10.01	14.26
R ≤ 4	1.20	3.84	1.20	3.84

Co-integration Equation:

LnSTSS = 52.37 + 2.138 LnSTDP - 0.8340 LnSTMP + 0.7529 LnHA - 3.5250 LnPRF

[3.120]** [2.2143] ** [1.5384] [3.9961]**

Notes: ** significant at 5 percent level,
The values in the parentheses [] are the t-values

Table 3. VECM Results; Dependent Variable is Production of Sawntimber

Lags	ECT[a]	ΔSTSS[a]	ΔSTDP[a]	ΔSTMP[a]	ΔHA[a]	ΔPRF[a]	C[a]
1	-0.1099* [-2.0022]	-0.1012 (-0.5589)	0.2219 (0.9951)	-0.0536 (-1.1415)	0.2615 (3.0913)**	0.6401 (0.8595)	-0.0143 (-0.4545)
2		-0.1616 (-0.9685)	-0.2078 (-1.0463)	0.0758 (1.5753)	-0.2277* (-2.0271)	0.8687 (1.2083)	

Diagnostics tests

R^2 = 0.7464, Normality test: JB ~ χ^2 = 0.25(0.8825), CHOW test: Prob. F(7,20) = 0.1590, Breush-Godfrey LM test: Prob. F(1,28) = 0.9236

Notes: [a] The values in parentheses are *t*-statistics
**significant at 5 percent level, * significant at 10 percent level
STSS (Production of Sawntimber), STDP (Domestic Price of Sawntimber), STMP (Import price of Sawntimber, HA (Annual harvested area), PRF (Permanent Reserve Forest), ECT (Error Correction Term), C (intercept)

Table 4. Granger Causality Tests

Wald Statistics	ΔSTSS[a]	ΔSTDP[a]	ΔSTMP[a]	ΔHA[a]	ΔPRF[a]	ECT[b]
ΔSTSS	-	1.2619 (0.5321)	1.3030 (0.2537)	8.3189** (0.0156)	5.5757* (0.0616)	-0.1099* [-2.0022]
ΔSTDP	0.8699 (0.6473)	-	2.9315 (0.2412)	0.2174 (0.8970)	0.8817 (0.6435)	0.1267** [2.3115]
ΔSTMP	0.2920 (0.8641)	5.0925* (0.0784)	-	0.7043 (0.7032)	4.2489 (0.1195)	-0.2008 [-1.5425]
ΔHA	3.4559 (0.4711)	0.4548 (0.7066)	0.0658 (0.9676)	-	0.3687 (0.8316)	-0.1703 [-0.7798]
ΔPRF	2.2415 (0.3260)	0.2749 (0.8716)	2.2017 (0.3326)	9.7979*** (0.0075)	-	0.0138 [0.9644]

Notes: [a]The values in parentheses are the probabilities,
[b]The values in parentheses () and [] are the *p*-value and *t*-statistics respectively.
***Significant at 1 percent level, **Significant at 5 percent level and * Significant at 10 percent level
STSS (Production of Sawntimber), STDP (Domestic Price of Sawntimber), STMP (Import price of Sawntimber), HA (Annual harvested area), PRF (Permanent Reserve Forest), ECT (Error Correction Term)