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An estimation of import demand function for wheat in South Africa: 1971-2007

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In the 1980s, South Africa was self-sufficient in the production of all important field crops, except rice. Currently, South Africa is a net importer of wheat, even though the country has managed to maintain average agricultural production above the population growth rate; some agricultural commodities are lacking and need to be imported. Using double logarithmic linear function and data obtained from secondary sources, this study investigated the determinants of import demand for wheat in South Africa, during the period 1971 to 2007. The estimated results of the model shows that income measured by the real gross domestic product per capita; the price of imported wheat; the price of sugar cane which is a complement for wheat; and the level of domestic wheat production are statistically significant in explaining the variation observed in the quantity of imported wheat during the period. Implications for policy are discussed.

Key words: Import demand, wheat, double logarithmic-linear function, South Africa.

INTRODUCTION

Wheat is an important commodity consumed by many households all over the world. It is consumed in the form of bread, pasta, breakfast cereals, chapatti, and bakery and confectionery products (Gomez-Plana and Devadoss, 2004). World wheat consumption in 2007 was about 609 million tons, while the total world wheat production was estimated at 603, 7 million tons, an estimated 110 million tons traded in world wheat market (IGC, 2008). The world's largest wheat producers are China, EU-27 and the USA. Other major producing countries are India, Russia, Canada, Pakistan and Turkey (FAO, 2010).

In South Africa, wheat is the most important grain crop after maize (Meyer and Kirsten, 2005). Wheat is a staple food for low-income consumers, produced mainly for human consumption. However, small quantities of poorer quality wheat are marketed as stock feed (Breitenbach and Fenyés, 2000; Meyer and Kirsten, 2005), while about 60% of the total quantity of flour and meal is used for the production of bread (Van Rooyen and Sigwele, 1998).

Wheat is mainly produced in the Western Cape and the Free State Provinces. The total wheat production in 1970 was estimated at 1,396 million tons, with the total wheat consumption estimated at 1,165 million tons. However, in 2007, the total wheat production was estimated at 1,913 million tons, with estimated 2,907 million tons total wheat consumption (DAFF, 2010). Wheat production in South Africa reached a peak of 3.5 million tons in 1988/1989 but declined sharply, causing wheat demand to outstrip the supply for all consecutive years since 1989/1990. A trend analysis of time series data for the period 1985 to 1998 shows a decrease in the area under wheat cultivation and production of 5.7 and 1.5%, respectively. The total area under wheat cultivation decreased at a rate of 5.7%, from 1.9 million ha in 1985 to only 748 000 ha in 1998, consequently, leading to unavoidable wheat importation (Breitenbach and Fenyés, 2000).

While there was a clear increase in total wheat production from 1970 to 2007, perhaps due to technological innovation, factors such as increases in consumers' real income and a high population growth rate may have caused the total wheat consumption to increase more than the total wheat production during this period. This might be an explanation for the increasing

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wheat imports during this period, as Meyer and Kirsten (2005) had predicted that over time, wheat consumption would increase relative to production. Thus, South Africa remained a net importer of wheat. The demand for wheat as a staple crop is largely determined by the size, composition, distribution and market behaviour of the population. The composition of the population and the variety of it needs to have a major impact on the consumption of the product. A large section of the population of South Africa is poor and is urbanising at a rapid rate. Urbanisation causes consumers to require more ready-to-eat food. Bread is such a product and, as a staple food, it is a substitute for maize-meal.

Furthermore, the introduction of the Marketing of Agricultural Products Act 47 of 1996 which serves to abolish the existing marketing control boards only results in more (relatively low) competitive prices of agricultural commodities, as opposed to the (relatively high) monopoly prices apparent in the former Act (Vink and Kirsten, 2000). Following the deregulation of the market, producers of wheat became more competitive in both the domestic and world markets. This has led to relatively low market prices for wheat. However, in recent years, there has been strong evidence of rising food prices, partly, as a result of diminished world stocks of major crops, including wheat, due to unstable weather conditions across the world (OECD, 2008). Even though, South Africa has managed to maintain the average agricultural production above the population growth rate, some agricultural commodities are lacking and necessitate importation (Breitenbach and Fenyes, 2000).

In the midst of market deregulation, there have also been land reform policies in the form of land redistribution, land restitution and tenure reform. Even though, progress in this programme has been slow, that is, not more than 2% of commercial farm land been transferred, there is a strong disincentive for current holders of land to invest in technological innovation in order to achieve higher productivity due to uncertainty (that is, risk/higher costs) associated with the land reform programme (Vink, 2004). This as a result could, in the long-run explain the below-population growth rate increase in the production of major field crops such as wheat. In addition to this, there are a number of macro-economic variables that influence production as well as consumption and, therefore, the importation of wheat along with other major field crops. Among these variables, there is the real rate of interest, inflation rate and the exchange rate. Fluctuations in these variables can affect the quantity of imported wheat either negatively or positively, depending on their impact on real income and real prices (Vink, 2004).

Cost of production has also played an important role in the production outcome of wheat. When South Africa is compared to countries such as USA, Canada and Australia, it faces relatively high wheat production costs. This difference in production costs can be attributed to

the efficiency of management, the quality of inputs used and the state of technology prevalent in these three countries (Vink et al., 1998). These high costs of production tended to restrict local production and may explain the move towards importing wheat, as world trade is driven by the comparative advantage possessed by different countries in wheat production (Vink et al., 1998; Kirsten, 1999).

In addition, the majority of South African consumers are low-income earners and, as a result, staple food such as bread, which is produced from wheat, forms a large share of their consumption and dietary requirements. Also, some low-income earners in the rural areas use wheat flour to make food products, such as *vetkoek* (South African) and cookies, which they sell to consumers in the rural areas and some parts of urban areas to generate an income. The rising food prices in recent years have impacted relatively more on low-income earners, as they value an extra rand gain or loss relatively more than a high-income earner.

EMPIRICAL EVIDENCES FROM PREVIOUS STUDIES ON IMPORT DEMAND ESTIMATION

Although, there is no study related to the import demand analysis of wheat in South Africa, there are some important studies about trade elasticities. Woods (1958) studied the relationship between the monetary value of visible imports and exports, and the monetary value of South Africa's aggregate income, by estimating a two-variable regression of income and trade. The result of the study showed that the average propensity to import has a fairly high degree of positive correlation with the trade cycle. Imports were found to be very sensitive to income.

Erasmus (1978) used an Ordinary Least Squares (OLS) regression model to estimate South Africa's import demand elasticities with respect to income and relative prices. The result of the study showed that imports are positively correlated to income. Kahn (1987) also estimated the import demand function for four manufacturing sectors of South Africa, the results of which revealed that relative prices and income are statistically significant in explaining the behaviour of import demand and import penetration in South Africa. On the other hand, Lawrence and Van der Westhuizen (1990, 1994), who used a Gross National Product (GNP) function framework, found that import demand is inelastic to relative price changes, which is in line with economic theory and consistent with the results of other studies.

In a study, Mwega (1993) investigated the short-run dynamic import function in Kenya, using an error correction model. Empirical results showed that import demand exhibits low elasticities with regard to relative price and income. The study concludes that stabilisation and exchange rate policies would not bring about rapid amelioration of the external disequilibrium, and foreign

exchange reserves appear to be the main determinant of imports. The Chow test revealed the stability of the function. Gumede (2000) examined aggregated and disaggregated import demand for South Africa in a framework of co-integration analysis. The study obtained the long-run relationship among the variables from the two-step Engle–Granger technique, and introduces it into a short-run dynamic model. Income elasticity was found to be much larger than price elasticity.

Narayan and Narayan (2005) estimated a disaggregated import demand model for Fiji using relative prices, total consumption, and investment and export expenditure variables for the period 1970 to 2000. They used a bounds testing approach for cointegration to test for a long-run relationship and autoregressive distributed lag model to estimate short-run and long-run elasticities. The study found a long-run cointegration relationship among the variables when import demand was the dependent variable, while the import demand was inelastic and statistically significant at the 1% level with respect to all the explanatory variables in both the long-run and the short-run.

Uzunoz and Akcay (2009) used the double logarithmic-linear function to analyze the factors affecting Turkey's import demand for wheat during the period 1984 to 2006. Turkey's import demand for wheat was specified as a function of domestic prices, gross national product per capita, Turkish lira–US dollar exchange rate, and lagged import, production value of wheat, domestic demand and trend factor. The results showed that a change of domestic wheat prices have a strong effect on the wheat import demand and Turkish consumers would rather purchase domestic wheat than import wheat.

The aim of this study is to identify the key determinants of import demand for wheat in South Africa for the period of 1971 to 2007. Specifically, it examined the effect of changes in the real gross domestic product (GDP) per capita, the import price, the price of substitute and complement food products, and the level of domestic wheat production on the quantity of wheat imported by South Africa.

METHODOLOGY

Study data

Secondary time series data were used for the study. The data was obtained from the Food and Agriculture Organization (FAO) statistical database and the 2010 Abstract of Agricultural Statistics published by the South African DAFF. Additional data was also obtained from Grain South Africa (GSA) to supplement the data obtained from FAO and DAFF.

Annual data were collected on six quantitative explanatory variables and one qualitative explanatory variable (trade barrier) for the period 1971 to 2007. The variable representing GDP per capita was calculated using data obtained from the Abstract of Agricultural Statistics (value added at basic prices which were deflated using the consumer price index (CPI) and then divided by the total population). The base year for deflator of real price and real income

was the year 1971. The import parity price is the price charged for domestically produced good that is set equal to the domestic price of an equivalent imported good. The variables representing the import parity price of rice (IPP_R), the domestic maize price (P_M), the domestic sugar cane price (P_S) and the lagged domestic wheat production (WPN_{t-1}) were obtained from the Food and Agriculture Organization. The variables representing the wheat import price (P_W) and trade barrier (dummy variable) imposed on imported wheat were obtained from GSA.

Analytical techniques

For this study, a commonly used form of regression model, the double logarithmic-linear model formed the basis from which the estimated import demand function for wheat was derived. The model is expressed in its implicit form as:

$$\ln(IW) = \beta_0 + \beta_1 \ln(GDP) + \beta_2 \ln(P_W) + \beta_3 \ln(IPP_R) + \beta_4 \ln(P_M) + \beta_5 \ln(P_S) + \beta_6 \ln(WPN_{t-1}) + \beta_7(T_W) + \epsilon$$

Where, IW = Quantity of imported wheat (tons)

GDP = Real gross domestic product per capita (Rands)

P_W = Real price of imported wheat (Rands per ton)

IPP_R = Real import parity price of rice (Rands per ton)

P_M = Real domestic price of maize (Rands per ton)

P_S = Real domestic price of sugar cane (Rands per ton)

WPN_{t-1} = Lagged domestic wheat production (tons)

T_W = Dummy variable for tariffs on imported wheat (0 – no tariffs; 1 – tariffs).

The explanatory variables included in the model aforementioned and their definitions and expected signs on wheat imports are presented in Table 1.

RESULTS AND DISCUSSION

Determinants of import demand for wheat in South Africa

The result of the estimation of the double-log regression model for South Africa's import demand for wheat (1971 to 2007) is presented in Table 2. The adjusted R^2 value of 0.808 indicates that 80.8% of the total variation in the quantity of imported wheat is explained by the explanatory variables in the model. The Durbin–Watson, d , statistic is a useful test used to detect auto-correlation. The d statistic for this study is 1.119. This lies between $d_L = 1.071$ and $d_U = 1.948$. Therefore, at the 5% level of significance, there is inconclusive evidence regarding the presence or absence of positive autocorrelation between error terms of different observations (Gujarati, 2006).

The estimated income elasticity of import demand for wheat is statistically significant and positively related to the quantity of wheat imported. This suggests that the import demand for wheat is income-elastic, implying that a 10% increase in income (real GDP per capita) would be associated with an increase in the quantity of imported wheat by 16.3%. A possible explanation is that rapid urbanisation and increasing income causes consumers to require more ready-to-eat food.

Table 1. Explanatory variables used in the double-log regression model for South Africa's import demand for wheat (1971-2007).

Variables	Definitions	Apriori effect on wheat import
Real gross domestic product (GDP) per capita	This represents the real income (in Rands) that the average South African consumer have at their disposal per given year.	+
Real price of imported wheat (P_W)	This represents the real price (in Rands per ton) that wheat millers and other private and public economic agents pay in order to import wheat from the world market.	-
Real import parity price of rice (IPP_R)	This represents the real price (in Rands per ton) that consumers pay in the domestic market for rice.	+
Real domestic price of maize (P_M)	This represents the real price (in Rands per ton) that the average South African consumer (e.g. maize millers) has to pay in the domestic market for maize.	+
Real domestic price of sugar cane (P_S):	This represents the real price (in Rands per ton) that the average South African consumer (e.g. sugar cane millers) has to pay in the domestic market for sugar cane.	-
Lagged domestic production of wheat (WPN_{t-1})	This represents the quantity of wheat (in tons) that is produced by domestic farmers. This quantity is lagged, as it appears that the quantity of imported wheat in the current year depends on the level of domestic production of wheat in the previous year.	-
Dummy variable for tariffs on imported wheat (T_W)	This represents the change in the policy of tariff rates on imported wheat. D=0 no tariffs; 1 if otherwise	+/-

Rand is the South African currency.

urbanisation and increasing income causes consumers to require more ready-to-eat food. increase in the import price of wheat per ton, could result in about 12.07% decrease in the quantity of imported wheat. A probable explanation for this could be due to the availability of many substitutes such as maize, sorghum and rice. Therefore, when an increase in the real import price of wheat is observed, it has implications for the quantity of wheat imported.

The estimated coefficient of the sugar cane cross-price elasticity of import demand for wheat is statistically significant and negatively related to the quantity of wheat imported, suggesting that

import demand for wheat is elastic in terms of the sugar cane price. That is, the import demand for wheat is sensitive to the price of sugar cane. A change in the real price of sugar occurs as a result of changes in demand and supply conditions in the sugar cane market and variations in yield. This is due to risks, for example, unpredictable weather patterns attached to production. The result shows that a 10% increase in the price of sugar cane per ton, is expected to result in about 53.2% decrease in the quantity of imported wheat. A possible explanation for this could be because sugar is an important complement in the consumption of wheat. Sugar

is a major ingredient in baking and confectionery industry.

The estimated coefficient of the lagged domestic wheat production variable is statistically significant and negatively related to the quantity of wheat imported, suggesting that a 10% increase in the level of domestic wheat production, would result in a decrease in the quantity of imported wheat a year later of about 32%. The negative relationship shows that South African consumers would rather purchase locally produced wheat than imported wheat. Also, the availability of a wide range of wheat substitutes allows low-income earners to switch to substitutes like maize

Table 2. Estimated coefficients of the double-log regression model for South Africa's import demand for wheat (1971-2007).

Parameter	Coefficient	S.E.	p-value	t-Stat
Constant	58.687	19.407	0.0051	3.0239
Ln(GDP)	1.633**	0.355	7.60E-05	4.6043
Ln(P _W)	-1.207*	0.668	0.0811	-1.8072
Ln(IPP _R)	1.910	2.832	0.5052	0.6746
Ln(P _M)	1.007	1.553	0.5215	0.6487
Ln(P _S)	-5.320**	1.392	0.0006	-3.8217
Ln(WPN _{t-1})	-3.199**	0.922	0.0016	-3.4686
T _W	-0.657	0.741	0.3824	-0.8869

** and * denote statistical significance at the 1% and 10% level respectively. Adjusted R² = 0.808, F = 22.671, d = 1.119.

and sorghum, as well as, domestically produced wheat.

Conclusions

The study revealed that variables such as income measured by real GDP per capita, the own price of imported wheat, price of sugar cane which acts as a complement for wheat, and the level of domestic wheat production are statistically significant in explaining the variation observed in the quantity of imported wheat during the period of 1971 to 2007. The result of the study revealed a strong responsiveness of wheat imports to the real price of sugar and the real import price of wheat. The demand for imported wheat is price-elastic, that is, a decline in the import price of wheat would induce a relatively large increase in the quantity of wheat imported into the country.

The South African wheat producers have argued that subsidies and protection in developed countries is unfairly affecting their competitiveness. Therefore, there is need to impose high import tariffs on imported wheat to discourage imports and to protect domestic wheat producers from low wheat prices offered by international competitors. While this may be a valid argument, tariff protection may not necessarily be the best policy action from a national welfare point of view. The reason for this statement is that standard (static) neoclassical trade theory predicts increased welfare, even if trade liberalization is one-sided (unilateral), implying that the imposition of tariff may induce an overall loss in welfare. Deregulation and liberalisation of South African grain markets has given rise to a decline in grain production, including wheat. If this trend in production continues, a need will arise for government to make efforts to stabilize the wheat market because of its strategic importance as staple food.

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