Testing the Law of One Price on Exports of Tropical Forest Products: A Co-integration Approach

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ABSTRAK

Teori perdagangan selalunya mencadangkan kewujudan satu harga perwakilan, iaitu satu harga yang akan wujud dalam semua pasaran. Ini dikenali sebagai Hukum Satu Harga (law of one price). Dalam kertas ini kesahan empirik LOP diuji dengan menggunakan kaedah "kointegrasi" yang baru diperkenalkan untuk eksport kayu kayan. Data bulanan dari Januari 1985 hingga Disember 1992 digunakan untuk menganalisis hubungan jangka panjang ini. Secara empirik kami dapati laluan kadar pertukaran untuk eksport adalah lengkap untuk semua keluaran dan pasaran. Hasil kajian ini menunjukkan data adalah konsisten dengan hukum satu harga sebagai satu hubungan jangka panjang. Kami merumuskan pasaran untuk hasil hutan tropika adalah bersaingan secara umumnya.

ABSTRACT

Trade theory often postulates the existence of a representative price, that is, a single price that prevails in all markets. This is known as the Law of One Price (LOP). In this paper the empirical validity of LOP was tested using the recently developed co-integration method for timber exports. Monthly data for the period January 1985 to December 1992 were used to analyse the long-run equilibrium relationship. Empirically, we found the exchange rate pass-through on the exports to be complete for all timber products and markets. The results obtained suggest that the data are consistent with the LOP as a long-run relationship. We conclude that the markets for tropical forest products are generally competitive.

INTRODUCTION

Schuh (1974) demonstrates the strong effect of exchange rates on prices received for U.S. farm exports. Since then much work has been done to see if exchange rate is the key determinant of export performance. however, the substantial trade imbalance in the world economy in 1980s despite substantive changes in exchange rates, both in nominal and real terms, have cast doubt on the ability of exchange rates to bring the necessary adjustment to correct trade imbalance. The failure of exchange rates in bringing the required adjustment in export (or import) prices is often referred to as the "pass-through" problem.

Most trade analysts maintain the hypothesis that exchange rates pass-through instantaneously to domestic price, that is, the Law of One Price (LOP) prevails.[1] As pointed out by Officer (1986), without this principle the traditional "pure" theory of international trade would not exist. In short, the law asserts the export price of a product should be the same regardless of destination, and import price should be independent of the country of origin.[2] Thus, the

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1 According to the extreme version of LOP, domestic and foreign products are characterized by a high degree of substitutability both in production and consumption (that is, they are homogeneous). Under free trade, if products are market competitively, commodity arbitrage is instantaneous so that LOP holds in the short-run. However, the less restrictive version of LOP allows for disparities in prices in the short-run but the law will hold in the long-run.

2 An example of a model that does not appeal to the law of one price is the Armington model. In this type of model a commodity originating from, or destined to, different countries is a distinct product with a distinct price.

world is viewed as a highly integrated closed economy rather than as a set of different national economies. The uniformity between foreign and domestic prices net of transportation cost is established by profit seeking actions of international commodity traders and arbitragers. Under such an assumption, currency realignments should have strong effects on exports and therefore, exchange rate is an important variable in trade models.

In recent years a great deal of work has been done to test empirically the hypothesis of law of one price with mixed results. However the bulk of the evidence seems to reject LOP either at the level of general price indices or at a more disaggregated level.[3] Isard (1977), after comparing U.S. and Germany prices of several commodities, states that "in reality the law of one price is flagrantly and systematically violated by empirical data". In another article, Officer (1990) reported that 70% of the past studies that used disaggregated products rejected the law.[4] The empirical evidence on the LOP for internationally traded commodities is rather limited except for the recent investigation by Jabara and Schwartz (1987), Ardeni (1989), Goodwin *et al.* (1990), Pompelli and Pick (1991), and Ahmad Zubaidi and Muzafar Shah (1993).[5] The reason for the lack of such investigation is that it is commonly believed that primary commodities are traded in flex-price markets. They are likely to possess identical attributes regardless of origin or destination, and therefore perfect and instantaneous arbitrage (that is, LOP holds) is claimed to be a reasonable assumption.

Generally, the results obtained from the above studies are not supportive of the law. They found significant and even persistent deviation from LOP for primary commodities and argued that international traders are unwilling to pass-through the effect of depreciation (or

appreciation) of exchange rates but instead absorbed these changes into profit margins. The failure of prices of traded goods to conform to this principle casts doubts on the role of price linkages in both international market integration and the transmission of economic disturbances across national borders. The presence of other than the purely competitive market structure helps to explain the observed deviation from LOP. The opportunities for complete arbitrage may not exist and costs are involved in changing prices. For instances, the denial of LOP in the export agricultural markets may be due to factors that are outside the arbitrage commodity market, such as national governments' monopoly power on tariffs and other trade restrictions. For example, Officer (1990) argued that governments engaging in price-stabilization schemes by carrying stocks can adversely affect the pass-through problems.

The primary objective of this paper is to test the validity of the law of one price for the Malaysian exports of timber products. The reasons for this study are to gain information on market efficiency and the degree of integration of international markets for tropical timber products. The model considered in this study has two important elements. First, we used disaggregated monthly data in our analysis. Second, the analysis used in this paper is based on the concept of co-integration. We follow Ardeni's (1989) approach to test for this long-run relationship and show that LOP holds for the Malaysian exports of tropical products.

METHODOLOGY

The Law of One Price

In its strict sense, the LOP states that prices of a commodity expressed in a common currency

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3 The literature dealing with aggregate price indexes like the consumer price index or wholesale price index is usually called the absolute purchasing power parity (PPP).

4 Examples of studies that are supportive of the LOP are Protopapadakis and Stoll (1986), Goodwin *et al.* (1990), Pick and Park (1991) and Baffes (1991). In the article by Goodwin *et al.*, the results were obtained by using a model in which agents traded on the basis of rational expectations.

5 All these studies except for Ahmad Zubaidi and Muzafar Shah (1993), were done mainly for the developed economy. The results reported by Ahmad Zubaidi and Muzafar Shah show that the LOP fails to hold for Malaysian agricultural exports, namely: rubber, palm-oil, cocoa and timber. Note that except for Ardeni, an econometric approach was taken to test the LOP.

should be the same in two markets after making the necessary adjustment on transaction costs (transport costs and trade barriers). Perfect commodity arbitrage ensures that a good (define in a common currency unit) traded in different markets has a single price. Should disparity between these prices be detected by international arbitragers, they will actively seek profit by transferring the goods in a lower priced market to the higher priced market. These actions will continue until prices are equalized across markets.

Problems in The Testing of Law of One Price

Traditionally, studies on LOP assumed a simple relationship of the form P=P*E or in the logarithm:

$$p_t = a_0 + a_1 \, p^*_t + a_2 \, e_t + u_t \qquad (1)$$

where u_t is the residual factor, assumed to have a zero mean and constant variance. The variables p_t and p^*_t are the natural logarithm of prices of a specific commodity in domestic and foreign markets respectively, and e_t is the exchange rate (unit of domestic currency per unit of foreign currency). The test of LOP in its strong form is usually done by regressing p_t on p^*_t and e_t (with a constant term, a_0) and testing the null hypothesis, H_0: $a_0=0$ and $a_1=a_2=1$. If the null hypothesis is not rejected, the conclusion is LOP holds. Alternatively, the weaker form of LOP can be tested by testing the null hypothesis, H_0: $a_1=a_2=1$ allowing a_0 to be different from zero.[6]

The results from these earlier studies have been criticized on several grounds. Firstly,

distinction should be made between the short-run and long-run. The more recent work indicates that the time for the pass-through of exchange rates to be completed ranges from several months to several years. By not allowing commodity arbitrage to occur instantaneously, Protopapadakis and Stoll (1986) showed that LOP as a short-run relationship may not hold. However, they found supportive evidence for LOP as a long-run relationship.[7]

Others argue that some of the empirical studies on the relationship between prices and exchange rates are based on an aggregative approach and therefore the results may be misleading because of problems associated with indexes and aggregation measurement errors. For example, when using aggregative export price indices the weighting schemes may differ across countries. The relative importance of international goods in each category is often not constant over time. Because of these reasons disaggregated data are used to test LOP (Karvis and Lipsey 1977; Goodwin 1990).

More important, Ardeni (1989) questioned the validity of the results that rely on econometric models to test LOP. Several weaknesses are inherent in the standard approach of testing LOP. First, both prices (domestic and foreign) in a large country case are determined simultaneously.[8] Consequently, applying OLS would yield biased and inconsistent estimates. Secondly, he argued that the validity of the test results is unreliable because the variables used in the analysis are non-stationary.[9] The non-stationary properties of time-series data used in the analysis invalidate the usual estimation

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6   Some authors, e.g. Carter *et al.* (1990) and Protopapadakis and Stoll (1983) argue that p_t and p_t^* are simultaneously determined and estimated Equation as $p_t - p_t^* = a_0 + a_2 \, e_t + u_t$. The null hypothesis of complete pass-through is then H_0:$a_2=1$ and $a_0=0$.

7   Ahmad Zubaidi and Muzafar Shah (1993) found that the exchange rates pass-through for the Malaysian agricultural export is not completed even in the long-run. The time period for the price adjustment ranges from 9 to 16 months. The results do not support LOP as a long-run relationship.

8   The prices in two trading countries are simultaneously determined regardless of the relative sizes of the countries (Protopapadakis and Stoll 1983), because information is shared across markets and because agents operate in more than one market at a time.

9   In this article the term stationary and I(O) are used interchangeably, although strictly they do not coincide. Note that if all the variables are stationary then it is valid to do regression for equation (1) and do the test on the restrictions of the parameters. However, the validity of the test still depends on the assumption that one of the prices is exogenous.

procedures and may lead to grossly inaccurate statistical inferences.[10] The approach followed in this study overcame these weaknesses by employing the cointegration analysis. It is most useful for analysing long-run relationship of economic variables. Examples of recent studies that used cointegration to test LOP include Baffes (1991) and Ardeni (1989).

Co-integration and LOP

The LOP as a long-run equilibrium relationship between prices of Malaysian timber exports to different countries can be empirically verified by using a methodology developed by Granger (1986) and Engle and Granger (1987). Nelson and Plosser (1982) and Baffes (1991) have pointed out that many economic variables (for example, prices) are known to be non-stationary, that is they may be at least I(1). Granger and Newbold (1974) showed that regressing one non-stationary variable on another will usually invalidate the conventional procedure of inferences in regression analysis and frequently leads to the acceptance of spurious regressions (Phillips 1986).

Traditionally, the solution to non-stationarity is applying Box and Jenkins (1970) method of differencing (examples Isard 1977; Richardson 1978). However, this method may result in loss of information about the equilibrium relationships between the levels and also may generate inconsistent parameter estimates. Granger (1981) coined the concept of co-integration as a statistical framework for avoiding "spurious" regression problems while retaining long-run information about the equilibrium in the level forms. Co-integration is a property possessed by some non-stationary time series data. For example, if X_t and Y_t are two non-stationary time series then in general it is usually true that a linear combination of X_t and Y_t, such as $X_t - aY_t = u_t$, will also be non-stationary. However, if there exist some constant b such that $X_t - bY_t = w_t$ is stationary (I (0)), then the series are said to be co-integrated with a co-integrating vector of b and the relationship $X_t - bY_t = w_t$ is called the co-integration regression.

Following Ardeni (1989), the LOP as a long-run equilibrium relationship can be tested by using the following equation :

$$P_{it} = \alpha + \beta P_{jt} + \epsilon_{it} \qquad (2)$$

where P_{it} is the domestic price in Malaysian Ringgit (RM) and P_{jt} is the foreign price in RM at a given time period t, say one month. LOP in its strong form implies that $\alpha=0$ and $\beta=1$. In addition, the residual term ϵ_{it} should be identically and independently distributed. The relationship under the null hypothesis can be rewritten as:

$$\epsilon_{it} = P_{it} - P_{jt} \qquad (3)$$

Equilibrium occurs and the LOP holds when $P_{it}=P_{jt}$, otherwise, ϵ_{it} would measure the deviation from LOP condition or the disequilibrium error. The disequilibrium error measures the extent of divergence from the long-run equilibrium path. In the present context co-integration means that if both P_{it} and P_{jt} are ~I(1) and their difference, that is ϵ_{it}, should be ~I(0). This implies that the two prices cannot drift apart, that is, they will move together in the long-run. If instead the linear combination of prices is not co-integrated then P_{it} and P_{jt} will drift apart without bound from the hypothesized value $\epsilon_{it} =0$.

A weaker form of LOP allows export prices to differ systematically. The possibility may arise because of differences in location of exporters and to differences in transport and handling costs. Thus, weak form of LOP allows for parameters α and β in Equation 2 to be different from zero and one respectively. This relationship can be written as:

$$\omega_{it} = P_{it} - \alpha - \beta P_{jt} \qquad (4)$$

The weaker form of LOP would be rejected if w_{it} in Equation 4 had a unit root (or ~I(1)).

The co-integration test proposed by Engle and Granger (1987) requires that the series have unit roots. Thus, the first step in the empirical analysis is to determine the order of

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10 The problem is becoming widely recognized in statistical analysis and is commonly referred to as spurious correlation. It arises when two variables that independently drift upwards overtime are regressed upon each other. The issue here is even if the two variables are unrelated, OLS will yield high R^2 and low Durbin-Watson statistic (Granger and Newbold 1974).

integration for the price series. In order to determine if the series has unit roots, we employed a test based on the work of Dickey and Fuller (1979, 1981). All the series were first estimated according to the following relation.

$$\Delta P_t = \alpha + \rho P_{t-1} + \Sigma_i^\tau \beta_i \, \Delta P_{t-1} + e_t \qquad (5)$$

where P_t denotes the variable being tested, Δ denotes the first difference operator, α, ρ and β are the parameters to be estimated and τ is a value chosen so that the residual series, e_t is approximately white noise. The Dickey-Fuller (DF) test is based on the regression when $\tau=0$ and Augmented Dickey-Fuller (ADF) test is based on values of $\tau>0$, to include some dynamics. Under the null hypothesis $\rho=0$, implying P_t is~$I(0)$, the t-ratio for the estimated ρ is distributed according to Fuller's t-like statistic found in Fuller (1976).[11]

Once it has been established that the order of integration is the same for each pair of the price variable, the second step is to show that the deviations from the equilibrium at time t for all pairs of price series, ϵ_{it} in Equation 3 (or ω_{it} in Equation 4) are stationary, that is, they are ~$I(0)$. The testing of co-integration will help in determining if these series move together in the long-run. Again we may use the DF and ADF tests to examine the co-integrating relationship. For example, LOP in its strong form is tested using the following equation:

$$\Delta \epsilon_{it} = \theta_1 \epsilon_{it-1} + \Sigma_{i=1}^p \varnothing_1 \Delta \epsilon_{it-1} + \eta_{it} \qquad (6)$$

where ϵ_{it} denotes the residual from the co-integration regression and $\Delta\epsilon_{it}$ their first difference. The test statistic here is the t-statistic of θ_1. Critical values for both the DF and ADF are tabulated in Engle and Yoo (1987). The null hypothesis H_o: P_{it} and P_{jt} are not co-integrated is rejected if the estimated θ_1 in Equation 6 is negative and significantly different from zero. Similarly, the co-integration test may be applied on Equation 4 to test whether the co-integrating residual, (ω_{it} is~$I(0)$.

In testing for unit roots, the power of the test depends on the lag length τ (Equation 5) and p (Equation 6). The number of lag is chosen such that the residual is a white noise. However, the ADF test lose power if the lag length is longer than necessary (over-parametrization). It will result in accepting the null hypothesis too often when in fact it should be rejected. In this study the approach adopted in determining the optimal lag length follows the method suggested in Engle and Yoo (1987). Briefly, the optimum lag length was chosen such that the Akaike (1969) final prediction error (FPE) criterion is minimized. The FPE value for an optimal lag length h is given by: FPE(h)=[(T+h+1)/(T-h-1)]*RSS(h)/T, where T is the total number of observations and RSS is the sum of squared residuals.[12]

SOURCES OF DATA

In this study, the LOP was tested on three commodities, plywood, sawntimber and wooden moulding. The data used in the analysis are based on a set of monthly data covering the period from January 1985 to December 1992, to cover a recent period of floating exchange rate. The monthly series on domestic and foreign prices were gathered from various issues of the *Maskayu*, a monthly bulletin published by The Malaysian Timber Industry Board (MTIB). These prices were quoted monthly at the domestic and export market location. The bilateral exchange rates figures were gathered from various issues of *International Financial Statistics* published by International Monetary Fund.

RESULTS

This section provides the empirical results for the test for LOP in accordance with the theory of co-integration. The LOP was tested for the following timber exports: plywood, sawntimber and wooden moulding. The major importing countries are Singapore (S), United Kingdom (UK), Germany (G), the United States (US), Hong Kong (HK), Japan (J) and Australia (A).

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11 The table is also reproduced in Harvey (1990), p. 386.

12 Alternatively, we may use the procedure recommended in Campbell and Perron (1991). In this procedure we may start at some maximum lag length, say 8 periods. The lag length is selected as the largest value of τ or p for which t-statistic on the last included lag is significant at the 10% error level.

The number of observations available for this study ranges from 92 to 96.

The results of the test that export prices have unit roots are given in Table 1. In all cases, the hypothesis that the level of the price series has a unit root cannot be rejected at the 5% confidence level based on either the Dickey-Fuller (DF) or Augmented Dickey-Fuller (ADF) tests. Results of the stationarity tests in first difference of the series are also reported in the table. As shown in Table 1, the results regarding stationarity test for first difference uniformly indicate that the prices are difference-stationary processes based on 5% level of significance. In general, they are consistent with the hypothesis that non-stationarity characterizes the levels of each of the variables used in this study. In other

words, the stationarity test uniformly indicates that all the price series contain a single unit root which cancels out on first difference (that is, I(1) process). Findings of non-stationarity for macroeconomic variables like exchange rates and prices have been presented by many others.

A straightforward application of the co-integration test is allowed here since all prices are integrated of the same order. The results of the co-integration tests as outlined in the previous section are presented in Table 2. Nine different co-integrating bivariates system were estimated in both directions. In addition to the two test statistics discussed above, we also report the co-integration regression Durbin-Watson (CRDW) statistic. The appropriate critical values are provided in Engle and Yoo (1987). Table 2 also

TABLE 1
Unit root tests on individual price series

$$\Delta P_t = \alpha + \rho P_{t-1} \sum_{i=1}^{\tau} \beta_i \, \Delta P_{t-1} = \epsilon_t$$

		Level		First-Difference	
	DF	ADF	τ	ADF	τ
Plywood					
P_{PM}	-	- 0.69	2	- 3.25	8
P_{PS}	-	- 0.56	3	- 3.42	3
P_{PUK}	-	- 1.20	7	- 3.61	5
P_{PHK}	-	- 0.82	4	- 3.95	4
Sawntimber					
P_{SM}	-	- 0.95	1	- 3.15	7
P_{SS}	-	- 2.30	4	- 5.59	6
P_{SN}	0.27	-	-	- 2.93	5
P_{SG}	-	- 0.17	2	- 3.03	5
Wooden Moulding					
P_{WM}	-	- 1.64	2	- 3.17	7
P_{WA}	-	1.24	5	- 1.91	6
P_{WJ}	-	- 0.94	2	- 7.55	2
P_{WUS}	-	- 2.09	6	- 4.53	7

Notes: 1. The first subscript identifies commodity: P is plywood; S is sawntimber; and W is wooden moulding. The second subscript identifies the country: M is Malaysia; S is Singapore; UK is United Kingdom; HK is Hong Kong; N is Netherlands; G is Germany; A is Australia; J is Japan and US is United States. If no lagged difference is significant, no ADF statistic is reported.

2. Critical values for t-statistics are from Fuller(1976);
100obs: -3.51(1%); -2.89 (5%); -2.58(10%)
50 obs: -3.58 (1%); -2.93(5%); -2.60(10%)

reports the estimated coefficient (β and the optimum lag length (p) for the ADF test. The slope coefficients of the cointegration are different but in most cases are of the correct sign (that is, positive) and close to unity.

Notice that the Durbin-Watson statistic (CRDW) is always higher than the tabulated critical value of 0.39 in all cases. The CRDW is significantly greater than zero, indicating that the price differential is I(0), and therefore rejecting the null hypothesis of no co-integration. However as noted by Engle and Yoo (1987), this is not a powerful test for co-integration.[13] The results of the ADF along with the Box-Pierce statistics [Q(k), where k=6,12] and Breusch-Pagan Lagrange Multiplier (LM) test for autocorrelation are also given in Table 2. The values of Box-Pierce as well as the LM statistics suggest that co-integration regressions are not serially correlated in all except one case. The results of the diagnostic tests for the co-integration relationship between the prices of plywood in Malaysia and Singapore suggest that an addition of 11 additional lagged dependents to Equation 6 are insufficient to induce residual whiteness. A further specification search on higher lag periods did not produce satisfactory results and so we report the 11 period lag model for the $P_{pm} \rightarrow P_{ps}$ regression. We conclude that the data supported the strong form of LOP for 5 out of 9 pairs of the price series based on the ADF test for co-integration.

Price series that fails the strong form test was also subjected to the weaker form of LOP test. While strong form interpretation requires that the difference between two series be stationary, the weaker form requires only some linear combinations of the two series to be stationary. The results are summarized in Table 3. Again the CRDW tests lead to the conclusion to reject the null hypothesis that the residuals from the co-integration regression is I(1) at the 5% level of significance. The ADF tests support the weak LOP at the 5% level for wooden moulding. However, the results of the test were ambiguous for sawntimber. The weak form of the law was accepted in only one direction of the co-integration regression, indicating that the

results are invariant to the choice of normalizing variable. As shown in Table 3, the weak law was rejected in two of the sawntimber cases using the ADF test: exports of sawntimber to Singapore and import prices of sawntimber to the Netherlands (i.e. $P_{SM} \rightarrow P_{SS}$ and $P_{SN} \rightarrow P_{SM}$). No convincing explanation can be provided here for the rejection of the hypothesis of co-integration relationship and hence the rejection of LOP in these two specific cases.

Generally, the findings suggest that contrary to the results reported by, Jabara and Schwarts (1987), Ardeni (1989) and Ahmad Zubaidi and Muzafar Shah (1993) there may be a long-term relationship between domestic and foreign prices for similar products. However, the results of this study are in agreement with those reported by Baffes (1991), Protopapadakis and Stoll (1986) and Goodwin et al. (1990) where they reported that international markets are competitive and export prices of the same commodity to be equal across countries. There is no evidence of imperfection in commodity arbitrage and exchange rates are fully transmitted to prices.

CONCLUSION

In this paper the LOP was tested at the disaggregated level for three timber products using the recently developed techniques of co-integration on non-stationary economic time series. The essence of co-integration is that although the price series may be individualy non-stationary, there may exist some linear combination of them which is stationary. In such cases the two variables form a co-integrating system, implying that there is a stable long-run equilibrium relationship between the series and they have the tendency to return to a common "equilibrium" value. However, non-co-integration among time series will tend to drift apart without bound.

Using monthly data from the period January 1985 to December 1992, we showed that commodity prices are non-stationary and that each pair of the price series is co-integrated. Thus the empirical results strongly support the LOP, that is, there is a tendency of prices in separate markets to converge, regardless of any

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13 Stationarity is rejected if the statistic is smaller than the critical values in absolute value. As noted by Engle and Yoo the critical values of the CRDW test are sensitive to parameters within the null hypothesis.

TABLE 2

Co-integration test (strong-form) : $P_{it} = \beta P_{jt} + \epsilon_{it}$

P_{ij}	P_{jt}	β	R^2	CRDW	ADF	τ	Q(6)	Q(12)	LM
PPM	PPS	1.02	0.98	0.98	- 13.92*	11	169.1	189.8	192.9
PPS	PPM	0.98	0.98	0.98	- 2.96*	3	0.2	13.9	20.4
PPM	PPUK	0.97	0.88	1.08	- 3.38*	2	5.9	13.9	23.3
PPUK	PPM	1.03	0.94	1.08	- 3.38*	2	5.9	13.9	23.3
PPM	PPHK	1.00	0.91	0.89	- 2.81*	2	5.9	10.7	19.3
PPHK	PPM	1.01	0.91	0.89	- 2.81*	2	5.9	10.7	19.4
PSM	PSS	1.12	0.32	0.89	- 1.53	3	1.9	6.0	11.4
PSS	PSM	0.89	0.28	0.89	- 1.53	3	1.9	6.0	9.5
PSM	PSN	0.92	0.74	0.49	- 1.69	3	2.1	7.5	9.6
PSN	PSM	1.09	0.85	0.49	- 1.67	3	1.8	7.5	9.1
PSM	PSG 19.5	0.91	0.65	0.46	- 2.18**	2	7.2	12.2	
PSG	PSM	1.10	0.80	0.46	- 2.17**	2	7.2	12.2	19.5
PWM	PWA	1.01	0.36	0.72	- 1.38	3	1.9	2.4	13.4
PWA	PWM	0.89	0.71	0.72	- 1.38	3	1.9	2.3	13.4
PWM	PWJ	1.00	0.20	1.41	- 1.50	3	2.1	4.7	11.4
PWJ	PWM	0.98	0.52	1.41	- 1.50	3	2.1	4.8	11.4
PWM	PWUS	1.02	0.90	0.82	- 3.46*	2	8.1	15.6	23.9
PWUS	PWM	0.97	0.20	0.82	- 3.82*	3	4.8	14.1	21.3

Notes: For definitions of variables, see Table 1. Critical values from Engle and Yoo (1987); 100obs: - 2.62(1%); -1.95 (5%); -1.61(10%). 50 obs: -2.60(1%); -1.95(5%); -1.61(10%). Critical values for CRDW test; 100 obs: 0.32 (1%); 0.39(5%) . 50 obs: 0.69(1%); 0.78(5%).

short-term disequilibria which may be due to trade restrictions (tariffs and non-tariff barriers) or other disturbances. In other words, common currency prices of similar products are related internationally in the long-run.

In this study we showed that the exchange rate changes are fully transmitted to prices, at least in the long-run. There is no evidence of price discrimination among countries and commodity arbitrage is working given that price differential in different geographical markets tend to disappear in the long-run. Our results also support the hypothesis that the international markets for timber products are fully integrated. This suggest that appreciation (or depreciation) of the Malaysian Ringgit can influence the volume of timber exports to United States, United Kingdom, Singapore, Australia and Japan.

Thus, the stronger Malaysian Ringgit (RM) is expected to have some impact on the flows of tropical products to the major consuming countries.

The findings of this study also suggest that in modelling trade flows, models that distinguish commodities by country of origin and destination (Armington-type) are unnecessary. In the long-run the competitive nature of the international market for tropical timber products will ensure that the export prices of the same commodity will be uniform across markets. Finally, for the timber products the LOP assumption can be made safely. To further investigate the validity of the LOP, a wider range of commodities must be examined before this principle can be generally accepted as an empirical truth in analysing trade issues.

TABLE 3

Co-integration test (weak-form) : $P_{it} = \beta P_{jt} + \omega_{it}$

P_{it}	P_{jt}	β	R^2	CRDW	ADF	τ	Q(6)	Q(12)	LM
Psm	Pss	0.90	0.34	0.63	- 1.11	3	1.3	5.5	9.4
Pss	Psm	0.38	0.34	1.73	- 1.37*	4	1.0	5.2	9.4
Psm	Psn	0.65	0.89	1.18	- 2.21*	9	0.4	0.7	7.5
Psn	Psm	1.37	0.89	1.05	- 1.31	3	0.4	7.2	8.5
Pwm	Pwa	0.58	0.75	1.66	- 5.53*	12	5.5	33.8	4.5
Pwa	Pwm	1.33	0.75	1.34	- 4.41*	1	5.0	7.12	0.9
Pwm	Pwj	0.53	0.52	1.28	- 2.49**	2	0.5	4.6	11.7
Pwj	Pwm	0.98	0.52	1.40	- 1.97*	2	2.2	5.0	10.5

Notes: For definitions of variables, see Table 1. Critical values from Engle and Yoo (1987); 100obs: - 2.62(1%); -1.95 (5%); -1.61(10%). 50 obs:-2.60(1%); -1.95(5%); -1.61(10%). Critical values for CRDW test; 100 obs: 0.32 (1%); 0.39(5%). 50 obs; 0.69(1%); 0.78(5%).

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