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Abstract

The study of various spatial price relationships is indeed crucial and has been greatly sought after. Likewise, this study is rather a debatable topic these days especially towards the pricing activity and competitiveness within the pepper industry. Evidence from six markets within Sarawak had found that a long run relationship between the pepper markets does actually exist. And using the MWALD test though, findings revealed that the white pepper prices do Granger cause the black pepper prices in all divisions. However, there is no indication of causality that runs from the black pepper towards the white pepper. In other words, white pepper does affect the black pepper, but not the other way around. Due to the integration within the pepper industry, thus, excess profit making opportunity will not be made beneficial as the pepper markets are efficient.

Keywords: Pepper markets, Granger Causality, Spatial Price, Sarawak.
JEL Classification: Q00, Q13, C32.

1. Introduction

Sarawak is the largest pepper producer in Malaysia whereby 95 per cent of total pepper production is grown within Sarawak while the remaining 5 per cent is being produced by the other states in Malaysia. Basically, Malaysia is the sixth largest world pepper producer with the annual production of about 20,000t in 2005. The first five are Vietnam, India, Indonesia, Brazil and China. In terms of exports, Malaysia ranks fifth with an annual export volume amounting to 18,000tonne (International Pepper Community- IPC, 2006).

Due to this, the pepper being produced in Malaysia is known as Sarawak pepper (Liew *et al.*, 2003). Sarawak pepper is well-known for its consistency and reliable quality in the

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international market. Nevertheless, the plantations of pepper in Malaysia have always been facing the awkward predicament of highly volatile pepper prices. As most of the pepper farmers have involved in pepper cultivation for years, traditional methods of cultivation that depend heavily on chemical products are being adopted. In Sarawak, the pepper cultivation is mainly carried out by the rural poor smallholders. Though pepper export only contributes trivially in the national economy, its economic and political significance in the state of Sarawak is profound. Pepper is in fact the most important cash crop in Sarawak, providing employment to some 74,710 families in Sarawak (Department of Agriculture- DOA, 2005).

Traditionally, 80 per cent of the pepper crop is processed into black and the remaining 20 per cent is being processed into white. However, the quality of white pepper is higher compared to the black pepper. Looking into the prices of both white and black pepper, profound that the Sarawak White Pepper prices are relatively higher than Sarawak Black Pepper prices (see Figures 1 to 6). As shown in the figures, the White Pepper dropped as low as RM200/100kg in the year 1992 consistently in the six markets, which substantial damage to the country's production capacity and other major producers. The downfall of white pepper prices is due to the larger supply than worldwide demand. Similarly, the black pepper prices recorded the lowest price in 1992, which accounted about RM100/100kg. As a result of the lower Ringgit against the US dollar, the price of white pepper recorded the highest peak in the year 1998, which accounted above RM2500/ 100kg. Meanwhile, Sarawak Black Pepper achieved the highest price in November 1999 accounted about RM1800/100kg due to the renewed coverage from US traders and a firmer market pushing the price up. Besides, low quantity of stock in the market had somewhat raised the prices of the pepper in the market.

[Insert Figures 1 to 6 here]

Should there be sufficiently complete information in the market, then the price differences between regional markets are equal or less than transportation costs. As such, a single price will prevail for there will be no scope for traders to make excessive profit. Reversely, should information be incomplete or in other words, the market is lacking information, the flow of goods is inadequate and the price differences between regional markets will exceed that of transportation costs. Market inefficiency will benefit traders. However, the farmers would endure negative impact, as they will not be able to enjoy the fruits of their own labor. Traders may take advantage on price over an informed clientele through the lower purchase price of commodity in one market and a higher selling price in another. Thus, abnormal return will be obtainable as trading of these commodities are possible.

These bring forth several queries. The questions are: Do white pepper prices and black paper prices substitute for each other? In other words, are these two prices linked together? The key objective of this paper is to empirically examine the two prices (white and black pepper) within six markets in Sarawak (Kuching, Sri Aman, Bingtangor, Sibu, Sarikei and Batu Niah). Unlike earlier studies by Baharumshah and Habibullah (1994) and Habibullah and Baharumshah (1994), this paper utilizes an alternative testing methodology, endorsed by Toda and Yamamoto (1995) with an adoption of a better finite sample size and power properties against the causality test based on vector error correction model (VECM). More importantly, the Toda-Yamamoto overcome the pretest biased associated with unit root and cointegration tests. In addition, the Johansen and Juselius (1990) (JJ) multivariate cointegration procedures will also be conducted in order to determine the long run relationship between white and black pepper prices in the six markets.

The rest of this paper is structured as follows. Section 2 briefly discusses the data and methodology deployed in the study. Section 3 reports the empirical findings, while concluding remarks are presented in Section 4 of the paper.

2. Data and Methodology

2.1 Source of Data

Monthly time series Sarawak white pepper and black pepper prices covering the period from January 1990 to June 2005 is adopted in this study. The data were gathered from various issues of Pepper Marketing Board Malaysia.

2.2 Unit Root Test

The standard ADF (see Said and Dickey, 1984) and DFGLS (see, Elliott *et al*., 1996) testing principles share the same null hypothesis of a unit root. Their differences however are centered on the way the latter specified the alternative hypothesis and treats the presence of the deterministic components in a variable's data generating process (DGP). Specifically the DFGLS procedure relies on locally demeaning and/or detrending a series prior to the implementation of the usual auxiliary ADF regression. The use of the DFGLS tests statistics is likely to minimize the danger of emerging erroneous inferences when the series under investigation has a mean and/or linear trend in its DGP. This is so because these statistics have been shown to achieve a significant gain in power over their conventional ADF counterparts (Elliott *et al*., 1996)[1]. The DFGLS mean (μ) and trend (τ) stationarity under a local alternative will be denoted by τ_μ and τ_τ respectively where they are constructed by estimating the following auxiliary regression of

[1] Using the Monte Carlo simulation, Vougas (2007) found that DFGLS suffers minimal or no size distortion/inflation compared to the ADF test when there is a neglected level or trend break under the null hypothesis.

$$\Delta x_1^m = \beta_0 x_{t-1}^m + \sum_{j=1}^{n} \beta_j \Delta x_{t-j}^m + \varepsilon_t \qquad (1)$$

where x_1^m is the locally demeaned and/or detrended process obtained from $x_t^m = x_t - \overline{\beta}' z_t$. Under this condition, $z_t = 1$ for the case of τ_μ while $z_t = (1 \quad t)$ for the case of τ_τ and $\overline{\beta}'$ is the regression coefficient of $\tilde{x}_t$ on $\tilde{z}_t$ for which $(\tilde{x}_1, \tilde{x}_2, ..., \tilde{x}_T) = [x_1 (1 - \overline{\rho} L) x_2), ..., (1 - \overline{\rho} L) x_T)]$, $(\tilde{z}_1, \tilde{z}_2, ..., \tilde{z}_T) = [z_1, (1 - \overline{\rho} L) z_2, ...(1 - \overline{\rho} L) z_T]$ under the local alternative of $\overline{\rho} = 1 + (\overline{c} / T)$. The $\tau_\mu (\tau_\tau)$ test statistic is given by the usual t statistic for testing $\beta_0 = 0$ in the associated ADF type auxiliary regression for the appropriate x_t^m variables shown in Equation (1). In addition, this procedure requires the choice of the local to unity parameter $\overline{c}$ through $\overline{\rho} = 1 + (\overline{c} / T)$ are set to -7 in the case of τ_μ and –13.5 in the case of τ_τ (see Elliott *et al*., 1996 for details).

In contrast, the KPSS (Kwiatkowski *et al*., 1992) semi-parametric procedure tests for level (η_μ) or trend stationarity (η_τ) against the alternative of a unit root is also adopted here. The KPSS test statistic for level (trend) stationary is

$$\eta_\mu (\eta_\tau) = \frac{1}{s^2 (k) T^2} \sum_{t=1}^{T} S_t^2 \qquad (2)$$

where $S_t = \sum_{i=1}^{t} u_i, u_t$ are the residuals from the regression of X_t on a constant (a constant and trend) for the level (trend) stationarity, $s^2(k)$ is the non-parametric estimate of the 'long run variance' of u_t while k stands for the lag truncation parameter. In this sense, the KPSS principles involve different maintained hypothesis from the ADF and DFGLS unit root tests.

2.3 Cointegration Procedure

The system-based cointegration procedure developed by Johansen and Juselius (1990) to test the absence or presence of long run equilibrium is adopted in this paper. One advantage of this approach is that the estimation procedure does not depend on the choice of normalization and it is much more robust than Engle-Granger test (see Gonzalo, 1994). Phillips (1991) also documented the desirability of this technique in terms of symmetry, unbiasedness and efficiency. Their test utilizes two likelihood ratio (LR) test statistics for the number of cointegrating vectors: namely the trace test and the maximum eigenvalue test. The Johansen procedure is well known in the time series literature and the detail explanation are not presented here. The importance of applying a degree-of-freedom correction for the Johansen-Juselius framework is necessary to reduce the excessive tendency of the test to falsely reject the null hypothesis of no cointegration. In this study, we relied on the correction factor suggested by Reinsel and Ahn (1992) that multiplies the test statistic by $(T-pk)/T$ to obtain the adjusted test statistics where T is total number of the observations, p is the number of variables in the system and k is the lag length order of VAR system.

2.4 Granger Causality Test

In the presence of cointegration, there is the existence of a corresponding error correction representation. In other words, if a VAR system is cointegrated, the Granger causality test may be conducted in the environment of VECM. Otherwise, the analyses may be conducted as a standard first difference vector autoregressive (VAR) model. The relevant error correction term (ECTs) must be included in the VAR to avoid mis-specification and omission of the important constraints. However, the workhorses of testing the non-causality such as ECM and VECM when the variables are cointegrated are cumbersome and sensitive to the values of nuisance parameters in finite samples and therefore 'the virtues of simplicity and ease of application have been largely lost' (Rambaldi and Doran, 1996: p.3).

One way to circumvent this problem is to posit a VAR in which variables appear purely in their level form. Toda and Yamamoto (1995) have proposed the modified WALD (MWALD) for testing *Granger non-causality* that allows causal inference to be conducted in the level VARs that may contain integrated and (non) cointegrated processes and require the determination of the true lag length of the model[2]. This procedure imposes (non-) linear restrictions on the parameters of VAR models without having to pretest for unit root and cointegrating rank. Rambaldi and Doran (1996) had shown that Seemingly Unrelated Regression (SUR) could easily compute the MWALD test. In what follows, we relied on the Toda-Yamamoto tests to make the causal inference among the variables in the VAR model.

Following Toda and Yamamoto's (1995) Granger non-causality test, these variables can be causally linked in a two-dimensional VAR system (assuming p=3):

$$\begin{bmatrix} WP_t \\ BP_t \end{bmatrix} = \begin{bmatrix} \alpha_{1t} \\ \alpha_{2t} \end{bmatrix} + \begin{bmatrix} \beta_{11}^{(1)} & \beta_{12}^{(1)} \\ \beta_{21}^{(1)} & \beta_{22}^{(1)} \end{bmatrix} \begin{bmatrix} WP_{t-1} \\ BP_{t-1} \end{bmatrix} + \begin{bmatrix} \beta_{11}^{(2)} & \beta_{12}^{(2)} \\ \beta_{21}^{(2)} & \beta_{22}^{(2)} \end{bmatrix} \begin{bmatrix} WP_{t-2} \\ BP_{t-2} \end{bmatrix} + \begin{bmatrix} \beta_{11}^{(3)} & \beta_{12}^{(3)} \\ \beta_{21}^{(3)} & \beta_{22}^{(3)} \end{bmatrix} \begin{bmatrix} WP_{t-3} \\ BP_{t-3} \end{bmatrix} + \begin{bmatrix} \varepsilon_{WP} \\ \varepsilon_{BP} \end{bmatrix} \quad (3)$$

where WP is white pepper price while BP is black pepper price. To test whether BP does not Granger cause movement in WP (if k=2 and d_{max}=1), the null hypothesis is H_0: $\beta_{12}^{(1)} = \beta_{12}^{(2)} = 0$ in the first equation of the system. The existence of the causality from BP to WP can be established through rejecting the above null hypothesis, which requires finding the

[2] They prove that in the integrated and (non-) cointegrated system, the MWALD test for restrictions on the parameters of a VAR(k) has an asymptotic χ^2 distribution when a VAR ($p = k + d_{max}$) is estimated, where d_{max} is the maximum order of integration suspected to occur in the system.

significance of the MWALD statistics for BP_{t-1} and BP_{t-2} identified above while BP_{t-3} is left unrestricted as a long run correction mechanism. These restrictions imply a long run causal inference since, unlike ordinary first difference VAR, this formulation involves only variables appearing in their levels. Similar analogous restrictions and testing procedure can be applied in testing the hypothesis that WP does not Granger cause movement in BP, i.e. to test H_0: $\beta_{21}^{(1)} = \beta_{21}^{(2)} = 0$ of the second equation of the system (Eq. 3). This procedure can be easily generalized for a larger number of lags in the VAR system.

3. Empirical Results and Discussions

3.1 Unit Root and Stationarity Tests

As the prelude to any cointegration and VAR testing procedure, the variables under investigation must be a stationary time series. For this purpose, we conduct two-unit root and one stationarity tests as discuss earlier for the six markets in order to discriminate the conclusion of stationarity and non-stationarity. The results of ADF, DFGLS and KPSS tests suggest the existence of unit root or nonstationarity in level or *I(1)* for the two variables. The findings that all the variables have the same order of integration allowed us to proceed with the Johansen cointegration analysis. The results are reported in Table 1.

[Insert Table 1 here]

3.2 Johansen and Juselius Cointegration Test

Before testing for the existence of any cointegrating relationship between the two-prices (pepper) in the six markets using Johansen procedure, it is necessary to determine the dynamic specification of the VAR model. It is widely known that the lag orders (k) can affect the number of cointegrating vectors in the system. For this purpose, multivariate generalization of Akaike Information Criteria (AIC) proposed by Gonzalo and Pitarakis (2002) were used to determine the optimal lag length for the vector autoregressive (VAR). The multivariate generalization of AIC yielded VAR (5) for the Kuching and Sarikei, VAR (4) for Bintangor, Sibu and Batu Niah while VAR (3) for Sri Aman. Despite different lag structures in each markets, the residuals did not exhibit any form of serial correlation or ARCH effects satisfying the normal specification criteria for the residuals.

After determining the optimal lag structure for VAR estimation, we proceed to the cointegration test. Results of the cointegration procedure (with and without the adjustment factor) are presented in Panel A of Table 2. The null hypothesis of no cointegrating vector (r=0) in favor of at least one cointegrating vector is rejected at 5 percent significance level for the six markets under investigation. We noted that both the trace and the maximum eigenvalue tests led to the same conclusion—the presence of one cointegrating vector. Rejecting the null hypothesis of no cointegration implies that the two prices do not drift apart and share at least a common stochastic trend in the long run. The results hold true for both with and without the adjustment factor.

[Insert Table 2 here]

To determine if these variables in the system belong to the cointegrating space, we apply the log-likelihood ratio (LR) test for the exclusion of each variable as discussed in Johansen and Juselius (1990: pp. 195). Panel B, Table 2 provides the test results of the exclusion restriction on WP and BP. The null of restricting the coefficients of WP and BP to zero can be easily rejected at the 5 percent significant level for all the six markets. Clearly, the two prices belong to the cointegrating space and cannot be ruled out from the analysis. This further implies that black pepper and white pepper prices in each of the six markets in Sarawak are cointegrated. The white pepper and black pepper market are linked together and this finding supported that the pepper prices do move together in the long run for these six markets.

3.3 Granger Causality Test

After determining the cointegration relationship, the question now is as to whether one variable will be able to forecast using information of other variable. Specifically, the query is as to whether one price leads the other price in the pepper markets or not. In this sense, Granger causality test based on Toda and Yamamoto (1995) has been employed to examine lead-lag relationship in pepper prices of the six markets in Sarawak. To ensure the robustness of the Toda-Yamamoto technique, we report for both d=1 and d=2, after selecting the lag length[3]. Most economic time series encountered in empirical studies to be at most *I(2)*. In their study, Toda and Yamamoto (1995, p.233) assume only for the case of d=2. However, in this paper, we generalized their reasoning by assuming that d=1 and d=2 (or the series can take either *I(1)* or *I(2)*). In this manner, the robustness of testing procedure is tested.

Clearly, the null hypothesis that WP do not cause (in Granger-sense) BP is easily rejected at conventional significant levels, indicating there is a unidirectional causality running from WP to BP in the six markets (see Table 3). The WP prices can be used to predict the BP prices in the long run. However, BP does not have ability to influence the WP in the long run. In addition, Table 4 yields similar conclusions. This suggests the robustness of the empirical result and the in-sensitivity of the Toda and Yamamoto (1995) procedure.

[3] We estimated the model using the same lag structure as in the cointegration experiment.

4. Concluding Remarks and Policy Implementations

Indeed the study of various spatial price relationships has been sought after to indicate the overall market performance. Given the importance of pepper prices in Sarawak, the performance of this particular pepper industry is of interest to many market players namely the traders, producers and also the end users. This analysis utilized a monthly price series of both the white and black pepper in order to assess price relationships among several markets in Sarawak. Basically, Kuching, Sri Aman, Bintangor, Sarikei, Sibu, and Batu Niah are the major pepper markets within this state.

Mainly, this study bows to several general conclusions. First, the pepper markets in Sarawak are said to be cointegrated. In this sense, both the white and black pepper markets are bound together in the long run. And therefore, the pepper market in Sarawak is price sensitive whereby the prices tend to move parallel with each other. Should any one market (white pepper) amend its price by raising or lowering the price setting), the rest of the markets (black pepper) would gage towards the similar direction too. As such, market efficiency and price predictability of pepper in Sarawak does prevail.

Second, causal chain runs predominantly from white pepper to black pepper for all six markets (but not vice versa). As such the prices of the black pepper are affected by the price setting of the white pepper. This finding does emphasize the role of the white pepper in terms of marketing decisions and market pricing strategies in Sarawak.

Considering the fact that price predictability can be derived as far as the pepper industry in Sarawak is concern, thus this particular market within Sarawak is rather efficient. As opined by Baharumshah and Habibullah (1994), integrated markets are those whose prices are determined interdependently. Meaning that the price of one market depends on its own and also that of other markets. With the price predictability on the possible price adjustments, abnormal profit within this market will not be made beneficial to traders and supplier as information and price changes in the white pepper market will fully transmit to the black pepper market. This conclusion is in the similar vein with Cheng *et al.,* (1991), Liang *et al*., (1998), Yang *et al.,* (2000), Fousekis and Klonaris (2002) in other commodities markets. These authors found price interdependencies exist for potato prices (Cheng *et al.,* 1991), dry bean prices (Liang *et al*., 1998), soybean prices (Yang *et al.* 2000) and olive oil prices (Fousekis and Klonaris, 2002) spatial markets.

As a conclusion, results do suggest that the Sarawak regional pepper markets are highly integrated. The prices will tend to move in unison across geographical separated markets in Sarawak, an incidence of pepper markets price interdependencies.

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Table 1: Unit Root and Stationary Tests

	Test Statistics					
	t_{μ}	t_{τ}	τ_{μ}	τ_{τ}	η_{μ}	η_{τ}
A: Level						
Kuching						
WP	-1.889 (6)	-1.771 (6)	-1.900(1)	-1.416(1)	0.592(1)*	0.186(2)*
BP	-1.946 (6)	-1.874 (6)	-1.780(1)	-0.480(1)	0.596(1)*	0.188(1)*
Sri Aman						
WP	-1.507 (2)	-1.344 (2)	-1.921(1)	-0.688(1)	0.805(1)*	0.944(1)*
BP	-1.475 (2)	-1.363 (2)	-0.782(1)	-2.498(1)	0.962(1)*	0.268(1)*
Bintangor						
WP	-1.549 (3)	-1.398 (3)	-2.257(1)	-0.924(1)	0.973(3)*	0.284(3)*
BP	-1.509 (3)	-1.409 (3)	-2.451(1)	-2.598(1)	0.954(3)*	0.280(3)*
Sibu						
WP	-1.519 (4)	-1.509 (4)	-0.438(1)	-0.466(1)	0.890(3)*	0.231(3)*
BP	-1.426 (4)	-1.154 (4)	-0.403(1)	-2.667(1)	0.886(3)*	0.226(2)*
Sarikei						
WP	-1.697 (6)	-1.539 (6)	-2.008(1)	-1.503(1)	0.990(3)*	0.273(3)*
BP	-1.438 (6)	-1.144 (6)	-1.241(1)	-1.578(1)	0.993(3)*	0.274(3)*
Batu Niah						
WP	-1.489 (7)	-1.771 (7)	-1.366(1)	-1.801(1)	1.011(3)*	0.281(3)*
BP	-1.946 (7)	-1.874 (7)	-1.892(1)	-1.329(1)	0.623(3)*	0.324(3)*
B: First Differences						
Kuching						
ΔWP	-6.123(6)*	-6.286(6)*	-3.777(1)*	-3.566(1)*	0.087(1)	0.076(2)
ΔBP	-6.848(6)*	-8.657(6)*	-6.705(1)*	-7.214(1)*	0.118(1)	0.117(1)
Sri Aman						
ΔWP	-6.510(2)*	-7.459(2)*	-6.618(1)*	-7.984(1)*	0.057(1)	0.059(1)
ΔBP	-6.385(2)*	-6.468(2)*	-9.678(1)*	-9.266(1)*	0.199(1)	0.057(1)
Bintangor						
ΔWP	-6.350(3)*	-6.513(3)*	5.173(1)*	5.269(1)*	0.134(3)	0.059(3)
ΔBP	-7.622(3)*	-7.180(3)*	-7.618(1)*	-8.984(1)*	0.319(3)	0.053(3)
Sibu						
ΔWP	-6.841(4)*	-6.993(4)*	-5.040(1)*	-4.994(1)*	0.135(3)	0.107(3)
ΔBP	-5.755(4)*	-5.850(4)*	-4.492(1)*	-4.477(1)*	0.138(3)	0.096(2)
Sarikei						
ΔWP	-5.729(6)*	-5.663(6)*	-4.612(1)*	-4.586(1)*	0.345(3)	0.096(3)
ΔBP	-5.985(6)*	-6.046(6)*	-4.882(1)*	-4.893(1)*	0.384(3)	0.071(3)
Batu Niah						
ΔWP	-7.866(7)*	-9.295(7)*	-5.932(1)*	-5.871(1)*	0.151(3)	0.086(3)
ΔBP	-7.603(7)*	-7.727(7)*	-5.995(1)*	-6.014(1)*	0.123(3)	0.096(3)

Notes: The t, τ, and η statistics are for ADF, DFGLS and KPSS respectively. The subscript μ in the model allows a drift term while τ allows for a drift and deterministic trend. Asterisk (*) indicates statistically significant at 5 percent level. Figures in parentheses are the lag lengths. The asymptotic and finite sample critical values for ADF are obtained from MacKinnon (1996) while the KPSS test critical values are obtained from Kwiatkowski *et al*. (1992, Table 1, pp. 166). The DFGLS for the drift term (μ) follows the MacKinnon (1996) critical values while the asymptotic distributions for the drift and deterministic trend (τ) are obtained from Elliott *et al*. (1996, Table 1, pp 825). Both the ADF and DFGLS test examine the null hypothesis of a unit root against the stationary alternative. KPSS tests the null hypothesis whether the series are stationary against the alternative hypothesis of a unit root or not. Δ denotes first different operator.

Table 2:Cointegration Test Results and Hypothesis Testing

Panel A: Johansen Cointegration Test

Kuching

Null	Alternative	k=5 r=1					
		λ-max			Trace		
		Unadjusted	Adjusted	95% C.V.	Unadjusted	Adjusted	95% C.V.
r = 0	r = 1	32.543*	30.793*	15.870	36.112*	34.171*	20.180
r<= 1	r = 2	3.569	3.371	9.160	3.569	3.371	9.160

Sri Aman

Null	Alternative	k=3 r=1					
		λ-max			Trace		
		Unadjusted	Adjusted	95% C.V.	Unadjusted	Adjusted	95% C.V.
r = 0	r = 1	25.894*	25.059*	15.870	28.683*	27.758*	20.180
r<= 1	r = 2	2.789	2.699	9.160	2.789	2.699	9.160

Bintangor

Null	Alternative	k=4 r=1					
		λ-max			Trace		
		Unadjusted	Adjusted	95% C.V.	Unadjusted	Adjusted	95% C.V.
r = 0	r = 1	21.191*	20.279*	15.870	24.830*	23.762*	20.180
r<= 1	r = 2	3.639	3.482	9.160	3.639	3.482	9.160

Sibu

Null	Alternative	k= 4 r=1					
		λ-max			Trace		
		Unadjusted	Adjusted	95% C.V.	Unadjusted	Adjusted	95% C.V.
r = 0	r = 1	25.795*	24.685*	15.870	28.747*	27.510*	20.180
r<= 1	r = 2	2.951	2.824	9.160	2.951	2.824	9.160

Sarikei

Null	Alternative	k=5 r=1					
		λ-max			Trace		
		Unadjusted	Adjusted	95% C.V.	Unadjusted	Adjusted	95% C.V.
r = 0	r = 1	20.842*	19.722*	15.870	25.212*	23.856*	20.180
r<= 1	r = 2	4.370	4.135	9.160	4.370	4.135	9.160

Batu Niah

Null	Alternative	k=4 r=1					
		λ-max			Trace		
		Unadjusted	Adjusted	95% C.V.	Unadjusted	Adjusted	95% C.V.
r = 0	r = 1	22.782*	21.802*	15.870	26.187*	25.061*	20.180
r<= 1	r = 2	3.404	3.257	9.160	3.404	3.257	9.160

Panel B: Test of Exclusion Restrictions Based on Johansen Procedure

Variables	**χ^2-statistics (p-value)**					
	Kuching	**Sri Aman**	**Bintangor**	**Sibu**	**Sarikei**	**Batu Niah**
WP	28.769 (0.000)*	23.018(0.000)*	17.452(0.000)*	22.561(0.000)*	16.275(0.000)*	19.082(0.000)*
BP	28.545(0.000)*	22.409(0.000)*	17.134(0.000)*	22.542(0.000)*	16.254(0.000)*	19.117(0.000)*
Intercept	4.195 (0.041)*	6.7490 (0.009)*	4.436(0.035)*	4.517(0.034)*	5.002(0.025)*	5.021(0.025)*

Notes: The k is the lag length and r is the cointegrating vector(s). Chosen r: number of cointegrating vectors that are significant under both tests. The unadjusted and the adjusted statistics are the standard Johansen statistics and the statistics adjusted for small sample correction factor according to Reinsel and Ahn (1992) methodology. Their finite sample correction multiplies the Johansen test statistic by the scale factor of $(T\text{-}pk)/T$, where T is the sample size, p is the number of variables, and k is the lag length for the VAR model. The exclusion test is based on a likelihood ratio test and has a $\chi 2$ (r) distribution, where the degree of freedom is r, the number of cointegrating vector. Asterisk (*) denotes statistically significant at 5 percent level.

Table 3: Test for Granger non-causality (d=1)

Null Hypothesis	Test Statistics		Conclusion
A: Kuching (k=5 d=1)	**MWALD**	**p-value**	
Black Pepper does not *Granger cause* White Pepper	4.761	0.445	Do not reject Ho
White Pepper does not *Granger cause* Black Pepper	12.525	0.028	Reject Ho
B: Sri Aman (k=3 d=1)			
Black Pepper does not *Granger cause* White Pepper	4.480	0.214	Do not reject Ho
White Pepper does not *Granger cause* Black Pepper	10.201	0.016	Reject Ho
C: Bintangor (k=4 d=1)			
Black Pepper does not *Granger cause* White Pepper	4.654	0.324	Do not reject Ho
White Pepper does not *Granger cause* Black Pepper	15.273	0.004	Reject Ho
D: Sibu (k=4 d=1)			
Black Pepper does not *Granger cause* White Pepper	4.019	0.403	Do not reject Ho
White Pepper does not *Granger cause* Black Pepper	11.177	0.024	Reject Ho
E: Sarikei (k=5 d=1)			
Black Pepper does not *Granger cause* White Pepper	4.907	0.427	Do not reject Ho
White Pepper does not *Granger cause* Black Pepper	11.465	0.042	Reject Ho
F: Batu Niah (k=4 d=1)			
Black Pepper does not *Granger cause* White Pepper	6.398	0.171	Do not reject Ho
White Pepper does not *Granger cause* Black Pepper	15.071	0.004	Reject Ho

Note: k = optimum lag and d = maximal order of integration.

Table 4: Test for Granger non-causality (d=2)

Null Hypothesis	Test Statistics		Conclusion
A: Kuching (k=5 d=2)	**MWALD**	**p-value**	
Black Pepper does not *Granger cause* White Pepper	4.594	0.467	Do not reject Ho
White Pepper does not *Granger cause* Black Pepper	12.134	0.032	Reject Ho
B: Sri Aman (k=3 d=2)			
Black Pepper does not *Granger cause* White Pepper	4.671	0.337	Do not reject Ho
White Pepper does not *Granger cause* Black Pepper	10.760	0.013	Reject Ho
C: Bintangor (k=4 d=2)			
Black Pepper does not *Granger cause* White Pepper	4.623	0.328	Do not reject Ho
White Pepper does not *Granger cause* Black Pepper	14.910	0.004	Reject Ho
D: Sibu (k=4 d=2)			
Black Pepper does not *Granger cause* White Pepper	3.908	0.418	Do not reject Ho
White Pepper does not *Granger cause* Black Pepper	10.941	0.027	Reject Ho
E: Sarikei (k=5 d=2)			
Black Pepper does not *Granger cause* White Pepper	5.104	0.403	Do not reject Ho
White Pepper does not *Granger cause* Black Pepper	11.584	0.040	Reject Ho
F: Batu Niah (k=4 d=2)			
Black Pepper does not *Granger cause* White Pepper	7.734	0.101	Do not reject Ho
White Pepper does not *Granger cause* Black Pepper	16.017	0.003	Reject Ho

Note: k = optimum lag and d = maximal order of integration.

Figure 1: Monthly White Pepper and Black Pepper Prices in Kuching

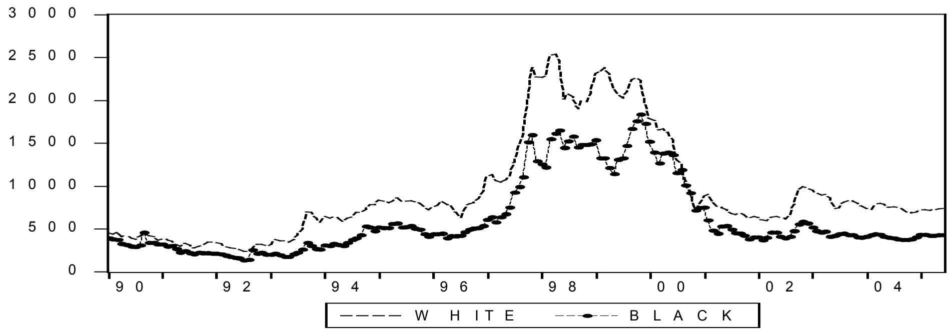

Figure 2: Monthly White Pepper and Black Pepper Prices in Sri Aman

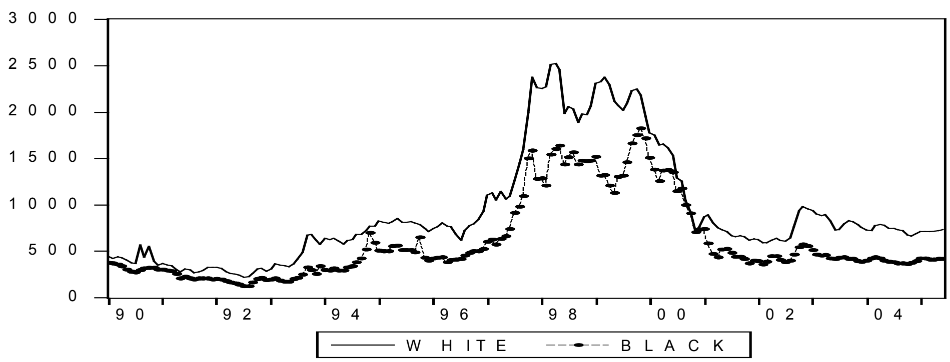

Figure 3: Monthly White Pepper and Black Pepper Prices in Bintangor

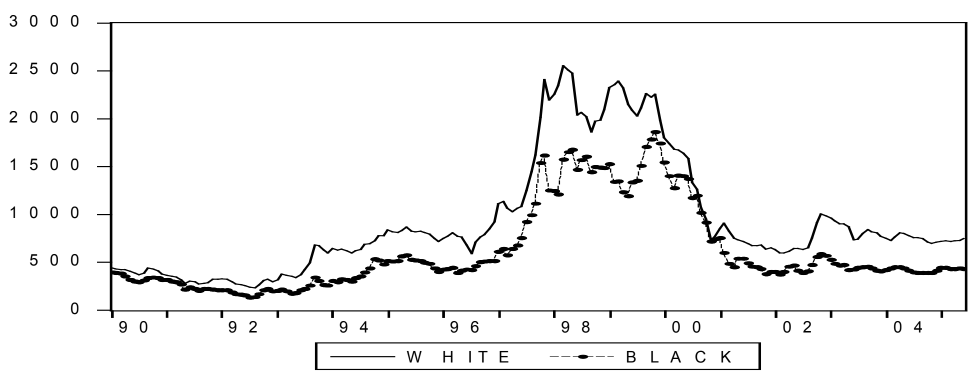

Figure 4: Monthly White Pepper and Black Pepper Prices in Sibu

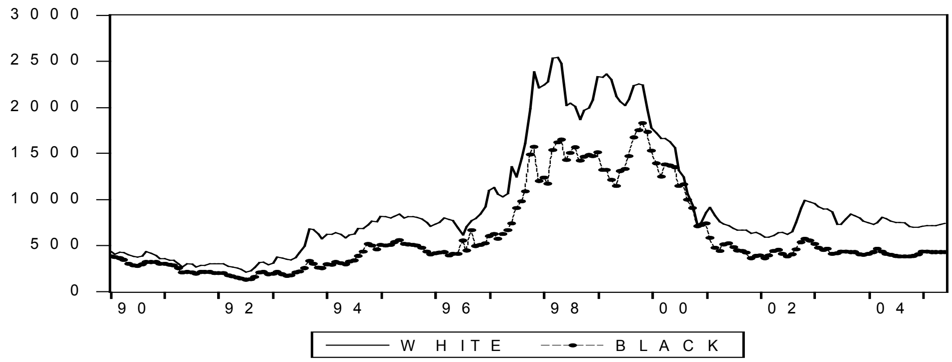

Figure 5: Monthly White Pepper and Black Pepper Prices in Sarikei

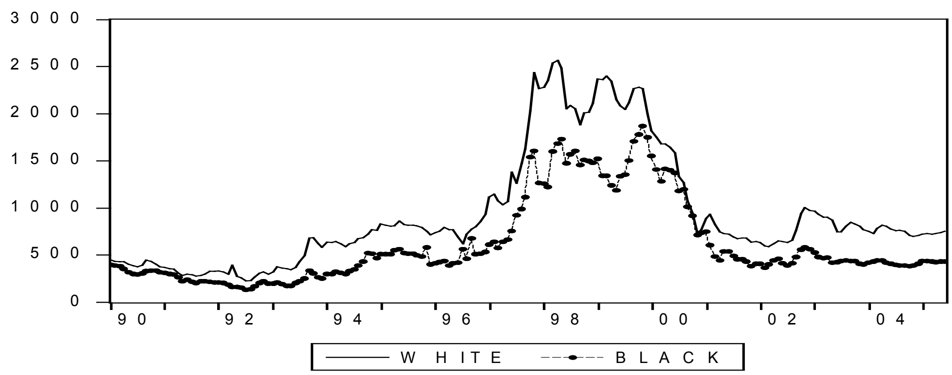

Figure 6: Monthly White Pepper and Black Pepper Prices in Batu Niah