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Do Import Tariff Adjustments Bolster Domestic Production? Analysis of the South African-Brazilian Poultry Market Case

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Abstract: The South African poultry industry plays an important food security contributory role, hence, consumer and producer interests ought to be accounted for in order to maintain the long term value of the industry in the presence of import competition. This study used the Error Correction Model (ECM) to investigate the relationship between the variables as well as the Impulse Response Model to assess the level of responsiveness of import volume and domestic production due to changes in the import tariff for the period 2010m04 to 2020m06. The ECM results with a negative ECT value of −0.53, indicate that a long run relationship exists between domestic broiler production volume, imported broiler quantity and the *Ad Valorem* import tariff. The Impulse Response Model has shown that over ten periods, the adjustments in the *Ad Valorem* tariff initially produce desirable results showing that a one standard deviation shock to the *Ad Valorem* tariff culminates in a sharp decline in import volume and a sharp increase in domestic volume produced. However, this response cannot be maintained over the long term, thus signaling the need for a more effective and viable solution other than an increase in the *Ad Valorem* import tariff to alleviate the stiff competition between domestic production and an increased supply of broiler imports. The study findings have policy implications for resolving internal issues in the South African poultry industry, such as improving production capacity and sector competitiveness at the same time maintaining the gains from trade especially for consumers.

Keywords: import tariff; ECM; impulse response model; long-run relationship; South African poultry

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1. Introduction

The linkage between domestic food production, international trade, and prices is an intricate subject involving more than the issues of domestic industry competition and national food security. In the early 2000s, the observation made in Gehlhar and Coyle (2001) considering the consumption shift from basic staples to higher value livestock products by developing nations explains the notion behind the expansion in the global trade of processed livestock products which has continued to date. Globally, animal products are the main source of energy and protein, and thus, are a major component of the human diet (Mazur-Włodarczyk and Gruszecka-Kosowska 2022). Given the global increase in hunger (Wijerathna-Yapa and Pathirana 2022) the available food supply must be increased and should be sustained, hence the increased importance of international trade of food and food products. However, industrial policies and practices together with import tariffs as instruments of trade policy that are applied at different stages of agricultural value chains are motivated by a search for beneficial economic and market outcomes, often leading to contestations, disputes, and policy reversals in sectors of strategic national importance such as in the poultry sector of South Africa. Disputes focused on imported poultry, specifically broiler meat from Brazil into South Africa has received much attention in literature (Sibanda 2014; Khanderia 2016; van der Westhuizen 2016; Hobbs et al. 2018; Lehloenya 2018). Such studies have elaborated the pursuit of policies centered around increased import tariffs to deter poultry imports, protect domestic production, and possibly entice producers to

expand local production in order to fill the potential import gap created by increased demand for livestock products. Nevertheless, it is less well understood whether broiler production volumes in South Africa have responded meaningfully to intermittent import tariff policy interventions. It is estimated that South Africa, with per capita consumption of 33 kg/year (in 2019), is among the highest consumers of chicken in the world (Makgopa 2020). In comparison to other sources of animal protein consumed in South Africa for the period 2008–2018, broiler meat recorded the highest annual per capita consumption (NAMC 2020). Although broiler production dominates the agricultural sector and is regarded as the main supplier or source of animal proteins followed by (Ncube 2018; Makgopa 2020), the Department of Trade and Industry (DTI 2017) indicated that South Africa does not produce enough quantities of poultry to meet its domestic demand. As a result, this situation paves the way for increased import competition that the industry faces specifically due to increased demand for imported poultry from Brazil in the form of frozen chicken portions.

Paradoxically, the South African poultry industry presents numerous industrialization opportunities given the increased domestic demand for frozen chicken portions. However, it might be difficult to fulfill those opportunities because imports for frozen chicken portions continue to rise too. Furthermore, the inability to respond to industrialization opportunities may be attributed to the underlying domestic issues such as the high input costs that domestic producers are facing in South Africa (Goga and Bosiu 2019). Rising feed costs that account for up to 70% of production costs (Makgopa 2020), and increasing imports which among other factors are seen to continuously affect the competitiveness and development of the industry have been identified amongst the challenges (Davids and Meyer 2017; Lemmer and Bowen 2019). The feed costs deemed to be above the sample average are attributed to the cost of soybean raw material net imports and, thus, have a negative impact on producers' ability to remain competitive in the global market relative to large poultry exporters (Brazil and the United States of America) worldwide (BFAP 2019). Although the integration of South Africa into the global market post-2008 when trade policy became more liberalized enabled South African producers to access advanced technology, that integration also exposed the industry to high competition (Tregenna and Kwaramba 2014). Consequently, to preserve the value of their businesses and to stay afloat producers need to be competitive (BFAP 2019). The South African poultry industry has been referred to in current and past literature as facing difficulties to the extent of being described as an industry in distress (Tregenna and Kwaramba 2014; Kapuya 2017; Lehloenya 2018; Nkunjana 2021). To protect the industry in the wake of perceived increases in cheap poultry imports, some stakeholders in the poultry industry have advocated for import tariffs and petitioned the International Trade Administration Commission (ITAC) of South Africa, and such action has most recently in 2020 led to an increase in the *Ad Valorem* tariff (defined as a tariff rate charged as a percentage of the price[1]) following a previous adjustment in tariffs made in September 2013 (Tregenna and Kwaramba 2014). Hobbs et al. (2018) characterized the use of tariffs as a contested issue given the differing interests between poultry producers, importers and exporters of poultry and poultry products. In general, on the topic of the use of tariffs in their different variations as instruments to protect domestic industries, several authors (Jeon and Ahn 2017; Ho Dinh et al. 2020; Muchopa 2021; Ya and Pei 2022) focusing on different countries, agricultural industries and different commodities concur that priority must be afforded to industries that have significant impacts on the domestic economy however, at times the full intended benefits are not realized due to the presentation of certain inefficiencies. In contrast, Ho Dinh et al. (2020) indicated that an increase in protection may boost the comparative advantage status of agricultural production. Given the contrasting views, this present paper adds to the knowledge regarding the impact of tariff adjustments on domestic production by analyzing the long run relationship among variables in a time series framework methodology.

It has long been established in economic theory that an increase in the *Ad Valorem* tariff on imports leads to an increase in both consumer and producer prices and a movement along the supply and demand curves (Salvatore 2007). Soaring prices motivate producers

to supply more into the market whereas it discourages consumers to consume more as they are more likely to bear the negative impact of high tariffs (Salvatore 2007). Aspects of the present paper which provide insight into the production-trade flows-prices nexus have an implication for food security considerations at national level. Apart from the increased costs of imports, the vulnerability of consumers to food prices increases may require the implementation of domestic interventions intended to stabilize domestic prices. Although the consumer impacts of the tariff change are outside the scope of this study, the present study establishes the extent to which price changes impact domestic broiler production in volume among other influential variables after a tariff change. Given the dearth of such literature in the context of the broiler sector of South Africa, this study contributes to the discussion by assessing domestic broiler production's response following an increase in tariffs. Often the concerns raised to support the increase in tariffs may be unrelated to imports as Fourie (2013) suggests that the South African poultry industry's problems stem from the economic structure of the country. In the context of poultry farming which refers to the rearing of birds such as chicken turkeys, and geese for meat, eggs, and feathers (Henuk et al. 2015), the broiler sector in South Africa is responsible for the largest poultry meat production with about a reported 93.6% contribution in the 2017/2018 production period (DAFF 2019). The South African poultry industry is dominated by a few commercial producers who operate in a vertically integrated setting whereby they account for the largest share of the value chain (Nkukwana 2018; Goga and Bosiu 2019; Louw et al. 2011).

This present study builds on the work of Davids and Meyer (2017) that evaluated the effect of proposed tariff protection for the South African broiler industry. In that regard, evidence-based tariff policy research is provided in the present study, and this is important to the work of International Trade Administration Commission (ITAC) of South Africa in settling and balancing the interests of different poultry sector stakeholder groupings (importers, producers, and consumers). Moreover, since broiler production is a key force behind job creation (Ncube 2018) and development as it remains the cheapest source of protein, government involvement should be conducted in a manner that ensures the industry remains competitive in the long run so that the producers are able to maintain the long term value of their businesses in the face of competitive import pressures without affecting broiler availability to poor households who rely on broiler meat for protein. The issue of the vulnerability of poor households to food price spikes is important hence an argument for price stabilization can be made in order to safeguard food security. It is therefore important, from a policy perspective, to understand the relationship between tariff protection and domestic industry production. Other studies (Fourie 2013; Gitau and Meyer 2018) also argue that the South African poultry industry's issues are of domestic origin thus tariff increases will not solely solve those issues. Therefore, the aim of the study is to analyze the impact of import tariff adjustments on domestic production. This will provide evidence regarding the extent or potential to which tariff adjustments or hikes contribute to solving poultry industry related problems. The study's focus on imports from Brazil is justified in that the country being one of the leading poultry-producer countries in the world was also the main source of South Africa's poultry imports accounting for over 60% and 54% in 2018 and 2019 respectively (SAPA 2019). Moreover, Brazil is solely affected by South African tariff adjustments unlike its competitors; the European Union and the United States of America (USA) with free trade agreements in place such as the Economic Partnership Agreement, the Development, and Cooperation Agreement (TDCA), and the African Growth and Opportunity Act (AGOA) that have allowed tariff-free exports to South Africa potentially reducing the impact of high tariffs on domestic chicken prices (Davids et al. 2015). The present study therefore determined how changes in *Ad Valorem* import tariff charged affect domestic broiler production and broiler import volume industry in South Africa.

The rest of the paper is arranged as follows: review of previous literature is presented in Section 2, analytical techniques are presented in Section 3, empirical results and discus-

sion of results are presented in Sections 4 and 5, respectively. The results from diagnostic tests are presented in Section 6 and lastly, the study's conclusion is discussed in Section 7.

2. The Literature Discussion

The problem investigated in this present paper is focused around the use of strategic policy in the form import tariffs that are intended to regulate import competition in a bid to promote domestic industry production. To set out the context, this literature discussion apart from identifying literature and studies (Coppo 2018; Hobbs et al. 2018; Lubinga et al. 2018; Sibanda 2020; Ganbaatar et al. 2021; Fathelrahman et al. 2021; Schiavo et al. 2021; Kriel 2022; Sun et al. 2022) carried out in the context of the use of trade policy instruments to regulate food imports, an account of other identified factors influencing domestic production is also presented in the literature review. In an investigation on procedural requirements prior to imposing anti-dumping measures, Sibanda (2020) concluded that South Africa was World Trade Organization (WTO) compliant and explains that the anti-dumping duties are in place to prevent the negative impacts of dumped products on the domestic industry. Coppo (2018) relays how the European Union (EU) has been a subject of anti-dumping investigations instituted by Australia and the United States for food products, namely preserved tomatoes. Lubinga et al. (2018) found that an increase in anti-dumping duties on imported chicken from the EU to the Southern African Customs Union (SACU) reduced imports and burdened consumers with increased consumer prices.

In economic theory and related previous literature (Elsedig et al. 2015; Banson et al. 2015; Davids and Meyer 2017; Arnade and Davis 2019) various factors influencing domestic production of a good that competes with imports have been identified to range from trade measures such as tariffs that target prices and quantities of competing imports, exchange rates, feed costs and domestic prices among others. Davids and Meyer (2017) in a study on the competitiveness of the South African chicken industry provided some evidence on the co-integrating long-run relationship between imported chicken prices, feed, and beef prices with the wholesale price of chicken as a dependent variable. The results of the study revealed that domestic chicken prices are more responsive to import parity price alterations than changes in feed prices. The present study differs from Davids and Meyer (2017) in that the exchange rate is incorporated into the system or analysis as a standalone variable. In addition, it also focuses on analyzing how domestic production reacts or adjusts following an increase in import tariff rather than the competitiveness of the chicken industry in terms of pricing as in Davids and Meyer (2017).

The growing body of literature (Mkhabela and Nyhodo 2011; Bett et al. 2012; Goldar et al. 2012; Davids et al. 2015; Hatzenbuehler et al. 2016; Karodia 2017; Arnade and Davis 2019; Ragasa et al. 2020) in South Africa and worldwide that links the relationship amongst the variables of interest in this study has generated varied results but have not empirically answered the question investigated in the present study. Mkhabela and Nyhodo (2011), analyzed farm-retail price transmission of poultry in South Africa utilizing price data from 2000 to 2010 using the Houck and Error Correction Model. It was revealed in that study that farm-retail price transmission of poultry in South Africa is asymmetric, and the retail price of poultry adjusts more to changes in decreasing farm prices than to increases in farm prices. Whilst Karodia (2017), critically analyzed the issues faced by the South African policy industry and later concluded that lack of policy consistency, high uncertainty level, and lack of organization in the poultry value chain, the study argued against high import tariffs citing that it is less likely to solve most of the industry's reasons for the collapse. Davids et al. (2015) evaluated the effect of proposed tariff protection for the South African broiler industry. The empirical results of the study projected a continual increase in both consumer and producer prices over time due to an increase in the import tariff rate on broiler products in 2013 thus harming the availability of imported broiler products in South Africa. The studies presented above relate to the South African case using the Error Correction Model framework to assess the poultry sector, alongside these studies, the present study not only assessed relationships between prices and tariffs but included

additional variables such as the exchange rate and import volumes. By employing the tariff change as a dummy to capture the policy change in addition to more up-to-date monthly data, this paper differs from the study of Davids et al. (2015) as well as that of Davids and Meyer (2017).

Ragasa et al. (2020) assessed the competitiveness of food that is domestically produced in West Africa with a focus on rice, chicken, and tilapia. The empirical results of the study revealed that consumers prefer domestic chicken and tilapia over imported chicken and tilapia due to their freshness. Hence, import substitution and trade diversion policies may be effective if production and processing costs are minimized because domestic products, have the advantage of freshness over imported produce. Considering studies from elsewhere other than South Africa, the available literature links the variables of interest in the present study within the trade theory context in which they are discussed. Goldar et al. (2012) assessed "the impact of the Doha Round of agricultural trade reforms on India's trade in agricultural products". The findings of that study indicated that tariff reductions affect both imports and exports of agricultural products indicating that exports of agricultural products increased by 2–4% whereas imports increased by 1% following a decrease in agricultural tariff rates. Arnade and Davis (2019) analyzed "The effect of Mexican policy and market changes on imports of U.S. broiler meat and feed products" using a two-stage Almost Ideal Demand System (AIDS) model. The study found a complementary relationship between broiler meat markets in Mexico and the USA indicating that as USA broiler meat prices increase due to tariffs, broiler meat demand in Mexico will also decline. Likewise, Bett et al. (2012) also found a complementary relationship between domestic poultry meat and broiler meat imports in Kenya. Hatzenbuehler et al. (2016) examined corn and soybean price responsiveness to exchange rates. The Error Correction Model was used to assess the hypothesis that agricultural commodity prices' high responsiveness to exchange rates is attributed to supply use factors such as limited stocks and policy shifts as they cause inelastic market demand. The empirical results of the study revealed that indeed corn prices are very reactive to variations in exchanges rate during a low stock period, and soybean prices are very reactive to variations in supply-use factors or policy adjustments. This indicates that poultry production may be more reactive to policy changes as soybeans are a key input in poultry production hence the present study will also investigate the relationship based on feed costs.

This study's focus was on assessing how domestic broiler production responds to changes in import tariffs and other factors such as imported broiler quantity and domestic prices. The understanding of the relationships amongst such variables contributes to policy clarification on the increase in tariffs and contributes to existing poultry trade literature by quantifying how well domestic production responds to changes in the import tariff charged. Evidently from the literature provided, there is abundant literature on trade barriers imposed on food imports, however, there is scanty literature directly addressing the use of import tariffs to regulate import competition at sector level. Thus, the findings from this study will contribute to the debate on the judgement on whether tariff increases are justified or not considering the role that poultry meat plays towards the food security status of South Africa and the need for a viable poultry sector in the country.

3. Methodology

The study used secondary monthly data covering a period of 122 months, 2010m04 to 2020m06 (April 2010 to June 2020). The choice of this sample size was dictated by data availability across all variables under study and also the need to capture the tariff adjustment effected in April 2020. The sample period also covers the changes that became prevalent in South Africa post the 2008 global recession (Hetzel 2009). The study focuses on broiler imports from Brazil as a leading exporter to South Africa and highly affected by the recent tariff adjustments (Jooste 2020). The specific broiler imports studied are identified by HS code 020,714—Frozen cuts of broiler chickens (*Gallus domesticus*). Table 1 shows the sources of the data used in the study. EViews 10 was used to analyze the collected data.

Table 1. Table of variables and data sources.

Variable	Units of Measurements	Data Source
Dependent variable: Domestic broiler production (DV)	Number of birds	South African Poultry Association (SAPA)
Independent variables		
Feed price index (FP)	Rand/tonne	South African Poultry Association (SAPA)
Retail price (RP)	Rand/kg	South African Poultry Association (SAPA)
Producer price (PP)	Rand/kg	South African Poultry Association (SAPA)
Exchange rate (ER)	SA Rand per US Dollar	Standard Bank database
Imported broiler quantity (IQ)	Tonnes	ITC Trade map
Import tariff charged (AD)	Policy dummy	South African Poultry Association (SAPA)

Analytical Techniques

The Error Correction Model (ECM) was adopted to determine the relationship between domestic production, prices and import tariff adjustments. However, before the ECM estimation, stationarity and co-integration tests were conducted to determine the order of integration of the time series variables and the co-integration relationship. The co-integration test was used to test for the existence of a long run relationship thus enabling the appropriate selection of the ECM in the absence of a long-run relationship. The Augmented Dickey-Fuller (ADF) unit root test was used to assess the features or stationarity amongst the time series data.

The general ADF (Dickey and Fuller 1981) together with the specific ADF are indicated below:

$$\textbf{General model: } \Delta Y_t = \alpha + \beta t + \partial Y_{t-1} + u_t \quad (1)$$

$$\textbf{Specific model: } \Delta DVt = \alpha + \beta t + \partial DV_{t-1} + \partial_1 \Delta DV_{t-1} + \ldots + \partial_n \Delta DV_{t-n} + u_t \quad (2)$$

where: DVt is domestic broiler volume produced at time t and $\Delta DVt = DVt - DV_{t-1}$

u_t is the disturbance term

α, β, *and* ∂ are the coefficients

H_0: $\partial = 1$ or 0 (not stationary)

H_1: $-1 < \partial < 1$ (stationary)

The null hypothesis of non-stationarity is accepted if the p-value is greater than 5% or when the ADF statistic is less than the critical value.

Johansen co-integration test was used in the second step to analyze the existence of co-integration among the variables (Vavra and Goodwin 2005). The Johansen co-integration test was conducted through two tests which are the Trace and Eigenvalue tests and the rationale of conducting these two tests subsequently is to improve the performance of the Johansen co-integration test and reduce the spurious rejection rate (Hjalmarsson and Osterholm 2007). Co-integrated variables have the same unit root and order of stochastic shocks (Ferris 2005). A co-integration relationship indicates that variables will reach equilibrium in the long run. Co-integrated variables may deviate from each other in the short run but move together in the long run and an equilibrium level can be reinstalled if the system is exposed to a shock. The general model of the Johansen Co-integration test is as follows (Engle and Granger 1987; Vavra and Goodwin 2005):

$$Y_t = \mu X_t + u_t \quad (3)$$

If Y and X are integrated of order one then the disturbance term will also be integrated of the same order unless co-integration exists between Y and X (Engle and Granger 1987). Therefore, the null hypothesis of no integration will be accepted if the disturbance term u_t is integrated of order one. It will be rejected if the disturbance term is integrated of order zero since it means that the two variables are co-integrated (Vavra and Goodwin 2005).

Co-integration and the ECM are based on the knowledge of long-run equilibrium whereby individual variables are not allowed to drift apart in long-run disequilibrium (Meyer and von Cramon-Taubadel 2004). ECM is based on linear error correction which corrects any deviation from long-run equilibrium irrespective of the magnitude of the deviation (Vavra and Goodwin 2005). The advantage of using ECM instead of Ordinary Least Squares (OLS) is that it can overcome spurious regression or regression without economic meaning which is important in economic analysis because economic time series data has trends overtime (Triphati 2008). The specific model used to assess the relationship is indicated below:

Specified model:

$$\Delta lnDVt = A + \sum_{i=1}^{k} \mu \Delta lnAD_{t-i} + \sum_{i=1}^{k} B\Delta lnRP_t + \sum_{i=1}^{k} C\Delta lnPP_{t-i} + \sum_{i=1}^{k} D\Delta lnER_{t-i} + \sum_{i=1}^{k} E\Delta lnDV_{t-i} + \sum_{i=1}^{k} F\Delta lnFP_{t-i} + \sum_{i=1}^{k} G\Delta IV_{t-i} + W^{+}ECT_{t-1}^{+} + V^{-}ECT_{t-1}^{-} + u \quad (4)$$

where:

A, B, C, D, F, G, W, V are the statistical parameters

T = number of lags (t = 1, 2, 3, 4)

k is maximum number of lags.

$\Delta lnDVt = DVt - DV_{t-1}$ are the lagged first differenced values of InDVt in period t

$lnADt = ADt - AD_{t-1}$ are the lagged first differenced values of InADt in period t

$IV = IVt - IV_{t-1}$ are the lagged first differenced values of InIVt in period t

ECT_{t-1}^{+} = positive error correction term lagged to one period

ECT_{t-1}^{-} = negative error correction term lagged to one period

W^{+} = estimated parameter or coefficient (Vavra and Goodwin 2005).

V^{-} = estimated parameter or coefficient (Vavra and Goodwin 2005).

Inclusion of the error correction terms serves two purposes in the long run equilibrium i.e., it corrects any deviations from the previous periods and allows the dependent variable to respond to changes in the independent variables (Vavra and Goodwin 2005). Error correction terms in Equation (4) measure the deviation from the long-run equilibrium between domestic prices and domestic broiler production and import tariff charged. Moreover, the error correction term coefficient should be negative and significant to ensure that any deviation from the long-run equilibrium is adjusted (Dougherty 2011). Lastly, the present study used the Impulse Response model to assess the level of responsiveness of domestic broiler volume and broiler imports volume to changes in *Ad Valorem* tariff charged on broiler imports. The results from the Impulse Response model will reaffirm or confirm the results of ECM as they indicate the direction and level of response for variables to a standard deviation shock.

4. Results

The results are presented and briefly analyzed in four subsections. The first sub-section discusses the results from Augmented Dickey Fuller test (Table 2), the second sub-section discusses the results of Vector Autoregression Lag Order Selection (Table 3), Johansen co-integration test results (Tables 4 and 5) and the ECM results are presented and analyzed in Section 3 (Table 6), followed by a more detailed discussion in Section 5 after the presentation of the Impulse response model results in Section 4. The results of diagnostic model tests are presented and discussed in Section 6 which comprises tests for normality and heteroscedasticity.

4.1. Stationarity Results

The null hypothesis that was tested postulates that the variables are non-stationary and have a unit root and the alternative hypothesis states that the variables are stationary. The results of ADF test are presented in Table 2, indicating that domestic broiler production volume, *Ad Valorem* import tariff, and exchange rate are stationary at levels. Additionally, Retail Price, Feed Price, and Import broiler quantity have a unit root at levels and their null hypothesis of non-stationarity is accepted. However, all the variables are stationary at first differences and it is concluded that the variables are integrated of order I (1).

Table 2. Stationarity test.

Variables	Results at Levels		Results at First Differences	
	p-Value	Conclusion	*p*-Value	Conclusion
Domestic broiler production volume (DV)	0.0461	Stationary	0.0000	Stationary
Ad Valorem Import tariff charged (AD)	0.0000	Stationary	0.0000	Stationary
Retail price (RP)	0.9887	Not stationary	0.0000	Stationary
Feed price (FP)	0.3842	Not stationary	0.0000	Stationary
Exchange rate (ER) (Rand to US Dollar)	0.0000	Stationary	0.0000	Stationary
Producer price (PP)	0.2059	Not stationary	0.0000	Stationary
Imported broiler Quantity (IQ)	0.1305	Not Stationary	0.0000	Stationary

Since all variables are stationary and integrated of the same order I (1), the Vector Autoregression Lag Order Selection criteria and a Johansen Cointegration test were performed (Nkoro and Uko 2016).

4.2. Vector Autoregression Lag Order Selection Criteria and Cointegration Results

The study adopted the automatic Vector Autoregressive (VAR) Lag Order Selection Criteria to estimate the ideal lag length to use in the Johansen co-integration test and Error Correction Model as shown in Table 3. The VAR Lag Order Selection Criteria uses the following measures: Schwarz Information Criterion (SC), Final Prediction Error (FPE), Sequential Modified LR test statistic, HannaQuinn Information Criterion (HQ), and the Akaike Information Criterion (AIC). However, AIC and SC are frequently used due to their high efficiency (Brooks 2008). The study mainly focused on the outcomes of the former three criteria AIC, SC, and HQ. The study, therefore, opted for lag two as the optimum lag length as shown by the Akaike information criterion.

Table 3. Vector Autoregression lag order selection criteria.

Lag	LogL	LR	FPE	AIC	SC	HQ
0	−3991.93	NA	7.02×10^{22}	69.63358	69.92001	69.74984
1	−3479.47	953.6080	1.77×10^{19}	61.34745	62.49316 *	61.81248 *
2	−3427.20	91.81663	1.34×10^{19} *	61.06446 *	63.06945	61.87827
3	−3398.81	46.90636	1.56×10^{19}	61.19679	64.06107	62.35939
4	−3362.88	55.60800	1.60×10^{19}	61.19807	64.92163	62.70945
5	−3337.81	36.18778	2.02×10^{19}	61.38816	65.97100	63.24831
6	−3304.66	44.40119	2.26×10^{19}	61.43761	66.87974	63.64654
7	−3377.66	33.33134	2.90×10^{19}	61.59424	67.89565	64.15195
8	−3228.49	55.5921 *	2.61×10^{19}	61.36509	68.52579	64.27158

* indicates lag order selected by the criterion.

The results of the Johansen Co-integration test conducted through the Trace and Eigenvalue tests are presented in Tables 4 and 5.

Table 4. Unrestricted Cointegration Rank Test (Trace).

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob. **
None *	0.3308	140.2734	125.6154	0.0047
At most one	0.2528	92.8821	95.7537	0.0775
At most 2	0.2262	58.4942	69.8189	0.2845
At most 3	0.1205	28.2356	47.8561	0.8034
At most 4	0.0595	13.0813	29.7971	0.8879
At most 5	0.0483	5.8486	15.4947	0.7133
At most 6	0.0001	0.0131	3.8415	0.9088

Trace test indicates 2 co-integrating equation(s) at the 0.05 level. * Denotes rejection of the hypothesis at the 0.05 level. ** MacKinnon-Haug-Michelis *p*-values.

Table 5. Unrestricted Co-integration Rank Test (Maximum Eigenvalue).

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob. **
None *	0.3308	47.3913	46.2314	0.0374
At most 1	0.2528	34.3879	40.0776	0.1903
At most 2	0.2262	30.2586	33.8769	0.1273
At most 3	0.1205	15.1544	27.5843	0.7359
At most 4	0.0595	7.2326	21.1316	0.9442
At most 5	0.0483	5.8355	14.2646	0.6344
At most 6	0.0001	0.0131	3.8415	0.9088

Max-eigenvalue test indicates 2 co-integrating equation(s) at the 0.05 level. * Denotes rejection of the hypothesis at the 0.05 level. ** MacKinnon-Haug-Michelis *p*-values.

According to the findings of the Unrestricted Co-integration Rank Test (Trace) as shown in Table 4 the first row (none) which states that there is no co-integration among the variables, its null hypothesis is rejected at a 5% level of significance since its critical value is less than the Trace statistic value.

The data presented in Table 5 indicates in the first row (none), the null hypothesis which states that there is no co-integration among the variables, and that hypothesis was rejected at a 5% level of significance since its critical value is less than the Trace statistic value. The study concludes that co-integration exists among the variables: total import quantity, domestic broiler production, domestic retail, and producer broiler prices. Further discussion and implications of the co-integration results are presented in Section 5.

4.3. Error Correction Model

The error correction term presented in Table 6 is significant at a 1% significance level and has a negative coefficient (−0.530835). A negative coefficient implies that the equilibrium estimated equation will be re-attained after exposure to a shock (Gujarati and Porter 2009).

As indicated by the coefficient associated with Error Correction Term (ECT) the speed of adjustment of this system is 53% which indicates that 53% of disequilibrium is corrected each month. The *Ad Valorem* tariff is statistically significant at 10% significance level and has a positive relationship with domestic broiler production. As the *Ad Valorem* tariff charged lagged to two months' changes or is adjusted, the difference in domestic broiler production when a tariff increase was implemented to when it was not implemented in a particular month is 0.04 which is equivalent to 4% growth. The findings show that imported broiler quantity is significant at a 5% level and has a direct long-run relationship with domestic broiler production. A unit increase in imported broiler quantity will result in a 0.036 growth in domestic broiler volume produced which is equivalent to a 3.6% increase. Therefore,

they follow the same direction or have a direct relationship however, domestic broiler volume produced increases with a lesser magnitude. Past domestic broiler production volume was found to be statistically significant at both 1% and 5% levels and has an indirect relationship with current domestic broiler production in volume. A unit increase in past month's domestic broiler production volume will result in a 0.033 (3.3%) reduction in the current production level and a domestic broiler production volume lagged to two months will lead to a 2.5% decline in the current production level.

Table 6. Error Correction Model results.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.004049	0.004746	0.853088	0.3956
D (LogDV (−1))	−0.329563	0.130465	−2.526060	0.0130 **
D (LogDV (−2))	−0.251964	0.095142	−2.648289	0.0094 ***
D (LogIV (−1))	0.036277	0.015889	2.283213	0.0245 **
D (LogIQ (−2))	0.006995	0.015510	0.450974	0.6529
D (LogPP (−1))	0.099051	0.088065	1.124745	0.2633
D (LogPP (−2))	−0.045430	0.101040	−0.449627	0.6539
D (LogFP (−1))	0.094058	0.180055	0.522384	0.6025
D (LogFP (−2))	−0.026451	0.175922	−0.150356	0.8808
D (LogRP (−1))	−0.248148	0.215486	−1.151574	0.2521
D (LogRP (−2))	−0.177483	0.242149	−0.732948	0.4652
D (AD (−1))	0.002999	0.021466	0.139714	0.8892
D (AD (−2))	0.041826	0.022859	1.829740	0.0702 *
D (LogER (−1))	0.001289	0.004154	0.310325	0.7569
D (LogER (−2))	0.003376	0.004075	0.828481	0.4093
ECT (−1)	−0.530835	0.155108	−3.422353	0.0009 ***
R-squared			0.549172	
Adjusted R-squared			0.484148	
F-statistic			8.445768	
Prob(F-statistic)			0.000000	

***, **, * represent 1% level of significance, 5% level of significance, and 10% level of significance respectively.

4.4. Impulse Response Function

The Impulse Response model was used to assess the responsiveness of domestic broiler production and broiler import quantity to changes in import tariffs. The impulse response model assesses the level of responsiveness of the independent variable (impulse) to changes in the dependent variable (response) in the current and future periods and its function lies within the 95% confidence interval (Brooks 2008).

The findings of the Impulse Response Model show that a one Standard Deviation (SD) shock (innovation) to *Ad Valorem* tariff initially increases domestic broiler volume produced, as demonstrated in panel (a) of Figure 1. This explains that domestic broiler production volume starts by being highly responsive to changes in the *Ad Valorem* tariff. However, this positive response sharply declines from period 3 to 4 and later maintains a stable level from period 7 as the *Ad Valorem* tariff continues to be adjusted. This indicates that adjustments in the *Ad Valorem* tariff can only make a positive impact on domestic broiler production in a short term hence a more effective and sustainable solution is required to significantly boost domestic broiler production in South Africa. These results are in support of Fourie (2013) who argued that increased tariffs may be a short-term solution to the poultry industry however with dire consequences to the poor consumers. Additionally, Gitau and Meyer (2018) argued that high government involvement has resulted in the inability to attain the desired results of food price stability. A one SD shock (innovation)

to *Ad Valorem* tariff initially declines the imported broiler quantity to a negative level as demonstrated in panel (b) of Figure 1. However, a stable stage is reached in periods 5 which indicates that increases in *Ad Valorem* tariff are only effective in reducing imports in the short run. Additionally, a one SD shock (innovation) to imported broiler quantity initially increases the log of domestic broiler production in volume, as demonstrated in panel (c) of Figure 1. This explains that domestic broiler production in volume starts by being highly responsive to changes in the quantity of broiler imported however, it sharply declines from period from period 2 to 3. This indicates that a decline in imported broiler quantity only makes a positive impact in the short term and cannot be maintained in the long term. Domestic broiler production volume response more likely the same to changes in imported broiler quantity and import tariffs charged as domestic broiler produced and imported broiler quantity both respond highly to changes in tariffs charged i.e., they are both highly responsive to an increase in tariff charged but only for a short term. The results are in line with the study of Hejazi et al. (2017) which emphasized that tariff reductions provide a small increase in sustaining current trade relations. These results imply that tariff as a policy interest is more likely to be insufficient to address the competing interest of both foreign poultry producers and domestic producers in South Africa. The results of the Impulse Response Model are therefore in line with the Error Correction Model results.

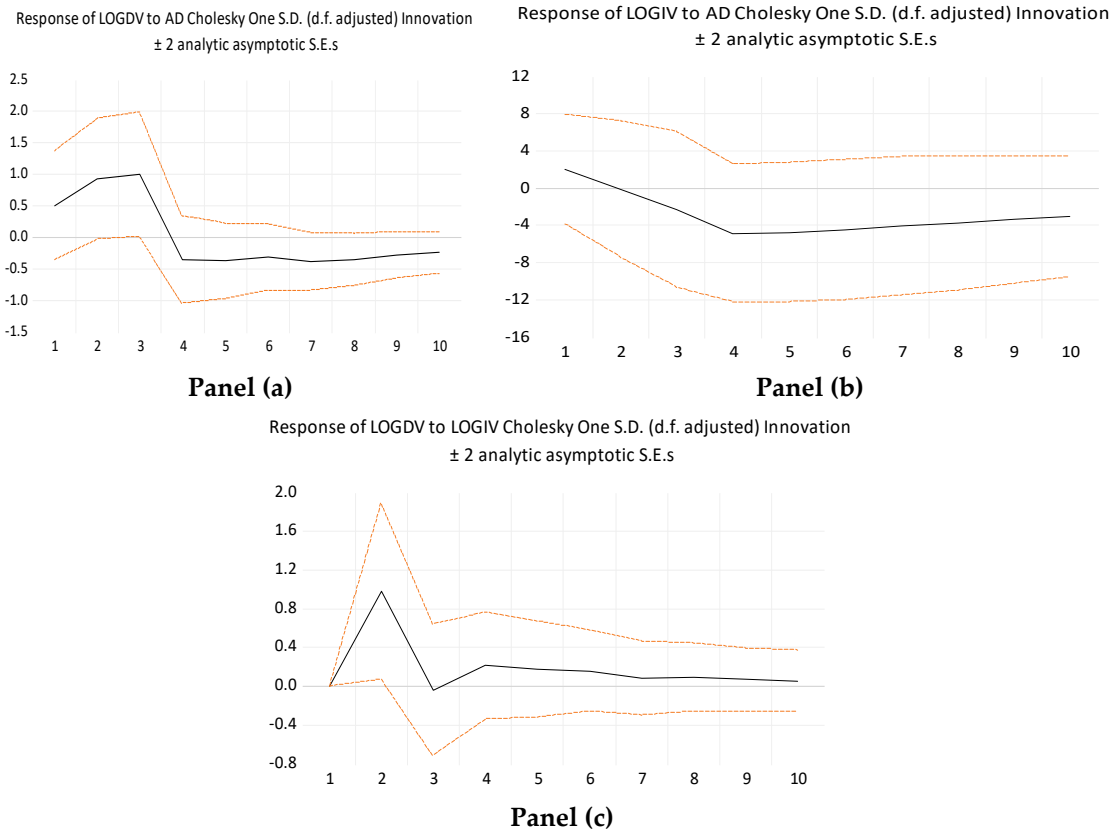

Figure 1. Response to Cholesky one S.D. (d.f. adjusted) Innovations ± 2 S.E analytic asymptotic S.E.s. * *Note to Figure 1*. Panels (**a**) and (**b**) present the response of domestic broiler volume produced (DV) and imported broiler quantity (LV) respectively to the *Ad Valorem* tariff. Panel (**c**) presents the response of domestic broiler volume produced (DV) to the imported broiler quantity (IV). The black line in each panel depicts the impulse movement and the red border lines represent the bounds of the 95% confidence interval. The vertical axis in each panel shows the response and the horizontal axis shows the time periods.

5. Discussion

Implications of the Error Correction Model results presented in Section 4.3 are further discussed in this section. The speed of adjustment indicating that a 53% of disequilibrium is corrected each month implies that domestic broiler volume produced is moderately responsive to changes in *Ad Valorem* tariff charged and past months' broiler volume produced and imported broiler quantity. Domestic broiler volume produced will only adjust by 53% in the first month after exposure to changes in equilibrium, and the remaining 47% will be attained in the second month. Therefore, other factors that are of domestic origin, such as input costs, may be affecting domestic broiler production. This is in support of Fourie (2013) who argued that increased tariffs may be a short-term solution to the poultry industry with dire consequences to the poor consumers. Domestic broiler production responds positively to import tariff increases although only in the short run whereas broiler imports decline following an increase in import tariffs in the short term. These results are in line with the study of Meyer et al. (2021) which indicated that broiler imports are expected to decline as import duties increase. Import duties thus have a significant role in diverting domestic demand from imports to domestic production. Additionally, Davids et al. (2015) stated that increasing tariffs is less likely to be adequate to sustain production in the long run since the industry is facing numerous challenges such as high feed costs and power cuts. A recent report of the Farmer's Weekly substantiates the present study's assertions noting that the measures to address unfair poultry trade has resulted in a 51% decrease of bone-in chicken imports and an increase in consumer prices (Kriel 2022). However, the reported increase in chicken meat prices affects domestic demand to the extent that hiking import tariffs has a limited impact on maintaining the long term value of the industry of the South African poultry industry whose major challenges emanate from the domestic market.

The present study also found that a complementary relationship exists between domestic broiler production and imported broiler quantity. This is also in support of Bett et al. (2012) who observed a complementary relationship between domestic poultry meat production and broiler imports in Kenya. Similarly, but in a different circumstance, Arnade and Davis (2019) found a complementary relationship between broiler meat market in Mexico and broiler meat market in the USA, because as USA broiler meat prices increase due to tariffs, broiler meat demand in Mexico will decline. The present study's findings on the complementary relationship can also be explained by the heterogeneous nature of broiler cuts and demand preference. Consumers in South Africa prefer bone-in chicken portions which creates a market for bone-in chicken portions imports, and less valued portions such as drumsticks and thighs (Delport et al. 2017). This high demand could also function as an incentive for domestic producers to produce broilers, which is expected since it guarantees high return on investment. This finding, however, seems to indicate that domestic production does not have to rely on the lowering of imports bearing in mind that there is a time lag between import substitution and domestic production. The structural issues presenting in the poultry industry of South Africa reinforce these findings besides the fact that the growth in domestic demand may not be rapid enough to trigger larger increases in domestic production after an import tariff increase also considering that the import demand is of a differentiated product (frozen cuts of broiler chicken). The reasons for what may be characterized as "non-growth" of production has also long been established in Ahmad (2007) to be a result of underdevelopment and capacity constraints.

An indirect relationship between past domestic broiler produced volume and current domestic broiler produced volume. This implies that domestic broiler producers tend to get discouraged over time and opt to reduce the level of production in the long run. This may be due to other domestic factors which hinder production such as high feed costs and electricity cuts (Banson et al. 2015; Goga and Bosiu 2019). These results are in support of Bosiu et al. (2017) who argued that high market concentration dominates the poultry industry and therefore limits growth and competition in the domestic market. Although the study could not find any significant evidence to characterize the relationship between producer prices, retail price and feed price, other studies have indicated that feed costs

continue to be a major challenge to farmers. High feed prices affect producer prices or farm gate prices since an increase in feed prices is not accompanied by increases in broiler producer prices (Davids and Meyer 2017; Louw et al. 2011). Based on the findings of this study, it is evident that broiler producers base their production decisions on past domestic volume. In addition, such production decisions are also based on farmer returns subject to consumer demand, hence the link can be established between domestic production and producer prices.

Overall, the findings of this study are in line with Ganbaatar et al. (2021) finding on the imposition of tariffs by China leading to a decrease in exports from Mongolia. The opposite action as found in Fathelrahman et al. (2021) highlighted that reducing tariffs on commodities has a potential to increase real incomes of poor people by 7.5% and thus increase their consumption habits to nutritional sound diets and also health is negatively affected by unpredictably high tariff (Sun et al. 2022). Hence, tariff adjustment decisions need to take note of the possible impact they have toward food security while trying to maintain the long-term value of the industry of industry affected.

6. Diagnostic Tests

Diagnostic assessments were conducted to check whether linear regression model assumptions are not violated. Violation of the classical Ordinary Least Square (OLS) assumptions harms the quality of the estimated model, variance may be inflated and thus lead to rejection of relevant variables and wrong recommendations. The study adopted the Jarque Bera test for normality test, Breusch-Godfrey Serial Correlation LM test for autocorrelation test, and the Breusch-Pagan-Godfrey test for heteroscedasticity.

6.1. Jarque Bera Test

The null hypothesis of normality is accepted since the probability value of the Jarque-Bera test is above 5% and which implies that the alternative hypothesis is rejected (Jarque and Bera 1980; Brooks 2008). The results of the Jarque-Bera test are shown in Figure 2.

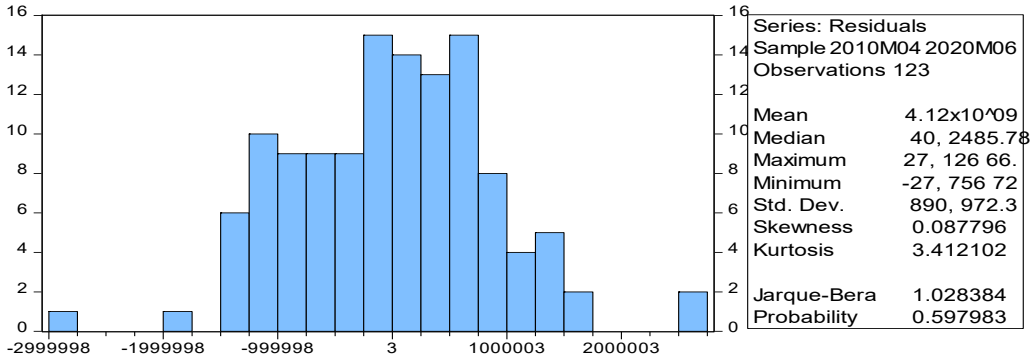

Figure 2. Jarque-Bera test.

6.2. Breusch-Pagan-Godfrey Serial Correlation LM Test

The null hypothesis tested by this test states that there is no autocorrelation amongst the series, and it is therefore favorable. Prob. Chi-Square is valued at 0.3915 which is greater than 0.05 as shown in Table 7 and thus evident that the null hypothesis of no autocorrelation is accepted. There is no sign of autocorrelation in this series.

Table 7. Breusch-Godfrey Serial correlation LM test.

F-Statistic	0.882514	**Prob. F (2,114)**	0.4165
Obs*R-squared	1.875338	**Prob. Chi-Square (2)**	0.3915

6.3. Breusch-Pagan-Godfrey Test

The study adopted the Breusch-Pagan-Godfrey test to measure the existence of the heteroscedasticity problem between the series. The null hypothesis of the Breusch-Pagan-Godfrey test states that there is homoscedasticity or there is no heteroscedasticity. The null hypothesis of homoscedasticity was accepted as the Prob. Chi-square is above 5% as supported by the findings presented in Table 8.

Table 8. Breusch-Pagan-Godfrey test.

F-Statistic	0.538673	**Prob. F (6,116)**	0.7779
Obs*R-squared	3.334177	**Prob. Chi-Square (6)**	0.7659
Scaled explained SS	3.576515	**Prob. Chi-Square (6)**	0.7338

6.4. Stability Test for the Estimated Error Correction Model

Figure 3 illustrates the results of the CUSUM of squares test which was performed to test the stability of the ECM.

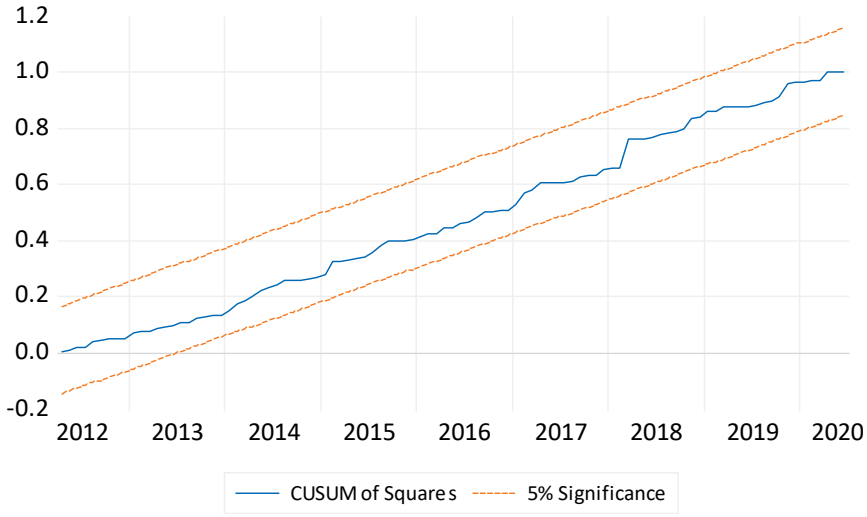

Figure 3. CUSUM of squares test results for Error Correction Model.

The plot for the CUSUM of squares falls within the five percent range (Brooks 2008) and hence, the null hypothesis is acknowledged which indicates that the ECM is correctly specified.

7. Conclusions

This paper analyzed the impact of import tariff adjustments on domestic production in the South African—Brazilian poultry case and adds to the literature on the use of strategic policy to regulate import competition for purposes of promoting domestic industry production. Although a long-run relationship was found to exist between domestic broiler production and past domestic broiler volume produced, *Ad Valorem* import tariff as well as imports, the study concludes that domestic broiler production is moderately responsive to changes in tariffs at a speed of 53%. Additionally, the results of the Impulse Response Model indicate that an increase in tariffs can only produce desirable results in the short-term confirming that import tariff adjustments do not necessarily bolster domestic production in the long run. Therefore, the hiking import tariffs is not a sufficient intervention to solve poultry industry challenges. A more viable solution such as the implementation of measures to reduce input costs is required to improve the viability of poultry farming businesses in the sector. Moreover, interventions and support should be provided in line with improving business management practices geared towards enhanced productivity at

the producer enterprise level. Additionally, high tariff uncertainty in the market is likely to increase chicken prices for consumers as domestic producers continue to struggle with high feed prices and thus the pressure on consumer prices (not a focus of the present study) will likely threaten the food security status of consumers. Moreover, the study did not cover the following aspects which can be areas for further studies: the impact of broiler imports on the poultry market structure, the impact of anti-dumping duties charged on some of largest broiler producing countries and lastly, the relationship between the South African poultry industry and major poultry producers such as the EU and the USA. Based on these findings, the study recommends a policy focusing on the reduction of barriers to expansion in the poultry industry. Further research is recommended on areas such as the effects of trade agreements on the broiler industry including research studies on consumer preference for imported chicken.

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Note

[1] World Trade Organisation (WTO) definition. Available online: https://www.wto.org/english/thewto_e/glossary_e/ad_valorem_tariff_e.htm (accessed on 22 August 2022).

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