Global Journal of Science Frontier Research: D
Agriculture and Veterinary
Volume 14 Issue 5 Version 1.0 Year 2014
Type : Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4626 & Print ISSN: 0975-5896

Vertical Price Transmission: A Case of Integrated Malaysian Broiler Industry

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GJSFR-D Classification : *FOR Code: 070199, 079999*

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Vertical Price Transmission: A Case of Integrated Malaysian Broiler Industry

Umar A. Muazu [α], Zainalabidin Mohamed [σ], Mad Nasir S. [ρ] & Ismail, A. [Ѡ]

Abstract- This paper examines how price changes are transmitted between farm-wholesale-retail market levels of broiler meat in Peninsular Malaysia. Data used in the analysis include average monthly farm, wholesale and retail price index for standard broiler meat for period 2000M01 through 2011M12. Johansen's and Juselius co-integration technique was used to examine whether long run relationship between the price indices exists. Asymmetry error correction model was used to analyze price transmission behavior along the vertical supply chain. The results indicate there is long run equilibrium relationship between the market price levels. The results of price transmission elasticity show retail responds to wholesale 0.943% and retail to farm 0.0284%. The sign of the value of ECT is negative (-0.659) and significant at 5% significance level implying an ECT towards equilibrium is expected. The formal test of asymmetry proved symmetric price transmission retail-wholesale and asymmetry behavior retail to farm.

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I. Introduction

Analysis of vertical price transmission is often related to detection of asymmetries between upstream and downstream market levels due to market power. Market power may be used at some stage in the market chain to avoid fully transmitting reduction in supply price, whilst perfectly transmitting price increases. Therefore, price transmission asymmetry may be a source of distortion in the transmission of information throughout the stages of the market chain. This may lead to inefficiencies in the market, preventing optimal resource allocation (Ben-Kaabia & Gil, 2007).

Despite voluminous number of studies that have investigated issues of vertical price transmission in agricultural commodity markets, there was no conclusion regarding causes or which policy decisions could be based. Although many research seeking imperfect price transmission noted strong support for it, the evidence is often mixed and varies widely across commodities and countries. This paper seeks to assess the price transmission process between three markets level; producer-wholesale- retail of the integrated Malaysian poultry industry supply chain. The crucial question is to find out whether price shock in one market level can results in asymmetry relationship with other market segment due to market power of the integrators. In essence, the study focuses on the extent of price shock adjustment, the timing of adjustment and the extent to which the adjustment is asymmetry.

The structure of the paper is organized as follows; next section outlines an overview of the present day structure of the Malaysian poultry supply chain. This will be followed by the discussion of the methodology adopted in this paper and the last section of the paper presents the results and discussion. Finally, the paper provides the concluding remark.

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II. Structure of the Malaysian Poultry Industry

The structure of the Malaysian poultry industry is different from the one that existed in the nineties. In recent years vertical coordination and integration has dominated the production-marketing system. Independent and self-operated activities that once dominated the production system have been replaced by contracts and outright ownership and operation of the production by integrators. By this many individual poultry processing companies own almost all aspects of production-breeding farms, multiplication farms, hatcheries, feed mills, some broiler growing farms, and processing plants.

The structure therefore, involve an aspect of integrated production-marketing systems which involves a single firm owning and operating every aspect of production from importing parent stock to marketing packaged meats in company owned outlets. The integrating production system allows the firm to achieve economies of scale, decrease transactions costs, as well as the ability to closely monitor product quality at every stage of production by controlling all inputs and processes at every level.

Past literatures on the structure of broiler-poultry industry in Malaysia (Kaur, 2006); 2006, (Zainalabidin, Kong Chee, & Mohaydin, 2004); (Kaur, Arshad, & Tan, 2010) describe the industry as oligopolistic. With integration, the level of concentration in the entire segments of the broiler-poultry value chain in Malaysia has increase considerably, for instance in the grower farms level, there has been tremendous increase in the large farms with capacity exceeding 100,000 birds. It has been reported that, from 1986 to 2009 broiler grower farms drop by 49%, exclusively in the category of small farms with capacity below 10,000 birds (DVS, 2010).

A report by Department of Veterinary Services (DVS), shows that in 2011, the broiler segment of the industry produced over 680 million birds, the largest processing company Leong Hup Poultry (LHP), an integrated company accounts for over 121,125,000 (17%) share of the total broiler production in the country. The Charoen Pokphand (CP) a Thailand base company the second largest has a market share of more than 12% of the poultry market in Peninsular Malaysia. The company was incorporated in the KLSE in 1974 primarily in the Poultry Integration industry and it's now one of the market leaders of the sector. There are fifteen largest independent companies with a total of 146,451,051 (21.4%) birds' capacity in 2011.

Overall, analyses have shown that the integrator companies account for over 62 percent of the total grower farms through both ownerships and contracts poultry production in Malaysia. The grown up broiler chicken from both contracts farms and integrator companies are sent to the company slaughter and processing units and to their retail outlets. Total output from the poultry contract farming in Malaysia has been increasing over the years from 20% in 1989 to 55% in 2001 and as high as 75% in 2010 (Tapsir, Mokhdzir, Nor, & Jalil, 2011)

On the marketing of the poultry products in Malaysia, the structure of the industry has categorized the marketing of the poultry products into two distinct networks depending on where the products originate. Poultry products from independent farms are characterized by a longer chain with a large number of collectors, wholesalers and retailers responsible for bringing the produce to the consumers (Kaur, 2006). Amongst the same independent poultry producers there are also middlemen carrying out other marketing functions and wholesaling of live chickens to retailers.

The marketing of the products involving integrators are quite different from the independent farmers since integrators are part of the supply chain activities from the production of day-old-chicks (DOC) to the marketing of the finished products. For instance a market weight broiler-chicken from integrator broiler growing farm or from contract farmers are sent to the integrator's own slaughter house for processing. The processed products are then sent to the integrator's own service centers or distributed to retailers in different locations all over the country. Four out of the ten integrators have their own retail outlets which sell dressed and chicken cuts or further processed chicken products such as roasted and related products such as chicken parts, meatballs, burger patties and sausages. The processed products are labeled with the integrator own brand name e.g Ayamas, Farm Best, Ayam Dindings and Ayam A1 among those involved in processed chicken products in the local markets.

On the price determination, a field survey conducted by FAMA, in 2007 shows that the price determination process at the farm level appears to be influenced predominantly by the wholesale. The survey reports concludes that any slight imbalance between supply and demand of poultry products in Malaysia raises the market condition to a great extent that causes sharp fluctuation in product prices. The selling price at retailers in turn, reflects the purchase price since wholesalers use mark-up pricing method (Kaur, 2006). The report shows about 80% of the wholesalers use the farm price as the reference price and add marketing costs in order to arrive at the wholesale selling price. Another 15% uses the retail price as reference and mark-up or down to account for marketing costs. And only 15% adopt their price determination based on prices provided by Federation of Livestock Farmers Associations Malaysia (FLFAM). With this report one can conclude that supply and demand conditions have bearing on the actual market price of poultry products in Malaysia and in most cases large wholesalers are able to influence price movements by their share volume of transaction.

III. Methodology

The methodology adopted is based on Granger's representation theorem; the theorem follows (Engle & Granger, 1987) two-step approach to estimate co-integration in an error correction specification. The model specification and estimation procedure followed can be summarized as follows.

In the first stage, Augmented Dickey-Fuller; (Dickey & Fuller, 1979), Phillips-Perron; (Phillips & Perron, 1988) unit roots tests are used to evaluate the time-series properties of the data.

The next procedure then follows the general two-step approach of Engle and Granger (1987): In the first step co-integration regression is estimated by simple ordinary least squares (OLS) and obtains the residual of the co-integrating relationship and applying a residual-based unit root test for co-integration. In the second step, the error correction model (ECM) is then specified and estimated. In the economic estimation of co-integration relationships, it is often important to integrate short-run economic behavior with long-run equilibrium relationships. That is, if the short run relationship is known, the long-run relationship can also be identified. Engle and Granger's (1987) co-integration theory addresses the issue of integrating short-run dynamics with long-run equilibrium in an error correction term. When residuals are used, the results may be sensitive to the normalization rule or method; results may not be unaffected by choices as to which of the variables is chosen as the left-hand-side variable in the co-integration regression.

The Augmented Dickey-Fuller unit root tests (ADF) test which is a modification of the DF test takes the following form;

Given an AR(p) process;

$$Y_t = \beta_0 + \sum_{j=1}^{p} \beta_j Y_{t-1} + \varepsilon_t$$

This can be written with differentiated terms as;

$$\Delta y_t = \alpha_0 + \delta y_{t-1} + \sum_{j=1}^{p} \alpha_j \Delta y_{t-1} + \alpha_p y_{t-p} + \epsilon_t$$

Testing the null hypothesis that H_0: $\delta=0$ Against $\delta<0$, rejecting the null hypothesis at level implies the series is I(0), rejecting the null hypothesis after first difference implies the price series is I(1). To determine the lag length we used the Schwartz–Bayesian criteria (SBC), and we choose the model that has SBC criteria with lowest value.

In the second stage, if the price series are found to be of the same order of integration, testing for the co-integration is performed by specifying a vector autoregressive model (VAR) and co-integration technique with an error correction (ECT) framework performed. Both co-integration and ECT models enable us to examine the equilibrium concept between retail, wholesale and retail price and how the process is adjusted back to the equilibrium after a price shock. These estimation methods also reveal the short and long-term effects of one market level price on another.

The coefficients of the estimates are elasticity since all price series are transform to their log.

The co-integration of the system is tested using the maximum likelihood $L_{max}(r)$ which is a function of the co-integration rank r. (Johansen, 1988) describe two test methods; (1) Trace Test and (2) Maximum EigenValue test. The trace test is based on the log-likelihood ratio and is conducted sequentially for r = k-1,….., 1,0. The trace test tests the null hypothesis that co-integration rank is equal to r against the co-integration rank is k.

The maximum Eigen value test is based on the log-likelihood ratio and is also conducted for r = 0, 1,….k-1. The maximum Eigen value tests the null that the co-integration rank is equal to r against that the co-integration rank equal to r + 1.

The c-integration equation with error correction term based on Ward (1982) an extended (Wolffram, 1971) and (Houck, 1977) specification takes the following form;

$$\Delta P_t^r = \alpha_0 + \sum_{i=1}^{p} \alpha_1 \Delta P_{t-i}^r + \sum_{i=0}^{q} \alpha_2 P_{t-i}^F + \sum_{i=0}^{r} \alpha_3 \Delta P_{t-i}^w + ZECT_{t-1} + \mu_{1t}$$

Where p and q and r are lags lengths, in equation (3), Δ is the difference operator, P^r is a natural logarithm of retail market price of standard broiler chicken at time period, P^F is the natural logarithm of farm level price of standard broiler chicken at time period and P^w is natural logarithm of wholesale market price of standard broiler chicken at time period, the ECT is the error correction terms and α's, and Z are coefficients to be estimated, μ is the disturbance term. The null hypothesis to be tested in equation (3) is Ho: $\alpha 1 = \alpha 2 = \alpha 3 = 0$ against H1: $\alpha 1 \neq \alpha 2 \neq \alpha 3 \neq 0$.

The inclusion of the ECT allows for the estimated price to respond to changes in the explanatory price series but also to correct any deviations from the long-run equilibrium that may be left over from previous periods. It will be interesting to view both positive and negative response, in view of this splitting the error correction term into positive and negative components makes possible to test for asymmetry price transmission. The ECT takes the following form;

$$\Delta P_t^r = \alpha_0 + \sum_{i=1}^{p} \alpha_1 \Delta P_{t-i}^r + \sum_{i=0}^{q} \beta_1 P_{t-i}^F + Z_i^+ ECT_{t-1}^+ + Z_i^- ECT_{t-1}^- + \mu_{1t}$$

Where, P^r and P^F are two vertically related prices; the Δ is the difference indicator, α's, β's, and Z's are coefficients to be estimated, ECT^+ and ECT^- are the positive and negative deviations from the long-run equilibrium. Since $ECT_{t-1} = ECT^+_{t+1} + ECT^-_{t-1}$, in equation (4), the null hypothesis of symmetry to be tested becomes;

$HO: Z_t^+ = Z_t^-$ (symmetric price transmission)

$HO: Z_t^+ \neq Z_t^-$ (asymmetric price transmission).

Thus, if Z_t^+ differ significantly from Z_t^- there is evidence of asymmetric price transmission.

IV. Results and Discussions

The data used is average monthly price of standard broiler meat for period (2000M01 through 2011M12). Average monthly ex-farm gate price as farm level price measured in RM/Kg was obtained from the website of the Federation of Livestock Farmers Association of Malaysia (FLFAM). The wholesale and retail monthly average price of standard broiler chicken for same period range was obtained from Federal Agricultural Marketing authority (FAMA). All price series were transformed to natural logarithm.

V. Preliminary Analysis of Broiler Price Series in Malaysia

At the starting point to the analysis, it may be logical to show the evolution and trend of the price series for both farm level, wholesale and retail during the period of this study. To show this, a plot of the price series against time for the entire period of the study was conducted to examine trend. The graphical representation of the price series as presented in Figure 1 which shows that since at the beginning of the data series, farm price remain lower than the wholesale and retail. All the market level prices have been on an upward trend over the study period and fluctuated within the mean, with an oscillation period of between 3 to 4 calendar months within a year.

The trend in the prices of all the market levels for broiler meat in Malaysia continue to show inclining trend from April 2005 up to last date of the data with exception of farm gate price which has declining trend starting August 2007 to January 2009 probably due to Malaysia's high alert for the avian influenza virus (H5N1) following outbreaks in the poultry industries in Egypt, Indonesia, Thailand and Vietnam. From the figure we cannot observe clear transmission process between the series. However, overall, all the price series have shown a linear trend which validates their statistical properties for the econometric estimation.

VI. Results of the Unit Root Tests

The result of the unit root tests (ADF and PP) with constant and time trend for individual price series to assess the order of integration is presented in Table 1. The null hypothesis of unit root for both ADF and PP at level was not rejected for all price series except farm level price which is stationary at level for both ADF and PP test statistics 5% level of significance. However, when the same hypothesis was tested after the first difference, the null hypothesis was rejected at 1% level of significance for the other price series. This result shows that the price series are integrated order of I(1) and may consequently give a linear combination of the series. A stationary time series is one that does not contain a trend i.e. it fluctuates around a constant mean. In most monthly data, seasonal unit roots can occur; and it has been established that ADF test is valid for non-seasonal series.

VII. Estimates of the General Co-integration Relationship

Long-run vertical price relations and reactions to deviations to the long-run equilibrium in the Malaysian poultry market were investigated and results presented in Table 2. In the long-run it is expected that the equilibrium price relationships exist in the form of co-integrating equilibrium and co-integrating vectors to describe the speed of adjustment towards equilibrium. The co-integration relationships were normalized on the retail price, such that retail prices were regressed on wholesale and farm-level prices with standard ordinary least square (OLS) to obtain the residual of the co-integrating relationship and applying a residual-based unit root test for co-integration.

The result shows both Trace test and Max-Eigen test are statistically significant to reject the null hypothesis of no co-integration between the price series i.e ($r = 0$). The two statistics Trace statistics and Eigen value test indicates 2 co-integrating equations at 5% level. Co-integration refers to a linear combination of two or more integrated variables, which implies that stochastic trends of variables linked over time.

VIII. Results of Asymmetric Price Transmission Analysis

This section of the paper presents results of test to establish if an increase in the price has the same price transmission as a decrease in the price. Thus, to measure how a price change at one level in the Malaysian poultry value chain is affected by either positive or negative changes in the price at another level. Asymmetry is tested by allowing the speed of adjustment to differ for the positive and negative components of the ECT.

The general-to-specific procedure selects the optimal lag corresponding to the regression with significant coefficients. A truncation lag length of 12 is significant, although lag 11 is insignificant, for the asymmetry analysis lag order at 12 for both retail and farm equations was chosen. The result of the estimates of the error correction specification is presented in Table 3 and Table 4.

Table 3 presents the result of the asymmetry error correction model with the retail price as the dependent variable. The asymmetric response of the retail price to positive and negative shocks to the marketing margin of producers is captured by the adjustment coefficients (ECT^{+} and ECT^{-}). Positive ECT indicates the margin is above its long-run equilibrium value, whereas the opposite holds for negative ECT.

The t-statistics based on Wald test for the adjustment coefficients are both statistically different from zero, thus, the null hypothesis that retail prices react symmetrically to increasing and decreasing farm

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price is rejected as shown in Table 5. The results indicate that retail prices respond to both positive and negative shocks, but ECT^- induces a significantly greater change in the retail price than ECT^+ because it has higher value in absolute term. In other words, if the ECT- is greater, it means that the producer margin is below its long-run equilibrium. If the producer margin is below its long-run equilibrium, this means, when producer prices increase, then retailers must react fast in response to the changes in producer price in order to return the equilibrium to normal because if the producer price, due to rise in cost, producer margins falls, and as a result producers will push the cost to the retailer. This will also affect the margin of the retailers. Whenever this happens, the retail price will adjust to correct the disequilibrium. Therefore ECT negative is said to induce a greater change in retail price than ECT positive.

It might be interesting to know how long it takes for retail prices to completely correct the disequilibrium. The analysis of the relationship is based on monthly data, it is therefore expected that the disequilibrium would be corrected within one month. The results show that the contemporaneous coefficients, including the adjustment coefficients ECT+ and ECT-, are significantly less than one, which implies that retail prices do not react completely within one month to farm price changes.

The lag in the price adjustment can be due to several reasons; retailers have the choice to accept and adjust to producer prices changes or search for alternative price. Because they do not have information about prices offered elsewhere due to the search cost involved, they would react to adjust to the producer price changes. They are expected to react instantaneously but because of the nature of the value chain they do not and hence there is a lag in the adjustment to equilibrium. The lag in adjustment is obtained by estimating the time it takes for the retail price to revert to equilibrium price. The results in Table 3 show that within one period, (in our case here one month) retail prices adjust so as to eliminate approximate 33.8 percent of a unit-negative change in the deviation from the equilibrium relationship caused by changes in farm prices. This implies that the retailers must increase their marketing margin by 33.8% in order to respond completely to a unit negative change in farm prices.

Also, Table 3 indicates that the retailers adjust to remove 31 percent of a unit-positive change in farm prices and also requires an increase of 31 percent in the marketing margin to respond to this unit-positive change. Even though retailers eliminate price shocks from producers at relatively the same rate, it can be deduced that adjustment towards the long-run relationship between producers and retailers is faster when changes in deviation are negative (i.e. farm prices rise that lowers the marketing margin) compared to positive (i.e. farm prices decline that increases the marketing margin) changes.

Using analogous procedure to determine whether retail market level responds to farm price increase and decrease are the same, Table 4, presents similar results of the asymmetry relationship with farm price as dependent variable. As compared to the retail price results presented in Table 5, the adjustment coefficients ECT^+ and ECT^- in the farm price equation are not statistically significant. This implies that the producer price does not respond to long-run negative and positive changes in the marketing margin. The reason might be due to limitations of chicken meat storage and therefore any temporary change in price does not affect the farmer's response. This situation is not the same with retailers who immediately respond to price increases or decreases by adjusting their prices.

In a similar direction asymmetry is tested with wholesale price as dependent variable to retail in one direction and to farm in other direction, the findings is similar to asymmetry analysis with farm price as dependent variable that retail and farm prices do not respond to long-run negative and positive changes to wholesale price as indicated by statistically insignificant coefficients of the adjustments term (ECT+ and ECT-). The results from these two analyses therefore mean that an effect of increase and decrease in wholesale broiler price in Malaysia on retail and on farm prices was found to be the same over the study period, implying symmetric price transmission behavior wholesale to retail market levels and wholesale to farm market level.

To ascertain the adequacy of the asymmetric price transmission model, a number of diagnostic tests were performed to show that the asymmetric price transmission error correction model is consistent and that the parameter estimate is valid under contemporary statistical inference. Four tests were performed to gauge the adequacy of the model; the Breusch-Godfrey Lagrange multiplier (LM) test of serial correlation, the Jarque-Bera test of normality, the White test of heteroskedasticity, and the autoregressive conditional heteroskedasticity (ARCH) test. The result of the diagnostic test is shown in the lower panels of Table 3 and Table 4. All diagnostic tests show that there is no violation of the classical linear regression assumption; hence the model fits the data well.

In summary, the results of the vertical price transmission analysis reveals that retail prices react more rapidly but not completely to increases upstream (producer) prices than to decreases, i.e the reaction is quicker when producer prices rises to squeeze the marketing margin than when they decline to stretch the margin. According to (Hassouneh, Cramon-taubadel, Serra, & Gil, 2012), this type of asymmetric relationship is termed positive price asymmetry and is more harmful to consumers than negative asymmetry. The result support the findings of von Cramon and in contrast to

Ward's idea of increasing concentration in the industry could lead to informational advantage leading to wholesale market level becomes the center of price formation. The results also contradict his believe as to flow of price direction from farm to wholesale to retail. The results of the asymmetric price transmission analysis in the Malaysian poultry markets could not prove the idea of perishable nature of the product could lead to increased market power at the wholesale market level. As shown wholesale market level has little influence in the price formation.

IX. Conclusion

A co-integration technique was employed to examine price transmission process along the supply chain between retail, wholesale and farm markets levels of the Malaysia broiler market. The examination of the vertical supply chain was aimed to evaluate the efficiency of the price transmission mechanisms in the integrated Malaysian poultry market. In essence we tested for the long run relationship between the retail-wholesale and farm market level prices. The results of price transmission elasticity show retail responds to wholesale 0.943% and retail to farm 0.0284%. The sign of the value of ECT is negative (-0.659) and significant at 5% significance level implying an ECT towards equilibrium is expected.

The formal test of asymmetry proved symmetric price transmission farm-retail but significant asymmetry behavior retail to farm. The findings are consistent with many asymmetries in price adjustments which have been related to various reasons such as structural rigidities and government interventions in agricultural product pricing. (Meyer, 2004) identified welfare effects of asymmetry in price transmission as it would imply a different distribution of welfare than would be if the transmission is symmetry. This is because it alters the timing and size of welfare changes that is associated with price changes.

X. Acknowledgements

The authors wish to acknowledge and thanks for the financial contribution of the Long Term Research Grant Scheme (LRGS-2012-2017:UPM/700-13/LRGS) funded by the Ministry of Education Malaysia (MOEM) and Research University Grants initiatives 6 (RUGS-2012-2013: RUGS/06-02-12-2004RU) funded by UPM under Research University Grant Scheme.

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Table 1 : Results of the Unit Root Test (Stationary)

Variable	Augmented Dickey-Fuller (ADF)		Philips-Perron (PP)	
	Constant without trend	Constant with time trend	Constant without trend	Constant with time trend
Retail	-1.96679	-5.17342*	-2.495166	-5.519442*
Wholesale	-1.40481	-4.85219*	-1.004803	-4.68446*
Farm	-1.96679	-5.17342**	-2.495166	-5.19442**

**and ** denotes significance at 1% and 5% significance level respectively*
Note: Critical values of ADF tests are based on Mackinnon (1996) one-sided values. Lag length selection is automatic based on Eviews Schwarz Information criteria

Table 2 : Results of the Johansen Co-integration test

Hypothesized No. of CE'(s)	Test Statistics		Critical Values (5%)	
	Trace Statistics	Max. Eigen Value	Trace Statistics	Eigen Value Statistics
None	44.04237**	24.50937**	29.79707	21.13162
At Most 1	19.53300**	18.93328**	15.49471	14.26460
At Most 2	0.599721	0.599721	3.841466	3.841466

*Note: Both Trace Statistics and Eigen Value statistics indicates 2 co-integrating equations at 5% level. **indicates significant at 5% level.*

Table 3 : Estimates of the asymmetric price transmission with error correction model Dependent Variable ΔRetail(t)

Regressors	Coefficient	Std. Error	t-Statistic	Prob.
Constant	0.007508	0.003930	1.910707	(0.0588)
ΔRetail(-1)	-0.103707	0.115806	-0.895521	(0.3726)
ΔRetai (-2)	-0.264918	0.110496	-2.397538	(0.0183)
ΔRetail (-3)	-0.195808	0.119437	-1.639423	(0.1041)
ΔRetail(-4)	-0.229762	0.118397	-1.940606	(0.0550)
ΔRetail(-5)	-0.049970	0.115198	-0.433777	(0.6653)
ΔRetail (-6)	-0.066341	0.113295	-0.585558	(0.5594)
ΔRetail(-7)	-0.068066	0.112168	-0.606816	(0.5453)
ΔRetail (-8)	-0.081568	0.110553	-0.737814	(0.4623)
ΔRetail (-9)	-0.050279	0.108186	-0.464743	(0.6431)
ΔRetail (-10)	0.007639	0.101270	0.075432	(0.9400)
ΔRetail (-11)	-0.025901	0.094529	-0.274001	(0.7846)
ΔRetail (-12)	0.138252	0.092599	1.493023	(0.1384)
ΔFarm(-1)	-0.020920	0.034638	-0.603978	(0.5472)
ΔFarm (-2)	0.018124	0.034001	0.533032	(0.5951)
ΔFarm (-3)	-0.036452	0.035577	-1.024605	(0.3079)
ΔFarm (-4)	-9.83E-05	0.035854	-0.002743	(0.9978)
ΔFarm (-5)	-0.006777	0.036906	-0.183632	(0.8547)
ΔFarm (-6)	-0.002969	0.038210	-0.077707	(0.9382)
ΔFarm (-7)	-0.068810	0.037498	-1.835001	(0.0693)
ΔFarm (-8)	-0.083070	0.037560	-2.211657	(0.0292)
ΔFarm (-9)	-0.127485	0.039508	-3.226837	(0.0017)
ΔFarm (-10)	-0.001789	0.040976	-0.043656	(0.9653)
ΔFarm (-11)	-0.044255	0.038779	-1.141211	(0.2564)
ΔFarm (-12)	-0.011091	0.036539	-0.303532	(0.7621)
ECT_{t-1}^{+}	0.309726	0.155776	1.988274	(0.0494)
ECT_{t-i}^{---}	0.337565	0.266008	1.269006	(0.2072)
R^2	0.294			
R^2 bar	0.119			
LM			0.636191	(0.5314)
JB			10.80850	(0.0597)
ARCH			1.225311	(0.2332)
DW			1.969971	

LM = Breusch-Godfrey Lagrange multiplier test of serial correlation
JB = Jarque-Bera test of normality
ARCH = autoregressive conditional heteroskedasticity test
DW = Durbin-Watson statistics

Table 4 : Estimates of the asymmetric price transmission with error correction model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	0.025775	0.012575	2.049749	(0.0429)
ΔFarm (-1)	-0.148311	0.110842	-1.338042	(0.1838)
ΔFarm (-2)	-0.306212	0.108806	-2.814295	(0.0058)
ΔFarm (-3)	-0.136319	0.113847	-1.197383	(0.2339)
ΔFarm (-4)	0.074998	0.114733	0.653671	(0.5148)
ΔFarm (-5)	0.067808	0.118100	0.574155	(0.5671)
ΔFarm (-6)	-0.078427	0.122273	-0.641407	(0.5227)
ΔFarm (-7)	-0.010237	0.119996	-0.085308	(0.9322)
ΔFarm (-8)	-0.318258	0.120194	-2.647873	(0.0093)
ΔFarm (-9)	-0.173874	0.126426	-1.375303	(0.1720)
ΔFarm (-10)	-0.142432	0.131125	-1.086230	(0.2799)
ΔFarm (-11)	0.036266	0.124094	0.292249	(0.7707)
ΔFarm (-12)	-0.047033	0.116927	-0.402239	(0.6883)
ΔRetail (-1)	-0.490198	0.370584	-1.322773	(0.1888)
ΔRetail (-2)	-0.828535	0.353591	-2.343203	(0.0210)
ΔRetail (-3)	-0.695937	0.382202	-1.820861	(0.0715)
ΔRetail (-4)	-0.582193	0.378875	-1.536637	(0.1274)
ΔRetail (-5)	-0.704060	0.368636	-1.909906	(0.0589)
ΔRetail (-6)	-0.340869	0.362549	-0.940202	(0.3493)
ΔRetail (-7)	-0.159156	0.358942	-0.443403	(0.6584)
ΔRetail (-8)	-0.087044	0.353774	-0.246044	(0.8061)
ΔRetail (-9)	-0.282600	0.346198	-0.816296	(0.4162)
ΔRetail (-10)	-0.416098	0.324067	-1.283988	(0.2020)
ΔRetail (-11)	0.104869	0.302497	0.346679	(0.7295)
ΔRetail (-12)	-0.325727	0.296319	-1.099242	(0.2742)
ECT_{t-1}^{+}	-0.030500	0.048680	0.626542	(0.5323)
ECT_{t-1}^{---}	-0.012025	0.023126	-1.347645	(0.1807)
R^2	0.320			
R^2 bar	0.152			
LM			0.346468	(0.7080)
JB			87.00215	(0.0010)
ARCH			1.254117	(0.2100)
DW			1.969971	

Dependent Variable Δ Farm(t)
LM = Breusch-Godfrey Lagrange multiplier test of serial correlation
JB = Jarque-Bera test of normality
ARCH = autoregressive conditional heteroskedasticity test
DW = Durbin-Watson statistics

Table 5 : Results of Wald test for asymmetry based on Error Correction Model Retail to Wholesale

Ho: $ECT^{+} = ECT^{-}$			
F-Statistics	2.363030	probability	(0.0491)
χ^2	4.726060	probability	(0.0441)
Retail to Farm			
Ho: $ECT^{+} = ECT^{-}$			
F-Statistics	1.334268	probability	(0.2678)
χ^2	2.668537	probability	(0.2634)