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Price Linkages within Selected Vegetable Markets in Malaysia

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ABSTRAK

Kertas kerja ini pola jalinan harga antara tahap ladang, borong dan runcit bagi sebelas pasaran sayuran terpilih di Malaysia. Kajian ini bertumpu kepada perhubungan dahulu – ikut antara tahap menegak dalam pasaran terpilih. Ujian statistik yang digunakan untuk meneliti arah penyebab dan perhubungan dahulu dan turut adalah berdasarkan kepada kaedah yang dipelopori oleh Grander dan Pearce. Penemuan kajian menunjukkan bahawa harga ditemui di pusat borong dan harga borong mendahului harga ladang dan runcit bagi sebahagian besar sayur-sayuran yang dikaji.

ABSTRACT

This study examined the nature of price linkages in farm, wholesale and retail markets of eleven selected Malaysian vegetables, and focused on the lead-lag relationship in vertical level within the selected markets. The statistical tests used for the causality and lead and lag relationship were based on methods developed by Granger, Haugh and Pearce. Findings indicate that price discovery is made at the wholesale centre and whole sale price appears to lead both farm and retail prices for most of the vegetables examined.

INTRODUCTION

The vegetable marketing in Malaysia is characterised by a number of structural inefficiencies which has resulted in lack of market transparancies between levels and even regional centres (Low, 1993). The market is allegedly highly concentrated at the wholesale, which has a relatively small number of traders with each accounting a significant share of the market trade. Price is determined here by the wholesalers themselves. Unlike the producers, the wholesalers are more equipped with information – both on the supply and the retail demand and arrive at the prices for vegetables which are then transmitted to the producers. Furthermore, this price information is received by producers normally 2-3 days after the produce is sold to the wholesalers. This is because the producers are practising marketing through consignment system – where the produce is consigned to a particular trader (normally wholesaler) to find the market for the produce. More than two thirds of producers in Selangor, Perak and Johor do so. (MARDI, 1981). Under such an arrangement, farmers surrender the price discovery function to the traders. In other words, they do not negotiate to arrive at the price for their produce. They are merely price takers in the pricing process. Such a marketing structure is conducive towards price mmpulation piculary by big time wholesalers.

Such allegation in the case of vegetable market is yet to be verified. Price manipulation is difficult to prove but a study on the nature of price linkages between market levels would provide a clearer picture and hence the pricing efficiency of the system. There are two major factors that determine the efficiency of price transmission between levels; firstly market structure of each level and secondly, information advantage of one level compared to another. It can distort the quality and timing of information received at each pricing level.

It has been shown that industry concentration at market levels beyond farm gate has resulted in asymmetric farm-retail price transmission in dairy products (Kinnucan and Forker, 1987). Ward (1982) further contended that besides market structure, the extent of product transformation has a direct bearing on price linkages. Agricultural products having many uses and going through considerable transformation are expected to exhibit weak price relationship among the exchange points. In contrast, price linkages should be stronger for perishable products requiring a minimal transformation. Besides these factors, differences in the assimilation of market information may result in price leads and lags among retail, wholesale and farm. This because the information flow throughout the vertical system may not be equal between levels and traders' abilities to assimilate and for respond to market signals can differ at each market level.

The statistical tests to ascertain causality, leads and lags in prices were developed by Granger (1969), Sims (1972) and Haugh (1976) and Pierce (1977). These tests have been used in empirical studies of price transmission (Heien, 1980, Lamm and Westcott, 1981 and Ward, 1982). Lamm and Westcott shows that the direction of causality runs from farm to retail in the case of dairy products. Heien further shows a joint causal relationship occurs between wholesale and retail price for butter and a unidirectional downward relationship for milk.

This paper examines the nature of price linkages of vegetable markets between farm, wholesale and retail levels. In particular it aims at ascertaining the lead-lag relationship of vegetable prices at the three market levels using direct Granger, Haugh and Pierce causality tests. The priori hypothesis being tested here is that there is a causal linkage from wholesale to retails and farm levels.

METHODOLOGY

This study utilises Heien's markup pricing model to examine the price transmission behaviour between market levels. This model assumes that the market is competitive, fixed – proportion production technology and constant returns to scale in food marketing system. The pricing rules are in the following general form

$$R = b_1W + b_2Z$$
$$F = a_1W_1 + a_2Z$$

where R is retail price, W is wholesale price, F is farm price and Z is a price vector (assumed exogenous) of marketing inputs, a_1, a_2, b_1 and b_2 are the coefficients of the variables.

The causality test developed by Granger (1977) provides us the nature of the causal direction and lead/lag relationship between prices. Granger provided a definition of causality among a set of variables that is based upon predictability as well as the fact that the effect of a change in an exogenous variable upon an endogenous variable requires time. According to Granger, a variable X causes another variable Y, with respect to a given universe or infornation set that includes X and Y, if present Y can be better predicted by using past value of X than not doing so, all other information in the past of the universe being used in either case. Causality from Y and X is defined in the same manner. Feedback occurs if X causes Y and if Y causes X. A causal relationship between X and Y does not exist if causality does not run from X to Y or from Y to X, and feedback does not occur. A variety of testing procedures have evolved in applyiag the Granger definition to economic time series. For the purpose of this study, direct Granger Test (1969) and Haugh (1972) and Pierce (1977) were employed.

Direct Granger Test

Direct Granger test as refined by Geweke (1980) relies on direct OLS (ordinary least squar) regressions on levels of the time series data. Sometimes it is suggested that the data series be transformed before causality test are performed. Pre-filtering procedures considered includ first and second differencing and second order filter of the form $(1 - 0.75\ L)^2$ as suggested by Sims (1972).

$$Y_t = a_1 + \Sigma_{j=1}^{p} a_{1j} Y_{t-j} + e_{1t} \qquad (1)$$

$$y_t = a_2 + \Sigma_{j=1}^{p} a_{2j} Y_{tj} + \Sigma_{k=1}^{q} b_{2k} X_{t-k} + e_{2k} \qquad (2)$$

where

p and q = number of lags (j and k) used to eliminate autocorrelation
e_{it} = white noise residuals
a_{ij} = parameters relating Y_t to its lag value
b_{2k} = parameters relating Y_t and the past values (from time t-k) of X

The direct Granger test based on (1) and (2) is equivalent to testing the following null hypothesis;

$$b_{21} = b_{22} = \ldots\ b_{2q} = 0$$

which can be carried out with F test.

$$F* = \frac{SSE_1 - SSE_2}{Q} \bigg/ \frac{SSE_2}{N - p - q - 1}$$

where SSE_1 and SSE_2 refer to the sum of squared errors from OLS regressions on (1) and (2) respectively, and N is the number of time series observation on Yt. Under the null hypothesis, F* is distributed as F with (q, N-p-q-1) degrees of freedom. For suitably ,large values of F*, the null hypothesis that X does not cause Y is rejected. The test of no instantaneous causality is done by using equation (2) and adding current values of X (Geweke, 1980);

$$Y_t = a_3 + \Sigma_{j=1}^{p} a_{3j} + \Sigma_{k=0}^{q} b_{3k} X_{t-k} + e_{3k} \quad (3)$$

Given equations (1), (2) and (3), the next task involves the choice of the lag length parameters of p and q. The choice of appropriate lag length is important since omission of lagged values whose underlying population coefficients are non-zero, is likely to produce serial correlation in the residuals. This limitation is shared by univariate cross-correlation approach since computation of the U-Statistics is dependent on the choice of the number of lags and a possibility exists that a significant cross-correlation value may not be captured by the test statistic. This will affect the conclusion drawn from the results.

A number of simple procedures for determining the length of autoregressive process such as partial autocorrelations are available. However, an attractive mechanical method can be based on Akaike's Final Prediction Error (FPE) criterion or Akaike's Information Criterion (AIC) Judge et al. (1982). AIC proposed by Akaike is based on an extension of the maximum likelihood principle. This criterion is used in this study.

A check to see if the chosen autoregressive order l is appropriate can be based on the portmanteau test statistic for white noise Box and Pierce (1970).

$$Q = T\ (\Sigma_{i=1}^{k} r_i^2) \qquad (4)$$

where the r_i's are estimated autocorrelation coefficients and $K > l$. Q has a chi-square $(k-l)$ distribution if the null hythesis of no autocorrelation (white noise) is tree. Once the length parameters p dan q have been determined, then Granger test for causality is performed.

The Haugh and Pierce Test

Technique suggested by Haugh (1972) and Pierce (1977) utilizes the cross-correlation tehnique which is essentially looking at relationships between the estimated innovations of stationary series. The procedure involves the determation of the appropriate ARIMA filter for each series such that they become white noise. The those innovations are cross-correlated. The strength of the relationsp between two series is measured through cross-correlations of residual from pre-whitened series.

Let X_t and Y_t be the realizations at time t of two stochastic process. Associated with X_t and Y_t are white noise terms, U_t and V_t

respectively. Also, $E(U_t) = E(V_t) = 0$; $E(U_t^2) = \sigma U^2$; $E(V_t^2) = \sigma v^2$. According to Haugh and Box (1977), the theoretical cross-correlation between the U's an d V's is defined at lag k as;

$$P_{UV}(k) = \frac{E(U_{t-k}, V_t)}{\sigma U \, \sigma V} \quad (5)$$

where $P_{UV}(k)$'s are the coefficients of the cross-correlation between U's and V's and can be used to assess the lead lag relationships between the original X and Y series.

Estimated U's and V's denoted as the $\hat{U}$'s and V's respectively, can be obtained *via* application of univariate time series modelling techniques developed by Box and Jenkins (1976). Statistical test of the significance of the calculated cross-correlations between the $\hat{U}$'s and V's denoted as the $r_{UV}(k)$'s may be used to interpret the lead-lag relationship between X and Y. Since individual estimated cross-correlation can be misleading, Pierce suggests a portmanteau statistic to test the hypothesis. As discussed by Pierce (1977), the hypothesis that X and Y are linearly independent may be rejected at significant level α if;

$$Q_{2m+1} = n \, \Sigma_{k=-m}^{m} \mid r_{UV}(k) \mid ^2 > X_\alpha^2, 2m+1 \quad (6)$$

where X_α^2, 2m+1 is the upper α percentage point of the chi-square distribution with d.f. # 2m+1; and m is chosen as to include a; $r_{UV}(k)$'s expected to differ from zero. The contention that X leads Y is supported at significance level α if;

$$Q_{m+1} = n \, \Sigma_{k=1}^{m} \mid r_{UV}(k) \mid ^2 > X_\alpha^2, m \quad (7)$$

Simirlarly, Y leads X may be assorted at α if;

$$Q_{m+1} = n \, \Sigma_{k=-m}^{-1} \mid r_{UV}(k) \mid ^2 > X_\alpha^2, m \quad (8)$$

If the inequities in equation (7) and (8) hold simultaneously, a feedback relationship between X and Y is indicated. Furthermore, if the cross-correlation is non-zero, then there exists instantaneous causality. Details on the nature of causality based on cross-correlation values are described in Pierce (1977).

Data

Eleven major vegetables which consisted of highland and lowland types and leafy and fruity vegetables were selected for this study. These varieties provided the more general types for the vegetable market and also represented variations the degree of perishability and shelf life in the industry. Undeflated wholesale, retail and farm prices A Chinese cabbage, tomato, chilli, cucumber, long beans, French beans, spinach, Chinese mustard, kangkong, lady's fingers and brinjal of the selected vegetables were compluted markly for the period January 1989 – November 1992 or a total of 204 observations. Undeflated prices were used to see the effects of nominal price changes. Average weekly prices of five market centres; Kuala Lumpur, Ipoh, Johor Bahru, Penang and Kuantan were computed for every level except farm price for tomato and Chinese cabbage. For the latter two types of vegetable, wholesale purchase prices in Kuala Lumpur and Ipoh were used as a representative. The criteria for the selection of the sample period, market centres and types of vegetable were based on the continuity and availabiliy of data for all levels of selected items, size of the market centres and popularity of the vegetables among farmers and consumers. The sample, represent 44% of the total prodction and 39% of the domestic consumption of common vegetables found in the market. The price series were collected from the Federal Agricultal Marketing Authority (FAMA).

RESULTS AND DISCUSSION

The results of the Granger causality test performed on the eleven popular vegetables selected are summarized in Table 1. Wholesale prices were found to lead farm price for more than half of the vegetables (Chinese mustard, brinjal, lady's finger, French beans, chilli and long beans). The lagged changes in wholesale prices were significantly associated at the 95% confidence level with the current change in farm prices. In other words, the changes in the wholesale prices tend to lead changes in the farm price of the above

TABLE 1
Granger causality test results between farm, wholesale and retail prices of selected fresh vegetables in Malaysia[a]

Item	F Value Regression[b]	Instantaneous	One way[d]	Direction of causality
	WS : WS	13.79*	–0.53	–
Chinese Mustard	FM : WS	19.98*	5.37*	FM ← WS
	WS : RT	83.46*	1.55	–
	RT : WS	76.40*	2.89*	RT ← WS
	WS : FM	6.27*	1.55	–
Brinjal	FM : WS	8.98*	3.58*	FM ← W
	WS : RT	8.13*	1.75	–
	RT : WS	12.99*	3.85*	RT ← W
	WS : FM	10.48*	1.63	–
Lady's Finger	FM : WS	19.97*	4.90*	FM ← WS
	WS : RT	58.31*	1.92	–
	RT : WS	55.54*	0.21	–
	WS : FM	32.78*	2.03	–
French Beans	FM : WS	46.47*	6.82*	FM ← WS
	WS : RT	82.51*	2.53**	WS ↔ RT
	RT : WS	84.41*	3.58*	
	WS : FM	85.11*	1.16	–
Chilli	FM : WS	88.55*	2.50**	FM ← WS
	WS : RT	181.97*	2.54**	WS ↔ RT
	RT : WS	288.66*	3.80*	
	WS : FM	16.70*	4.63*	FM ↔ WS
English Cabbage	FM : WS	9.60*	2.05**	
	WS : RT	23.00*	1.31	–
	RT : WS	25.40*	2.15**	RT ← WS
	WS : FM	51.10*	2.47**	FM ↔ WS
Spinach	FM : WS	53.09*	3.43*	
	WS : RT	62.46*	0.82	–
	RT : WS	63.60*	1.32	–
	WS : FM	53.18*	5.88*	WS ← FM
Kangkong	WS : WS	39.96*	2.10	–
	WS : RT	34.17*	5.19*	WS ↔ RT
	RT : WS	28.50*	3.82*	
	WS : FM	27.63*	1.95	–
Long Beans	FM : WS	34.89*	4.16*	FM ← WS
	WS : RT	83.31*	5.47*	WS ↔ RT
	RT : WS	56.62*	2.48**	
	WS : FM	58.23*	33.89*	WS ← FM
Tomato	FM : WS	27.85*	1.38	–
	WS : RT	23.81*	0.56	–
	RT : WS	105.03*	8.95*	RT ← WS

Table 1 (cont'd)

Item	F Value Regression[b]	Instantaneous	One way[d]	Direction of causality
Cucumber	WS : FM	27.31*	2.76**	FM ↔ WS
	FM : WS	33.44*	0.73	
	WS : RT	72.56*	4.52*	WS <-> RT
	RT : WS	68.33*	2.81**	

Note:
a Lag length determined through Akaike's information criterion
b The variable to the left of column is dependent: FM, WS and RT refer to farm wholesale and retail prices respectively
c Test is based on equation (3) and (1)
d Test is based on equations (2) and (1)
– Asterisk represents rejection of null hypothesis of no causality significance level $\alpha = 0.01$ (*), $\alpha = 0.05$ (**)

vegetables. The reverse effects, however, is shown for tomato, kangkong and cucumber where changes in farm prices significantly influenced changes in the wholesale prices. English cabbage and spinach showed bi-directional relationship between farm and wholesale prices. The tests of same-week causality, however, indicate that for all vegetables under study, changes in farm and wholesale prices exhibited a significant same-week relationship. It appears that prices tend to be discovered within the same-week at both levels.

The lagged changes in wholesale prices are also found to be significantly associated at the 95% confidence level with the current changes in retail prices as shown by the F-values of nine out of eleven types of vegetables under study (Table 1). This means that wholesale price changes tend to lead changes in the retail prices. The reverse effect (retail on wholesale), however, is found to be significant for French beans, chilli, kangkong, long beans and cucumber, indicating bi-directional relationship between retail and wholesale levels. Independent relationships exist between both prices for lady's fingers and spinach as shown by the insignificant association of both prices for both direction. However, the F-values for the effect of wholesale on retail changes is bigger for spinach which implies that wholesale changes lead retail changes. Similar to the farm-wholesale price relationship, instantaneous relationship between retail-wholesale is found for all vegetables indicating that prices tend to be discovered within the same week at wholesale and retail levels.

The empirical evidence from Granger's test suggests that wholesale prices of the vegetables tend to lead both farm and retail prices of more than half the vegetables examined. Such results are consistent with most of the previous studies (Ward, 1982, and Heine 1980) and our *a priori* expectation.

As an alternative to Granger's test, the direction of causality between farm and wholesale levels can be established using the Haugh and Pierce test. Estimated autocorrelations of the wholesale and farm price changes for up to ten lags are given in Table 2. The standard errors of individual autocorrelations may be approximated by $n^{-1/2}$; here $204^{-1/2} = 0.07$. The series are found to be autocorrelated since some of the coefficients exceed the value 0.07, hence this univariate residual cross-correlation analysis is less likely to be misleading in explaining the relationship of both prices (Miller, 1980).

Results in Table 2 indicate, that Q_{10+} exceed the critical value of $X^2_{5,10} = 18.3$ for four out of eleven vegetable under study, the implication being that wholesale changes lead farm price changes. The test reveals that for the other two varieties, i.e; English cabbage and long beans, bi-directional relationship exists between both wholesale and farm levels, with the effect of wholesale price changes on farm price being greater than the reverse direction as shown by greater portmanteau statistic Q_{10+}. While an independent relationship exists for chilli and

TABLE 2
Estimated cross correlations between White Noise residual of weekly wholesale and farm prices

Lag	C. Mustard		Brinjal		Lady's Finger		French Beans		Chilli		Eng. Cabbage		Spinach		Kangkong		Long Beans		Tomato		Cucumber	
	POS	NEG	POS	NEG	POS	NEG	POS	NEG	POS	NEG	POS	NEG	POS	NEG	POS	NEG	POS	NEG	POS	NEG	POS	NEG
1	0.02	0.02	0.18	0.04	0.20	0.15	0.19	0.08	0.05	0.08	0.08	0.27	0.18	0.11	0.06	0.11	0.21	0.03	0.02	0.37	0.00	0.17
2	-0.06	0.90	0.12	0.18	-0.04	0.01	0.05	-0.01	0.00	0.00	-0.05	0.10	-0.12	-0.04	-0.03	0.17	0.04	-0.07	-0.07	0.06	0.00	-0.07
3	-0.07	-0.11	-0.03	-0.12	-0.01	-0.04	-0.10	0.02	0.11	0.09	0.00	0.04	0.03	0.02	0.02	-0.16	-0.26	0.04	-0.03	0.02	-0.23	-0.10
4	-0.02	0.02	0.02	-0.05	0.08	-0.02	-0.09	-0.05	-0.14	-0.05	0.09	0.08	-0.03	-0.09	-0.20	-01.8	-0.06	0.02	0.05	-0.04	-0.07	-0.21
5	-0.12	-0.13	-0.02	-0.23	-0.05	0.04	-0.06	0.06	0.09	-0.07	-0.04	0.03	-0.07	-0.14	-0.11	-0.06	0.09	-0.13	0.01	-0.13	-0.07	-0.02
6	-0.013	-0.016	-0.08	-0.10	0.07	-0.11	-0.01	-0.02	0.06	0.09	0.01	0.04	-0.10	-0.03	-0.09	-0.23	0.04	-0.09	0.04	-0.14	0.06	0.05
7	0.02	0.07	-0.09	0.04	-0.06	0.07	-0.02	-0.03	-0.15	-0.11	-0.03	-0.14	0.10	0.11	-0.08	0.14	-0.10	0.04	-0.08	0.00	0.09	0.10
8	0.04	0.01	0.03	0.03	-0.03	0.00	0.08	0.02	0.04	0.03	0.06	0.10	-0.02	-0.01	0.08	-0.06	0.05	0.12	0.02	0.05	0.02	-0.02
9	0.07	0.15	0.12	0.04	0.21	0.13	0.15	0.02	0.00	0.02	-0.15	-0.08	0.03	0.02	-0.05	0.07	0.13	0.10	0.05	-0.19	-0.05	0.05
10	-0.04	-0.07	0.12	0.04	0.00	0.03	-0.10	-0.16	-0.12	0.04	-0.24	-0.04	-0.12	-0.11	0.08	-0.03	0.04	-0.20	-0.09	-0.03	-0.02	-0.13
Q_{10+}	26.95*		19.04**		20.73**		19.40**		17.07		20.82**		17.74		17.43		31.61*		5.72		15.14	
Q_{10-}	9.80		24.48*		12.43		7.93		8.77		25.71*		13.52		35.66*		20.12**		43.89*		26.64*	
$r_{WF}(0)$	0.55*		0.30*		0.49*		0.55*		0.80*		0.51*		0.67*		0.66*		0.61		0.48*		0.64*	

Note: – Asterisk reprresents rejection of null hypothesis of no causality at significance level α = 0.01 (*) α = 0.05 (**)
– $Q_{10}\ \alpha\ (0.01) = 23.21$, $Q_{10}\ \alpha\ (0.05) = 18.3$

TABLE 3

Estimated cross correlations between White Noise residual of weekly wholesale and retail prices

Lag	C. Mustard		Brinjal		Lady's Finger		French Beans		Chilli		Eng. Cabbage		Spinach		Kangkong		Long Beans		Tomato		Cucumber	
	POS	NEG	POS	NEG	POS	NEG	POS	NEG	POS	NEG	POS	NEG	POS	NEG	POS	NEG	POS	NEG	POS	NEG	POS	NEG
1	0.12	0.04	0.30	-0.90	0.30	0.11	0.21	0.12	0.00	0.03	0.13	0.18	0.05	0.03	0.12	0.17	-0.01	0.16	0.22	0.07	0.05	0.11
2	0.03	0.03	0.25	0.07	0.08	-0.04	0.01	-0.09	-0.05	0.03	-0.03	-0.08	-0.02	0.02	0.04	0.10	-0.29	-0.09	-0.05	-0.03	0.02	-0.09
3	-0.19	-0.03	-0.10	0.11	-0.06	0.00	-0.13	0.05	0.10	0.03	0.12	0.10	-0.07	-0.03	-0.18	-0.08	-0.24	0.04	-0.08	0.00	-0.20	-0.19
4	-0.02	0.09	-0.01	-0.01	-0.03	0.11	0.00	-0.08	-0.11	-0.08	0.09	0.01	0.01	0.00	-0.22	-0.07	0.01	0.07	0.03	-0.05	-0.12	-0.17
5	-0.09	-0.17	0.01	-0.15	0.04	-0.05	0.04	0.07	-0.04	-0.11	-0.05	0.00	-0.06	-0.10	-0.03	-0.27	0.12	-0.06	-0.03	0.01	-0.08	-0.10
6	-0.13	-0.15	-0.12	0.03	-0.10	0.10	-0.02	-0.08	0.14	0.04	-0.03	0.03	-0.07	0.00	-0.14	-0.02	-0.05	0.01	-0.04	0.06	0.10	0.18
7	-0.05	-0.04	0.08	-0.21	-0.03	-0.03	0.09	0.06	-0.15	-0.12	-0.04	-0.03	-0.09	0.03	0.03	-0.04	-0.08	-0.08	-0.01	-0.02	0.05	0.06
8	0.03	-0.04	-0.21	-0.08	0.02	0.07	-0.05	0.00	0.10	0.05	0.08	0.03	-0.01	0.14	-0.01	-0.03	-0.05	0.12	-0.07	-0.05	0.02	0.04
9	0.06	0.07	-0.15	-0.02	0.14	-0.07	0.08	0.02	0.09	0.03	-0.06	0.00	-0.03	0.05	0.18	0.04	0.07	0.12	-0.03	-0.06	0.03	-0.05
10	0.01	0.01	-0.27	0.04	-0.10	0.04	-0.16	-0.12	0.13	-0.09	-0.20	-0.15	-0.12	-0.07	-0.05	-0.04	-0.03	-0.14	-0.11	-0.04	-0.11	-0.03
Q_{10+}	16.67		43.80*		20.73**		20.67**		20.50**		18.70**		10.11		30.44**		35.40**		15.76		17.39**	
Q_{10-}	13.86		20.11**		12.43		12.04		8.77		14.73*		8.35		26.03**		19.58**		3.89		27.08*	
$r_{WF}(0)$	0.80*		0.35*		0.49*		0.68*		0.80*		0.70*		0.75*		0.66*		0.69*		0.70*		0.74*	

Note: – Asterisk represents rejection of null hypothesis of no causality at significance level $\alpha = 0.01$ (*) $\alpha = 0.05$ (**)

– $Q_{10}\ \alpha\ (0.01) = 23.21$, $Q_{10}\ \alpha\ (0.05) = 18.3$

spinach as showns by insignificant Q_{10-} statistic at 95% confidence level in both directions, the effect of wholesale price changes on farm prices is again found to be stronger than the effect of farm price changes on wholesale price. Wholesale is found to lead farm for both varieties if the confidence level is reduced to 90%.

Instantaneous effect of wholesale price on farm price is very significant for all vegetables, as indicated by the large individual cross-correlations at zero lag. However, other large cross-correlations are found at either positive or negative lags, depending on the direction of causality discovered earlier. Since our *a priori* expectation that wholesale price changes lead farm price changes cannot be rejected for the majority of the vegetables at the 90% or even at the 95% confidence level, only the large cross-correlation at positive lags will be discussed. For example, Chinese mustard, brinjal and lady's fingers indicate significant cross-correlations at lag 1, 6 and 9 weeks, respectively. The implication is that the largest response of farm level changes to wholesale level changes is instantaneous, whereas wholesale level changes precede farm changes by 1, 6 and 9 weeks, for the respective varieties.

The effects of wholesale price changes on retail price is evident for all the vegetables (Table 3). However, it is statistically insignificant at the 95% confidence level for Chinese mustard, lady's fingers, spinach and tomato as shown by the values of Q_{10+} that are less than the critical value. The reverse effect is also found to be significant as shown by Q_{10-} for brinjal, kangkong, long beans and cucumber, and this reflects the existence of bidirectional relationship between wholesale and retail price changes for these varieties. Again, the instantaneous effect of wholesale price changes on retail price is revealed by significant cross-correlation coefficients at lag zero. The other large correlations at positive lags also exist for all the vegetables, except spinach. The results imply that the largest impact of retail price changes on wholesale price is instantaneous, while most wholesale prica changes lead farm price changes by less than a month (Table 3).

The Haugh and Pierce test provides empirical evidence that reaffirm the findings on Granger's test. Our *a priori* that wholesale leads both farm and retail levels cannot be rejected.

CONCLUSION

The outcome of the tests indicate that the hypothesis of price independence at the farm retail and wholesale levels cannot be rejected for all vegetable under study, except for lady's fingers and spinach at retail level only. At farm level, bi-directional relationships exist for English cabbage and spinach. Similar relationships at retail level are shown by long beans, French beans, chilli, kangkong and cucumber. In contrast, farm leads wholesale prices for kangkong, tomato and cucumber while for other vegetables, wholesale leads at both farm and retail levels.

The variation in direction of causality, the impact of wholesale prices on farm and retail prices are generally greater, even in the case of bi-directional and independent relationships. This evidence can be accepted at a degree of confidence of not less than 90%.

Using the pricing efficiency framework proposed by Fama, the above evidence of leads and lags relationship between markets suggest that information is not fully transmitted to all levels and in particular at the farm level. It is evident that the price discovery is made at the wholesale level. As noted by Mohd. Ariff et al., (1985), in the case of fish, the fish wholesalers use information both from the landing and retail in the price determination. While the fishermen do not use the corresponding information from the former (as they normally consign their fish for sale to the wholesaler). Such pricing is also applicable in the case of vegetable marketing where marketing through consignment is predominant among the producers. In short, for some vegetable markets, wholesale market leads in the pricing process hence suggesting there exists an opportunity for extra-normal profit from arbitrage leaving a contention which requires further empirical investigation.

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