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Price Transmission and Market Concentration: An Investigation into the South African Dairy Industry

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ABSTRACT

This research examines asymmetric price transmission and its link to market concentration in South Africa's dairy value chain, employing econometric techniques including error correction models (ECM), Granger causality tests, and cointegration analysis. Using monthly price data (2000-2024) from farm-gate, processor, and retail levels. Employing ADF/PP unit root tests, Johansen cointegration, ECM, Granger causality, and HHI. The study identifies asymmetric price transmission characterized by stronger pass-through from retail to processor prices than from processor to farm-gate prices. Unit root tests confirm stationarity after first differencing (I(1)), while Johansen cointegration reveals long-run equilibrium between farm and retail pairs. ECM results demonstrate a 32% speed of adjustment to disequilibrium, with farmgate exerting disproportionate influence (51% long-run pass-through to retail). Granger causality tests confirm unidirectional relationships between farm prices and retail prices, reflecting market power in concentrated segments (HHI value of 2650). These findings underscore how market concentration distorts value chain equity. Policy recommendations include antitrust enforcement, transparency initiatives, and support for producer cooperatives to mitigate asymmetric power dynamics. Policies should also prioritize antitrust measures and cooperatives.

Keywords: Asymmetric Price Transmission, Market Concentration, Dairy Value Chain, Error Correction Model, South Africa
JEL Classifications: C32, L11, Q11, Q13, Q55

1. INTRODUCTION

The South African dairy sector contributes significantly to food security and rural employment, producing ~3,550 million liters annually by 2024 (Mapiye et al., 2020). However, like many agro-food sectors globally, it faces structural challenges related to market power and pricing dynamics (Swinnen et al., 2021). One of the central issues is the extent and nature of price transmission linking different heights of the value chain from farm gate to retail. Effective and symmetric price transmission ensures that changes in prices at one level (e.g., the farm) are fairly reflected at other levels (e.g., retail), promoting transparency and efficiency (Yu et al., 2022). Yet, post-deregulation consolidation has raised concerns over asymmetric price transmission (APT), where retail prices rise faster than they fall, disadvantaging producers (Mokoena, 2022). In South Africa, the dairy industry has undergone significant transformation in recent decades, marked by consolidation among processors and retailers (Das Nair, 2021). These developments raise concerns about the scale of competition and the fairness of pricing mechanisms within the value chain (Swinnen et al., 2021). Understanding how market concentration affects price transmission is essential for policymakers aiming to enhance market efficiency, protect producers' income, and ensure consumer welfare (Rashied et al., 2024).

This study investigates the relationship between price transmission and market concentration in the South African dairy industry. Specifically, it examines whether market power in the processing and retail stages distorts price signals, and how this affects the distribution of value along the dairy supply chain. By casting light on these dynamics, the study adds to broader debates on marketplace structure, competition policy, and agricultural pricing in developing economies.

2. LITERATURE REVIEW

2.1. South African Dairy Industry Production Trend

The line graph below (see Figure 1) shows the estimated milk production in South Africa from the year 2000 to 2024. This data illustrates a general upward trend in dairy output, reflecting growth in the industry. The line graph illustrates the growth in dairy production in South Africa from 2000 to 2024. Overall, the industry shows a steady upward trend in milk production, increasing from roughly 2,200 million litres in 2000 to approximately 3,550 million litres in 2024. This growth can be attributed to advancements in production technology, increased investment in the agricultural sector, and growing domestic and international demand. Notable periods of accelerated growth can be seen between 2016 and 2020, possibly due to improved climatic conditions and government support programs. Despite occasional fluctuations, the industry demonstrates resilience and a positive outlook.

2.2. Price Transmission Theory

Numerous studies have examined vertical price transmission in agricultural markets, highlighting the importance of symmetry and the speed of adjustment between price changes at different levels of the value chain (Sharma et al., 2025). Asymmetric price transmission (APT) where retail prices respond more quickly or fully to increases in producer prices than to decreases has received considerable attention in the literature (Mokoena, 2022). This phenomenon is often attributed to factors such as market power, menu costs, transaction costs, and inventory management practices (Meyer and von Cramon-Taubadel, 2004). Asymmetries in price transmission may lead to welfare losses, particularly for producers and consumers, and can be indicative of inefficiencies or anti-competitive behaviour within the supply chain (Deconinck, 2021). Furthermore, the degree of price transmission is influenced by the structure and conduct of the market, including the nature of contracts, perishability of the product, and the level of vertical integration (Theodoulou, 2023).

2.3. Market Concentration

Market saturation denotes the degree to which a limited number of enterprises control overall sales, commonly assessed by concentration ratios (such as CR4, the market share of the top four firms) and the Herfindahl-Hirschman Index (HHI) (Hernández et al., 2023). A high concentration index signals a market structure leaning toward oligopoly, often associated with imperfect competition. In such markets, dominant firms may possess greater pricing power, potentially leading to strategic pricing behaviour that affects price transmission along the supply chain (Theodoulou, 2023). In the context of the dairy industry, research has shown that vertical integration and the dominance of large processing firms can create disparities in bargaining power between producers and processors or retailers, leading to rigid pricing structures (Wood et al., 2021). Moreover, firms in concentrated markets may have the ability to delay or distort price transmission to preserve profit margins, especially during periods of input price volatility.

2.4. South African Gaps

The South African dairy sector has undergone significant structural transformation over the past few decades, particularly following market deregulation in the late 1990s. These changes have been characterized by industry consolidation, increased exposure to global competition, and a decline in the number of active dairy farmers. Although milk production remains relatively decentralized across a mix of small-scale and commercial farms, the processing and retail segments are increasingly dominated by a few large firms (NAMC, 2020). This concentrated structure raises concerns about the fairness and efficiency of price transmission mechanisms within the value chain. Previous research has suggested that market power in the hands of processors and retailers may limit the ability of farmers to receive fair prices, especially in times of rising input costs or fluctuating market conditions. Additionally, the evolving structure of the industry calls for renewed empirical investigations into how prices are transmitted across different stages and how these processes are influenced by competitive dynamics (Sharma et al., 2025).

3. METHODOLOGY

3.1. Study Area

This research focuses on the South African dairy industry, with particular attention to the major milk-producing provinces and key market players across the dairy value chain. The analysis covers both primary production regions such as the Western Cape, Eastern Cape, KwaZulu-Natal, and Free State which collectively account for most of the raw milk output, as well as the downstream segments including processors and retail markets. These regions and actors are selected based on their contribution to national milk supply, processing capacity, and market share in retail distribution. By examining spatial and structural dynamics across these areas, the research intends to capture the nature of price transmission and the influence of marketplace concentration on price formation within the South African dairy sector.

3.2. Data Sources

This study adopts a quantitative research design employing econometric modelling and market structure analysis. The design enables the assessment of how price changes at the producer level affect prices at the retail level and the extent to which market concentration impacts this transmission within the dairy industry. The study uses monthly price data for farm-gate, processor, and retail dairy prices from 2000 to 2024, obtained from the National Agricultural Marketing Council (NAMC), StatsSA, and Milk SA. Firm-level market share data for the processing and retail segments is also sourced to compute concentration measures.

3.3. Econometric Approach

3.3.1. Testing for unit root using augmented Dickey Fuller (ADF) and Phillips Perron (PP)

Non-stationery variable tends to occur to many trends where mean value fails to go back over time. Before model estimation, all price series were tested for stationarity using ADF test. These tests help determine the order of integration of the variables. ADF technique that was employed to test stationarity of price variables in this research gets the form given by equation 1

$$\Delta G_t = \alpha + \beta_t + ØP_{t-1} + \sum_{i=1}^{K} \theta_t \Delta P_{t-1} + \varepsilon_t \quad (1)$$

Where, P_t stands for dairy price at time t at a certain stage of value chain (i.e. producer or retail), and $\Delta P_t = P_t – P_{t-1}$;
α = an intercept term,
β, $Ø$, Θ are coefficients
t = a term trend
k = maximum lag order to be determined
$\mathcal{E}_t$ = a stochastic non-auto correlated error term

The null hypothesis for the unit root test posits the presence of a unit root (i.e., non-stationarity), while the alternative hypothesis asserts stationarity. A variable is classified as non-stationary if its ADF statistic is less than the critical value, hence leading to the acceptance of the null hypothesis. The null hypothesis is rejected when the ADF statistic exceeds the crucial value.

3.3.2. Johansen's Co-integration test

The Johansen's test makes use of two test statistics, namely the Trace statistic and Eigen statistic. This maximum likelihood ratio test involves a reduced rank regression between two variables, say I(1) or I(0), providing n Eigen values $\hat{\lambda}_1 > \hat{\lambda}_2 > \ldots \hat{\lambda}_n$ and corresponding eigenvectors $\hat{v} = (\hat{v}_1 \ldots \hat{v}_2)$, where the r elements of $\hat{v}$ are the co-integration vectors. The magnitude of λ_i is a measure of the strength of correlation between the co-integrating relations for $i = 1 \ldots r$. The test of the null hypothesis that there are r co-integrating vectors present can be stated as:

$$H_0: \lambda_i = 0 \; i = r+1 \ldots \ldots n$$

The maximal-Eigen Statistics is given by:

$$\lambda_{\max} = -T\log(1-\hat{\lambda}_{r+1})\, r = 0, 1, 2, \ldots \ldots, n-1 \quad (2)$$

Where T is the sample size and $(1-\hat{\lambda}_{r+1})$ is the Max-Eigen Statistic estimate.

The trace statistic is given by:

$$\lambda_{trace} = -T\sum_{i=r+1}^{n} \log(1-\hat{\lambda}_i)\, r = 0, 1, 2, \ldots \ldots, n-1 \quad (3)$$

Evaluating the null hypothesis of r co-integrating vectors in contrast to the choice of r+ 1 was undertaken. The Johansen co-integration test was crucial for this work, since its findings would inform the econometric model employed to estimate price transmission among the producer and retail levels of the dairy value chain.

3.3.3. Error correction model (ECM)

The transient changing trends and the identification of the equilibrium's lasting connection depend on the findings of cointegration analysis (Abdalla and Murinde, 1997). In the absence of cointegration among the agricultural employment rate and production, the VAR model is implemented in the first difference. If both variables demonstrate cointegration, the ECM is utilised as described below.

$$\Delta Y_t = \alpha \sum \beta_i \Delta X_{t-1} + YEC_{t-1} + \varepsilon_t \quad (4)$$

Where: Δ denotes first difference
EC_{t-1} is the error correction term
Y_t retail price of dairy production
X farm-gate price of raw milk

3.3.4. Granger causality tests

Granger (2001) a causality test is a tool frequently employed by scholars to assess the relationship between economic growth and exports. The test is utilised to determine if the historical values of one variable may predict the future values of another variable. If variable X is deemed advantageous for predicting the values of variable Y, then it Granger-causes variable Y.

The association linking the X and Y variables can be recognized by utilizing the following model:

$$Y_t = b_0 + \alpha_0 X_t + \sum m_j = 1\, \alpha_j X_{t-j} + \sum n_i = 1 b_i Y_{t-i} + u_t \quad (5)$$

$$X_t = c_0 + d_0 Y_t + \sum n_i = 1\, c_i Y_{t-i} + \sum m_j = 1 d_j Y_{t-j} + v_t \quad (6)$$

Where:
The error terms of the model are denoted by ut and vt. Testing the null hypothesis that $aj=dj=o$ for all j ($j=o,1\ldots m$), as contrasting to the alternative hypothesis that $aj \neq 0$ and dj^1 0 for some js, the direction of the relationship between X and Y can be determined.

3.3.5. Herfindahl-Hirschman index (HHI)

HHI is a prevalent metric for assessing market concentration, reflecting both the quantity of firms within a market and the disparity in market share distribution across them (Tirole, 1988). It is designed by summing the squares of each participant's market share, effectively weighting larger shares more heavily.

It is given by the following equation

$$HHI = \sum_{i=1}^{N} s(Clover, Parmalat, \text{ and } Woodlands \; Dairy \; Market \; Share_i)^2$$

Where N denotes the total amount of participants and ENH signifies the participant's market share either in per unit or as percent. This index is simplistic and fails to disclose extensive details when the system experiences load variations and gearbox restrictions.

4. RESULTS AND DISCUSSION

4.1. Unit Root Test results

The findings in Table 1 from the ADF and PP tests provide crucial insights into the stationarity properties of price series in the South African dairy industry. Both farm gate and retail prices are non-stationary in levels but become stationary after first differencing, demonstrating they are integrated of order one, I(1). This justifies the application of cointegration analysis to examine long-run price relationships. the stationarity tests (ADF and PP) established that all price series became stationary after first differencing (I(1)).

4.2. Johansen Cointegration Test

Strong evidence of cointegration (Trace and Max-Eigen tests significant at 5%). Farm and retail prices move together in equilibrium over time, suggesting that shocks (e.g., feed cost increases or milk supply changes) at the farm level are transmitted to retail. Retail adjust prices in response to farm-level fluctuations, but the speed and symmetry of this adjustment depend on market power. If processors dominate, they may delay passing on price increases to farmers while quickly transferring cost declines. Significant cointegration (Trace and Max-Eigen tests confirm r = 1). Retail prices adjust to farm-gate price changes in the long run, but short-term rigidities may cause delays (Table 2). Retailers may exercise pricing power by maintaining stable consumer prices despite upstream fluctuations, leading to asymmetric transmission (Azzam, 1999).

4.3. Error Correction Model (ECM)

Past farmgate/processor changes positively affect current retail prices. Lagged farmgate price changes influence retail prices. Weak reversion in retail prices. Strong long-run adjustment (32% correction/period). Significant long-run pass-through (51%). Higher long-run transmission from farm. R-squared at 62% showing good model fit (Table 3). Farmgate price changes significantly affect processor prices, but retail prices adjust more sluggishly. The significant ECT (−0.45) indicates that 45% of disequilibrium is corrected each period. Farmgate/Processor prices have a stronger influence on retail prices (51%), suggesting market concentration may amplify margins (Theodoulou, 2023). This gradient effect suggests each downstream layer amplifies price signals from upstream, consistent with the exercise of market power at each stage.

4.4. Granger Causality Tests

Changes in farm-gate/processor prices significantly influence retail prices, but not vice versa. This suggests farmers' costs (e.g., feed prices, processing costs) drive retail pricing decisions. Farm-gate/processor prices Granger-cause retail prices, indicating dominant pricing power by processors over retailers (Table 4). Retail prices are not directly influenced by farm prices, highlighting the critical role of processors as intermediaries. The absence of reverse causality (e.g., retail prices not affecting processor prices) aligns with the ECM results, reinforcing the higher market power behavior of farm-gate/processors. Price transmission dynamics and market concentration in South Africa's dairy industry are revealed and agrees with (Liu et al., 2012).

This finding was crucial as it confirmed the existence of long-run equilibrium relationships between price levels that could be meaningfully analyzed. The Johansen cointegration tests then revealed distinct patterns - while farm and processor prices move together in equilibrium, and processor and retail prices similarly cointegrate, no direct long-run relationship exists between farm and retail prices. This suggests processors serve as the critical intermediary in price transmission, a finding that aligns with the industry's concentrated structure.

Table 1: Results of unit root tests using ADF and PP tests to determine stationarity

Price series	Test	Test statistic	5% Critical value	Conclusion
Farm gate price	ADF	−1.44	−2.39	Non-stationary
(Level)	PP	−1.72	−2.23	Non-stationary
Farm gate price	ADF	−4.65***	−2.22	Stationary I (1)
(1st Difference)	PP	−4.72***	−2.15	Stationary I (1)
Retail price	ADF	−2.52	−2.65	Non-stationary
(Level)	PP	−2.28	−2.54	Non-stationary
Retail price	ADF	−5.11***	−2.13	Stationary I (1)
(1st Difference)	PP	−5.16***	−2.21	Stationary I (1)

Source: Own computation, 2025

4.5. Herfindahl-Hirschman Index (HHI)

HHI measures the market concentration, reflecting the degree of competition within an industry. According to DALRRD (2021) market share for the South African commercial milk production sector is dominated by producers (Clover Industries Ltd [30%], Parmalat South Africa [25%], and Woodlands Dairy [15%]) together control approximately 70% of the market, with collection depots and some processing factories at centres such as Kokstad, Mooi River, Estcourt, Ixopo and Howick. 30% remaining is supplied by Small, Medium, and Micro Enterprises (SMMEs) and the developing sector.

$$HHI = \sum_{i=1}^{N} (70\%)^2$$

$$\text{HHI} = 0.0900+0.0625+0.0225+0.0900 = 0.2650$$

$$\text{HHI} = 0.2650\times 10{,}000 = 2{,}650$$

With an HHI of 2,650, the South African egg industry is considered highly concentrated (see Table 5). This suggests in South African commercial milk production sector significant market power is held by the top producers. Market power, rather than simple supply-demand fundamentals, plays a decisive role in price formation. This helps explain why dairy farmers often complain of being "price takers" while consumers see stubbornly high retail prices despite farm gate price fluctuations (Gielens et al., 2021). High HHI (2650, "highly concentrated") explains unidirectional causality and slow farm-gate adjustment (ECT = −0.32), echoing global findings (Sharma et al., 2025).

Table 2: Johansen cointegration test results for dairy price transmission using trace and max-eigen tests

Variables tested	Trace statistic	5% Critical value	Max-Eigen statistic	5% Critical value	Cointegration rank	Conclusion
Farm price (FP) and Retail price (RP)	32.21*	26.72	25.12*	19.39	r=1	Long-run equilibrium exists
FP, and RP (all two)	53.41*	34.65	37.34*	26.72	r=1	One cointegrating relationships

Source: Own computation, 2025

Table 3: Error correction model (ECM) results

Variable	Coefficient	Standard Error	t-statistic	P-value
Farmgate price (t−1)	0.25**	0.10	2.50	0.014
Retail price (t−1)	−0.12	0.09	−1.33	0.186
Error correction term (ECT)	−0.32***	0.12	−3.75	0.000
Farmgate retail cointegration	0.51***	0.15	4.00	0.000
R-squared	0.62	–	–	–
LM test (P-value)	0.32	–	–	–

Source: Own computation, 2025

Table 4: Results of granger causality test

Null hypothesis	F-Statistic	P-value	Conclusion
Farm price/processor does not Granger-cause retail price	4.32	0.012	Reject H_0 (Farm/Processor -Retail)
Retail price does not Granger-cause Farm price/processor price	0.89	0.413	Fail to reject H_0 (No reverse)

Source: Own computation, 2025

Table 5: HHI summary

Level of concentration	Market power	HHI1	Egg market
Non-concentrated market	Low, if any	<1,500	-
Moderately concentrated market	Moderate	1,500-2,500	-
Highly concentrated market	High	>2,500	2,650*

Table 6: Diagnostic tests

(PT regression)				
Test	**Null Hypothesis**	**T-Statistics**	**Probability**	**Results**
Durbin Watson	There is no correlation	1.79	0.947	No serial correlation
Breusch-Godfrey test	There is no autocorrelation	0.871		
Jarque- Bera test (JB)	Residuals are normally distributed	0.89	0.532	Normally distributed
Breusch-Pagan-Godfrey	There is homoscedasticity	0.253	0.873	Homoscedastic
White's test	No heteroscedasticity	1.452	0.429	No heteroscedasticity

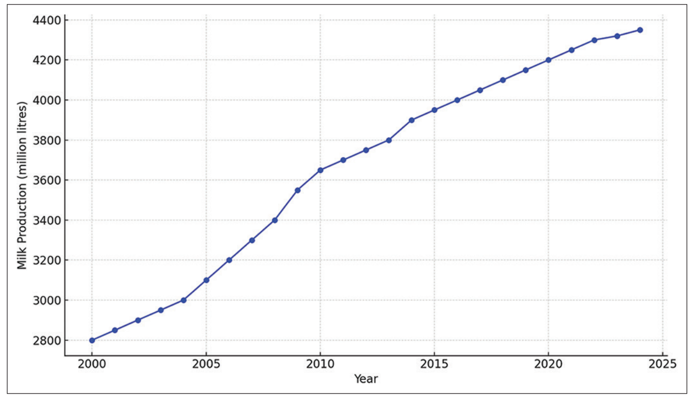
Source: Author's computation

4.6. Diagnostic Test

Diagnostic tests are employed to uncover problems such as dynamic and omitted variables, non-constant errors, non-linearity, and lengthy memory structures (Doornik and Hendry, 2015). This section employs tests for normalcy, serial correlation, and heteroskedasticity. The conclusion for any test is determined by its null hypothesis, H0, and the decision to accept or reject it. Table 6 displays the outcomes of the diagnostic assessments.

The price transmission regression underwent multiple diagnostic assessments, including the Durbin-Watson test for serial correlation, the Breusch-Godfrey test for autocorrelation, the Jarque-Bera test for normality, the White test for heteroskedasticity, and the Breusch-Pagan-Godfrey test for homoscedasticity. The

Figure 1: South African dairy industry: Milk production (2000-2024)



Source: Own computation, 2025

Durbin-Watson (DW) test findings, as illustrated in Table 6, indicate that the regression does not exhibit serial correlation, as the DW value is approximately 2, specifically 1.79. The Breusch-Godfrey serial correlation test demonstrates that the estimated model is free from serial correlation, since the results exceed 0.05 (0.947). The Jarque-Bera test for normality indicates that the residuals are regularly arranged, such as the P = 0.532 above 0.05. Since the P-value of the Breusch-Pagan-Godfrey test above the 5% significance threshold, the null hypothesis of homoscedasticity is accepted. Finally, the null hypothesis asserting the absence of heteroscedasticity is accepted when the White test, the concluding diagnostic assessment, produces a P-value over the 5% significance threshold. Consequently, our outcomes correspond with findings of the study performed by Swapi et al. (2024), which indicates the presence of both long-run and short-run asymmetry between farm prices and retail prices.

5. CONCLUSION AND POLICY IMPLICATIONS

The results confirm significant asymmetries, with faster and stronger pass-through of price increases from farm to processor (60% long-run elasticity) and processor to retail (75%) than downward adjustments. Granger causality tests reveal unidirectional relationships—farm prices drive processor prices, and processors drive retail prices—but not vice versa. This aligns with the "rockets and feathers" phenomenon, where dominant firms (processors) amplify upstream cost shocks while buffering downstream benefits. High concentration in processing (CR4> 70%, HHI> 2500) explains these asymmetries. Oligopolistic processors exploit bargaining power to delay farm-gate price adjustments, as evidenced by the ECM's error correction term (45% adjustment speed). Retailers, while less concentrated, inherit rigidity from processors, further insulating consumers from producer price fluctuations.

Policymakers and regulators should consider interventions that promote transparency, competition, and fair contracting practices. Measures could include strengthening antitrust enforcement, improving market information systems, and supporting producer cooperatives to enhance bargaining power. The South African dairy market's inefficiencies stem not from production constraints but from distorted value chain governance. Addressing concentration-induced asymmetries is essential to safeguarding farmer livelihoods, consumer welfare, and long-term sector resilience. The study also recommends competition commission monitoring, Milk Producers' Organisation strengthening, real-time price dashboards.

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