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Factors Driving South African Poultry and Meat Imports[1]

Fawzi A. Taha[ⓘa] and William F. Hahn[b]

[a] *Economist, Food Security & Development Branch, Economic Research Service, United States Department of Agriculture, 355 E Street SW, Washington, DC 20024, USA.*

[b] *Economist, Animal Products and Cost of Production, Economic Research Service, United States Department of Agriculture, 355 E Street SW, Washington, DC 20024, USA.*

Abstract

Import demand for poultry has made it South Africa's fastest growing meat product, while demand for beef, sheep, and goat meat is generally declining. Poultry was found to be a statistically significant substitute for pork and other meat (sheep, goat, and offal), but insignificant with respect to beef. Pork tends to be complementary to beef, though statistically insignificant.

The article investigates which of three crucial factors are most affecting South Africa meat imports: (1) changes in consumer tastes and/or meat processing technology, (2) prices, or (3) scales indicating the total size of the imported meat market. Major findings showed that changes in taste-technology had a greater impact on increasing poultry and pork imports than changes in prices, even though poultry prices tended to increase less than the prices of beef, pork, and other meats, making it a better bargain.

Keywords: import demand system, taste-technology, scale, and price, South Africa, poultry, beef, pork, sheep & goat

[ⓘ]Corresponding author: Tel: + 1. 202.694.5454
Email: F.A. Taha: faha@ers.usda.gov
W.F. Hahn: whahn@ers.usda.gov

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Introduction

Animal products are by far the largest agricultural sector in South Africa (SA), contributing 46.4 percent to the total gross value of agricultural production in 2012/13, followed by field crops (28.6 percent), and horticultural products (25.0 percent) (Trends in the Agricultural Sector 2013). Nonetheless, the deficit in the SA balance of trade for meat rose from a low of US $3.8 million in 2002 to US $428 million in 2013 in nominal terms, after reaching a record high of US$546 million dollars in 2012. Although statistical data for 2013 and 2014 showed that the SA meat trade deficit is slightly declining, poultry imports have continued to grow, accounting for over 81 percent of SA total meat imports.

The goal of this research is to explore the key drivers of the South African meat imports, focusing specifically on which of three factors have the most effects on meat imports: prices, scale, or taste-technology. Initially, we estimated the demand shift among various meats in relation to their own prices, cross-prices, and scale elasticities to determine the patterns of consumer demand for different meats and the substitution effects. These elasticities have a number of potential uses. The United States is a major exporter of these four types of meats; the more we know about how the world's meat buyers respond to prices, the better U.S. forecasts and analysis of U.S. meat exports will be. Estimated elasticities could also be used to analyze implications of SA policy changes and reforms affecting the meat trade. In addition, we would expect that South Africa's growing economy will normally lead to expanding consumer demand for meat, and likely to higher imports. Of course, expanding supply could have offset expanding demand. On the other hand, attempts to expand SA's corn and soybean markets could fail and lead to higher domestic feed prices, higher cost of production for domestic meat producers, and higher meat imports from more competitive world markets. Consequently, formal analysis of the role of government policies affecting domestic supply and exports of critical feed commodities requires more focus in future research work.

Over the past few decades, authors in a number of countries have investigated the demand for meat imports in those countries, among them Hayes, Wahl, and Williams (1990) in the United States; Kawashima and Sari (2010) and Yang, and Koo (1994) in Japan; Lopez (2009) in Mexico; Ablayeva et al. (2004) in Russia**;** and Pantzios and Fousekis (1999) in Greece**.** To the authors' knowledge, however, no study has investigated which of three crucial factors are most affecting South Africa meat imports: (1) changes in consumer tastes and/or meat processing technology, (2) prices, or (3) scales.

The following sections describe the SA livestock sector, meat production, meat consumption, and meat imports from 1997 to 2014. It also includes a discussion of the economic literature on SA import demand for meats, documenting a similar shift in consumer preferences from red meat toward poultry in other countries. Following the discussion of economic literature are the methodology, empirical results, and conclusions.

South Africa's Meat Production and Consumption

Total SA meat production nearly tripled from 1,009 million Kg in 1975/76 to over 2,752 million Kg in 2012/13. Bovine was consistently the most produced meat until 1995/96, when poultry outpaced red meats (beef, pork, sheep, and goats). Both red and poultry meats made striking increases over the period, but poultry production was the most impressive, accounting for 56 percent of SA's total meat production. Table 1 shows the shift in total meat consumption from red meats toward poultry. Based on South Africa's official data, per capita consumption of poultry meat surpassed that of the four-red meats in 1997/98 (20.7 Kg versus 20.2 Kg per year). As Table 1 shows, the gap continued to increase in favor of poultry, rising to 35.1 kg in 2010/11, and slightly thereafter to 36.3 Kg in 2012/13. On the other hand, most of the decline in per capita red-meat consumption occurred versus 24.9 kg for red-meat in 2012/2013.

Table 1. Production, Consumption White and Red Meat

	Poultry		**Red Meat**		**Poultry**	**Red Meat**
	Prod.	Cons.	Prod.	Cons.	Per capita Cons.	
	Million Kg				Kilogram	
1975 - 1976	294	290	715	831	13.5	33.1
1980 - 1981	364	338	806	891	14.1	31.7
1985 - 1986	474	474	905	939	17.4	29.8
1990 - 1991	593	593	987	1050	19.4	29.9
1995 - 1996	699	736	740	865	18.7	21.8
2000 - 2001	869	938	736	828	21.5	18.9
2005 - 2006	1143	1383	1060	1162	29.5	24.8
2010 - 2011	1474	1753	1164	1240	35.1	24.8
2011 - 2012	1484	1836	1168	1242	35.5	24.0
2012 - 2013	1529	1899	1223	1297	36.3	24.9

Source. Abstract of Agricultural Statistics, 2014.

South African consumers' shift to poultry from red meats seems similar to the shift among European and U.S. consumers more than 40 years ago, and there are common drivers of change. Generally, these have included rising consumer awareness of healthy and unhealthy eating—e.g., of dietary fat causing high levels of cholesterol—as well as safety concerns following outbreaks of animal diseases, increased emphasis on convenience (time to cook and prepare) for housewives as their participation in the labor market rises, and changes in relative meat prices. These concerns are seemingly correlated with increasing per capita income.

For example, in the United States, health issues (linking fat content and high cholesterol levels and strokes) initiated a change in meat demand from beef to poultry/chicken, lean pork, and fish products (Piggott and Marsh 2004; Moschini and Meilke, 1989; and McGruirk et al. 1995). Similarly, Huston (2000), in discussing reasons for the demand shift from red-meat to poultry, included the factors mentioned above: safety, health issues, convenience (time to cook and prepare), and relative prices. In the United States, some of these factors, if not all, contributed to a decrease in U.S. per capita consumption of beef from 84 to 62.5 pounds per year, and a remarkable increase in chicken from 40 to over 80 pounds, during the period 1970-1999 (Davis and Stewart 2002).

In the UK, the decline in beef and veal consumption during 1990-1998 was attributed to safety concerns about beef as a food, animal welfare and environmental issues, outbreaks of animal diseases, changes in demographics, changes in relative prices, health concerns (fat content), and the demand for convenience (Resurreccion 2003). In other parts of the world, authors reported that changing lifestyles led to the shift toward more convenience in meat and food preparation. Anderson and Shugan (1991) and Grunert (2006) found that consumer demand for convenience boosted demand for poultry relative to beef. Grunert called convenience the most significant trend contributing to rising chicken sales.

Increasingly, fat content in meat is generally seen as negative. This was confirmed in four European countries; France, Germany, Spain, and the UK (Grunert 1997), as well as in South Africa (Shongwe et al. 2007). Also in South Africa, Nieuwoudt (1998) and Louw et al. (2010) explained changing demand for meat in general to growth in population and per capita income, urbanization, and food preferences among different racial groups. Louw et al. also explained the rise in demand for poultry to "global derived factors," including health concerns, expansion of fast food outlets, and demand for convenience.

Taljaard, et al. (2006) also examined the factors driving South Africa's demand for meat. Their econometric models included prices, income, and a group of taste effects measuring consumer demands for health and safety, convenience, quality, animal welfare and the environment. Taljaard et al. split their sample into two separate periods: 1970-1988 and 1985-2003. Prices and income were the most important drivers of demand in the first period; the group of taste factors was the most important in the later period, when taste-technology was one among a group of several factors but was not the standout factor.

Economists widely believe that demand for poultry is rising mainly because it has the lowest relative prices of all major meats. Does this apply to South Africa, where poultry imports averaged over 81 percent of total meat imports over the last five years? This article concentrates on this question, namely, investigating which of three factors is most strongly effecting changes in import demand for meats in South Africa; prices, scale, or taste-technology.

Commercial Meat Trade

Total meat imports to South Arica increased 124 percent, but poultry rose the most: 281 percent from 1997 to 2014. During the last five years (2010-2014), the rise in poultry meat imports brought them to over 81 percent of SA's total imports, followed by other meat (9 percent), beef (2 percent), and pork (6 percent) (Table 2).

In 2014, about 48 percent of the SA poultry imports originated from the EU-27, 43 percent from Brazil, 5 percent from Argentina, and only 1.3 percent from the United States. This was mainly due to the Anti-dumping duties case against U.S. poultry products and the imposition in 2000 of anti-dumping tariffs, amounting from Rand 2.24/ kg to 6.96/kg (US $0.32 to US $1.00), in addition to an import duty of Rand 2.20/kg (US $0.31/kg) (USDA-FAS Gain Report, Republic of South Africa 2011).

Table 2. South Africa's Meat Imports, 1997-2014

	Poultry	**Beef**	**Pork**	**Other**	**Total**
			Million Kilogram		
1997	103	48	6	58	216
1998	87	16	7	53	163
1999	98	16	12	58	184
2000	93	13	11	72	190
2001	78	5	9	51	143
2002	94	4	8	35	141
2003	153	10	18	33	214
2004	182	16	22	37	257
2005	214	20	27	46	307
2006	294	19	21	56	389
2007	276	17	23	58	374
2008	220	7	18	51	296
2009	231	10	27	44	311
2010	265	6	26	42	339
2011	349	11	32	41	433
2012	403	7	33	39	482
2013	389	6	27	38	461
2014	393	24	19	48	483

Source. World Trade Atlas, February 2015

Meat exports from South Africa, albeit small, more than tripled from $US 133.6 million in 2010 to $US 254.3 million in 2014, mostly shipped to neighboring African countries in 2014. Exports in 2014 consisted of 45 percent beef and 34 percent poultry, with the remaining 21 percent consisting of other, i.e., pork, sheep, and goat meat and offal.

Statistical Analysis of South African Import Demands

The analysis of South African meat imports has two basic goals:

1. To determine what factors are driving SA poultry imports. As noted, previous studies have typically agreed that the low relative price of poultry has been a driver of increased poultry demand, as would be expected, while several of the studies found that taste shifts have also contributed to the increase. In this article, we develop a model simulation to determine which of the following three factors has the most effect on South African meat imports (1) taste-shift, (2) prices, or (3) scales.

2. To estimate South Africa's meat import demand system to provide support for future work. We can use these model estimates to calculate South Africa's meat import demand elasticities. These elasticities have a number of potential uses. The United States is a major exporter of these 4 types of meats; the more we know about how the world's meat buyers respond to prices, the better U.S. forecasts and analysis of U.S. meat exports will be. In addition, these elasticities could also be used to analyze implications of SA policy changes and reforms affecting the meat trade.

Modeling SA Meat Import Demand System

The study used the Central Bureau of Statistics (CBS) model developed by Keller and Van Driel in 1985. The name refers to the authors' employer, the Dutch Central Bureau of Statistics. The CBS model is essentially conditional on the "scale" of meat imports, where scale is a measure of the total outputs produced using the imported meats. The CBS model was augmented by adding a trend variable to cover changes in consumer demand, triggered by consumers' rising preference for certain meat.

The demand for inputs can be changed by both shifts in consumer demand for outputs and by changes in the technology used to produce those outputs. Economic analysts often use time trends to model taste and/or technology shifts. Trend terms imply constant, straight-line growth over time. Additionally, consumer demand for meat products could change the demand for the meat imports used to make them. Changes in meat processing technology could also encourage meat importers to shift among the types of meat.

This sort of straight-line change in taste or technology effects is rather simplistic; however, we allowed for a more complex pattern by adding a squared-trend term to the model. A squared trend gives us a more flexible taste-technology shift. A pure trend will either constantly increase or decrease the demand for a product. By adding a squared-trend in the model, we can have reversals in the taste and technology shifts. For example, demand for one of the imports could grow early on, then reverse and begin to decline later on during a certain time period. Together, the trend and squared-trend terms measure the effect of changes in tastes and/or technology[2].

Keller and Van Driel originally developed the CBS system to model consumer demands. Meat imports are intermediate goods: they must be further processed before sale to consumers. Prior to the development of the CBS model, Theil (1977) showed that consumer demand models are also consistent with cost-minimizing input demand.

All differential demand systems use the total differential of the budget constraint:

$$(1)\ \partial\left(\sum_i q_i p_i = x\right) \rightarrow \sum_i w_i \partial \ln p_i + \sum_i w_i \partial \ln q_i = \partial \ln x\,,$$

where q_i and p_i are the quantity and price of good i, x is the total expenditure, or in the case of derived demand, the total cost of inputs, and $\partial \ln \cdot$ stands for the change in the natural logarithm of the term "·". The term w_i is the budget share for product "i", defined as:

[2] The CBS model also included seasonal demand shifters. These seasonal shifters measure how one month's demand for a type of meat differs from others. It seems more likely that these would be driven by shifts in consumer tastes rather than technology. As we set these up, these monthly shifters only cause imports to vary month-to-month and not over longer periods of time. Our discussion of these is limited given our focus on the long-term drivers of import demand.

$$(2)\ w_i = \frac{p_i q_i}{x}.$$

The summation terms in equation (1) are often replaced with divisia price and quantity indices, defined as:

$$(3)\ \partial P = \sum_i w_i \partial \ln p_i\ ,$$

$$(4)\ \partial Q = \sum_i w_i \partial \ln q_i\ .$$

Equations (3) and (4) can be inserted in (1) and rearranged to produce:

$$(5)\ \partial \ln x - \partial P = \partial Q\ .$$

In their development of the Central Bureau of Statistics (CBS) model, Keller and Van Driel (1985) used equation (6) below, which is a more appealing version from the standpoint of consumer theory. In a derived demand context of the current analysis, equation (6a) is more convenient. Actually the forms in (6) and (6a) are equivalent; one simply uses different sides of equation (5) in the specification.

$$(6)\ \ w_i \cdot \left[\partial \ln q_i - \partial Q\right] = \sum c_{i,j} \partial \ln p_j + b_i \left[\partial \ln x - \partial P\right], \text{ or}$$

$$(6a)\ w_i \cdot \left[\partial \ln q_i - \partial Q\right] = \sum c_{i,j} \partial \ln p_j + b_i \partial Q\ .$$

Theil (1977) showed that changes in the divisia quantity index corresponded to changes in total output. The coefficient b_i, which multiplies the quantity index in (6a), shows how demand for an input responds to changes in the total output. As is common in applied demand analysis, we will refer to the b_i as "scale" terms. If all the b_i's are 0, the technology has constant returns to scale. Negative b_i implies that the cost share (the w) for input "i" decreases as the total scale of output increases, and vice versa. The cross-price elasticities (c_{ij} coefficients) show how quantity "i" reacts to changes in the price of "j." The c_{ij} also include c_{ii}. These coefficients can be used with the budget share to derive price and scale elasticities of demand using the following formulas:

$$(7)\ \varepsilon_{ij} = \frac{c_{ij}}{w_i}$$

$$(8)\ \eta_i = 1 + \frac{b_i}{w_i}\ .$$

In (7) and (8), ε_{ij} is the elasticity of demand for input i and price j and η_i is input i's scale elasticity of demand.

Keller and Van Driel demonstrated that the CBS model is a locally flexible functional form. One can take any set of demand elasticities and find a set of CBS coefficients consistent with these elasticities. In order to be consistent with optimization, the coefficients have to be homogenous of degree 0, consistent with the budget or total-cost constraint defined in equation (1) and symmetric. This will be true if the following two equations hold:

$$(9)\ \sum_i c_{ij} = 0 \forall j\,,$$

$$(10)\ \sum_i b_i = 0\,.$$

Equations (9) and (10) imply that the c_{ij} and the b_i coefficients sum to 0 when added over all the inputs. Other constraints require demand to be homogeneous of degree 0 in prices-expenditures and symmetric, as shown in equation (11) and (12), respectively:

$$(11)\ \sum_j c_{ij} = 0 \forall i\,,$$

$$(12)\ c_{ij} = c_{ji} \forall i, j\,.$$

All constraints in equations (9-12) are linear equality restrictions. Optimal cost-minimizing demand derivatives also have to be negative semi-definite (NSD) in prices. The CBS system is globally NSD when the matrix of c_{ij}, is itself NSD, which could be achieved by imposing economic restrictions of equations (9-12) on all CBS estimations. One implication of demands being NSD is that their own-price elasticities of demand are negative.

The economic drivers for this demand system are the import prices of the 4-meats, and "scale." "Scale" is an economic measure of the final amount of products meat importers make from a certain quantity of imported meat. The scale of the market is going to be determined by a larger set of internal and external economic factors; internally, they include supply, demand, and policy conditions, and externally, the prices paid for meat imports.

Estimation Forms for the CBS Model and Preliminary Tests

The CBS and other differential models of demand start with demand derivatives. Demand derivatives are not observed; prices and quantities are. The CBS models are estimated under the assumption one can approximate the differential equations with finite differences. A general way to write the difference equation would be:

$$(13)\ w_{it}\left[Ln\left[\frac{q_{i,t}}{q_{i,b}}\right] - \sum_j w_j Ln\left[\frac{q_{j,t}}{q_{j,b}}\right]\right] = y_{it} = \sum_k H_{k,t} * d_{i,k}\ .$$

$$\sum_j c_{ij} Ln\left[\frac{p_{j,t}}{p_{j,b}}\right] + b_j\left(Ln\left[\frac{X_t}{X_b}\right] - \sum_j w_{jt} Ln\left[\frac{p_{j,t}}{p_{j,b}}\right]\right) + e_{it}$$

The terms $q_{i,t}$ $p_{i,t}$ and X_t are actual quantities, prices and expenditures for a specific month. The $q_{i,b}$ $p_{i,b}$ and X_b are the baseline values; the baseline expenditure is consistent with the baseline prices and quantities. The term $e_{i,t}$ is a random error term. By virtue of the model's construction, the error terms in each time period sum to 0.

The $H_{k,t}$ are a set of other exogenous variables that act as taste-technology shifters; the $d_{i,k}$ are estimated coefficients, which have to sum to 0 over "i" for each "k" if the budget constraint is to hold. The H variables include an intercept, a trend, a squared trend, and 12 monthly dummies. The intercept and monthly dummies are perfectly collinear, so the dummies' coefficients are identified by making each meat's set of monthly dummies sum to 0 when summed over the year. Unlike the other terms in (13), the $H_{k,t}$ are not explicitly differenced from a baseline. The interpretation of the intercept and error depends on what one uses as a baseline. The most common baseline used in this type of demand analysis is last period's value; for example $q^b_{i,t}$ would be $q_{i,t-1}$. In this type of non-linear first-difference approach, the intercept would represent the difference of a trend, and the intercept's coefficient is generally interpreted as a taste-change variable.

This analysis follows Hahn and Mathews (2007), who used a non-lagged baseline to calculate average prices and quantities to create baseline prices, quantities, shares, and expenditures. This type of formulation is based on the assumption that average quantities are optimal given average prices, which might not be the case. The intercept terms in this case can be interpreted as correcting the baseline quantities or measuring the shift necessary to make them optimal. The monthly dummies allow for some monthly variation in this "correction." The intercept can be interpreted as the average correction for the year; the dummies are the seasonal variance from that average. If the monthly dummy coefficient for a product is 0, that product's demand is at its yearly average level in that month. The trend and trend-squared terms allow shifts in demand[3]. Because these are derived demands, the demand shifts can be due to both changes in consumer tastes and meat-processing technology. If the trend and squared trend coefficients are all 0, there are no taste-technology shifts.

Also, like Hahn and Mathews, we specified our error term as a vector autoregressive (VAR) process:

$$(14) \qquad e_{i,t} = \sum_{k=1}^{3} v_{i,j,k} e_{j,t-k} + u_{i,t}$$

In (14), the term $v_{i,j,k}$ is the estimated effect of the k-lag of demand "j" on the current error for demand "i", while $u_{i,t}$ stands for an identically, independently distributed random component[4]. The initial runs used a 3rd-order VAR. Because of the construction of the endogenous variables, the errors, e, and u, also sum to 0 over equations in each time period. The sum of the $v_{i,j,k}$ over "i" is also 0 for each j,k pair. The current and lagged errors are perfectly collinear. To identity the $v_{i,j,k}$ the "j" subscript is defined for only three of the four quantities.

It has long been determined (Barten 1969) that the solution to estimating systems with singular errors is to estimate the model using all but one of the equations, then using the economic restrictions to estimate the parameters associated with the dropped equation. If one uses Full Information Maximum Likelihood estimation (FIML), the estimates are independent of the excluded equation.

[3] Using both a trend and its square gives us more flexibility in modeling the pattern of shifts.
[4] The "$u_{i,,t}$'s" are independently distributed over time; they will have covariance over equations.

Model Structure Testing

Prior to developing the final-form model on which this analysis is based, we dealt with a number of side issues. For example, were the taste-technology shifters statistically significant? Results showed that all four types of meats had statistically significant trends. Additionally, beef and pork had statistically significant squared-trends (Table 5). This indicated that taste-technology changes were experienced in all four meat types, and squared-trends were experienced in beef and pork. The implication of these two changes was a steady rise in the imports of poultry and a steady decline in other meats. Imports of pork were initially increasing, but later on declined, as a result of the statistically significantly squared-trend. For the same reasons, beef imports were initially declining, then changed course in the last few years.

The empirical results presented next are based on a simpler model than that outlined in equations (13) and (14), which have a large number of parameters in it. We were aggressive in restricting the model and eliminating terms from the model. We have already mentioned that we restricted the quadratic parts of the shifters; poultry and other-meat quadratic terms were statistically insignificant. The following restrictions were imposed on the model:

- We were able to eliminate the 2nd and 3rd lags from the VAR error terms and greatly restrict the 1st-order terms. The pork, poultry, and other meat's "VAR" had only their own lagged error; beef had all three lagged errors. The most common method for putting auto regression in these demand models was developed by Berndt and Savin (1975), and it uses a "diagonal" type structure, as we found with a common set of autoregressive coefficients. We were able to reject this diagonal structure; the lagged-error coefficients for pork, poultry, and other meats are statistically significantly different from each other.

- We started with 12 monthly dummies and managed to eliminate most of them from the model. Only January, August, September, November, and December have significant dummies, and each of these matters for only 2 of the meats. The two meats that matter vary by the monthly dummy.

Data Sources

South Africa's monthly data were compiled from the World Trade Atlas covering the period January 1997-October 2010.Data included volumes and prices (unit-values) of each meat category. Meat imports were divided into four categories: poultry; beef; pork; and all other meats. Other meat's category included sheep, goat, edible animal offal, horses, asses, and mules; salted, dried or cured meat; and animal fat. A unit value ($US per kilogram) was calculated as a weighted average for each of the four categories.

Empirical Results

Table 3 has the "R-square," a measure of how well the model explains the data. An R-square of 100% means that the model fits the data perfectly. There are two versions of the R-square, shown in Table 3. The first column shows the fit relative to the CBS endogenous variable as defined in equation (13). As seen in (13), this endogenous variable is a complicated function of the actual quantities. We used the simulation model that created Figures 1 to 4 to turn the predicted CBS endogenous into predicted quantities. The fits for the actual quantities are quite good for a non-linear model of this type.

Table 3. R-squares in Percent's Relative the Naïve Model

	CBS Endogenous Variable	Quantity Via Simulation
Beef	83.14	42.83
Pork	60.40	57.64
Poultry	78.87	86.97
Other meat	86.52	57.20

Demand shift among various meats, their own prices, cross-price, and scale elasticities were estimated and are used to examine patterns of consumer demand for the different meats and substitution effects in the South African meat demand system (Table 4). Because the price terms are symmetric, we show only the upper triangular part of their matrix. Note that our use of Z statistics is somewhat misleading. For example, the own-price term for beef appears to be statistically insignificant, but in fact it is not, because we required the $c_{i,j}$ coefficient matrix to be negative-semi-definite (NSD) in the model. However, all of the Monte Carlo iterations of the beef own-price term were negative and statistically significant.

Poultry was found to be a statistically significant substitute for pork, sheep/goat, and offal meats, but not significant with respect to beef. Also, pork tends to be complementary to beef, but was statistically insignificant. Most likely, the insignificant relationships are due to small beef imports, averaging 2.4 percent of all meat imports over the last 10 years. Table 5 has the intercept, trend, squared trend, and monthly dummy terms.

Table 6 shows the cost-minimizing elasticities of demand. These are calculated using the coefficient estimates from Table 4 and equations (7) and (8). The price-elasticities of demand show how each import will respond to changes in each price. Most of these elasticities are small. Our price-based simulations can only have large impacts on demand if there are large shifts in the relative prices. Import demand would appear to be sensitive to changes in total market scale.

Table 4. The Price and Scale Estimates for the SA Meat Import Demand System

		Own- and Cross-Price Estimates				**Scale**
		Beef	**Pork**	**Poultry**	**Other**	**or bi**
Beef	Estimate	-0.0032	-0.0107	0.0022	0.0116	0.0449
	Z-stat.	-0.45	-1.21	0.18	1.24	3.34
Pork	Estimate		-0.0818	0.0805	0.012	-0.0194
	Z-stat.		-4.77	4.31	0.86	-1.33
Poultry	Estimate			-0.1182	0.0355	0.0031
	Z-stat.			-3.77	1.72	0.14
Other	Estimate				-0.0591	-0.0285
	Z-stat.				-2.46	-2.03

Note. [1] Standard deviations and Z statistics are a based on 5,000 Monte Carlo iterations.
[2] Z-stat. means Z-Statistics

Table 5. Intercepts, Demand Shifters, and Seasonal Terms[1]

Meat	Beef		Pork		Poultry		Other	
	Estimate	Z-stat.	Estimate	Z-stat.	Estimate	Z-stat.	Estimate	Z-stat.
Intercept	0.1622	7.19	-0.1164	-5.68	-0.1601	-5.82	0.1143	4.65
Trend	-0.547	-7.09	0.4443	5.98	0.2918	6.2	-0.1892	-4.54
Trend squared	0.334	4.9	-0.334	-4.9				
January			-0.0212	-6.31			0.0212	6.31
August					0.0145	3.17	-0.0145	-3.17
September					0.0067	1.46	-0.0067	-1.46
November	-0.0212	-6.31	0.0212	6.31				
December	0.0212	6.31			-0.0212	-6.31		

Note. [1] Only 5 of the monthly dummies are statistically significant. All of the 5 monthly dummies sum to 0 for each meat-kind.
[2] Standard deviations and Z statistics
[3] Z-stat. means Z-Statistics

Model Simulation: Which of the Three Variables Are Driving SA Meat Imports the Most?

The CBS has a number of desirable features one likes to see in a demand system, but it has one major drawback: it uses a rather convoluted function of quantities. We used a simulation model that allowed us to turn the changes in prices, scale, and the taste-technology shifters into changes in quantities imported. When running these simulations, we started with a baseline import level. The baseline level for each meat is approximately the amount imported at the average prices and scale. The simulations keep all other parameters constant (***ceteris paribus***) and then estimate import demand using each month's actual (1) taste-shift, (2) prices, or (3) scales. Results were depicted for each meat kind in comparison to SA's actual import demand levels.

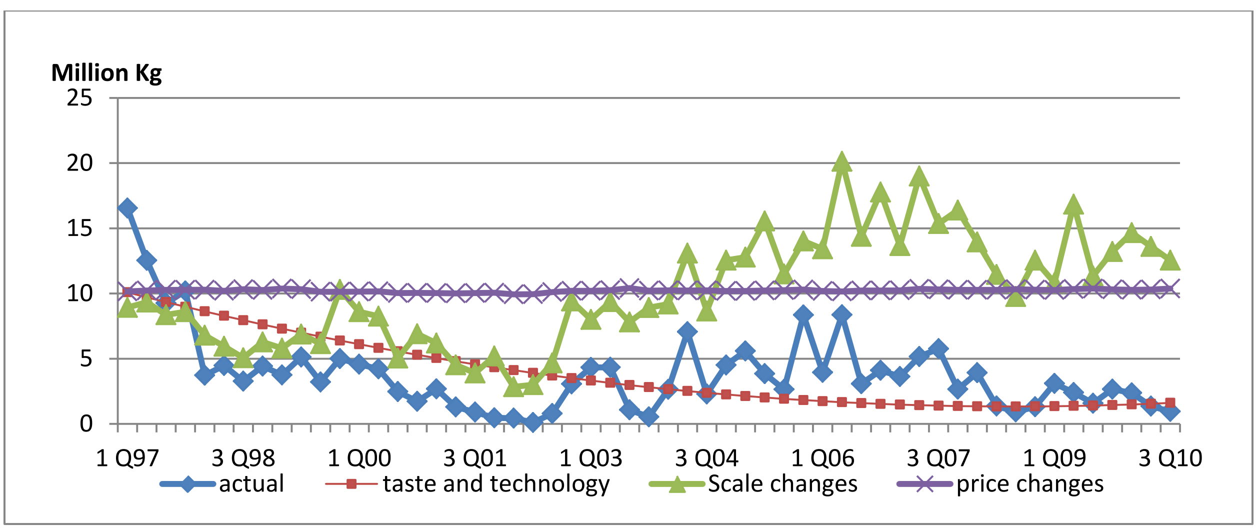

Figure 1. Beef Imports, 1997-2010

Figure 1 shows that actual beef imports were highest early in the sample and lowest in 2001-2002. Beef had both the linear and quadratic taste and technology shifters. Its shifter effect is a smoothly curved line that declines throughout the early-year periods, turning up slightly sometime in 2003-2009.

As shown in Table 6, beef has the highest scale elasticity of all the meats and generally the smallest changes in own and cross-price elasticities. This indicates that price changes have small effects on beef imports, while scale changes have larger effects. Between 2001 and 2002 when beef imports were at their lowest levels, both the taste-technology and scale effects were contributing to lowering beef imports. However, in 2003, beef imports started to increase and were largely driven by the increasing scale of South African total meat imports.

Table 6. Cost-Minimizing Import Demand Elasticities[1]

	Price Elasticities				
Meat	**Beef**	**Pork**	**Poultry**	**Other**	**Scale**
Beef	-0.033	-0.112	0.023	0.122	1.47
Pork	-0.07	-0.54	0.531	0.079	0.872
Poultry	0.004	0.147	-0.216	0.065	1.006
Other meats	0.056	0.058	0.172	-0.287	0.862

Note. [1]Estimates based on World-Trade Atlas Data, February 2015.

Pork also has a quadratic taste-technology term. The remaining two meats have only linear effects. Pork's quadratic has to offset beef's quadratic. As illustrated in the case of beef (Figure 1), beef's quadratic trend caused its taste-technology shifter to have a valley pattern; pork's quadratic trend made it looks like a hill (see Figure 2). Pork is much less sensitive to scale changes than beef but more sensitive to price changes.

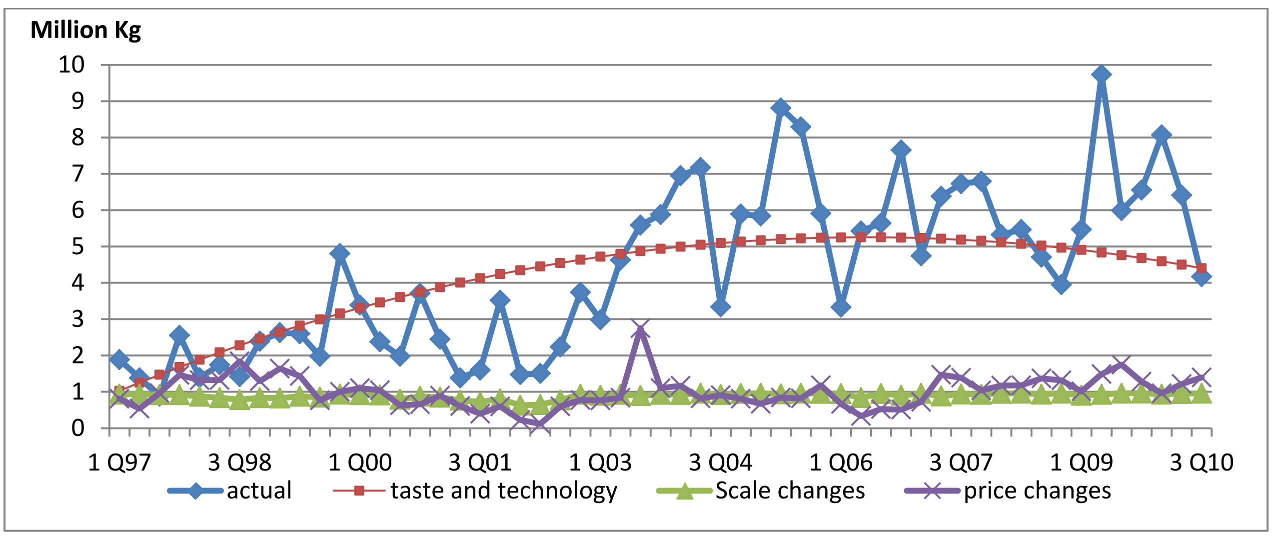

Figure 2. Pork imports, 1997-1010

Like beef, poultry imports are relatively responsive to changes in scale. South African poultry imports have increased, albeit irregularly, throughout the sample period (Figure 3). Poultry's taste-technology effect is purely linear and implies increasing poultry imports. Changes in scale over time have increased poultry demand as well, since 2003. While poultry is more price-responsive than beef, as with beef, price changes have had small effects on poultry imports.

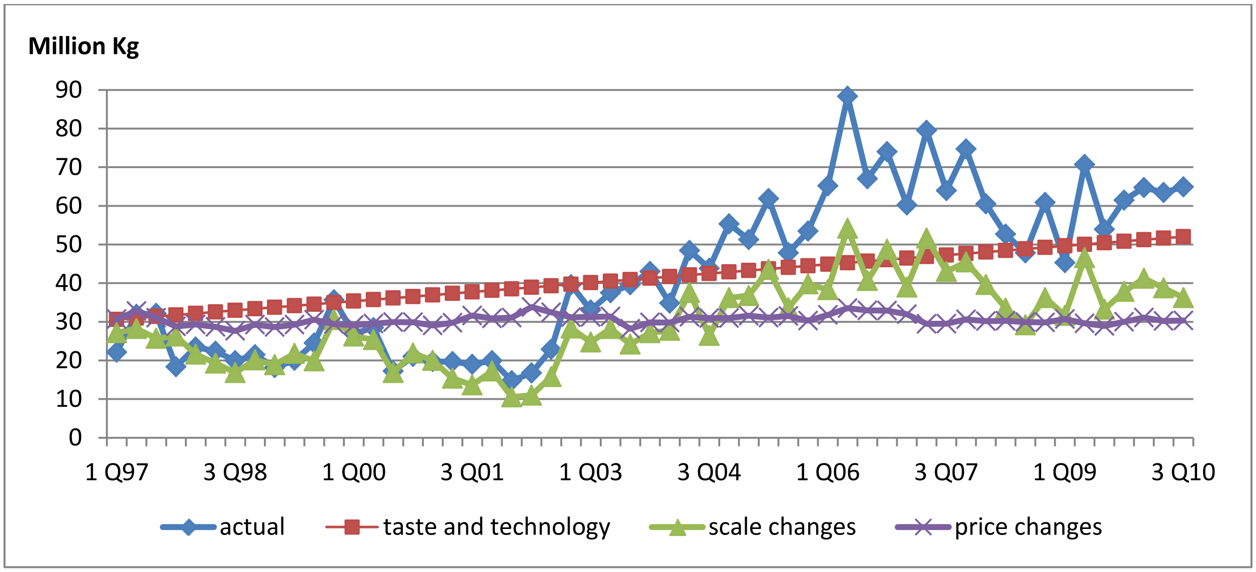

Figure 3. Poultry imports, 1997-2012

Figure 4 shows the results for other meats. Its import pattern mirrors beef: relatively high at the beginning, low in the middle, with some recovery toward the end. Like beef, both the declining tastes effect and the scale effect work together early-on to lower its demand. Toward the end of our sample, the shifter and scale effects go mostly in the opposite directions.

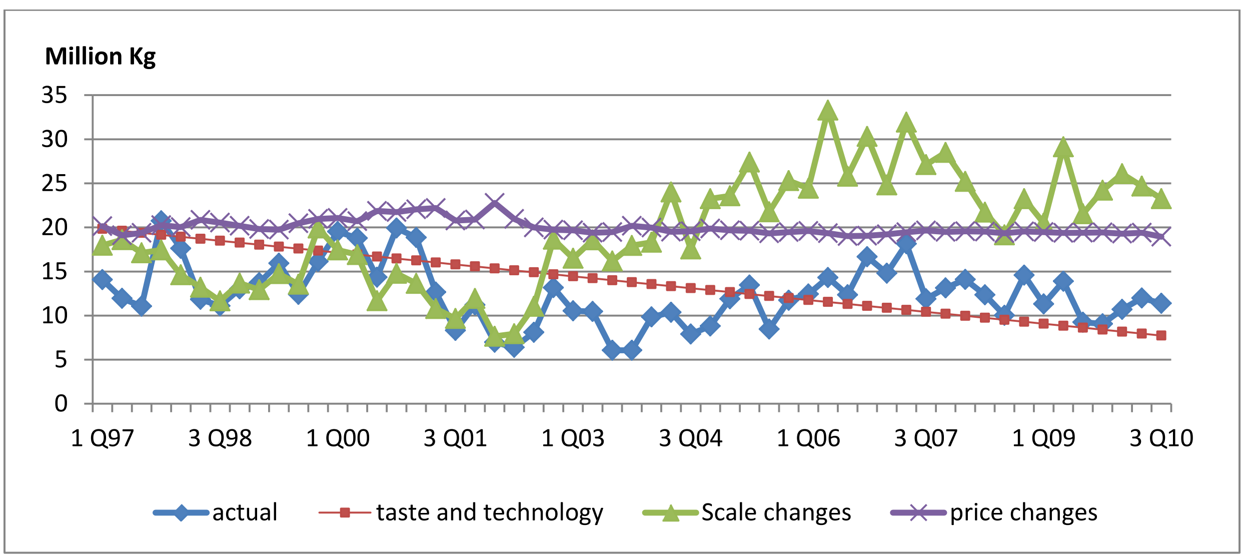

Figure 4. Other meat Imports, 1997-2010

As noted in our literature review, poultry consumption has grown rapidly worldwide. Studies of poultry demand invariably find that its relatively low price is a major factor in its expansion; poultry prices have tended to increase less than the prices of red meats, making it a better bargain. In contrast and unlike all previous studies, our estimates show that poultry prices have had small effects on the long-term trends in South African meat imports, while taste shifts have the largest effects on SA rising demand for poultry meat imports. Of all meat, only pork is extremely sensitive to price changes, which make pork imports more volatile.

The fact that taste or technology changes have increased the imports of poultry is consistent with the results of demand studies in other countries, as noted in our literature review. Moreover, we found similar, if not identical explanations of what is driving these changes. As in several countries cited in the literature review, poultry in South Africa is perceived to be healthier than all other meats. Increasing health concerns are an example of a taste shift. Other studies have found that more convenient, ready-to-cook cuts of poultry have also increased its demand. Part of the added convenience appeals to consumers, shifting their tastes; much of the added convenience is the result of changing processing technology.

The total scale of meat imports is an important driver for at least three of the four types of meats. Although no formal analysis of factors driving meat import scale has been discussed here, we would expect that South Africa's growing economy will normally lead to expanding consumer demand for meat. This expanding consumer demand could lead to higher imports. Of course, expanding supply could offset expanding demand. Attempts to expand and stabilize SA's corn and soybean markets failed, which led to higher domestic feed prices and higher costs of production for domestic meat producers, making them less competitive in world markets. More analysis of the agricultural supply, demand, and policy conditions in South Africa would be valuable.

Finally, a complete structural model would be able to analyze SA's feed-meat complex, one that would include agricultural supply and demand for feed grains such as yellow corn, sorghum, and millet, oilseeds or oilseed-meals, including soybean seeds, sunflower seeds, cotton seeds, rapeseeds, and flaxseeds. The model might usefully include SA agricultural policies, especially domestic policies relating to trade in general and specifically to export parity pricing and import parity prices. However, this article is based on a statistical model (CBS model), and is based on time-series meat import statistical data since 1997.

Conclusions

This article used the Central Bureau of Statistics (CBS) model developed by Keller and Van Driel in 1985, due to several advantages entailed in the CBS model. A demand model is linear in its parameters and restrictions. The CBS model was used to estimate acceleration in meat imports, the patterns of consumer demand for meats by kind, own-price, cross-price, scale elasticities, and substitution and/or complementary effects. We also augmented the analysis using a conditional demand model, adding a trend and trend-square variables to capture possible changes in meat imports since 1997. We specifically focused on three possible shifts that might be triggered by consumers' rising preference for certain meat, due to changes in taste-technology, in meat prices, and in market scales to explore which of these is the most influential in South Africa.

Poultry was found to be a statistically significant substitute for pork, sheep/goat, and offal meats, but not significant with respect to beef. Beef and pork tend to have a complementary relationship, albeit statistically insignificant. Most likely, the insignificant relationships are due to beef small imports, averaging 2.4 percent of all meat imports over the last 10 years. All the model's scale elasticities are positive, indicating that demand for all 4 products grows as the market expands. Increases (decreases) in scale are the only parameters that may expand (contract) the imports of all products simultaneously.

The simulation model also shows that taste-technology and market scale had greater impact on SA meat imports specifically poultry imports than changes in meat prices. More specifically, taste-technology effect was purely linear that increases poultry imports and decreases other meat imports. Beef had both linear and quadratic taste-technology shifters, and as a result beef imports were trending downward up to one point in later years (see figure 1). Pork has only a quadratic taste-technology term, making its imports trend upwards. Pork's quadratic effect has to offset beef's quadratic effect, leaving pork up slightly.

The simulation model also shows that taste-technology had a greater impact on rising SA import demand for poultry than changes in poultry prices. In part, however, the growth in poultry imports is driven by the fact that its price has increased less than the price of red meats, making it a better bargain.

The fact that taste and/or technology changes have increased the imports of poultry is consistent with the results of demand studies in other countries, as mentioned in the literature review. This is because worldwide, poultry is perceived to be healthier than other meats, and increasing health concern is an example of a taste shift.

Lastly, the simulation model showed that price changes have small effects on poultry, beef, and other meat imports, while pork is more sensitive to price changes and poultry is more price-responsive than beef. Therefore, price changes have had smaller effects on poultry imports than on imports of beef, pork, and other meat. In general, poultry prices have tended to increase less than the price of red meats. The analysis helps to explain why South Africa's poultry imports grew from 48 percent of South Africa's meat imports in 1997 to 81 percent in 2014.

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