SHORT- AND LONG-RUN EFFECTS OF SUSTAINABLE FOREST MANAGEMENT PRACTICES ON WEST MALAYSIAN LOG SUPPLY: AN ARDL APPROACH

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ABDUL RAHIM AS & MOHD SHAHWAHID HO. 2009. Short- and long-run effects of sustainable forest management practices on West Malaysian log supply: an ARDL approach. The Malaysian log supply is facing deficit since 1995; thereafter major timber products have moved from resource surplus to one of deficit. It seems obvious that without planted forest in the future, the timber industries have almost reached the limit for growth. The log supply model for West Malaysia is based on an equation of domestic log supply from natural and planted forests as a function of weighted price of log, annual logging area and royalty of logs. The results showed that the bounds test of log supply model was cointegrated at 10% significance. The short-run analysis revealed that log supply would increase as the price of logs increased. However, in the long run, it would lead to substantial reduction in the log supply. This is because when the price of logs increases, the log supply tends to decrease. It is believed that this is due to controlled production and the stringent harvesting regulation to achieve sustainable forest management. Furthermore, an increase in domestic price of logs would help to compensate for the lost volumes in the long run.

Keywords: Cointegration analysis, price of logs, timber products, conservation, design strategies

ABDUL RAHIM AS & MOHD SHAHWAHID HO 2009. Kesan jangka pendek dan jangka panjang pengurusan hutan mampan ke atas penawaran kayu balak di Semenanjung Malaysia: Pendekatan ARDL. Penawaran kayu balak di Malaysia berkurangan sejak 1995; seterusnya trend keluaran kayu utama beralih daripada lebihan sumber kepada kekurangan. Tanpa perladangan hutan pada masa depan, industri kayu pasti akan menghadapi pertumbuhan yang terhad. Model penawaran kayu balak di Semenanjung Malaysia berdasarkan persamaan bagi penawaran kayu balak domestik dari hutan asli dan hutan ladang yang bergantung pada harga wajaran balak, kawasan pembalakan tahunan dan royalti. Keputusan menunjukkan bahawa ujian batasan bagi model penawaran kayu balak berkointegrasi pada 10% tahap signifikan. Analisis jangka pendek menunjukkan bahawa penawaran kayu balak akan meningkat apabila harga kayu balak meningkat. Bagaimanapun dalam jangka panjang, penawaran kayu balak akan mengalami pengurangan yang besar. Ini kerana apabila harga kayu balak meningkat, penawaran cenderung berkurangan. Ia dipercayai akibat kawalan pengeluaran dan undang-undang pembalakan yang ketat bagi mencapai pengurusan hutan secara mampan. Seterusnya, peningkatan harga kayu balak dapat mengimbangi kekurangan kuantiti dalam jangka panjang.

INTRODUCTION

Malaysia is committed to managing its natural production forests in a sustainable manner to ensure continued timber production, maintain forest multiple functions, conserve biodiversity and control environmental impact (Anonymous 1994, 1996). To achieve these aims, substantial information and better understanding of the growth and ecology of the forest stands are required. This is essential to manage and determine the cutting regime that best suits the forest stand, site, environment, cutting cycle and expected timber output (Anonymous 1994). The sustainable management definition and objectives require maintenance of the forest stand re-generation not only for timber production but also for environmental stability, biodiversity conservation, recreational preservation and other forest product and forest component conservation.

These forest functions have been refined and further stressed in the 1992 revised Malaysia

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National Forest Policy. Malaysia is committed to achieving the International Tropical Timber Organization (ITTO) Year 2000 Target of sustainable forest management. For forest to be sustainable, it requires to fulfil several criteria, namely, environment, economic and social. Sustainable forest management (SFM) has led to greater planning and monitoring of the environment. It focuses on minimizing environmental damage during and after logging process. In terms of economy, there is cost incurred due to additional forest management activities in order to comply with SFM.

To achieve SFM, Malaysia has committed to maintain at least 50% of the land area under forest cover. With a total land area of 32.9 million ha, the natural forest base currently stands at 18.9 million ha. Of this, a total of 14.1 million ha of natural forests have been designated as Permanent Forest Estate (PFE) which will be permanently managed. The Malaysian government has imposed limits on the opening of annual PFE for harvesting, which is called annual coupe. This is part of the conservation strategy to ensure sustainable timber production (Mohd Shahwahid & Awang Noor 2002).

The production of logs increased gradually with slight fluctuations from 6.5 million m^3 in 1970 to 13.0 million m^3 in 1992 and then decreased to 4.4 million m^3 in 2005 (Figure 1). The 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 2000 objectives and international certification standard in attaining SFM (Lim 2002). On the other hand, from 1995, the consumption of logs was greater than the production. This pressured the industry and led to serious establishment of forest plantations. Freezailah (2001) mentioned that an increase in the extent of conservation areas would reduce the area of production forests. The resulting shortfall in timber production can be met from plantation forests. However, Awang Mohdar and Ahmad Zuhaidi (2005) stated that in spite of the high demand for timber worldwide and the upsurge in price over the years, forest plantation in Malaysia was developing at a very slow pace.

The calculation of the allowable cut is an important element of forest management. It is expressed in terms of forest area of wood volume to be harvested. The goal is to obtain a sustainable yield of the best possible yield. Mohd Shahwahid and Awang Noor (2002) revealed that the annual coupe was lower than the official approved annual coupe by 34%. In fact, in West Malaysia, annual coupes have been steadily declining. This is part of the conservation strategy to ensure sustainable timber production. Furthermore, in recognition of the need to strengthen SFM, Malaysia has undertaken the critical step to reduce the annual coupe or allowable cutting rate (AAC) in the

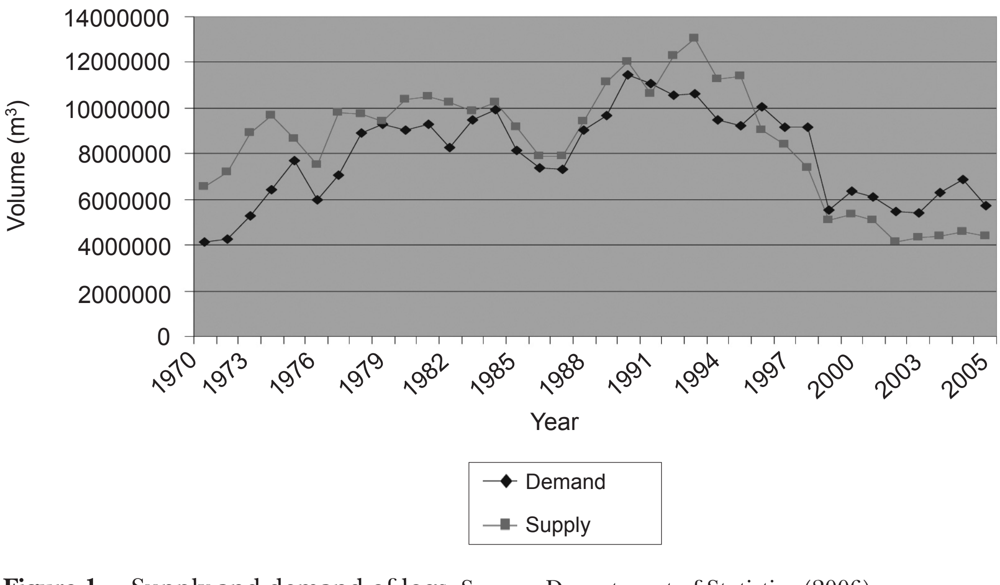

Figure 1 Supply and demand of logs. Source: Department of Statistics (2006).

country (Woon & Tong 2004). Another study by Palo and Mery (1996) revealed that, in the short term, SFM processes caused reductions in harvested volume and consequently affected wood supply. Woon (2001) indicated that, as a result of decreasing log supply, the number of mills in operation would be drastically reduced to about 200 sawmills, 8 plywood/veneer mills and 32 moulding mills in five till seven years' time.

On the other hand, Schwarzbauer and Rametsteiner (2001) have analysed the potential impacts of SFM certification on forest product markets using a simulation model of the Western European forest sector. The empirical evidence shows that the market impact of timber supply reduction from certified forest would be more distinct than the impact of chain of custody costs. Further, Eriksson *et al.* (2007) indicated that full adoption of the Forest Steward Council standard on the entire land base can result in a substantial reduction in supply. It could also induce a price increase in situations where supplied quantities are maintained at the current level.

Therefore, the proficient analysis on the behaviour of log supply is needed particularly in the short and long run. This will help the industry to design strategies in facing the various impacts of SFM practices. Moreover, wood is an essential raw material for the local industries such as those manufacturing furniture and building frame structures, which are heavily concentrated in West Malaysia. The analysis is also important for the government as a guideline to implement policies and strategies in future.

METHODOLOGY

Data

In dealing with time series analysis, there is a large number of empirical studies utilizing the unrestricted reduced-form model in the Vector Autoregression (VAR) context to investigate the effect of forest-related policy on forest products (Laaksonen *et al.* 1997, Hanninen 1998, Nanang 2000, Stordal & Nyrud 2003). VARs are dynamic systems of equations that examine the interrelationship between economic variables, using minimal assumptions about the underlying structure of the economy. Since the right-hand side of the models consists of only predetermined variables and the error terms are the ordinary least square (OLS) method in estimating the VAR model, it is well known from the literature on simultaneous equation estimation that the OLS method yields efficient estimates of the VAR coefficients. In recent study, on the other hand, Baek (2007) has used autoregressive distributed lag (ARDL) model to analyse the forest products trade in the United States.

The cointegration techniques such as Engle and Granger (1987) or Johansen types (Johansen 1988, Johansen & Juselius 1990) are commonly used in empirical economics to study the existence of long-run equilibrium relationship in levels between variables. These methods involve a pre-testing step for unit roots in order to determine the order of integration of the variables in the model. In particular, they require all variables under study to be integrated to the same order of one, that is I(1). In practice, however, not all variables have a unit root. Some variables are stationary in level, I(0), while others might have two unit roots, I(2), or stationary in second differences. If the orders of integration of the variable under study are different, it will cast doubt on the accuracy and validity of the estimation results obtained from the above cointegration testing procedures.

Engle and Granger (1987) highlighted that if the time series is non-stationary, one can include lagged dependent and independent variables using a sufficiently complex dynamic specification such as an ARDL model to ensure the residual stationary. As such, in this study, ARDL bounds testing approach proposed by Pesaran *et al.* (2001) was used to allow the regressors to have different orders of integration, either I(1) or I(0), in estimating the functions. The bounds test which is based on the estimation of an unrestricted error correction model (UECM) is applicable irrespective of whether the underlying regressors are purely I(0), I(1) or mutually cointegrated. Furthermore, the ARDL model is more robust and performs better for a small sample size than standard cointegration methods (Pesaran & Shin 1999).

Empirical model

To construct the ARDL model, we adopted and modified the domestic supply of logs model by Mohd Shahwahid (1993):

$$DS_t^* = a_0 + a_1 DP_t + a_2 LA_t + a_3 R_t \qquad (1)$$

where DS is the desired domestic supply or production at time t; DP_t is the domestic price of forest log at time t; LA_t is the annual logging area at time t; and R_t is the royalty payments from logging operations at time t. To illustrate the ARDL modeling approach, we then express eq. (1) in a log linear form as follows:

$$\ln DS_t^* = a_0 + a_1 \ln DP_t + a_2 \ln LA_t + a_3 \ln R_t + \varepsilon_t \quad (2)$$

Hence, macroeconomic variables used in this study are most likely referred from eq. (2). They are the quantity of log supply (lnLOGSS), weighted price of logs (lnLOGWP), annual logging area (lnLOGAREA) and the royalty of log (lnLOGROY) in natural logarithmic form. We obtained weighted price of logs via summation of price of log by species multiply by ratio of log quantity by species at a particular year. The dependent variable is the quantity of log supply.

The ARDL approach involves estimating the error correction version of the ARDL model for variables under estimation (Pesaran *et al.* 2001). From eq. (2), the ARDL model of interest can be written as follows:

$$\begin{aligned}\Delta \ln LOGSS_t &= \beta_0 + \beta_1 \ln LOGSS_{t-1} + \beta_2 \ln LOGWP_{t-1} + \beta_3 \ln LOGAREA_{t-1} + \beta_4 \ln LOGROY_{t-1} + \sum_{i=0}^{p} \alpha_5 \Delta \ln LOGSS_{t-1} \\ &+ \sum_{i=0}^{p} \theta_6 \Delta \ln LOGWP_{t-1} + \sum_{i=0}^{p} \delta_7 \Delta \ln LOGAREA_{t-1} + \sum_{i=0}^{p} \varphi_8 \Delta \ln LOGROY_{t-1} + \varepsilon_t \quad (3)\end{aligned}$$

where $\ln LOGSS_t$, $\ln LOGWP_t$, $\ln LOGAREA_t$ and $\ln LOGROY_t$ are as mentioned above; Δ denotes a first difference operator; ln represents natural logarithmic transformation; β_0 is intercept and ε_t is a white noise error term.

There are two steps in testing the cointegration relationship between $\ln LOGSS_t$, $\ln LOGWP_t$, $\ln LOGAREA_t$ and $\ln LOGROY_t$. First, the model above is estimated by OLS technique. Second, the null hypothesis of no-cointegration H_o: $\beta_1 = \beta_2 = \beta_3 = \beta_4 = 0$ is tested against the alternative of H_1: $\beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq 0$ by the means of F-test. Two sets of critical value bounds for the F-values are generated by Pesaran *et al.* (2001). If the computed F-value falls below the power bounds critical value, the null hypothesis of no cointegration cannot be rejected. On the contrary, if the computed F-value lies above the upper bounds critical value, the null hypothesis is rejected. This implies that there is a long-run cointegration relationship among the variables in the model. Nevertheless, if the calculated value falls within the bounds, inference is inconclusive.

The general-to-specific procedure by Hendry and Ericson (1991) can be used to obtain a parsimonious UECM by dropping sequentially the insignificant first difference variables. The long-run elasticity of the independent variable was then calculated over the estimated coefficient of one-lagged level dependent variable (multiplied with a negative sign). For instance, the estimated long-run coefficients of $\ln LOGWP_t$, $\ln LOGAREA_t$ and $\ln LOGROY_t$ in the model above can be obtained by taking the ratios of $-\frac{\beta_2}{\beta_1}$, $-\frac{\beta_3}{\beta_1}$ and $-\frac{\beta_4}{\beta_1}$ respectively. For the short-run elasticity of the independent variable, it is captured by the estimated coefficients of the first differenced variable in ARDL model above. In addition, we detected the short-run causality through the error correction representation for selected ARDL model.

This study intended to evaluate the impact of SFM on West Malaysian log supply based on annual data from 1970 till 2005. Published annual data on log supply, weighted price of logs, logging area and royalty were made available by the Forest Department of Peninsular Malaysia, the Ministry of Primary Industry and Department of Statistics. The monthly data on domestic log prices were obtained from *Maskayu*. We used weighted price of logs instead of the average price of logs by species. This is due to the availability of price of logs in various species and to enhance accuracy.

RESULTS AND DISCUSSION

Approach

The ARDL approach in this analysis involves several steps (Pesaran & Pesaran 1997). As mentioned earlier, this model does not require the unit root test. Hence, we directly proceeded to the bounds test analysis of the determinant of log supply in West Malaysia. Then, we estimated the long-run coefficient of log supply. Finally, we estimated the short-run error correction representation for the selected ARDL model of log supply. All of these analyses were carried out using Microfit 4.

ARDL bounds testing

The methods adopted in the literature in previous years mainly concentrated on cases in which the underlying variables were integrated to the order I(1) (Pesaran *et al.* 2001). The ARDL approach has some advantages over other approaches. Firstly, the series used do not have to be I(1) (Pesaran & Pesaran 1997). Secondly, even with small samples more efficient cointegration relationships can be determined (Ghatak & Siddiki 2001). Finally, the ARDL approach overcomes the problems arising from non-stationary time series data which lead to spurious regression coefficient that are biased towards zero (Laurenceson & Chai 2003).

In the ARDL estimation of log supply for West Malaysia, the significant variables are lnLOGSS(-1) at 1% level, lnLOGWP at 10% level and lnLOGWP(-1) at 1% level (Table 1a). Only lnLOGWP and lnLOGSS(-1) determined the log supply while the rest were insignificant. For example, an increase in price of logs would increase the log supply as the coefficient of correlation was a positive sign. However, the result for price of logs by lag one period revealed that it was negatively correlated with log supply. Furthermore, based on the goodness of fit of the ARDL model, it is clear from Table 1(a) that the model is well fitted as it passes all the diagnostic tests. The diagnostic tests revealed no evidence of misspecification. Also no evidence of autocorrelation was found. To test for structural stability, we utilized the cumulative sum of recursive residuals (CUSUM) and CUSUM of square stability test and it indicated that the estimated coefficients of the model were stable (Figures 2a and 2b). Furthermore, there was cointegrating relationship given that the computed F-value was greater than the upper bounds critical value at 10% level of significance (see Table 1b).

Table 1(a) ARDL estimation of log supply for West Malaysia

Variable	Coefficient	Standard error	t-statistic	p-value
lnLOGSS(-1)	0.79206	0.07585	10.4415	0.000
lnLOGWP	0.26023	0.14093	1.8465	0.075
lnLOGWP(-1)	-0.44877	0.15262	-2.9405	0.007
lnLOGAREA	-0.08625	0.13961	-0.61786	0.542
lnLOGROY	-0.01912	0.14351	-0.13325	0.895
C	5.4637	3.4024	1.6059	0.120

Diagnostic tests:	
R^2	0.92336
R^2	0.90968
Durbin Watson-d	1.9268
Serial Correlation	0.850
Functional Form	0.197
Heteroscedasticity	0.984
CUSUM	Stable
$CUSUM^2$	Stable

Table 1(b) Cointegration result of bounds test for West Malaysia lnLOGSS

Variables: lnLOGSS, lnLOGWP, lnLOGAREA, lnLOGROY		
Computed F-value: 3.6218*	Critical value	
	Lower bounds	Upper bounds
10% significance	2.618	3.532
5% significance	3.164	4.194
1% significance	4.428	5.816

The bounds critical values were obtained from Narayan *et al.* (2000); Critical values for the bounds test: Case II: restricted intercept and no trend (k = 3); *Significant at 10% level

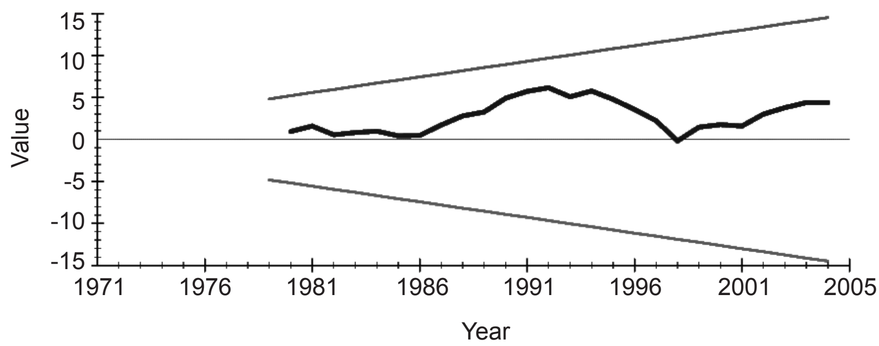

Figure 2(a) Plot of cumulative sum of recursive residuals. The straight lines represent critical bounds at 5% significance level.

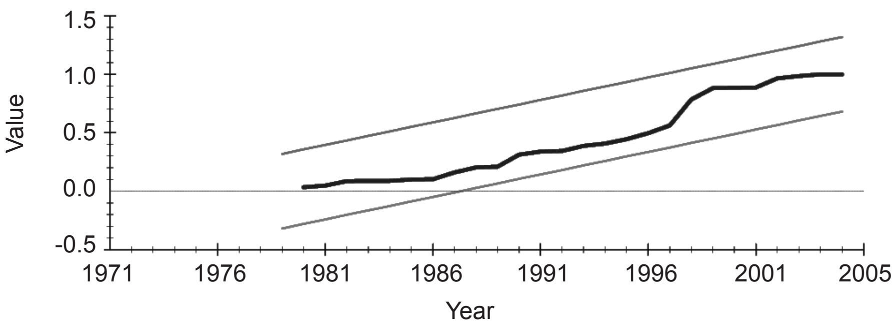

Figure 2(b) Plot of cumulative sum of squares of recursive residuals. The straight lines represent critical bounds at 5% significance level.

Then, we estimated the coefficient of the long-run relationships. The lag lengths are determined by Schwartz Bayesian Criteria (SBC) following Pesaran and Pesaran (1997). The long-run test results revealed that only the price of logs was negatively and significantly related to log supply (Table 2). This implies that as price of logs increases, the log supply decreases. This will affect the long-run log supply since the government keeps on restricting the annual allowable cutting rate. The producers cannot simply increase their production and this is the reason for the reduction of log supply in the long run even when the price increases. In other words, the production of logs is restricted by the government in order to achieve SFM. The reduction of log supply is also due to the planned reduction in logging rate in ensuring that the extraction of forest resources is in line with sustainable capacity of the forests in the long run. A downward trend of log supply can be seen by referring to AAC or annual coupes. The downward trend pressures the local production of timber as well as other timber products. This is also mentioned by Lim (2002) that the decline in log production was mainly due to the reduction of annual coupes resulting from the Rio Convention and Malaysia's needs to achieve ITTO 2000 objectives as well as international certification standard in attaining SFM. Further, Tan *et al.* (2003) revealed that the supply of Malaysian timber had been declining mainly due to Malaysia's commitment to SFM practices.

Lastly, the result in Table 3 reveals the error correction representation for selected ARDL model of log supply. This is also known as the short-run dynamic coefficient estimation. There is only one variable which is significantly and positively related to log supply in the short run, i.e. the price of logs (significant at 10%). The result is consistent with the theory of supply whereby the price and its products are positively correlated (Parkin 2003). This implies that in the short run, an increase in price of logs will lead to increase in the log supply. In other words, producers may increase their production in the short run when price increases but not in the long run. This is due to the availability of logs in the permitted area to be harvested for that particular period. However, this permitted area for logging has been continuously reducing in the long run.

Table 2 Estimated long-run coefficient using the ARDL approach of log supply

Variable	Coefficient	Standard error	t-statistic	p-value
lnLOGWP	-0.9067	0.41431	-2.1885**	0.037
lnLOGAREA	-0.4148	0.62693	-0.6617	0.514
lnLOGROY	-0.0919	0.67759	-1.1357	0.893
C	26.2757	11.5754	2.2700**	0.031

**Significant at 5% level

Table 3 Error correction (ecm) representation for the ARDL model of log supply

Variable	Coefficient	Standard error	t-statistic	p-value
dlnLOGWP	0.26023	0.14093	1.8465*	0.075
dlnLOGAREA	-0.08626	0.13961	-0.6179	0.541
dlnLOGROY	-0.01912	0.14351	-0.1333	0.895
dC	5.4637	3.4024	1.6059	0.119
ecm(-1)	-0.2079	0.075857	-2.7412**	0.010

*Significant at 10% level; **significant at 5% level; dC = intercept in short run

The error correction term was found to be negative and statistically significant. This term indicates the speed of adjustment process to restore equilibrium following a disturbance in the long run. A negative and significant error correction term implies how quickly variables return to equilibrium. For instance, the model of log supply implies that 21% (ecm coefficient = -0.2079) of the disequilibrium of the previous year's shocks are able to readjust to the long-run equilibrium in the current year.

CONCLUSIONS

The bounds test of log supply model was cointegrated at 10% significance. The short-run analysis revealed that log supply would increase as price of logs increased. However, the long-run analysis indicated substantial reduction in the log supply.

Annual area for logging and royalty were not significant factors to log supply either in the long or short run. This is due to the fact that SFM practices play an important role in controlling and monitoring forest utilization. The total revenue from log harvests is referred to the government revenue from royalty paid by logging companies. The reduction in government revenue has been indicated by shrinking log supply.

This study has identified several economic instruments and policies that could improve the West Malaysia log market performance. For example state governments should give preference to meet the domestic needs for logs over exports. State governments also could substantiate the federal government's financial assistance for forest plantation establishment by allocating adequate land with attractive terms to encourage participation from private sectors. In addition, the government may provide incentives to encourage overseas sourcing of raw materials to help ease local supply constraints. Thus, state government through their subsidiary companies and the support from the state forestry departments should be actively involved in reforestation programmes.

The ongoing adaptation of West Malaysian forestry to the standards of SFM certification programmes could have substantial effects on the log supply and other timber products. It will probably influence the international competitiveness of the West Malaysian forest sector.

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REFERENCES

Anonymous. 1994. *Final Project Reports Project PD10/87(F)—Forest Management of Natural Forest in Malaysia.* Report presented to the International Tropical Timber Organisation (ITTO). Forestry Department Peninsular Malaysia, Kuala Lumpur.

Anonymous. 1996. *Forestry in Peninsular Malaysia.* Forestry Department Peninsular Malaysia, Kuala Lumpur.

Awang Mohdar H & Ahmad Zuhaidi Y. 2005. Forest plantation development in Malaysia—an overview. Conservation of biological diversity through improved forest planning tools. Pp. 337–347 in Lee SS & Lim HF (Eds.) *Proceedings of the Conference on Forestry and Forest Products Research (CFFPR 2005). Investment for Sustainable Heritage and Wealth.* 22–24 November 2005, Kuala Lumpur.

Baek J. 2007. The J-curve effect and the US–Canada forest products trade. *Journal of Forest Economics* 13: 245–258.

Department of Statistics. 2006. *Malaysia Economic Statistics—Time Series 2005.* Department of Statistics, Kuala Lumpur.

Engle RF & Granger CWJ. 1987. Co-integration and error correction: representation, estimation and testing. *Econometrica* 55: 251–276.

Eriksson LO, Sallnass O & Stahl G. 2007. Forest certification and Swedish wood supply. *Forest Policy and Economics* 9: 452–463.

Freezailah CY. 2001. Tropical forestry research in the new millennium: Meeting demands and challenges. Pp. 3–9 in Azmy HM *et al.* (Eds.) *Proceedings of the International Conference on Forestry and Forest Products Research (CFFPR 2001). Tropical Forestry Research in the New Millennium: Meeting Demands and Challenges.* 1–3 October 2001, Kuala Lumpur.

Ghatak S & Siddiki J. 2001. The use of ARDL approach in estimating virtual exchange rates in India. *Journal of Applied Statistics* 28: 573–583.

Hanninen RH. 1998. The law of one price in United Kingdom soft sawnwood imports—a cointegration approach. *Forest Science* 44: 17–23

Hendry DF & Ericsson N. 1991. An economic analysis of UK money demand in 'Monetary trends in United States and the United Kingdom by Milton Friedman and Anna J. Schwartz.' *American Economic Review* 81: 8–38.

Johansen S. 1988. Statistical analysis of cointegration vectors. *Journal of Economic Dynamics and Control* 12: 231–254.

Johansen S & Juselius K. 1990. Maximum likelihood estimation and inference on cointegration—with applications to the demand for money. *Oxford Bulletin of Economics and Statistics* 52: 169–210.

Laaksonen S, Toppinen A, Hanninen R & Kuuluvainen J. 1997. Cointegration in Finnish paper exports to the United Kingdom. *Journal of Forest Economics* 3: 171–185.

Laurencerson J & Chai JCH. 2003. *Financial Reform and Economic Development in China.* Edward Elgar, Cheltenham.

Lim HF. 2002. *The Economic Aspects of Private Forest Plantations in Peninsular Malaysia.* Forest Research Institute Malaysia consultancy report commissioned by small-scale fast growing forest plantation project.Tin Brothers' Printing Co, Kuala Lumpur.

Mohd Shahwahid HO. 1993. Modeling the West Malaysian log market. Pp. 69–81 in *Malaysian Agriculture Commodity Forecasting and Policy Modeling.* Universiti Putra Press, Serdang.

Mohd Shahwahid HO & Awang Noor AG. 2002. *Responses of Timber Concessionaires to Selected Policy Instrument: The Case of Peninsular Malaysia.* Research Report No: 2003–RR1. Economy and Environment Program for Southeast Asia (EEPSEA). Co-published with the International Development Research Center, Singapore.

Nanang DM. 2000. A multivariate cointegration test of the law of one price for Canadian softwood lumber markets. *Journal of Forest Policy and Economics* 1: 347–355.

Narayan PK. 2005. The saving and investment nexus for China: evidence from cointegration tests. *Applied Economics* 37: 1979–1990.

Palo M & Mery G (Eds.). 1996. *Sustainable Forestry Challenges for Developing Countries.* Kluwer Academic Publishers, Dordrect.

Parkin M. 2003. *Economics.* Addison Wesley, Boston.

Pesaran MH & Pesaran B. 1997. *Working With Microfit 4.0.* Camfit data Ltd, Cambridge.

Pesaran MH & Shin Y. 1999. An autoregressive distributed lag modeling approach to cointegration analysis. In Strom S (Eds.) *Econometrics and Economic Theory in the 20th Century: The Ragnar Frisch Centennial Symposium.* Cambridge University Press, Cambridge.

Pesaran MH, Shin Y & Smith RJ. 2001. Bound testing approaches to the analysis of level relationships. *Journal of Applied Econometrics* 16: 289–326.

Schwarzbauer P & Rametsteiner E. 2001. The impact of SFM certification on forest product markets in western Europe—an analysis using a forest sector simulation model. *Forest Policy and Economics* 2: 241–256.

Stordal S & Nyrud AD. 2003. Testing roundwood market efficiency using a multivariate cointegration estimator. *Journal of Forest Policy and Economics* 5: 57–68.

Tan YE, Razak MAA & Rajan S. 2003. Promoting the use of timber construction. Pp. 355–361 in Lee SS *et al.* (Eds.) *Proceedings of the Conference on Forestry and Forest Products Research (CFFPR 2003). Forestry for Society.* 6–8 October 2003, Kuala Lumpur.

Thang HC. 2002. Towards achieving sustainable forest management in Peninsular Malaysia. Paper presented at the National Seminar on Practising Sustainable Forest Management: Lessons Learned and Future Challenges 20–22 August, Kota Kinabalu.

Woon WC. 2001. The impact of sustainable forest management (SFM) on wood-based industries in Peninsular Malaysia. Pp. 286–292 in Azmy HM *et al.* (Eds.) *Proceedings of the Internatinal Conference on Forestry and Forest Products Research (CFFPR 2001). Tropical Forestry Research in The New Millennium: Meeting Demands and Challenges.* 1–3 October 2001, Kuala Lumpur.

Woon WC & Tong PS. 2004. Sustaining the Malaysian wood-based industries. Pp. 411–418 in Lee SS *et al.* (Eds.) *Proceedings of the Conference on Forestry and Forest Products Research (CFFPR 2003). Forestry for Society.* 6–8 October 2003, Kuala Lumpur.