Price Transmission in the Beef Value Chain – The Case of Bloemfontein, South Africa

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Abstract:

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JEL Codes: C13, Q13

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JEL Classification: Q10, Q13

1. INTRODUCTION

The large difference between the producer price of a beef carcass and the retail prices of individual beef cuts raised concerns among producers (FSRPO, 2012). These concerns were brought about by the possibility of asymmetry in price transmission in the market, as it seems as if the variation in the producer price and the retail prices does not always reflect the same relationship. Producers believe that they are carrying all the risk and that retailers are fixing the retail prices, irrespective of the producers' price at that stage. Producers therefore believe that when the price of the carcass increases, the retailer increases the price of various beef cuts accordingly, but that when the carcass price decreases, the retailer does not act accordingly. According to the producers this behaviour then leads to an increase in the retail price margin over time, resulting in positive asymmetric price transmission.

The South African beef value chain starts with the producers who produce livestock (cattle) and ends with the final consumer. The beef industry is a very important sector in South Africa as slaughtered cattle contributes the largest part, 12.7%, of the gross income of agriculture (DAFF, 2017). In addition to its direct economic contribution, the red meat industry is also a major employer in the agricultural sector. The primary agricultural sector employs approximately 810 000 people in South Africa (StatsSA, 2017). Livestock producers creates about a quarter (200 000) of the available jobs in agriculture while the mixed farming producers (crops and livestock) creates a further 50 000 jobs. Jobs created by agriculture through secondary and tertiary linkages are not included in these statistics and should further increase the importance of the red meat value chain as a contributor to employment. Approximately 65% – 70% of the produced cattle in South Africa are sold to feedlots where the animals are fed until they reached a market acceptable weight and carcass classification. The market ready animals, from the feedlot, are then slaughtered at an abattoir after which carcasses are classed and distributed to wholesalers, processors, butcheries and retailers. Consumers (the end user) purchase the final product at the end of the marketing channel (DAFF, 2011). The price transmission between the producer price (PP) and the retail price (RP) must thus be analysed to determine if it is symmetrical or asymmetrical of nature.

Effective price transmission, or the lack thereof, has formed part of numerous research titles, such as Hahn (1990), Babiker and Abdalla, (2009), Tey (2009), Alemu and Ogundeji (2010), Spies (2011), Rumánková (2012) and Alemu (2012). Despite the differences in the main objectives of these studies on price transmission, other major differences also exist, such as the country in which the scenario plays out, the commodity that determines the industry, the characteristics of the data used (frequency and length of data), the unique level of infrastructure of each country which influences marketing margins and the choice of time series (Rumánková, 2012; Babiker and Abdalla, 2009). Apart from the above-mentioned differences between studies, some of the approaches used to analyse price transmission are also criticised. The Error Correction Modelling (ECM) approach, commonly used in causality and price transmission modelling, serves as an example of a technique that received critique. The method was criticised based on the approach it employs to confirm co-integration. Engle – Granger (EG) (1987) assumes that the adjustment towards equilibrium is symmetric, which may not be true when actors in the market respond differently to different price trends (Alemu, 2012). This put the power of EG under suspect when the system exhibits asymmetric departure from the equilibrium (Enders and Siklos, 2001).

Despite the available literature on price transmission, it must be remembered that markets, and their according pricing strategies, are not static and that the price transmission situation between the PP and RP might thus change over time. This study aims to contribute towards addressing concerns among beef producers regarding the current status of price transmission. The contribution made by this study are two fold, firstly the data used in most price transmission analyses are based on national averages hence fewer observations and a generalised conclusion. In this study, the RPs of beef cuts were physically collected from four different retail outlets (supermarkets) in the same geographical area on a weekly basis over a period of three years. This makes it possible to investigate how different retailers react to changes in the producer price instead of making a general conclusion based on national averages. Secondly, the concern about the Engle-Granger method of co-integration is addressed by applying the Threshold Autoregressive (TAR), Momentum Threshold Autoregressive (M-TAR) and Momentum Consistent Threshold Autoregressive (MC-TAR) procedures by Enders and Siklos (2001). These methods were applied to test for the presence of co-integration and thereafter to conduct a test for symmetric adjustments. These methods have been confirmed to perform better than the EG approach.

2. PRICE TRANSMISSION AND THE SOUTH AFRICAN BEEF VALUE CHAIN

In order for price transmission to take place, a medium is required through which to transmit. In this study the medium is the vertically integrated beef industry. According to Spies (2011), the theory of vertical integration consists of assumptions of which the applications may vary from sector to sector and from commodity to commodity. Motivated by economic welfare distribution, economists attempt to explain the relationship between farms and the market in lieu of the allocation of scarce economic resources, production and marketing efficiency in the economic system (Spies, 2011).

In the case of vertically integrated markets, price theory suggests the existence of a long-term equilibrium relationship between producer and retailer prices through such a market (Veselska, 2005). This theory implies that, in the long term, the price of goods will engage in economic activity reflecting economic value, which is directly correlated with the availability or scarcity of the goods or service. Given this theory on the equilibrium relationship, any external shock(s) to in- or output prices are expected to trigger an adjustment towards the new equilibrium in the short and long term. In the end, if a shock was initiated at in- or output price level, the price will deviate from the initial relationship between producers and retailers, and as it transmits through the vertical chain it should adjust back, maintaining the initial relationship and reflecting symmetrical price transmission.

Studies contradicting symmetrical price transmission behaviour, have revealed evidence that, in practice, transmission from producer to retailer may not always be homogenous in maintaining the same price relationship (symmetrical), but rather asymmetrical (Meyer and Von Cramon-Taubadel, 2004; Peltzman, 2000; Ward, 1982). Vertical price transmission from producer to retailer can thus be either symmetrical or asymmetrical. These two types of symmetry describe the efficiency of the transmission or the lack thereof throughout a value chain, from the start (producer) right down to the end where the retailer will sell the final product to the consumer.

Literature reviewed on price transmission indicate that there are different factors that can cause asymmetry or influence the transmission of price in the red meat industry, from various value-adding chain segments right down to the retail product. Influential factors such as anticompetitive behaviour, information asymmetry, adjustment cost and government intervention (policies) are factors that may have a role to play in asymmetry price transmission (Balke and Fomby, 1997; Kinnucan and Forker, 1987; Ward, 1982). Aguiar and Santana (2002) identified other factors that cause asymmetrical transmission. In the first instance the characteristics of the product will influence the price decision, especially in the case of products that have a short shelf life (perishable), because retailers will not increase prices unnecessarily for fear of losing stock on hand. Secondly, market concentration, or the intensity of the competition, also plays a role. If a retailer increases price too rapidly or lowers price too slowly, he might relinquish market share (lose consumers). The third factor is price expectation. When consumers expect a price increase due to a weakened currency or meat shortage, it is easier to transmit a price increase. The fourth factor is the degree of organisation of the consumer, because a disorganised consumer will be less focussed on checking and comparing price, making it easier for the retailer to transmit price increases

The most commonly applied procedure to test co-integration in previous studies, has been Engle and Granger (1987), but despite its popular appeal they were criticised because of the symmetrical nature of price adjustments models. The Engle and Granger (EG) model assumes symmetry and linearity. Enders and Granger (1998) and Enders and Siklos (2001) suggested the use of the threshold adjustment models as alternative procedures, for example the threshold autoregressive (TAR) and the momentum threshold autoregressive (M-TAR) models. These procedures account for APT within the most vertically integrated markets. With the M-TAR, TAR and MC-TAR models one is able to make predictions in the short and long term.

Various studies have been conducted in the South African meat industry using these procedures. Spies (2011) conducted an analysis of the red meat value chain but the shortfall of the study was that there were only 52 observations based on national average data, but overall the EG, TAR, M-TAR and MC-TAR worked satisfactorily. Uchezuba (2010) performed an analysis on price transmission in the poultry industry, determining the long term co-integration relationship between producer-retail market chain links by means of EG, TAR and M-TAR procedures. The data used was based on time-series observations made from January 2000 to August 2008. Alemu and Ogundeji (2010) found the South African food market price transmission to be asymmetrical through various market segments using long term data series recorded from January 2003 to December 2008. The authors applied the traditional Engle and Granger (EG), the standardised Dickey-Fuller, the TAR model, the M-TAR model and the MC-TAR model to test for co-integration and APT. MC-TAR was then selected as the model best suited to represent the data analysed. These three studies are but a few examples of successful analyses conducted specifically in South Africa using these procedures to analyse the effectiveness of price transmission or the lack thereof.

3. DATA AND PROCEDURES

The data used in this study consists of two price series, namely the Producer Price (PP) and Retail Price (RP). Data collection (observation) took place every week on Monday over a period of three years from January 2012 to December, 2014 (156 observations). The PP comprises the average price for class A2/3 beef carcasses (in R/kg) which were collected weekly by the Red Meat Abattoir Association (RMAA) and represents the average price that abattoirs paid producers (farmers/feedlots) for the carcasses of this class in South Africa during that specific week. The RPs were collected by recording shelf prices at three supermarkets and a butchery in the Langenhoven Park area of Bloemfontein on a weekly basis. The three chosen supermarket outlets one branch from each of the three largest supermarket chains in South Africa, provides a good representation of the retail market as one supermarket can be described as small and convenient, the other one as medium sized and the last as large. The butchery was also included in the analysis as, although a usually less expensive option to buy meat, consumers tend to make more use of the supermarkets when purchasing meat. In order to compare the PP with the RPs, it is necessary to calculate the price at which the retailer sells the whole carcass, and not individual cuts, so that the producer carcass price can be compared to the carcass price of the retailer.

The retail prices of various cuts of beef is determined through a beef cutting test. The whole carcass is broken down to its individual cuts and the price of each cut is then calculated from a price determining factor that is based on the availability of the cut and the demand for the cut. To obtain a retail carcass (selling) price, it was necessary to calculate a collective retail carcass price. Using only one type of cut would have been pointless, as a carcass does not consist of one cut only and the economic value of each cut differs from the next. The reflection of the relationship between a high value retail cut only and the producer carcass price would thus be inaccurate. The reverse calculation of a collective RP (carcass price) was done with the three meat cuts representing high, medium and low value cuts, namely fillet (high value), rump (medium value) and stewing meat (low value). The shelf price (R/kg) of each of the cuts were divided by its price determining factor in the SAMIC (2008) *Beef Cutting Test* in order to determine the carcass price from where the price of the individual cut was derived. The average of the three calculated carcass prices from the three different cuts were then used as the collective carcass price for the specific retailer.

Figure 1 reflects the difference between the weekly PP (A2/3), collective carcass price of Supermarket 1 and the price for fillet of Supermarket 1 over a period of three years (2012 – 2014). It is evident from Figure 1 that there is almost no visual correlation between the PP and the RP of only a high value cut (fillet). The argument of producers that there may be asymmetry present in the market is based on this comparison between the producer and the retail price of an individual cut. However, when the PP and the collective carcass price (RP) of the supermarket are compared the correlation between the price ranges is much clearer. This collective carcass price for each of the three supermarkets and the butchery will be used as the RP in this study.

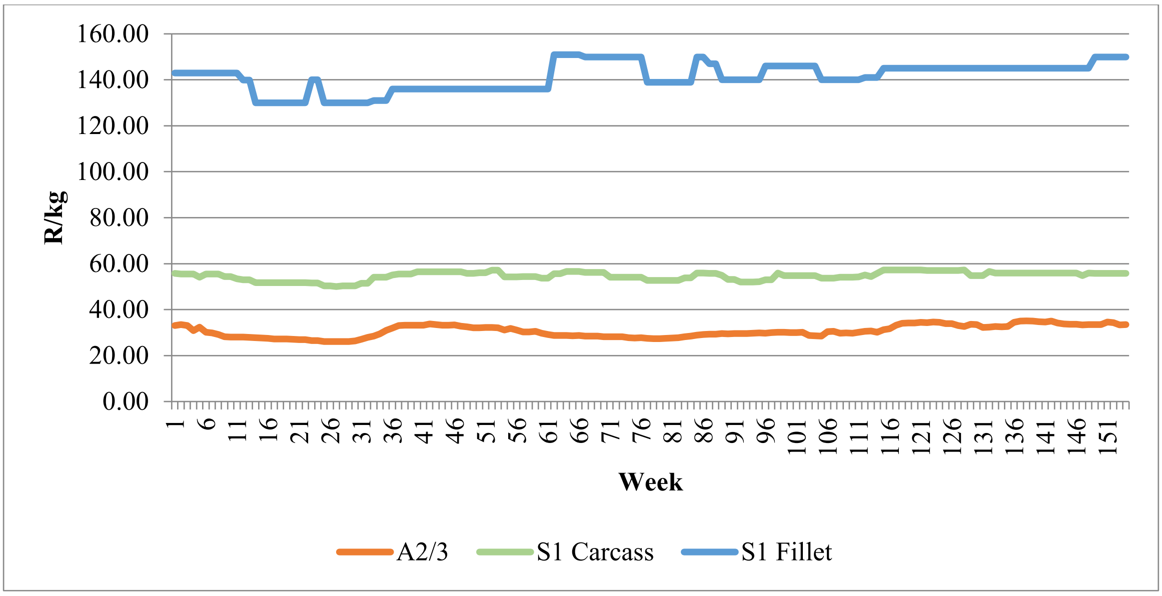

Figure 1: Weekly A2/3 carcass price, collective carcass price for S1 and fillet price for S1
Source: RMAA and own data collection and calculation.

The procedures and models used are the augmented Dickey-Fuller (ADF) for the stationary test (Dickey & Fuller, 1979, 1981; Gujarati, 2003) and the four competing procedures for co-integration analyses are the EG model (Engle-Granger, 1987) and the TAR, M-TAR and MC-TAR models. The Error Correction (EC) and the Granger Causality (GC) test are used to analyse the short-term correction ability and the directions of influence between variables

The model estimation starts by testing the statistical properties of the variables with ADF stationarity test. Once this is confirmed, co-integration tests are carried out. Two approaches that are commonly used to test long-run relationships among variables are the Johansen (1996) and the Engle-Granger (1987) co-integration tests. If conducted using the Johansen methodology, the test will be about establishing the rank of π in [1].

$$\Delta x_t = \pi x_{t-1} + \sum_{i=1}^{k} \Delta x_{t-i} + \psi_t \qquad (1)$$

Where $x_t = [x_{1t}, x_{2t}]'$ is a matrix consisting of the two price variables which are $I(1)$, π is a matrix of coefficients, $\psi_t = [\psi_{1t}, \psi_{2t}]$ is a matrix of disturbance terms, and k is lag length to be determined based on the Akaike information criterion (AIC). Co-integration (long-run relationships) between variables is confirmed when the rank of π is different from zero i.e. $rank\ (\pi) \neq 0$.

The EG method on the other hand is conducted in two steps. In step one, an equation given by a long-run equation given by [2] is fitted

$$x_{1t} = \varphi_0 + \sum_{i=1}^{n} \varphi_i x_{it} + \varepsilon_t \qquad (2)$$

Where the x_i's are individual variables, the φ_i's are parameter estimates and the ε_t's are residuals.
In step two, [3] is fitted to check for the stationarity of the variable ε_t in [2] by testing the null hypothesis of no co-integration i.e. $\rho = 0$ against its alternative hypothesis of co-integration i.e. $-2 < \rho < 0$.

$$\Delta\varepsilon_t = \rho\varepsilon_{t-1} + \sum_{i=1}^{k} \delta_i \Delta\varepsilon_{t-i} + v_t \tag{3}$$

Once co-integration is established, error-correction representation of the form is given by [1] for Johansen and by [4] for Engle-Granger.

$$\Delta x_{1t} = \sum_{i=1}^{n} \varphi_i \Delta x_{it} + \varphi_{n+1}\varepsilon_{t-1} + v_t \tag{4}$$

One major weakness of the above methodologies is their implicit assumption that the system makes symmetric adjustment towards the equilibrium. If adjustment is asymmetric, the estimated equations could be misspecified. Enders & Siklos (2001) extended the Dickey-Fuller equation to test for the co-integration, with asymmetric adjustment toward equilibrium being made part of the alternative hypothesis. They suggested estimating [5]

$$\Delta\varepsilon_t = \rho_1 I_t \varepsilon_{t-1} + \rho_2(1 - I_t)\varepsilon_{t-1} + \sum_{i=1}^{k} \Delta\varepsilon_{t-i} + v_t \tag{5}$$

Where ε_t is as defined before, ρ_1 and ρ_2 are adjustment coefficients, and I_t is the Heaviside indicator given by [6] below. The necessary and sufficient conditions for the stationarity of ε_t requires that ρ_1 and ρ_2 be less than zero and $(1 + \rho_1)(1 + \rho_2) < 1$ for any value of τ (Petrucelli and Woolford, 1984).

$$I_t = \begin{cases} 1 \; if \; \varepsilon_{t-1} \geq \tau \\ 0 \; if \; \varepsilon_{t-1} < \tau \end{cases} \tag{6}$$

Where τ is the threshold. The threshold in [6] could take a value of 0, in the case of TAR and M-TAR models. Where τ is assumed unknown (the case of MC-TAR), a grid search is conducted to search for its value over the potential threshold variable. The consistent estimate of τ is given by the equation which yields the lowest residual sum of squares in [1] (Chan, 1993). The TAR model differs from the M-TAR model on how the Heaviside indicator is created. In TAR models, it is created using ε_{t-1} in [4], but in M-TAR models the first difference of ε_{t-1} i.e. $\Delta\varepsilon_{t-1}$ is used instead. M-TAR models are preferred to TAR models when deviations from equilibrium are believed to exhibit more momentum in one direction than the other (Enders and Siklos, 2001).

Two types of tests are performed on the estimates from [5]. Firstly, to check for co-integration by jointly testing for the null hypothesis that is $\rho_1 = \rho_2 = 0$ and secondly to test for symmetry in adjustment by checking whether $\rho_1 = \rho_2$. A non-standard testing procedure is recommended to conduct the first test as parameters are only identified in the alternative null hypothesis. Enders & Siklos (2001) developed critical values by running a Monte Carlo experiment. The critical values are compared against a value from F-distribution to conduct the test for co-integration. They labelled the F-statistic Φ for TAR and M-TAR models and its analogue ϕ^* for the Momentum consistent TAR (MC-TAR) model. According to Enders & Siklos (2001), the Φ and ϕ^* must be used only when ρ_1 and ρ_2 satisfy convergence conditions (the necessary and sufficient conditions discussed above).

After co-integration is confirmed and the true values of τ, ρ_1 and ρ_2 are known, a standard F-test could be invoked to test for the symmetric null hypothesis ($\rho_1 = \rho_2$) against its alternative of asymmetric adjustment ($\rho_{\downarrow 1} \neq \rho_{\downarrow 2}$) because OLS estimates for ρ_1 and ρ_2 have an asymptotic multivariate normal distribution (Tong, 1990).

Equation [1] can further be expanded to analyse the error correction model as follows:

$$\Delta x_{1t} = \alpha_{11} + \sum_{i=1}^{k} \varphi_{1i} \Delta x_{1t-i} + \sum_{i=0}^{k} \beta_{1i} \Delta x_{2t-i} + I_t \rho_{11} \varepsilon_{t-1} + (1 - I_t) \rho_{12} \varepsilon_{t-1} + \nu_{1t} \quad (7)$$

$$\Delta x_{2t} = \alpha_{21} + \sum_{i=1}^{k} \varphi_{2i} \Delta x_{1t-i} + \sum_{i=0}^{k} \beta_{2i} \Delta x_{2t-i} + I_t \rho_{21} \varepsilon_{t-1} + (1 - I_t) \rho_{22} \varepsilon_{t-1} + \nu_{2t} \quad (8)$$

Where the α's, φ's, β's and ρ's are parameter estimates and the ν's are independently and normally distributed residuals.

4. RESULTS AND DISCUSSION

Test results on the level of integration of the price variables indicated that they are integrated of order 1, that is *I*(1). This was followed by estimation of long run equations. Four long run equations [9 – 12] were estimated representing Supermarket 1 (S1), Supermarket 2 (S2), Supermarket 3 (S3)and Butchery (B) respectively:

$$x_{1\mathrm{t}} = 1.3074 + 0.2897 x_{2t} + \varepsilon_t \quad (9)$$
$$x_{1\mathrm{t}} = 1.4625 + 0.1646 x_{2t} + \varepsilon_t \quad (10)$$
$$x_{1\mathrm{t}} = 0.4500 + 0.8707 x_{2t} + \varepsilon_t \quad (11)$$
$$x_{1\mathrm{t}} = 0.7477 + 0.6347 x_{2t} + \varepsilon_t \quad (12)$$

Where $x_{1\mathrm{t}}$ is the logarithm of the RP, $x_{2\mathrm{t}}$ the logarithm of the PP and ε_t represents the residual. All parameters are significant at 1% level. Next the four competing models (EG, TAR, M-TAR and MC-TAR) were fitted for each of the supermarkets and the butchery (A2/A3 vs S1, A2/A3 vs S2, A2/A3 vs S3 and A2/A3 vs B). The best-fitted model for each retail outlet is presented in Table 1. The best model was selected based on the AIC criterion where the model with the highest value of AIC in absolute value is considered as the best model. Applying the AIC criteria, we selected MC-TAR for S1, MC-TAR for S2, M-TAR for S3 and MC-TAR for butchery.

Table 1: Estimates of price transmission in the Bloemfontein beef market.

Retail outlet	Supermarket 1	Supermarket 2	Supermarket 3	Butchery
Model Selected	MC-TAR	MC-TAR	M-TAR	MC-TAR
ρ_1^a	-0.0827 (-1.7078)	-0.9193 (-7.4612)	-0.4449 (-6.0703)	0.0843 (-1.7538)
ρ_2^a	-0.9057 (-5.9965)	-0.1749 (-2.8675)	-0.0304 (-0.6363)	-0.9996 (-9.0025)
AIC	-7.5503	-5.8094	-6.3641	-7.4870
LAG	1	2	4	1
$P1 = P2 = \phi^b$	19.3836	30.7429	14.0184	41.4032
$\rho_1 = \rho_2^c$	27.0064 (0.0000)	30.8304 (0.0000)	11.9151 (0.0007)	59.2680 (0.0000)
γ	-0.0084	0.0144	0	-0.0136
$Q(3)^d$	4.6233 (0.2020)	1.7063 (0.6360)	1.2777 (0.7340)	3.9409 (0.2680)
$Q(6)^d$	8.3421 (0.2140)	5.5988 (0.4700)	2.3772 (0.8690)	4.5008 (0.6090)
$ARCH^e$	0.5077 (0.9066)	0.6348 (0.8092)	0.9087 (0.5403)	0.3206 (0.9846)
$err^{+}t-1^f$	-0.0997 (-1.9704)[a]	-0.9413 (-7.4623)[a]	-0.3420 (-5.0440)[a]	-0.0985 (-2.4509)[a]
$err^{-}t-1^i$	-0.9494 (-6.2361)[a]	-0.1732 (-2.8011)[a]	-0.0128 (-0.3167)[a]	-0.9133 (-9.7356)[a]

Notes: EG, Engle-Granger; AIC, Akaike information criterion; TAR, threshold autoregressive model; M-TAR, momentum threshold autoregressive model; MC-TAR, momentum consistent threshold autoregressive model; ARCH, autoregressive conditional heteroskedasticity.

[a] Entries are estimated value of ρ_1 and ρ_2 with t-statistic in parentheses.

[b] Entries in this row are the sample values of ϕ and ϕ^* . Critical values for two variables case and no lagged changes for ϕ (TAR and M-TAR) are 5.01, 5.98 and 8.24 at 10%, 5%, and 1%, respectively. The corresponding values for ϕ^* (MC-TAR) are 5.95, 6.95, and 9.27.

[c] Entries in this row are the sample **F-statistic** for the null hypothesis that the adjustment coefficients are equal. Significance levels are in parentheses.

[d] Q(p) is the p-value for the autocorrelation test of the first p residuals. It is based on Ljung-Box statistic.

[e] Test for first –order ARCH residuals. The numbers in parentheses report p-values.

[f] refers to positive error

[i] refers to negative error

To test for co-integration in the long run, it was necessary to jointly test for the null hypothesis that $\rho_1 = \rho_2 = 0$ against its alternative hypothesis of $\rho_1 = \rho_2 \neq 0$, where the alternative hypothesis represents the existence of co-integration or a long run relationship. Row 6 gives the F-statistics ϕ and ϕ^* useful to test the null hypothesis of $\rho_1 = \rho_2 = 0$, which are 19.38369, 30.74292, 14.01841 and 41.40322. These values were compared against the critical values (bottom of Table 1) and are all higher than the corresponding critical value at 1% level of significance. The null hypothesis for the test was thus rejected. Therefore the results indicate that in the case of S1, S2, S3 and B there are long run relationships between the producer and retailer prices, thus confirming the existence of co-integration in the long run. The selected models also met the necessary and sufficient conditions for co-integration as indicated by Petruccelli and Woolford (1984) and by Enders and Siklos (2001). They required that the adjustment parameters ρ_1 and ρ_2 must be negative to meet the convergence conditions and that the operation $(1+\rho_1)(1+\rho_2)$ must be smaller than one. Table 1 (column 2, 3, 4 and 5, Rows 2 and 3) provides values of the adjustment parameters ρ_1 and ρ_2 for the selected models. As evidenced by Table 1, both parameters for each selected model are negative. In addition, the operation $(1+\rho_1)(1+\rho_2)$ in each of the selected model give a value less than 1.

Next the test results were analysed on the symmetric null hypothesis that $\rho_1 = \rho_2$. This test helps to establish whether actors respond to negative and positive shocks differently. According to the results (Table 1, column 2, 3, 4 and 5, Row 7), the symmetric null hypothesis was rejected at conventional significance level for the selected models. Retail outlets S1 (ρ_1 = -0.0827 and ρ_2 = -0.9057) and B (ρ_1 = -0.0843 and ρ_2 = -0.9996) both exhibited a greater response towards a price increase than to a decrease. For the case of S1, 8% of the positive shock and 90% of the negative shocks are rolled over to the following week, while for the butchery, 8% of the positive shocks and 99% of the negative shocks are rolled over to the next week. The results suggest that in the case of S1 and B, a deviation from the equilibrium will persist due to positive shocks (a decrease in PP) rather than to negative shocks (an increase in PP). These retailers are therefore quicker to respond to shocks that squeeze their margins than to those that stretch them, which results in positive APT in the long term.

In the case of S2 (ρ_1 = -0.9193 and ρ_2 = -0.1749) and S3 (ρ_1 = -0.4449 and ρ_2= -0.03042) the response is in the opposite direction. S2 and S3 respond quicker to shocks that stretch their margins (decrease in price) than to those that squeeze their margins (increase in price). This implies that if positive and negative deviations from the long term equilibrium are eliminated at 91.93% and 17.49% of the change in price per week for S2 and 44.49% and 3.04% per week for S3, the discrepancies of these shocks will lead to negative APT in the long term.

The ECM model, specified in [7] and [8], was estimated to analyse the short run dynamics in the meat market. If the t-statistics of the adjustment coefficients are both statistically different from zero, the RP responds to both positive ($err +_{t-1}$) and negative shocks ($err -_{t-1}$). The shock that is greater in size is the one that will have a greater change in the RP via its speed and magnitude. It is evident from Table 1 that S1 and B react faster and at a greater magnitude, to a price increase than to a price decrease. As for S1 and B, the speed of return to the equilibrium is 94% and 91% respectively for a price increase ($err -_{t-1}$), while for a price decrease ($err +_{t-1}$) the speed of return is only 9.97% and 9.85% respectively. S2 and S3 exhibit opposite results and a decrease in price will be transferred quicker and at a greater magnitude than an increase in price. In the case of S2 and S3 the speed of return to the equilibrium is 94% and 34% respectively for a price decrease ($err +_{t-1}$), while it is only 17% and 1% respectively on the evening of a price increase ($err -_{t-1}$).

The Granger (1969) causality test was performed to determine the causal direction of information flow between variables, to identify whether causality runs from retailer to producer (RP→PP) or vice versa (the arrow indicates the direction of causality). The Granger causality test was used to test the null hypotheses stating that the RP's does not affect the PP (S1 ⇏A2/A3) and that the PP does not affect the RP (A2/A3 ⇏ S1), as shown in Table 2. Results can however either be unidirectional (influence flow one way) or bidirectional (influence if in both directions) or there might be no influence at all.

Table 2: Granger causality test results for beef

Null Hypothesis	F-Statistic	Probability
S1 ⇏A2/A3	3.32645	0.0386**
A2/A3 ⇏ S1	7.61983	0.0007*
S2 ⇏A2/A3	0.46450	0.6294
A2/A3 ⇏ S2	1.88571	0.1553

S3 $\nRightarrow$A2/A3	1.94554	0.1465
A2/A3 $\nRightarrow$ S3	7.92196	0.0005*
B$\nRightarrow$A2/A3	0.49680	0.6095
A2/A3 $\nRightarrow$ B	18.1209	0.0000*

* and ** denote significance at a 1% and 5% significance level respectively.

The results in Table 2 clearly indicate that causality differs among the various retailers. S1 is the only retailer that presents bidirectional causality. Information therefore flows from the producer to the retailer and from the retailer to the producer. A change in PP thus causes the RP of S1 to change and a shock in RP also influence PP. In the case of S3 and B there is unidirectional causality with the flow of information only from producer to retailer. Contrary to the other retailers, S2 reflects no direction of causality. In the case of S2 there is thus basically no flow of information, leaving the PP and RP without an influence on one another.

5. CONCLUSION AND RECOMMENDATIONS

The results confirmed the existence of a long term relationship between the PP and RP in all four retail outlets (S1, S2, S3 and B) of the beef market. The relationship was analysed over the long- and short term and the price transmissions at S1, S2, S3 and B were found to be asymmetrical. The actual asymmetry, however, differed between the retailers, as S1 and B were found to be positively asymmetric while S2 and S3 exhibited negative asymmetry. The market margins for S1 and B in the long run thus increased over time (stretch), while the market margin for S2 and S3 decreased (squeeze). Positive asymmetry is said to be detrimental to the consumer while negative asymmetry price adjustment behaviour would benefit the consumer over time.

Despite the results obtained from the estimated models, it is important to understand the functioning of the entire beef value chain in order to gain a better understanding of the changes in the producer to retail (PR) price margin. Important aspects regarding the four retail outlets, observations made during data collection, the results of the analysis, reviewed literature, existing knowledge of the South African red meat industry and current economic circumstances should also be taken into account. Factors such as input- and processing cost and perishability of meat probably played a role in the nature of price transmission of non-symmetry persisting in Bloemfontein and the differences between retailers.

Aside from external factors, there are also internal factors that can possibly contribute to fluctuations in prices between outlets. One should remember that retailers are from different supermarket chains and even retailers of the same chain in different geographical areas, differ in many ways. Observations revealed a difference in capacity and facilities among retailers. Although retailers only buy enough carcasses to meet their demand for the week and then buy in fresh meat the next week, they remain exposed to possible higher prices (price-takers). Those retailers that have greater storage facilities (cold storage rooms) have a competitive advantage as they are able to maintain a more stable price and negotiate for a better price, as they have bargaining power allowing them to buy on a large scale when prices are low.

Demand factors bring us to the next influencing factor, namely the market structure with respect to competition and market demand. An analysis of the competition with regard to the number of outlets versus the geographical area of consumers they supply to revealed relatively healthy competition. Competition melts down to a marketing strategy that is determined by demand and the type of consumer the retailer wishes to attract. Consumer preferences and habits differ, for example in their frequency of buying: some buy daily, some weekly and others monthly. Consequently retailers' marketing strategies must differ, some catering for daily buyers by offering smaller parcels of meat and others for monthly buyers who wish to purchase a bulk pack. Most of the special retail offers on the bulkier packs, are designed to attract consumers. Retailers presenting special offers make less profit per kilogram on bulk sales, but the total number of kilograms sold increase. The retailer who caters for the weekly buyer has to counter the specials of other retailers with a special in order to maintain his market share. So as not to confuse their regular buyers by fluctuation in the prices of luxury cuts such as fillet, these weekly specials mostly focus on special prices for the less expensive cuts and products, such as mince and stewing beef.

It is suggested that producers remain informed by taking note of the current price transmission status. Furthermore, producers should rather focus on what they can change and on more productive and efficient ways of producing red meat. Producers can collaborate with producer organisations to educate the consumer to become more selective regarding their support of red meat outlets, applying indirect pressure on outlets to remain market related and competitive, hopefully maintaining the PR margin more symmetrically.

6. References

Alemu, Z.G. 2012. Causality links between consumer and producer price inflation in South Africa. *Applied Economics Letters*, 19(1), pp.13–18.

Alemu, Z.G. & Ogundeji, A.A. 2010. Price transmission in the South African food market. *Agrekon*, 49(4), p.433.

Babiker, B.I. & Abdalla, A.G. 2009. Spatial price transmission: A study of sheep markets in Sudan. *Afr. J. Agric. Resour. Econ*, 3(1), pp.43–56.

Balke, N. & Fomby, T. 1997. "Threshold cointegration," *International Economic Review*, 38, pp. 627–645.

Chan, K.S. 1993. Consistency and limiting distribution of the least squares estimator of a threshold autoregressive model. The Annals of Statistics 21,pp. 520-533.

Department of Agriculture, Forestry and Fisheries. 2011. A profile of the South African mutton market value chain. Available at: http://www.daff.gov.za/.

Department of Agriculture, Forestry and Fisheries. 2017. Abstract of agricultural statistics. Available at: http://www.daff.gov.za/.

Dickey, D.A. & Fuller, W.A. 1979. Distribution of the estimators for autoregressive time Series with a Unit Root. Available at: http://www.jstor.org/stable/2286348.

Dickey, D.A. & Fuller, W.A. 1981. Likelihood ratio statistics for autoregressive time series with a unit root. *Econometrica: Journal of the Econometric Society,* 49(4), pp.1057–1072.

Enders, W. & Siklos, P. 2001. Cointegration and Threshold Adjustments. *Journal of Business and Economics Statistics,* 19, pp.76–166.

Engle, R.F. & Granger, C.W. 1987. Co-integration and error correction: representation, estimation, and testing. *Econometrica: Journal of the Econometric Society*, pp.251–276.

Free State Red meat Producer's Organistaion. 2012. Personal communication with the management of the FSRPO on a management meeting held in January, 2012.

Granger, C.W. 1969. Investigating causal relations by econometric models and cross-spectral methods. *Econometrica: Journal of the Econometric Society,* pp.424–438.

Gujarati, D.N. 2003. Basic econometrics. Boston, MA: McGraw-Hill Higher Education.

Hahn, W.F. 1990. Price transmission asymmetry in pork and beef markets. *The Journal of Agricultural Economics Research*, 42(4), pp.21–30.

Kinnucan, H.W. & Forker, O.D. 1987. Asymmetry in farm-retail price transmission for major dairy products. *American Journal of Agricultural Economics*, 69,pp. 285–292.

Johansen, S. 1996. Likelihood-based inference in cointegrated vector auto-regressive models. Oxford: Oxford University Press.

Meyer, J. & Von Cramon-Taubadel, S. 2004. Asymmetric price transmission: a survey. *Journal of Agricultural Economics*, 55(3), pp.581–611.

Peltzman, S. 2000. Prices rise faster than they fall. *Journal of Political Economy*, 108(3), p.466.

Petruccelli, J. & Woolford, S. 1984. A threshold AR (1) model. *Journal of Applied Probability,* 21:270-286.

RMAA. 2012. Weekly red meat price information. Available from http://rvav.co.za/price-information-system/.

Rumánková, L. 2012. Time series properties and their influence on the results of price transmission - Case Study of the Czech Pork Market. AGRIS on-line Papers in *Economics and Informatics*, 4(4).

Spies, D.C. 2011. Analysis and quantification of the South African red meat value chain. Dissertation submitted for the degree Philosophiae Doctorate in the Department of Agricultural Economics, Faculty of Natural and Agricultural Sciences, University of the Free State.

Tey, Y.-S. 2009. Symmetry in farm-retail price. MPRA Paper from the University Library of Munich, Germany.

Tong, H.1983. Threshold Models in Non-Linear time Series Analysis, New Yolk: Springler –Verlag.

Uchezuba, D.I. 2010. Measuring asymmetric price and volatility spillover in the South African poultry market. Dissertation submitted for the degree Philosophiea Doctorate in the Department of Agricultural Economics, Faculty of Natural and Agricultural Sciences, University of the Free State.

Veselska, E. 2005. The process of vertical coordination and its consequences within the beer commodity Chin. *Zemedelska Ekonomika-Praha*, 51(9), p.419.

Ward, R.W. 1982. Asymmetry in retail, wholesale, and shipping point pricing for fresh fruits and vegetables. *American Journal of Agricultural Economics*, 62: 205-212.