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Analysis of Asymmetric Price Transmission of Selected Vegetables in Peninsular Malaysia

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ABSTRACT

The wholesalers are practicing strategic pricing behavior in Malaysian vegetables markets to the extents that increase in the farm products prices were not fully transmitted to farmers as decrease, resulting to marketing inefficiency and loss of farmer's income. Thus, the study aims to examine the existence of asymmetric price transmission (APT) in the vegetables supply chain of Peninsular Malaysia. Monthly data on farms, retails, and wholesale prices of two selected vegetables (Mustard and Spinach) for the period of ten years were sourced from federal agricultural marketing authority (FAMA). The data were analysis using Houck model to investigate for APT. The findings shows that relationship along the supply chain of selected vegetables were bidirectional. However, the results indicates that wholesale price reacts faster on price increase than price decrease to the changes made by farmers. On the other hand, farm prices response faster on price decrease than price increase as wholesaler change their prices. Besides, a long run estimation of price transmission for both vegetables revealed that wholesaler increases their price more than changes made by either retailers or farmers. Thus, the findings suggested that wholesalers exert market power in the vegetable industry.

Keywords: Asymmetric price transmission, wholesale prices, retail prices, farm prices, Peninsular Malaysia.

1. Introduction

More often than not, the wholesalers in Malaysia play a dominant role in the vegetables marketing supply chain through strategic pricing behavior. They fixed the prices and expect the farmers to accept it or otherwise decline in purchasing their vegetables. However, vegetables being a perishable commodity the farmers have less option rather than to accept the giveaway price offer to them by the wholesalers to avoid total spoilage or losses. In addition, high demand of vegetables especially during festive seasons lead to escalating of price at retail level which is rarely transmits to farmers. Thus, farmers fail to benefit from high price at retail and wholesale levels while facing high inputs costs. Perhaps, this scenario may lead many vegetable farmers to exit or switch to other agribusiness that is more profitable. On the other hand, while consumers are bitterly complaining of hike in vegetables retail prices, the retailers of course have no other choice but to raise the price of vegetables depending on the prices set by wholesalers in order to cover their marketing margin.

Furthermore, few wholesalers at the upstream level of vegetable supply chain implies that they maybe exercising market power that result in a slow and incomplete transmission of decrease in the downstream prices while a fast and complete transmission of increase in the downstream prices. In addition, yhe shock changes in vegetables supply and demand cause supply not to match with demand in the market in which the upstream use this opportunity to increase the prices. Moreover, the climatic changes and festive seasons are some of the factors that also contribute to fluctuations of prices along the marketing channel. For instance, while the monsoon season reduces the vegetables production and supply, the festive season's causes increases in demand leading to higher retails prices but with small or no price transmission to farms level. Thus, farmers are at high risk in term of expected income since they are receiving lower prices while production costs keep on increasing.

The fluctuations of prices along the vegetables marketing channel do not lead to the new equilibrium price, but to the asymmetry price transmission (APT). However, the degree of adjustment and speed with which price changes are transmitted is a vital factor that more often than none reflect the immediate actions each market players will likely to take along the supply chain. Moreover, the relationships between farms, retail and wholesale prices will provides deep-insights into marketing efficiency. Thus, it is against this background that the study aims to investigate price transmission process at different level of marketing supply chain. This information is vital in designing policy that will overcome imperfections in the supply chain.

2. Asymmetric Studies in Vegetables and Meat Sectors

According to Arshad and Hameed (2014), the relationship between retailer and farm gate prices for watermelon and banana was found to be bidirectional. On the other hand, the relationship between prices of farm gate and retail for jackfruit and durian was fond to be unidirectional with no feedback effect. Hassan and Simioni (2001), reported that symmetric price transmission exist in tomatoes and chicory supply chain but there is existence of APT in carrots and tomatoes supply chain (Ward, 1982). Zainalabidin et al. (1996), investigates the occurrence of APT for some chosen vegetables and their findings indicated that APT occurred along the different layers of the supply chain for some of the vegetables studied. Zachariasse and Bunte (2003), found evidence of APT along the supply chain of potato. On the other hand, Worth (1999), studied the price transmission of six different vegetables in the US and his findings shows inexistence of APT for the four vegetables. However, APT where found in carrots and tomatoes in which retail price show a large response to increase in shipping-point price.

Many studies of APT in meat and fish sectors also exist in the literature. Singh et al. (2015), found no evidence of APT along the fish supply chain.Gordon and Maurice (2015), reported that the relationship between ex-vessel prices and downstream market along fish supply chain is not very strong. On the other hand Sapkota et al. (2015), results show that the relationship between retail and wholesale prices of fish was unidirectional, which implies that the wholesalers have more market influence than the retailers on the prices. Fernandez-Polanco and Llorente (2015), found no evidence of APT along the supply chain for domestic seafood production. However, there is evidence of APT for imported seafood perhaps due to market power of the producers from importing countries. Muazu et al. (2014) reported the occurrence of symmetric price transmission between farm and retail but APT between retail and farm in broiler prices. Furthermore, evidence of APT was reported in poultry and egg market in Malaysia (Sharifuddin et al., 2013). Kaur et al. (2010), reported evidence of APT in broiler prices between central and regional market. Goodwin and Holt (1999), found price transmission of beef prices along the supply chain to be unidirectional, but not moving in the opposite way. On the other hand, there was the presence of a long-run relationship for the lamp prices but with causality moving only from retailer to farmer's prices (Tiffin and Dawson, 2000).

3. Methodology

3.1 Data source

The study used monthly average data for farms, retails, and wholesale prices of only two selected vegetables for the period of five years. The selected vegetables are spinach and mustard, which are among important horticultural products in the country. The data were sourced from Federal Agricultural Marketing Authority (FAMA), which is one of the agencies responsible for marketing agricultural products in Malaysia. Nevertheless, the study focuses on Johor State in Malaysia perhaps due its large volume of vegetable production, marketing and near to Singapore as captive market.

3.2 Unit root test

The stationary or unit root test is the first step of the analysis in this study. There are several models for unit root tests which include the Dickey-Fuller (DF), the Augmented Dickey-Fuller (ADF) and the Phillips-Perron (PP). However, ADF is the most popular model for unit roots test and as such adopted for the study. However, the result of unit root test of either stationary at level or stationary at first different form will determine the next step of the analysis. Houck approach is most appropriate if stationary at level. However, if the time series is not stationary at level but become stationary at first difference then Johansen test of cointegration will be performed. Error corrected model (ECM) or vector error correction model (VECM) is more suitable if the times series are found to be cointegrated. On the other hand, vector autoregressive (VAR) is more appropriate if the time series not cointegrated.

3.3 Houck approach

The Houck (1977), model for investigating the APT is expressed below:

$$\Delta P_t^r = \alpha + \beta_1^+ \sum_{t=1}^{T} D_t^+ \Delta P_t^f + \beta_1^- \sum_{t=1}^{T} D_t^- \Delta P_t^f + \mu_t \tag{1}$$

The Houck model was further developed by Ward (1982) by including lags of independent variables in the equation (4):

$$\Delta P_t^r = \alpha + \sum_{j=1}^{K}(\beta_j^+ D_t^+ \Delta P_{t-j+1}^f) + \sum_{j=1}^{L}(\beta_j^- D_t^- \Delta P_{t-j+1}^f) + \mu_t \tag{2}$$

The price transmission speed is captured by the individual β while the price transmission magnitude is captured by the sum of these $\beta's$

3.4 Error Correction Model (ECM)

Cramon-Taubadel and Loy (1996) , argued that if the time series prices are not stationary at first level but became stationary at first difference, the used of error correction model (ECM) is more appropriate for the tests of asymmetric price transmission (APT). The ECM can be expressed as follows:

$$\Delta P_t^r = \alpha + \sum_{j=1}^{K}(\beta_j^+ D^+ \Delta P_{t-j+1}^f) + \sum_{j=1}^{L}(\beta_j^- D^- \Delta P_{t-j+1}^f) + \theta^+ ECT_{t-1}^+ + \theta^- ECT_{t-1}^- + \gamma_t \tag{3}$$

The equation (3) can only be used to estimate the price transmission speed, but does not estimate the price transmission magnitude. This is so because APT with magnitude implies permanent variances between negative and positive ways of transmission. Thus, ratchet the prices apart in long-run and resulting into not cointegrated (Meyer and Cramon-Taubadel, 2004)

3.5 The Granger causality test

The Granger-causality test investigate two set of time series data for prices to find out whether series P^f precede P^r, P^r precede P^f, or if the movement is contemporaneous. The concept of Granger-causality is that a series P^f Granger cause P^r, if series P^r can be well predicted by employing the history of both P^f and P^r than it can be predicted if employ the history of P^r alone. The direct Granger test model is an important tool for investigating the evidence and direction of Granger-causality. It regress the dependent variable with lagged value of itself as well as lagged value of independent variable as expresses below:

$$\Delta P_t^r = \alpha + \sum_{i=1}^{K}(\delta_i \Delta_{t-i}^r) + \sum_{j=i}^{L}(\beta_i \Delta P_{t-i}^f) + D_t + \mu_t \tag{4}$$

Where P^r denotes retail price, P^f denotes farm price, δ and β are coefficients of lagged P^r and P^f, D_t represents deterministic while μ represents random error term.

Two hypotheses will be tested in the study. Firstly, the null hypothesis to be tested is that P^r doesn't granger cause P^f (β=0). Rejecting the null hypothesis and accepting the alternative hypothesis on the other hand implies P^r granger cause P^f (i.e. $\beta \neq 0$). Secondly, the equation (4) will be re-estimated using P^f as dependent variable and perform the test of null hypothesis that P^f doesn't granger cause P^r. However, rejecting both null hypothesis implies a bilateral granger causality between the two prices.

4. Results and Discussion

4.1 Unit root test results

The unit root test was employed to assess the stationary properties for the time series prices. Table 1 illustrates the findings of stationary or unit root test of the two selected vegetables prices series using the Augmented Dickey- Fuller (ADF). Based on the ADF test, all vegetable prices reject the null hypothesis at 1 percent level and conclude that the time series prices are stationary at level or does not have unit root. This suggested that the Houck model is most appropriate approach for examining the asymmetric price transmission (APT).

Table 1: Augmented Dickey Fuller (ADF) Unit Root Test Results

Variables	Constant without-trend	Constant with-trend
Farm price mustard	4.6883***	5.4591***
Wholesale price mustard	5.4897***	6.1235***
Retail price mustard	5.7767***	6.7463***
Farm price spinach	6.4567***	6.4902***
Wholesale price spinach	7.6779***	7.7814***
Retail price spinach	7.3073***	7.5343***

Note: ***, ** and * indicate significance at 1%, 5% and 10% significant levels, respectively

4.2 Asymmetric price transmission

Based on the results of the ADF, the Houck Approach was chosen as the most appropriate for investigating price transmission in the two selected vegetables (spinach and mustard) included in this study. The results for long-run estimation and Houck approach for farm-wholesale and wholesale-retail relationships were presented in Table 2. In the long run estimation, one percent increases in spinach retail price will lead to 0.7384 percent increase in the wholesale price. Similarly, the findings showed that the spinach retail price will increase by 0.5789 percent for every one percent increase in the spinach wholesale price. In case of mustard however, wholesale price will increase by 0.7875 percent for every one percent increases in retail price in the long run estimation. Similarly, the results depict that mustard retail price increased by about 0.5987 percent for every one percent increase in mustard wholesale price. Thus, wholesale response higher to changes in prices than retailers do in the long run for both vegetables.

The Houck analysis shows the speed and magnitude of price transmission in a retail-wholesale relationship and wholesale-retail relationship, respectively (Table 2). The result indicates that the rate of price transmission to spinach wholesale causes by increased in spinach retail price is much faster (0.8161) than price decrease (0.7006). However, the cumulative effect on spinach wholesale price attributable to increase in spinach retail price (1.4485) is less than cumulative effect attributed to decrease it retail price (1.4667). The Wald test shows that the price transmission in a farm-wholesale relationship is asymmetry. This asymmetric relationship is weak since the null hypothesis of symmetry is only rejected at 10 percent of significant. Similarly, the price increased was transmitted faster (0.5797) than price decreased (0.5224) to the spinach retailer as spinach wholesaler changes the price in the market. Indeed, the cumulative effect on retail price attributed to the increase in wholesale price (0.8935) exceeds the cumulative effect attributed to decrease in wholesale price (0.7866). However this indicator is not sufficient to reject the null hypothesis of symmetry in the Wald test and conclude that the price transmission is symmetry.

Furthermore, the result also depicts that the rate of price transmission to mustard wholesale due to the decrease of mustard farm price is faster (0.8906) than price increase (0.8715). The cumulative effect on mustard wholesale price attributed to the increase in mustard farm price (1.1429) is less than cumulative effect attributed to the decrease in mustard farm price (1.1981). The result of the Wald test shows that the price transmission in a mustard farm-wholesale relationship is symmetry. In the downstream market, a price increase in the mustard wholesale (0.5894) is transmitted faster to mustard retail than a price decrease (0.5326) in the marketing channel. However, the cumulative effect on mustard retail price attributed to the increase in mustard wholesale price (0.9788) exceeds the cumulative effect attributed to the decrease in mustard wholesale price (0.8522). However this indicator is not sufficient to reject the null hypothesis in the Wald test and concludes that the price transmission in the downstream market is symmetry.

The results of diagnostic testing shows absence of serial correlation in the estimated equation using BG-LM test for both relationships, either farm wholesale price relationship or wholesale retail price relationship for both vegetables. In addition, the value of R-square for both relationships is approaching one which shows that most of variance is explained by the equation in both relationships. The lowest value of AIC determined the numbers of lag in the model for best estimation.

Table 2: Long run and Houck approach estimation of vegetables price in Johor downward the marketing channel

Long run Estimation					
Variable (Farm-Wholesale)	Spinach P_t^w	Mustard P_t^w	Variable (Wholesale-Farm)	Spinach P_t^r	Mustard P_t^r
Constant	0.4904***	0.5376***	Constant	0.6939***	0.7660***
P_t^f	0.7384***	0.7875***	P_t^w	0.5789***	0.5987***
R^2	0.8525	0.9163	R^2	0.8454	0.8370
F-Stat	3004.519***	5710.700 ***	F-Stat	2850.106***	2677.985***
Houck Approach					
Constant	0.0099	0.0032	Constant	-0.0053	-0.0050
P_t^{f+}	0.8161***	0.8715***	P_t^{w+}	0.5797***	0.5894***
P_{t-1}^{f+}	0.2904***	0.1276***	P_{t-1}^{w+}	0.1602***	0.2200***
P_{t-2}^{f+}	0.1775***	0.1438***	P_{t-2}^{w+}	0.1536***	0.1694***
P_{t-3}^{f+}	0.1645***	-0.0249	P_{t-3}^{w+}	0.0548	0.0429
P_{t-4}^{f+}	-0.0894***				0.0193
P_{t-5}^{f+}	-0.0404				
P_t^{f-}	0.7006***	0.8906***	P_t^{w-}	0.5224***	0.5326***
P_{t-1}^{f-}	0.2713***	0.1460***	P_{t-1}^{w-}	0.1678***	0.2203***
P_{t-2}^{f-}	0.2254***	0.1615***	P_{t-2}^{w-}	0.0964***	0.0993***
P_{t-3}^{f-}	0.1973***	0.0138	P_{t-3}^{w-}	0.0617	0.0418
P_{t-4}^{f-}	0.0354				0.0140
P_{t-5}^{f-}	0.0721***				
P_{t-1}^{w}	-0.3016***	-0.1898***	P_{t-1}^{r}	-0.2784***	-0.3902***
P_{t-2}^{w}	-0.2003***	-0.1573***	P_{t-2}^{r}	-0.1962***	-0.2135***
P_{t-3}^{w}	-0.2010***		P_{t-3}^{r}	-0.1069***	-0.1228***
R^2	0.7676	0.8424	R^2	0.7448	0.6784
F-Stat	110.3727***	277.9401***	F-Stat	138.1924***	84.9082***
AIC	-1.8917	-2.3561	AIC	-2.7247	-2.3867
SIC	-1.7603	-2.2659	SIC	-2.6263	-2.2719
BG-LM	0.2053 [0.6505]	3.7561 [0.2890]	BG-LM	4.1472 [0.1257]	2.1488 [0.3415]
Asymmetry Test	3.3134* [0.0693]	1.7233 [0.1899]	Asymmetry Test	2.0072 [0.1572]	2.6314 [0.1054]

Note: *, **, *** denote significance at 10%, 5% and 1% significant level respectively. The figures in the Bracket [...] represent the p-value. The lag length on all the models was selected by using the Akaike Info Criterion (AIC). P_t^{f+} : Increase in farm price, P_t^{f-} : Decrease in farm price, P_t^{w+} : Increase in wholesale price, P_t^{w-} : Decrease in wholesale price, P_{t-n}^{w} : Lag of wholesale price, P_{t-n}^{r} : Lag of retail price.

The long run estimations and Houck approach results for farm-wholesale and wholesale-retail relationship is revealed in Table 3. In the spinach long run estimation, farm price will increase 1.1543 percent for every one percent increase in wholesale price in the wholesale-farm relationship. Similarly, the wholesale price increases by 1.4607 percent for every one percent increases in retail price at spinach retail-wholesale relationship. On the other hand, the results for mustard wholesale-farm relationship shows that the farm price will increase by 1.1637 percent for every one percent increases in wholesale price. Similarly, the mustard retail-wholesale relationship result indicates that the wholesale price will increase by 1.3986 percent for every one percent increase in retail price. Thus, there is a high response by wholesale price than both retail and farm price in the long run for both vegetables.

The short run analysis results of price transmission using the Houck approach was illustrated in Table 3. The result revealed that the rate of transmission of farm price to decrease in wholesale price is faster (1.0006) compared to increase (0.9745). The cumulative effect on farm price attributed to an increase in wholesale price (1.8134) is more than cumulative effect attributed to decrease in wholesale price (1.7807). In the downstream market, price increase (1.4515) transmits faster than price decrease (1.2310) to the wholesalers as retailers change the price in the market. Besides, the cumulative effect on wholesale price attributed to the increase in farm prices (2.2212) was close cumulative effect attributed to the decrease in farm price (2.1707). The Wald test shows that the price transmission in wholesale-farm and retail-wholesale relationship is symmetry as it accepted the null hypothesis of symmetry.

In mustard, the result depicts that the rate of price transmission to farm by the decrease of wholesale price is faster (0.9718) than increase (0.9524) in the short run. In addition, the cumulative effect on farm price attributed to the increase in wholesale price (1.6375) exceeds the cumulative effect attributed to the decrease in wholesale price (1.3475). However, the Wald test accept the alternative hypothesis which indicates that the price transmission in wholesale-farm relationship is asymmetry.

Furthermore, the transmission of price increase (1.1873) is slower than price decrease (1.2000) to the wholesale as retailers change the price in the market. Similarly, the cumulative effect on wholesale price attributed to the increase in farm price (2.0533) is more than cumulative effect attributed to a decrease in farm price (1.9898). the result of Wald test failed to reject the null hypothesis of symmetry and concludes that the price transmission in retail-wholesale relationship is symmetry.

Diagnostic checking indicates there is no evidence of serial correlation in the estimated equation using BG-LM test for both. In addition, the value of R-square for both relationships is closer to 1 indicating that a greater proportion of variance is accounted for by the model in both relationships. The lowest value of AIC determined the numbers of lag in the model for best estimation.

Table 3: Long run and Houck approach estimation of vegetables price in Johor upward the marketing channel

Long run Estimation					
Variable (Wholesale-Farm)	P_t^f	P_t^f	Variable (Retail-Wholesale)	P_t^w	P_t^w
Constant	-0.6018***	-0.6166***	Constant	-0.9656***	-0.9702***
P_t^w	1.1543***	1.1637***	P_t^r	1.4607***	1.3986***
R^2	0.8525	0.9163	R^2	0.8454	0.8370
F-Stat	3004.519***	5710.700 ***	F-Stat	2850.106***	2677.985***
Houck Approach					
Constant	-0.0017	-0.0095	Constant	-0.0031	0.0001
P_t^{w+}	0.9745***	0.9524***	P_t^{r+}	1.4515***	1.1873***
P_{t-1}^{w+}	0.3287***	0.2459***	P_{t-1}^{r+}	0.5038***	0.5575***
P_{t-2}^{w+}	0.3040***	0.2443***	P_{t-2}^{r+}	0.2659***	0.1957***
P_{t-3}^{w+}	0.2062***	0.1000*	P_{t-3}^{r+}	0.1354	0.1128
		0.0949*	P_{t-4}^{r+}	-0.0236	0.0282
P_t^{w-}	1.0006***	0.9718***	P_t^{r-}	1.2310***	1.2000***
P_{t-1}^{w-}	0.4072***	0.1699***	P_{t-1}^{r-}	0.4338***	0.5226***
P_{t-2}^{w-}	0.2138***	0.2058***	P_{t-2}^{r-}	0.3253***	0.2672***
P_{t-3}^{w-}	0.1591***	0.0258	P_{t-3}^{r-}	0.1806	0.1330
		0.0313	P_{t-4}^{r-}	0.0522	-0.0421
P_{t-1}^f	-0.3157***	-0.1623***	P_{t-1}^w	-0.2540***	-0.3252***
P_{t-2}^f	-0.2217***	-0.2035***	P_{t-2}^w	-0.1538***	-0.1205***
P_{t-3}^f	-0.1608***	-0.0464	P_{t-3}^w	-0.0896***	-0.0438***
R^2	0.7562	0.8502	R^2	0.7456	0.6808
F-Stat	146.7914***	210.2835***	F-Stat	117.5803***	85.694***
AIC	-1.6044	-2.3097	AIC	-1.8363	-1.6650
SIC	-1.5059	-2.1864	SIC	-1.7214	-1.5500
BG-LM	0.5448	4.7019	BG-LM	2.5815	0.9944
	[0.4604]	[0.3193]		[0.2751]	[0.1038]
Asymmetry	0.0797	7.4409***	Asymmetry	0.3224	4.87E-05
Test	[0.7778]	[0.0066]	Test	[0.5704]	[0.9944]

Note: *, ** , *** denote significance at 10%, 5% and 1% significant level respectively. The figures in the Bracket [...] represent the p-value. The lag length on all the models was selected by using the Akaike Info Criterion (AIC). P_t^{f+} : Increase in farm price, P_t^{f-} : Decrease in farm price, P_t^{w+} : Increase in wholesale price, P_t^{w-} : Decrease in wholesale price, P_{t-n}^f : Lag of farm price, P_{t-n}^w : Lag of wholesale price.

4.3 Grange-causality results

The result of Granger causality is illustrated in Table 4. The findings show that farm prices granger-cause the wholesale prices and also the wholesale granger-cause farm price since null hypotheses of no Granger cause were rejected in both cases. Similar results were found between the wholesale price and retail price, where not only the wholesale price granger-cause the retail price but the retail price also granger-cause the wholesale price. Thus, the relationship between the three tiers of the marketing channel is bidirectional.

Table 4: Granger Causality Test Result for Vegetables Price

Direction of Causality	Spinach	Mustard
Farm Granger Cause Wholesale	2.8882*	2.2552*
	[0.0566]	[0.0621]
Wholesale Granger Cause Farm	7.0300***	3.0030**
	[0.0010]	[0.0181]
Retail Granger Cause Wholesale	2.4994*	2.9178**
	[0.0831]	[0.0209]
Wholesale Granger Cause Retail	2.4470*	3.0530**
	[0.0876]	[0.0167]

Note: ***, ** and * indicate significance at 1%, 5% and 10% significant level respectively. The figures in the Bracket [. . .] represent the p-value.

5. Conclusion

The asymmetry price transmission was detected in two cases and both in farm-wholesale relationship and each one happened at the downward and upward of the marketing channel. First case of asymmetry price transmission shows that wholesale price reacts faster on price increase than price decrease to the changes made by the farmers downward the marketing channel. Second case of asymmetry price transmission detected that farm price reacts faster on price decrease than price increase as wholesaler change their prices upward the marketing channel.

Thus, the result suggested that market power in the vegetable industry is more obviously at the wholesale level of marketing channel. Besides, a long run estimation of price transmission for both vegetables revealed that wholesaler increases their price more than changes made by either retailers or farmers. The situation of vegetables industry do not seem to change as Zainalabidin et al. (1996), stated in their study of price linkages within selected vegetables in Malaysia, that price discovery is made at the wholesale center and the wholesale price appears to lead both farm and retail prices for most of the vegetables examined.

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