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Abstract: This study intends to determine the farm-retail price transmission behaviors of pork in Malaysia to serve as a good implication for pork pricing system in Malaysia. Using data from January 1997 to December 2008, both the Houck and ECM approaches were found symmetric where a change in farm price of pork was observed to have similar change in retail price of pork in Malaysia. The price setting system of pork can therefore be further described by the estimated price transmission elasticities where retail price is very sensitive to the changes in farm price. A change in farm price is expected to result in a bigger change in retail price of pork while other things remain unchanged.

Key words: symmetry, pork, elasticity of price transmission

JEL Classification: Q11, Q13

INTRODUCTION

There has been a spate of changes in pork industry in Malaysia that precipitated by the doubling of feed, production, and marketing costs over the years. The unprecedented crises in 2008 – namely oil crisis, food crisis, and financial crisis did not only mark the end of cheap food era but also the end of cheap feed era in a more uncertain economic environment. Started off with crude oil crisis, the cost of expensive crude oil passed through and caused an increase in the price carbon-based fertilizers and agro-chemicals used as inputs, through an increase in the cost of operation as well as in transportation and freight. With no option, Malaysia - as a net importer of feed had to continue importing expensive feed. Such unintended burden was even slugged by the food crisis before the tsunami of the financial crisis at latter stage.

All these costs are embedded in the price changes of pork in Malaysia. Farm and retail prices of pork have increased about 42 and 28 percent from January 2001 to RM6.30 and RM12.17 in the end of 2008 respectively. Perhaps, this inequitable change between farm and retail prices of pork is self-explanatory of the recent debate over the determination of pork retail price. For the past few years, National Pork Seller Association determined the retail price in response to the farm price given by the farmers in the top producing states - Johor, Selangor, Penang, and Perak. Some quarters argued that such pricing system is not efficient and viable where farmers' profit is minimal and arguing to seek for ideal farm price but retailers, on the other hand, tend to make higher profit and place the burden on consumers instead of the need to ensure retail price stabilization.

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Arising from the above, there is an urgent need to review the price transmission system of pork in Malaysia. Without the availability of wholesale price data, this study hence intends to determine the farm-retail price transmission behaviors of pork in Malaysia. The relationship between farm and retail prices provides insights into marketing efficiency as well as consumer and producer welfare (Capps and Sherwell, 2007). This will serve as a fundamental implication for pork pricing system in Malaysia.

PORK INDUSTRY IN MALAYSIA

After poultry, swine is the next largest component of the Malaysian animal industry though it is consumed by non-Muslim who make up a significant minority (30 percent) of the population. This sector has been one of the fastest growing industries and self-sufficient since 1981. The country was once recorded 137% self-sufficient in pork with the excess exported to Singapore. Unfortunately, the Nipah virus outbreak in 1998/99 resulted in the closure of 950, mostly small farms and more prudent attention and stringent animal health, farm operation and environmental regulations. In 2000, the country was only 79% self-sufficient in pork due to massive culling of pigs during Nipah virus outbreak.

In 2003, there were about 824 pig farms in Malaysia. 20 percent of the farms had over 1,000 head and accounted for 70 percent of total pork production. The rest - small farms are rapidly being replaced by large intensive operations or eliminated during annual renewal of license (due to inability of compliance with the stringent pig farming regulations). The bulk of the new measures as well as stepping up of on-going efforts are directed at increasing food safety and environmental friendly pig production system or modern pig farming system in short.

Should there is policy intervention, Tey (2009) suggested that per capita consumption of pork would be further decreased from 7.35kg in 2006 that slumped from 10.73kg in 1980 to a lower level. The new policy at large, though not directly, is expected to boost consumers' confidence in domestic pork products and improve the statistics of decreasing per capita consumption of pork. The new policy, however, may not perform at its best to compensate the small holders' loss of production in short-term looking at the widening gap of domestic production (200,110 and 195,070 tonnes) and domestic consumption (204,690 and 201,920 tonnes) of pork (in 2007 and 2008 respectively).

METHOD

Markup pricing model has been notably applied in previous studies (Heien, 1980; Kinnucan and Forker, 1987; Ferris, 1998). However, Gardner (1975) and Wohlgenant and Mullen (1987) found the inferior performance of the markup pricing model compared to the relative price spread specification. This is because the farm-retail price spread changes when retail food demand, farm product supply, or the supply of marketing services shifts.

Encountering such issues in policy applications, Wohlgenant and Mullen (1987) suggested a relative price model. The relative price model was compared with the markup pricing model in Dickerson (2003) and Tey *et al.* (2009). It was found that the markup pricing model performed

better than the relative price model and hence yielded more plausible elasticity of price transmission. The markup pricing model can be expressed as:

$$MM_t = c + \beta_1 P_{rt} + \beta_i P_{rt-i} \quad (1)$$

where MM_t is retail price minus farm price in month *t* (Ringgit/kilogram), and

P_{rt} is retail and farm prices of pork (Ringgit/kilogram).

Equation 1 can be estimated via generalized least squares/ordinary least squares[1]. Subsequently, the ultimate benefit of the markup pricing model is of its ability to yield elasticity of price transmission for pork over a series of time at general level. The formula for the elasticity of price transmission is:

$$EPT_t = \frac{1}{(1-\beta_1)} * \frac{P_{ft}}{P_{rt}} \quad (2)$$

The previous studies mentioned above obtained elasticities of price transmission by assuming symmetry in price transmission which means that retail prices would behave in the same manner of both increases and decreases in farm prices. However, some other previous studies suggested that price transmission is largely asymmetric. Von Cramon-Taubadel and Meyer (2000) explained that the presence of asymmetric price transmission often is considered to be evidence of market failure or the abuse of market power. Kinnucan and Forker (1987), Hahn (1990), Bernard and Willett (1996), and Capps and Sherwell (2007) found that price transmission elasticities in conjunction with rising farm prices generally are larger than corresponding elasticities associated with falling farm prices. On the other hand, Ward (1982) and Punyawadee *et al.* (1991) argued that it should be another way round.

Further to Von Cramon-Taubadel and Meyer's (2000) point, it is a doubt whether there has been market failure or the abuse of market power in the Malaysian pork market. This needs to be tested, particularly to determine whether price transmission in pork is symmetric or asymmetric before conducting analysis on farm-retail price spread for pork in Malaysia. As suggested by Capps and Sherwell (2007), this study adopted Houck (1977) model which has been empirically applied by Boyd and Brorsen (1988), Kinnucan and Forker (1987), Bailey and Brorsen (1989), Zhang *et al.* (1995), Mohanty *et al.* (1995), Bernard and Willett (1966), Willett *et al.* (1997), Peltzman (2000), and Aguiar (2002). The model implicitly builds on the notion that retails prices is a function of farm prices and not vice versa. It can then be expressed as:

$$\Delta P_{rt} = \alpha_o + \alpha_1 \Delta P_{ft}^{+} + \alpha_2 \Delta P_{ft}^{-} + \in_t \quad (3)$$

where P_{ft} is farm prices of pork (Ringgit/kilogram,

t = 1, 2, . . .,

Δ is the first difference operator,

ΔP_{ft}^{+} is cumulative of $P_{ft} - P_{ft-1}$, if $P_{ft} > P_{ft-1}$ and 0 otherwise, and

[1] Use generalized least squares if serial correlation is evident OR ordinary least squares if serial correlation is not evident.

ΔP_{ft}^{-} is cumulative of $P_{ft} - P_{ft-1}$, if $P_{ft} < P_{ft-1}$ and 0 otherwise.

However, it is rare to have perfect efficiency in price transmission like illustrated in Equation (1). In Malaysia, National Pork Seller Association is currently the sole collector of the farm price of pork and decision maker for the retail price of pork. The association announces the price changes only via daily mainstream newspapers. Pig farmers, mostly are not highly educated, perhaps do not read these newspapers and the common channel to get the information of price changes is via word-of-mouth. Hence, Equation (3) with incorporation of lag length that to be estimated via generalized least squares/ordinary least squares (see Footnote 1) can be rewritten as:

$$\Delta P_{rt} = \alpha_o + \sum_{i=0}^{M1} \alpha_1 \Delta P_{ft}^{+} + \sum_{i=0}^{M2} \alpha_2 \Delta P_{ft}^{-} + \in_t \qquad (4)$$

where *M1* and *M2* are the length of the lags, and
other variables are as described in Equation (3).

At the outset, it is prudent to examine whether the Malaysian price transmission of pork is asymmetric. Following Gardner (1975), a formal test on the following asymmetry hypothesis,

$$H_0 : \sum_{i=0}^{M1} \alpha_{1i} = \sum_{i=0}^{M2} \alpha_{2i} \qquad (5)$$

can be conducted using a t-test or an F-test. Failure to reject the null hypothesis would mean that the price transmission is symmetric. On the other hand, a rejection of the null hypothesis would provide evidence of asymmetry and hence Equation (5) can then be estimated by employing error correction model (ECM).

The ECM approach is laid on the fact that retail price and farm price are cointegrated, where its residuals can be incorporated in the Engle-Granger Representation Theorem expression of the price transmission process below:

$$\Delta P_{rt} = \alpha_o + \alpha_1 \Delta P_{ft} + \alpha_2 ECT_{t-1} + \sum_{i=1}^{M1} \alpha_{3i} \Delta P_{rt-i}^{+} + \sum_{i=1}^{M2} \alpha_{4i} \Delta P_{ft-i} + \in_t \qquad (6)$$

where ECT is the residuals from the cointegrating relation between P_{rt} and P_{ft} and other variables are those defined earlier.

Granger and Lee (1989) improved the model by modifying Equation 6 to segment the ECT into positive and negative components. Further improvement made by Cramon-Taubadel and Loy (1999) to allow incorporation of ΔP_{ft} sees the asymmetric error correction model to be expressed as:

$$\Delta P_{rt} = \alpha_o + \sum_{i=1}^{M1} \alpha_{1i} \Delta P_{rt-i} + \sum_{i=0}^{M2} \alpha_{2i}^{+} \Delta P_{ft-i}^{+} + \sum_{i=0}^{M3} \alpha_{2i}^{-} \Delta P_{ft-i}^{-} + \alpha_3^{+} ECT_{t-1}^{+} + \alpha_3^{-} ECT_{t-1}^{-} + \in_t \qquad (7)$$

Equation 7 provides long-run (cumulative) effect of rising and falling of farm-retail price transmission. For the sake of completeness, this study is also interested to look at the short-run

effect of rising and falling of farm-retail price transmission and the final ECM model can be expressed as:

$$\Delta P_{rt} = \alpha_o + \sum_{i=1}^{M1} \alpha_{1i} \Delta P_{rt-i} + \alpha_{2i}^{+} \Delta P_{ft-i}^{+} + \sum_{i=0}^{M2} \alpha_{3i}^{+} \Delta P_{ft-i}^{+} + \alpha_{4i}^{-} \Delta P_{ft-i}^{-} + \sum_{i=0}^{M3} \alpha_{5i}^{-} \Delta P_{ft-i}^{-} + \alpha_6^{+} ECT_{t-1}^{+} + \alpha_7^{-} ECT_{t-1}^{-} + \in_t \quad (8)$$

With the estimation of Equation 8 via generalized least squares/ordinary least squares (see Footnote 1), any of the coefficients, α_{1i}, α_6^{+}, α_7^{-}, are statistically different from zero will provide evidence that the ECM approach is better than the Houck approach. A further verification whether the Malaysian pork price transmission is asymmetric can be done by performing an F-test or t-test on the hypothesis of:

$$H_0 : \alpha_{2i}^{+} = \alpha_{4i}^{-} \text{ or } \sum_{i=0}^{M2} \alpha_{3i}^{+} = \sum_{i=0}^{M3} \alpha_{5i}^{-} . \quad (9)$$

Also, short-run and long run elasticities for farm-retail price transmission can be yielded from the estimation of Equation 8. The formulas are:

Short-run elasticity of price transmission for rising farm prices: $\varepsilon_{sr}^{+} = \alpha_{2i}^{+} * P_{ft} / P_{rt}$ (10)

Short-run elasticity of price transmission for falling farm prices: $\varepsilon_{sr}^{-} = \alpha_{4i}^{-} * P_{ft} / P_{rt}$ (11)

Long-run elasticity of price transmission for rising farm prices: $\varepsilon_{LR}^{+} = \sum_{i=0}^{M2} \alpha_{3i}^{+} * P_{ft} / P_{rt}$ (12)

Long-run elasticity of price transmission for falling farm prices: $\varepsilon_{LR}^{-} = \sum_{i=0}^{M3} \alpha_{5i}^{-} * P_{ft} / P_{rt}$ (13)

DATA

Monthly data from January 2001 to December 2008 for farm and retail prices of pork was collected from the Ministry of Agriculture and Agro-based Industries, Malaysia. Table 1 presents the descriptive statistics associated with the price series discussed in earlier section. It is apparent that the retail price was more than double of farm price of pork at average within 2001-2008. This could be resulted from the growth in the sector itself as a recovery after Nipah virus outbreak in 1997. Hence, there was more rising in farm price of pork than falling in the same period.

Table 1: Descriptive statistics

Mean price		**Cumulative**	
Farm	Retail	Rising	Falling
4.6094	9.51	18.78	-16.33

A further observation in the spread of farm and retail prices of pork is shown illustratively in Figure 1. The spread represents an aggregate of marketing costs and profits. Ferris (1998) suggested that the price spread is equal to the equilibrium of demand and supply of marketing

services and materials per unit of product, where marginal value of the marketing services and materials per unit of product (addressed as marketing margin in this study) is equal to marginal cost. In general, it is seen that a change in farm price of pork led to similar change in retail price of pork. Perhaps, this indicates that the price transmission is symmetric. The price spread was quite stable even at the outbreak of Nipah virus in 1997 but it plunged to its worst in 1999 due to lagged consumers' confidence crisis in pork products. It started to pick up since 2000 and the spread widened in the latter years of observation. Perhaps, there were more marketing costs involved in transferring pork products from farm to retail. Part of them, perhaps the most significant one is diesel price, which was just RM0.651/liter in 1997 but it went up to its peak at RM2.582/liter in June 2008 and recorded slightly lower at RM1.75/liter at the end of 2008. There were more marketing costs associated with the diesel price changes hereafter.

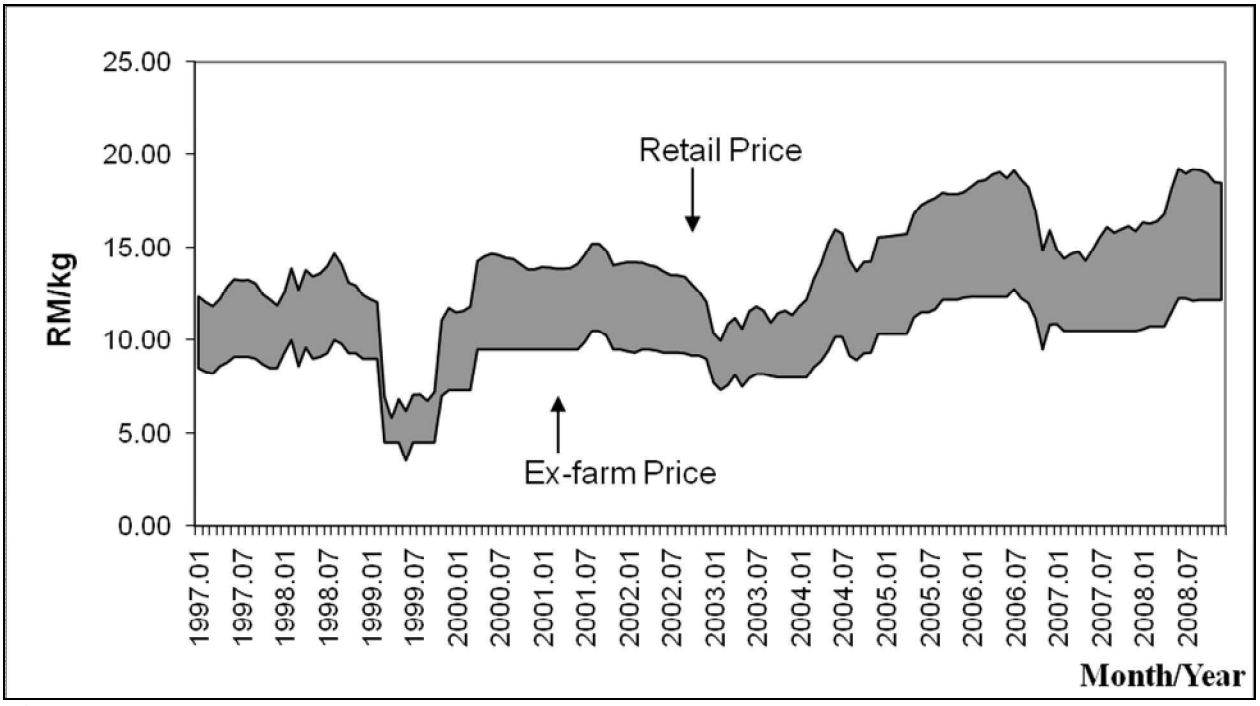

Figure 1: Farm-retail price spread in pork, Malaysia, 2001-2008

RESULTS

A correlation test was performed to measure the degree to which the marketing margin and retail prices of pork are linearly related. The estimated correlation coefficient of 0.8259 shows that there is positive and strong correlation between these two variables. Subsequently, Equation 1 was estimated using generalized least squares and the results are presented in Table 2. It is evident that an increase in retail price of pork is likely to lead to an increase in marketing margin of pork in Malaysia.

Table 2: Parameter estimates of markup pricing model

	Coefficient	**Std. Error**
Intercept	-1.1050	(0.6889)
P_{rt}	0.7824	(0.0442)***

P_{rt-1}	-0.1593	(0.0435)***
AR(1)	0.8996	(0.0435)***
R-square	0.9198	
Akaike info criterion	0.4656	
Schwarz criterion	0.5488	
Durbin-Watson stat	2.1769	

Note: *** Statistically significant at 1% level of significance.

The discussion above presents an overview of retail prices behavior in relations to changes in farm prices. To provide a better picture on the behavior of retail price of porn in response to rising and falling farm price of pork, Houck approach was further applied. Before a formal estimation on Equation 4, the lag length(s) was determined based on the Akaike Information Criterion (AIC) and the Schwarz Information Criterion (SIC). It was found that the number of lags associated with both rising and falling farm price is one in the Houck approach. With such specification, the estimated parameters are presented in Table 3. An t-test on the coefficient of ΔP^{+}_{ft-1} (1.2594) and ΔP^{-}_{ft-1} (1.2229) revealed that the Malaysian farm-retail price transmission of pork is symmetric as we failed to reject the null hypothesis (Equation 5) is statistically rejected at 5 percent significance level.

Table 3: Parameter estimates of the Houck approach

	Coefficient	**Std. Error**
Intercept	-0.2473	(0.4916)
ΔP^{+}_{ft}	-0.4606	(0.2298)**
ΔP^{+}_{ft-1}	-0.3851	(0.2233)*
$\sum \Delta P^{+}_{ft}$	1.2594	(0.1723)***
ΔP^{-}_{ft}	-0.6542	(0.3131)**
ΔP^{+}_{ft-1}	-0.3586	(0.2896)
$\sum \Delta P^{-}_{ft}$	1.2229	(0.2036)***
AR(1)	0.7960	(0.0524)***
R-square	0.9153	
Akaike info criterion	1.7151	
Schwarz criterion	1.8816	
Durbin-Watson stat	2.1245	

Note: *** Statistically significant at 1% and ** 5% level of significance.

A further cointegration test on the relationship between farm and retail prices show that they are indeed cointegrated. Hence, the ECM approach of Equation 8 was estimated and the results are presented in Table 4. The coefficient of ECT^{+}_{t-1}, ECT^{-}_{t-1}, $\sum \Delta P_{rt-1}$ that is statically different from zero and the R-square value show that the ECM approach performed better than the Houck approach. To reaffirm such indication, ECM was also found superior to the Houck approach based on the lowest Schwarz and Akaike criteria. A further verification using an t-test found that

the Malaysian farm-retail price transmission is symmetric [coefficient of $\sum \Delta P_{ft}^{+}$ (0.3647) and $\sum \Delta P_{ft}^{-}$ (0.3645)] at 5 percent significance level.

Table 4: Parameter estimates of the ECM approach

	Coefficient	**Std. Error**
Intercept	-0.0037	(0.1048)
ΔP_{ft}^{+}	0.1990	(0.2551)
ΔP_{ft-1}^{+}	-0.4947	(0.2484)**
$\sum \Delta P_{ft}^{+}$	0.3647	(0.0959)***
ΔP_{ft}^{-}	0.6337	(0.3046)**
ΔP_{ft-1}^{+}	0.3716	(0.3169)
$\sum \Delta P_{ft}^{-}$	0.3645	(0.1006)***
ECT_{t-1}^{+}	0.2008	(0.1920)
ECT_{t-1}^{-}	-0.3718	(0.1457)**
$\sum \Delta P_{rt-1}$	0.7850	(0.0613)***
R-square	0.9234	
Akaike info criterion	1.6372	
Schwarz criterion	1.8444	
Durbin-Watson stat	2.1432	

Note: *** Statistically significant at 1% and ** 5% level of significance.

Arising from the findings of both the Houck and ECM approaches that suggests symmetry in the Malaysian pork farm-retail price transmission, elasticities of price transmission from the markup pricing model were estimated. Figure 2 illustrates the changes of the elasticity of price transmission for pork within 2007-2008. It is obvious that the elasticities vary from month to month. This is because the ratio of the farm price to retail price varies from month to month. Hence, the elasticity of price transmission is defined as the percentage change in retail price due to a one percent change in farm price. For instance, the average elasticity of price transmission (2.2655) computed at the sample mean can be interpreted as one percent increase in farm price is likely to see 2.2655 percent increase in retail price of pork.

On the whole, the price transmission has been very elastic even at its lowest level of 1.34 in April 1999. The lowest level of price transmission elasticity can be attributed to consumers' confidence level carried over from the Nipah virus outbreak in late 1997. Subsequently, it saw astonishing shift away from pork consumption where retailers were forced to sell at as low as RM0.80/kg marketing margins in June 1999. Since the recovery in 2000, the market has corrected itself to reward the retailers with commensurate marketing margins between RM2.87/kg and RM6.88/kg.

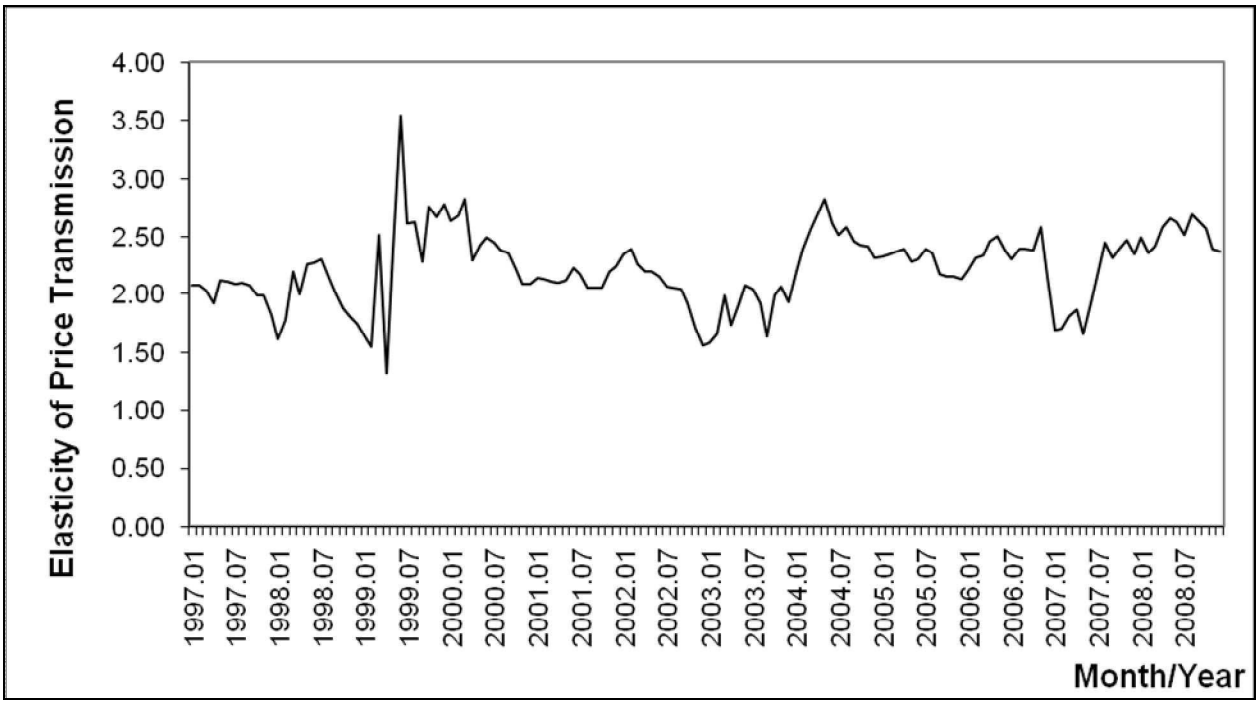

Figure 2: Changes of the price transmission elasticity for pork in Malaysia, 1997-2008

From the discussion on the more plausible model - ECM approaches also provides zoom-in ability to see the short-run and long-run price transmission behaviors. These figures, however, are purely indicative of their behaviors. Table 5 presents the short-run and long-run elasticities of price transmission that estimated at the sample means of the data. All estimated elasticities of price transmission are far less than unity and hence inelastic. The short-run elasticity of price transmission for falling farm prices (0.3072) is about triple as large as the short-run elasticity of price transmission for rising farm prices (0.0965). It implies that retail price of pork is more responsive to the falling farm prices compared to rising farm prices in short-run. This result, however, does not hold in long-run. The elasticity of price transmission for rising and falling farm prices is similar, only with marginal difference in long-run.

Table 5: Estimates of short-run and long-run elasticities of price transmission

	Short-run elasticity of price transmission		**Long-run elasticity of price transmission**	
	Rising farm prices	**Falling farm prices**	**Rising farm prices**	**Falling farm prices**
ECM Approach	0.0965	0.3072	0.1768	0.1767

CONCLUSION

Using data from January 1997 to December 2008, a quantitative analysis on price transmission from farm to retail in the Malaysian pork market was undertaken. Both the Houck and ECM approaches were found symmetric where a change in farm price of pork was observed to have similar change in retail price of pork in Malaysia. The price setting system of pork can therefore be further described by the estimated price transmission elasticities where retail price is very sensitive to the changes in farm price. A change in farm price is expected to result in a bigger

change in retail price of pork while other things remain unchanged. This is crucial looking at the future international commodity market is increasingly uncertain where the feed is sought from, consumers would have to continue consuming expensive pork or stop consuming pork and seek for substitutes, should there is no corrective action taken in the current price transmission system of pork. If it is so, an effort to assure retail price stabilization will be at the expense of farm price and subsequently pig farmers' revenue and profit.

Beyond the dependent on the gloomy price transmission system, future challenge in the market does not only lay on inter-organizational competition but also on inter-supply chain system competition. Some retailers have elected to take the current price transmission system as a benchmark against their efficiency in operation and ability to offer lower price to consumers by taking initiative to team-up with pig farmers in a context of contract farming and lean supply chain system. The direct supply from farm to retail has seen quite a success in the development of pork specialized retail outlets in several major cities in Malaysia. This initiative should also be extended to pig farmers by setting up co-operatives jointly and applying leaner supply chain system to run pork specialized retail outlets in future. The operational and cost efficiencies are expected to benefit most parties, particularly consumers where farmers and retailers both make commensurate profit as well.

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