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Examination of Price Linkage in Wood Product Markets in Malaysia

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Introduction

Markets are efficiently linked together through price as hypothesised by law of one price (Jung and Dorodians, 1994). Information about changing demand and supply conditions is transferred to both consumers and producers alike through price mechanism. For example increasing price -cost margins reveals enhanced profit opportunities and rivals entering the market and endeavouring to take advantage of above normal returns will increase the output with the result that price and hence profit will return to competitive level. This argument is cast in terms of the perfectly competitive model of neo-classical microeconomic theory.

Unfortunately this perfect world does not exist. Such things as imperfect information, transaction costs, price expectations and technological innovations all serve to mitigate the ideal condition to use the perfectly competitive model.

Previous studies have dealt with the issue of price linkage in product markets rather extensively either by the notion of one price (Jung and Dorodians, 1994; Uri and Boyd, 1990; Protopapadakis and Stoll, 1983,

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1986; Ardeni, 1989; Baffes, 1991,1998;Buongiorno and Uussivuori, 1992; Hanninan, 1998; or under the notion of market integration (Ravalion, 1986; Sexton, Kling and Carman, 1991; Gardner and Brooks, 1994; Fatchamps and Gavian, 1996; Baulch, 1997). However, not much has been done in this direction in Malaysian forestry industry. As is expected the price increase in one market is likely to be transferred to the related or resource market. Luppold et al (1998) found that lumber price and stumpage price do not always move in the same direction but tend to move where there are large changes in lumber prices. This means that the continual decline in lumber prices do not often result in continual decline in stumpage prices because of apparent price expectation of stumpage owners.

Stumpage price is positively related to the price of the final product - as lumber and end-wood- product prices rise, the production expands and the producers demand more stumpage inputs (Daniels and Hyde, 1986; Uri and Boyd, 1990). Horowitz (1977) found that price uniformity and the extent to which different goods or services constitute a single market depends on the relevant cross elasticities, which are a function of the direct elasticity for the good or service.

The objective of this paper is to examine a linkage between the primary products and round wood markets in Malaysian forestry industry, based on the derived demand concept. The concepts are useful in developing information about the demand for factors that are used to produce the final product. The round wood is input into the primary product industry and thus the demand for round wood is derived from the demand for primary products. The policy-relevance of this paper centers in understanding how policies that affect one part of the forest products market can lead to effects on the other parts of the market. For example, a log export ban could lead to low price of roundwood and consequently in product market. This paper is divided into four sections. The first section is the introduction; second section is model specification and data. The third section presents the results and analysis, while the fourth section concludes the paper.

Model Specification and Data

Most price linkage studies used marketing margin analysis (Luppold et al, 1997; Haynes, 1977) or correlation coefficients (Lele, 1967; Southworth, Jones and Pearson, 1979; Timer, Falcon.and Pearson, 1983; Stigler and Sherwin, 1985) or regression analysis (Isard, 1977; Mundlak and Larson, 1992; Gardner and Brooks, 1994). In this paper we apply regression model of Baffes and Ajwad (1998). Regression of factor price is estimated as a linear function of product prices expressed as.

$$P_t^a = \alpha + \beta P_t^x + \varepsilon_t \qquad [1]$$

where and denote the factor and product prices of commodity under consideration (a and x represent factor and product markets respectively), and (are parameters to be estimated and is the error term that is . The hypothesis that the slope coefficient (() equals to one and intercept term equals zero is testing the law of one price (. Alternatively tests are performed of whether the price differential is a white noise (i.e. term. Early studies (Baffes and Ajwad, 1998; Jaramillo and Nupia, 1998) have shown that estimating (1) and testing the hypothesis presents two fundamental problems. First, it is unlikely that trade and other public policies, differences in quality, high transfer costs relative to price in commodity markets will lead to a constant zero intercept, required for the null hypothesis to be accepted and for true price differential to be white noise. Therefore test may reject the null hypothesis even where there is strong relationship between product and factor prices. The second shortcoming deals with the times series properties of the series involved in (1) namely non-stationarity. If product and factor prices are non-stationary, it is not possible to make valid inference about the parameters in relationship (1). Deaton and Laroque (1992) have shown that agricultural prices tend to follow non-stationary processes. Thus it is necessary to employ a general enough model that imposes no a priori requirements on the stationarity properties of the series in question and the same time allows some degree of flexibility.

To deal with the problem of non-stationarity one can examine the order of integration of the error term in (1) and make inferences regarding the validity of the model (Ardeni, 1989). If prices are non-stationary the existence of a stationary error term implies co-movement between two prices. To account for the non-unity slope coefficients one can restrict the parameters of (1) according to , in which case the problem is equivalent to testing for unit root following the univariate process (Engel and Yoo, 1987). Baffes (1998) used it to check whether the relationship between is one to one.

$$p_t^a - p_t^x \sim I(0) \qquad [2]$$

If the price differential in (2) is stationary then one can conclude that price signals is transmmitted from one market to another in long run. Inference about the distribution are better grounded in recent econometrics advances than testing for (1). However, this test cannot answer important questions about the speed of adjustment in the transmission relationship. To tackle this issue, Baffes (1998) suggested a simple but practical methodology . It begins by considering the dynamic revised version of (1) proposed by Hendry, Pagan and Sargan (1984).

$$P_t^a = \alpha + \beta_1 P_t^x + \beta_2 P_{t-1}^a + \beta_3 P_{t-1}^x + v_t \qquad [3]$$

where and (i = 1,2,3) are parameters to be estimated and denotes error term. With this model the non-stationarity problem may be circumvented as well as restrictive nature of (1). Imposing homogeneity restriction (3) can be expressed as an Error Correction Model (ECM) (Jaramillo, 1998)

$$\Delta P_t^a = \alpha + \gamma\left(P_{t-1}^x - P_{t-1}^a\right) + \theta \Delta P_t^x + v_t \qquad [4]$$

where and . In this relationship inferences about the parameters will be valid if the differenced series are stationary. Moreover (4) allows for a useful economic interpretation of paramenters.The indicates how much of a given change in the product prices is transmitted to the factor price in the current period (short run effect). An indicates how much of the past differential between factor and product prices is eliminated in the following period (i.e. error correction coefficient). Values of and nearing one reflect rapid adjustment of factor prices to variation in product prices.The use of specification (3) or (4) depends on the stationarity of data. If it is stationary at its level, specification (3) is more appealing, but if not (4) is used. In this paper, only specification (4) is employed. This model is used to test the impact of product prices on factor prices (round wood) in Malaysia. This, however, is analogous to examining the linkage between wood product markets (stumpage and lumber markets).

Prices of wood products in different wood markets covering the period 1961 to 1997 (37 observations) were constructed. Price data were collected from the FAO forest product prices (different years) and statistics on commodities, (Ministry of Primary Industry Malaysia, various years)

Results and Analysis

To determine the order of integration in price data the augmented Dickey-Fuller (ADF) and the Phillip-Perron (PP) procedures are used based on the following.

$$\left(P_t - P_{t-1}\right) = \alpha + \beta P_{t-1} + lags\left(P_t - P_{t-1}\right) + \varepsilon_t \qquad [6]$$

where denotes the series under consideration (Dickey and Fuller, 1981). The results of order of integration are presented in Table 1

Table 1: Tests for Unit Root

Variables	*ADF statistics*		*PP statistics*	
	Level	Δ	Level	Δ
LPr	-0.619	-5.699*	-0.592	-6.607*
LPs	-0.875	-5.668*	-0.539	-5.777*
LPl	-0.486	-3.533**	-0.625	-6.994*
LPwbp	-0.876	-7.158*	-0.343	-7.885*
	Price differential			
Ps-Pr	-1.048	-5.482*	-0.626	-6.619*
Pl-Pr	-0.661	-3.592**	-1.171	-7.463*
Pwbp-Pr	-1.141	-7.699*	-0.764	-10.364*

The critical t-values 10% =-2.611, 5%= -2.947, and 1% = -3.628, *1%, ** 5%, *** 10%.
LPr = log price of round wood, LPs = log price of sawn wood, LPl = log price of plywood and Lwp = log price of other wood based panel, Δ = first differencing
Source: Estimated by the authors

Table 1 shows that the price series exhibit unit root at the log-based level, indicating that null hypothesis of a unit root cannot be rejected at 5% significance level. However, all the prices are negatively and significantly different from zero at first differencing at 5% significance level. This indicates that the price series are I (1) (i.e. integrated of order one).

The lower panel of Table 1 reports the stationarity of price differential, a measure of the degree of co-movement between pairs of wood prices. The log-based levels of the price differentials are not stationary. However, they exhibit no unit root at first differencing, indicating that the degree of co-movement of prices in both markets is substantial in all cases as parameters are significant at 5% percentage level at first differencing. This indicates that there are linkages in wood markets. Although these are robust with respect to stationarity tests (ADF and PP), they are not in contrast to what is expected. The error correction mechanism is expected to yield more insight into the long run convergence issue regarding the ADF and PP stationarity tests.

Having determined the stationarity of the prices, we proceed with the Johansen cointegration test to detect any long run relationship among the different forest product markets. The beginning task in cointegration is to determine the optimum order of lag length. This is very important as under-parameterisation would tend to bias the results and over-parameterisation would diminish the power of the tests. To determine the lag length, an information theoretic model selection criterion of Akaike (Akaike information criteria) was considered. Based on this procedure, a lag length of two was selected for all the price equations.

Table 2: Johansem Cointegration Tests

Variables H_0	Ps, Pr, (n=2) *Trace*	Critical value 95%	$\lambda - max$	Critical value 95%
$r = 0$	0.633	14.880	9.756	17.860
$r \leq 1$	0.878	8.070	0.878	8.070
Variables	Pr, Pl, (n=3)			
$r = 0$	19.696*	14.880	18.589*	17.860
$r \leq 1$	1.107	8.070	1.107	8.070
	Pr, wp, (n=1)			
$r = 0$	18.519*	14.880	18.266*	17.860
$r \leq 1$	0.259	8.070	0.253	8.070
Variables	Pr, Ps, Pl, wp, (n=3)			
$r = 0$	78.851*	48.850	48.735*	27.420
$r \leq 1$	30.117	31.540	21.460	21.120
$r \leq 2$	8.657	17.800	7.298	14.880

Notes: The r indicates the number of cointegrating vectors, n= number of lags. The (*) indicates statistically significant from zero at 5% and (**) indicates significance at 10%

In all the equations, the cointegration tests are conducted with unrestricted intercepts and no trend. As shown in Table 2, both the trace and maximum eiginvalue test statistics indicate that at least one cointegrating vector is present in each of three models, except in the case of round wood and sawn wood model, at 5% level of significance. In all cases, except in the round wood and sawn wood model, the null hypothesis against the alternative is rejected, implying that the null hypothesis of no cointegration is rejected. The results show that the prices of plywood, wood based are cointegrated with the round wood price, indicating one linear, long run equilibrium relationship among the variables, while the price of sawn wood is not and is temporarily in disequilibrium. There are no previous empirical studies on the price linkage the within the forestry industry to compare our results with, as this is the first time a linkage study is undertaken in the forestry industry, in Malaysia. There are some important implications of the above results. First, there is information flow between the product markets and factor markets in forestry industry in Malaysia. Second, cointegration between two prices or more is sufficient to establish the presence of causality relation in at least in one direction. This implies that a variable helps to determine or forecast the other. In this case the error correction term has to be included in the models to capture the extent to which the system is out of equilibrium in order to examine the causal relationship among the forestry products prices.

Having confirmed that the price series except the sawn wood price are indeed first differenced stationary and cointegrated with factor price, we estimate the models based on the error correction model. Joint test for all price series show that at least there is one cointegrating equation. The residuals of cointegrating equation have been generated and lagged one period and are included as regressors in ECM models. Two lags of each variable are included in each regression equation. Starting with the longest lagged; the lagged terms that are not statistically significant at 10% are eliminated gradually.

The least square results based on error correction model are reported in Table 3. A diagnostic test is performed to check the adequacy of the ECM model. These tests include the Lagranger multiplier (LM) test for the autocorrelation in the residuals, ARCH test for autocorrelation in the squared residuals, and Ramsey RESET test for functional form misspecification. The test results are presented in the lower part of Table 3. The LM tests reject the null hypothesis of autocorrelation in residual and square residuals. Ramsey RESET test shows no serious violation in the linearity assumption in the structure of the ECM models.

Table 3: OLS estimates of Restricted Model based on the error correction model

Independent Variables	Dependent Variable			
	ΔLPr	ΔLPs	ΔLPl	$\Delta LPwp$
ECT	-0.450** (-2.667)	-0.307** (-2.335)	-0.408** (-2.344)	-0.959* (-5.286)
ΔLPr		0.359* (3.658)	0.220*** (1.781)	-0.118 (-0.702)
$\Delta LPr(-1)$	-0.175 (-1.132)			-0.179 (-1.296)
ΔLPs	0.619** (2.786)		0.3667*** (1.897)	0.754*** (3.426)
$\Delta LPs(-1)$			0.423** (2.404)	
ΔLPl	0.377*** (1.924)	0.268** (2.379)		0.059 (0.285)
$\Delta LPl(-1)$	0.200 (1.136)		-0.170 (-1.119)	
$\Delta LPwp$	-0.117 (-0.873)	0.271* (3.512)	0.136 (1.078)	
$\Delta LPwp(-1)$			-0.221** (-2.048)	0.180 (1.393)
R^2	0.61	0.66	0.62	0.670
DW	1.96	2.10	1.81	1.87
$F-statistics$	43.12		52.62	47.95
LM-test	0.084	0.092	0.083	0.632
Arch-test	0.479	0.436	0.151	1.341
RESET-test	2.370	0.330	0.619	0.071

The figures in parenthesis are t-statistics. Significance levels *** 10%, ** 5% and * 1%.

The higher R-square (0.61 to 0.67) in the price equation for each wood market suggests that statistical fit of the model is satisfactory. The error correction term in each price equation is statistically significant and has correct signs. A significant and negative error correction term validates the existence of a long run equilibrium relationship among the wood markets in Malaysia, and suggests that ignoring the nonstationarity and cointegration of the price series would introduce misspecification in the underlying dynamic structure (Arize, 1995). The magnitude of error correction term coefficient provides a measure of speed of adjustment toward long-run equilibrium. For example, from the Table 3, it is evident that for sawn wood 31% adjustment toward long-run equilibrium occurs within the first year due to changes in prices of other wood markets in Malaysia. Similarly, for shocks in the product markets, round wood market adjusts 45% toward long-run equilibrium in the first year. Due to the nature of forestry industry, this adjustment toward equilibrium can be considered to be fair. The round wood sector can adjust to changes in the product markets if only there is enough inventory or sudden policy changes in response (such as increasing hectarage set aside for logging).

In the round wood price formation equation, the prices of sawn wood, and plywood have statistically significant coefficients. This implies that the round wood market is affected by changes in the sawn wood and plywood markets. In other words there is full flow of information from the product markets to the factor market in Malaysia forestry industry. However, the movement in wood based panel market seems to have significant impact on the round wood market. Similarly, sawn wood price formation is affected by the prices of round wood, plywood, and wood based panel, but the previous prices (i.e. lagged prices) have no effect on it. Again the flow of information from these to sawn wood market is instantaneous.

Plywood price responds to changes in the round wood and sawn wood markets. Their impacts are positive, and sawn wood competes with plywood for round wood. The other wood based panel does not affect the price formation in the plywood market. But its previous price seems to have an effect and is negative. This suggests substitution within wood based panel industry. The other wood based panel is affected by the changes in the sawn wood market. In fact, this result is not surprising as most wood based panels are in nature luxury goods and only the rich can afford it. As a result, changes in its price would not affect much other wood markets.

The effect of changes in each product market on factor market is also analysed and the results are presented in Table 4. The analysis is based on error correction model. But the effect of changes in sawn wood market on round wood market is determined without inclusion of the error correction term (Table 4, part C). Again all the error term have the expected signs and are statistically different from zero. This indicates long-run equilibrium among the various wood markets in Malaysia. There is no evidence of serious serial correlation in residuals or in squared residuals and functional form is not mis-specified (Table 4, parts A and B). The F-test does reject null hypothesis of the homogeneity restrictions. This indicates that the relationship that exists between the markets (prices) is of short run and thus price differential is not integrated of order zero.

Table 4: OLS estimates of restricted model based on the error correction model between factor and products markets

A

Independent variable	Dependent Variable	
	ΔLPr	ΔLPl
ECT	-0.225 (-2.046)**	-0.328 (-2.469)**
ΔLPr		0.491 (4.611)*
$\Delta LPr(-1)$	-0.325 (-2.071)**	0.225 (1.781)***
ΔLPl	0.886 (5.001)*	
$\Delta LPl(-1)$	0.352 (1.99)***	-0.203 (-1.407)
Constant	0.054 (2.120)**	-0.021 (-0.776)
R^2	0.48	0.50
DW	2.10	1.77
$F-statistics$ (P-value)	35.51	57.60
LM-test	1.655	0.487
Arch-test	0.007	0.230
RESET-test	0.217	0.060

The figures in parentheses are t-statistics, *1%, ** 5% and *** 10% significance level.

B

Independent variable	Dependent variable	
	ΔLPr	$\Delta LPwp$
ECT	-0.325 (-1.879)***	-0.747 (-3.808)*
ΔLPr		0.386 (2.368)**
$\Delta LPr(-1)$	-0.034 (0.183)	-0.175 (-0.968)
$\Delta LPwp$	0.415 (2.486)**	
$\Delta LPwp(-1)$	0.057 (0.343)	0.172 (1.013)
Constant	0.0467 (1.463)	0.017 (0.531)
R^2	0.23	0.39
DW	2.01	1.79
$F-statistics$	26.69	28.77
LM-test	2.683	4.558
Arch-test	0.240	1.106
RESET-test	0.175	1.009

The figures in parentheses are t-statistics, *1%, ** 5% and *** 10% significance level.

C

Independent variable	Dependent variable	
	ΔLPr	ΔLPs
ΔLPr		0.467 (3.904)*
$\Delta LPr(-1)$	-0.309 (-1.760)***	0.168 (1.132)
$\Delta LPr(-2)$	-0.211 (-1.504)	0.146 (1.003)
ΔLPs	0.740 (4.117)*	
$\Delta LPs(-1)$	0.313 (1.379)	-0.131 (-0.703)
$\Delta LPs(-2)$		-0.297 (-1.590)
Constant	0.026 (0.815)	0.0442 (1.680)
R^2	0.47	0.44
DW	1.79	1.97
$F-statistics$	27.59	29.10
LM-test	1.130	0.114
ARCH-test	0.491	0.858
RESET-test	0.243	1.799

The figures in parentheses are t-statistics, *1%, ** 5% and *** 10% significance level.

Conclusion and Policy Implications

This paper has tested whether the factor market (round wood market) is integrated with the product markets (sawn wood, plywood and other wood based panel markets). The order of integration is examined using the Dickey-Fuller and Phillip-Perron procedures. The price series are not stationary at the levels and are integrated of order one. The study reveals that prices of plywood, wood based panels are cointegrated with the round wood price, and the sawn wood price is not. Taking all the prices together test indicates that there is at least one cointegrating vector (Table 2). Thus, the need to include the error correction terms in OLS regression. While the long and short run relationship between markets are established, the movement toward long run equilibrium is very weak (or not perfect) as indicated by the error correction terms except in the case of other wood based panel whose error correction term is very close to unity (Table 3). However, there is likelihood of convergence of prices in the factor and product markets.

The results of the study have some interesting policy implications. First, the failure of sawn wood price to cointegrate with round wood price shows that there is intervention in one of the markets. The market forces are not allowed to determine the demand and supply or regulate the movement of forestry products between the round wood and sawn wood markets. This result is not far from practice in most forestry industries in the world where the area to be logged in a certain year in determined by government policy. In addition the gestation period of forestry tree species is a probable factor that prevents the transmission of changes from the sawn wood market to the round wood market. It will take round wood sector ten to forty years (depending on the tree species) to adjust, unless there are enough forestry inventories (i.e. enough mature trees ready for harvest). Secondly, the price stability is very important for the downstream wood industries as this affects the profit margins and costs of production. High prices of roundwood increase the production costs and reduce the profit. This has serious consequences in the economy that derives part of its revenue from the export of primary products. It might lead to closure of some wood processing industries or retrenchment. The export revenue from the forestry sector will decrease substantially. A ban on log export might ease the high costs of production in the downstream wood industries in short term. Competitive environment is advantageous in the long run.

Thirdly, the emphasis on the value added products without adequate provision for the supply of inputs might pose environmental danger. As the loggers could harvest under aged tree species in bid to maximize profit. Measures to ensure a regular supply of round wood needs to be enshrined in the forestry policy.

Finally this study has some shortcomings. It does not examine the dynamic properties of the system. That is the analysis of dynamic interaction among the variables in post sample period via variance decomposition (VDC) and impulse response function (IRF). Price data used in this study is very simple average of different species of forestry trees.

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