Quantifying the impact of phytosanitry standards with spesific reference to MRLs on the trade flow of South African avocados to the EU

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Abstract

In this study a gravity model was used to investigate the impact of country specific MRLs that are more stringent than the MRLs set by CODEX on avocado exports by South Africa to the EU with specific reference to Prochloraz. The results revealed that the more stringent Prochloraz MRLs indeed have an impact on avocado exports to the EU. The simulation results show that the revenue foregone due to the more stringent Prochloraz MRLs is US$15.27 million. In relative terms this is significant, and should the Prochloraz MRLs be relaxed to the CODEX levels the contribution of the avocado industry to the gross domestic value of agricultural products would increase significantly. Furthermore, several studies have revealed the potentially negative impacts of abnormal levels of Prochloraz. The question arises why there are anomalies in the application of Prochloraz MRLs between countries and whether the CODEX MRL already account for these negative impacts. In depth analysis should be done with respect to the anomalies prevailing for Prochloraz MRLs to provide a proper scientific basis for applying them. Other recommendations are that much more attention should be given to the development of the national market for avocados and that other markets than the EU market should be explored for exports.

Keywords: Impact of Phytosanitary Standards, Maximum Residue Levels (MRLs), Codex Standards, Trade Flows

1. Introduction

In South Africa the subtropical fruit industry is the sixth largest contributor to the gross value of horticultural products. The two main contributors to the gross value of production of subtropical crops were avocados and bananas

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over the period 1999/00 to 2004/05, i.e. on average 18 per cent and 49 per cent respectively (NDA, 2006). However, only avocados contribute to gross value generation through local consumption and export marketing. During 2002/03, exports of avocados contributed 61.1% to the total value of exports of subtropical fruit. Moreover, the South African avocado industry is export orientated, with an average of 70% of the annual crop being exported; Europe is the major export destination (NDA, 2004).

Of particular importance for fruit exporters are the technical (whether they are mandatory or voluntary) standards that apply to fruit exports to the European Union (Jooste, Kruger & Kotze, 2003). The avocado industry is no different. Moreover, according to Oyejide, Ogunkola & Bankole (2000), consuming countries in general require that many domestically produced and imported goods should satisfy certain minimum levels of quality, health and safety standards. These standards are particularly prominent with respect to agricultural, food and health products, and many of these fall under the category of Sanitary and Phytosanitary (SPS) measures[4]. Of importance within the context of this study are Maximum Residue Limits (MRLs). MRLs are defined as the maximum concentration of pesticide residue (expressed as milligrams of residue per kilogram of food) likely to occur in or on food stuffs after the use/application of pesticides according to Good Agricultural Practice (PRC, 2002). MRLs thus falls under the broad group of SPS measures that require prior approval certifying that a product has met some pre-specified safety criteria before it can be released onto the market (Oyejide *et al*., 2000).

This study is aimed at identifying and discussing what is known about the effects of SPS measures, with specific reference to MRLs, on the trade of South African subtropical fruit and more specifically South African avocados to which they apply; the extent to which these measures may influence the external market access of South African avocados; and whether and how these effects can be quantified.

[4] *SPS measures refer to measures designed by consuming countries to:*

- *Protect human or animal life from risks arising from additives, contaminants, toxins or disease – causing organisms in food;*
- *Protect human life from disease;*
- *Protect animal and plant life from pests, disease or disease-causing organisms; and*
- *Protect an importing country from the entry, establishing or spread of pests.*

2. Background to SPS measures and MRLs

On 15 April 1994 Ministers from most of the 125 governments that participated in the Uruguay Round met in Marrakesh, Morocco, to sign the deal concluding the Uruguay Round of the General Agreement on Tariffs and Trade (GATT), the predecessor of the World Trade Organization (WTO). The final text of the Agreement on the Application of Sanitary and Phytosanitary Measures that was approved at the end of the Uruguay Round was largely based on the Dunkel text and fulfilled the general objectives set out for it in the Punta del Este Declaration (Griffin, 2005). According to Griffin (2005), it was largely underpinned by (i) SPS measures should not represent disguised trade barriers; (ii) should be harmonized on the basis of generally-accepted scientific principles; (iii) special consideration should be given to developing countries; (iv) transparency should be ensured in setting regulations and in solving disputes; and (v) an international committee should be established to provide for consultation regarding standards.

While the agreement confirms the legitimate right of countries to use SPS measures for the purpose of providing the level of health protection they consider appropriate, it also aims at ensuring that this right is not abused for protectionist purposes and that its exercise does not have unnecessary negative effects on international trade (Oyejide *et al.,* 2000). Moreover, the SPS Agreement provides a set of rules, principles and benchmarks aimed at ensuring, among other things, that SPS measures are justified and do not constitute disguised restrictions (i.e. Non Tariff Measures impacting as Non Tariff Barriers) on international trade (Henson & Caswell, 1999).

The impact of a specific SPS measure can be expected to depend on the safety level or quality standard specified as well as the form of its regulatory mechanism (such as product, process of performance standard) through which the specified targets are meant to be achieved (Henson & Caswell, 1999). This implies that SPS measures can be highly product and firm-specific and hence that their impact may be difficult to estimate. At the analytical level, Thilmany & Barrett (1997) argue that SPS measures may increase effective demand for the products to which they apply to the extent that their use relieve consumers' concerns about the quality and the safety of such product. But SPS measures can also act as a trade quota. Oyejide *et al.,* (2000) argue that the effect of SPS measures on the volume of trade is analytically ambiguous. For example, in a study instructed by the UK's Department for International Development (DFID) and conducted by the Rural Livelihoods Department (RLD) the following range of impacts, due to EU MRLs on developing countries, have amongst others been identified (Chan & King, 2000):

- Increased costs of production (although adoption of integrated pest management/IPM approaches may lead to a fall in costs in the long run in certain cases);
- A higher risk of crop wastage and/or crop failure;
- Smaller growers no longer being able to export; and
- Smaller exporting countries being excluded from the supply chain.
- Importers will cut back on sourcing from exporters who rely largely on smallholder production for their supply of produce;
- Exporters will cut back on their sourcing from smallholders if alternative sources of supply are available;
- Exporters are likely to discontinue sourcing from independent smallholders (i.e. those that are not attached as outgrowers to particular exporters);
- Smallholders will face increased costs of production (more expensive pesticides, and costs of control, monitoring, training etc. may be passed down by exporters)
- Exporters are likely to tighten control over their smallholder suppliers, and in general smallholders will become more dependent on exporters and/or other outsiders; and
- Those smallholders with an option to produce cash crops for the local market instead may choose to switch (back) to local market production.

Given the aforementioned it is worthwhile to briefly explore the manner in which MRLs are handled in the EU. Since 1993 the EU has been implementing a programme to establish harmonised MRLs for pesticide residues in foodstuffs sold in the EU. Between 1993 and July 2000, the EU has been aiming to establish MRLs for approximately 100 pesticide active ingredients. However, acceptable data for establishing MRLs has not been available for a significant number of crop/active ingredient combinations. In such situations, the EU has left the MRL position as an "open position" for a limited period of time. During this period, data can be submitted to the EU to provide for the establishment of an MRL; this is usually done by agrochemical companies, but can also be done by other interested parties. If the period expires and no acceptable data has been received, the MRL is set at the analytical Limit of Determination (LOD) i.e. “analytical zero” (Chan & King, 2000). LOD MRLs

are usually between 0.01 and 0.05 mg/kg (SCPH, 2000). Once EU MRL positions have been established, EU member states are obliged to incorporate these MRLs into their national legislation within 12 months.

Out of the many exported fruit and vegetables important to developing countries, only bananas and citrus are considered as "major crops" by the agrochemical companies, and in general they have not considered it commercially worthwhile to defend MRLs for minor crops. For this and other reasons, MRLs for many of the first 100 active ingredients used by developing country growers on tropical, sub-tropical and out-of-season fruit and vegetables have been set at LOD. In fact, proportionately more MRLs have been set at LOD for these fruits and vegetables, as compared to temperate crops grown in the EU. Some of these chemicals are currently seen by growers to be essential for producing crops for export, e.g. post-harvest fungicides required to preserve fruit during shipping (Chan & King, 2000). Moreover, in many developing countries, exports of horticultural products not only constitute an important source of national income and foreign exchange, but also provide cash income for many smallholders and employment for many of the poor. The implementation of the EU harmonization programme, and the potential for a consequent fall in export production, therefore raises specific concerns about its impact on developing countries that rely heavily on fruit exports.

3. Concentration in avocado trade

The concept of concentration refers to the extent to which a country or region concentrates its trade of a product (or products) to foreign markets and the extent to which foreign countries or regions concentrate their exports to domestic markets (Lubbe, 1992). Through the study of regional exports and imports one can determine the preference with regard to trading partners.

The Gini coefficient is used as a measure of concentration. The degree of concentration can vary from a situation with no concentration (total diversification with regard to markets serviced) to a situation of total concentration or focusing on a single market. To calculate the Gini-coefficients a similar methodological approach than applied by Grote and Sartorius von Bach (1994) and Jooste (1996) was used. The following decision rules with regard to the Gini coefficient are applicable:

- Gini coefficient = 0: Trade is equally distributed; and
- Gini coefficient = 1: Trade restricted to one region or country.

From the calculated Gini coefficients in Table 1 it can be seen avocado trade is highly concentrated, i.e. to the EU market and particularly Belgium, France, the Netherlands and the UK. Interesting to note is that the Netherlands is emerging as a replacement for Belgium as an important destination for South African avocado exports.

Table 1: Long term South African avocado trade concentration patterns

Year	Gini - Export value	Gini - Export quantity	Exports mainly to:
1988	0.77	0.78	UK, Belgium and France
1989	0.78	0.80	France and Belgium
1990	0.77	0.78	France and Belgium
1991	0.80	0.79	France and Belgium
1992	0.72	0.75	UK, Belgium and France
1993	0.80	0.78	UK and Belgium
1994	0.77	0.77	UK, Belgium and France
1995	0.90	0.89	Belgium
1996	0.87	0.86	UK and Belgium
1997	0.87	0.88	UK and Belgium
1998	0.85	0.83	UK and Belgium
1999	0.77	0.81	UK, Belgium and France
2000	0.73	0.75	France and Belgium
2001	0.73	0.72	UK, France and Netherlands
2002	0.61	0.63	UK, France and Netherlands
2003	0.70	0.70	UK, France and Netherlands

Source: Own calculations.

The aforementioned provides the basis for focussing the study specifically on avocado trade with the EU.

4. Research methodology and data used

In this study the trade flow of avocados from South Africa to selected EU countries, subjected to national as well as CODEX[5] MRLs, are investigated by using a gravity model. The next sub-section provides a brief discussion on the choice of the MRL used, followed by a discussion on the modelling approach used.

4.1 Choice of MRL used

Almost all of the 523 chemicals used on avocados during the production and post harvest processes show similar or harmonized MRLs. Only five chemicals

[5] *The Codex Alimentarius is a collection of food standards, guidelines and other recommendations that define many aspects of food quality and safety for foods moving in the international trade.*

show a reasonable variance between MRL levels, i.e. Carbaryl, Carbendazim, Chinomethionate, Metalaxyl and Prochloraz. Of these chemicals Prochloraz MRLs varied the most between countries and MRL setting bodies. It is due to meeting this requirement of MRL variance between countries that Prochloraz was selected for inclusion in this study. The countries for which Prochloraz showed the largest variation and that are more stringent that the CODEX MRL is France, Netherlands, Greece, Switzerland, Italy and Spain (See Table 2).

Table 2: Prochloraz MRLs as applicable to avocados

MRL for Prochloraz			
National MRLs (Mg/Kg)			**CODEX MRL harmonized in 1995 with directive 38**
Belgium, Germany, UK & Portugal	France	Netherlands, Italy, Spain, Switzerland and Greece	CODEX
Mg/KG			
5	0.3	0.05	5

Source: FAOSTAT, 2005.

Prochloraz is a broad-spectrum fungicide and is used as seed treatment and foliar spray on a range of crops such as cereals, oilseed, grapes, rice, mushrooms, ornamentals and as post harvest treatment of certain fruits. To minimize post harvest disease and simultaneously make the export of avocados a viable operation an integrated suite of strategies, including the use of Prochloraz, is needed (Everett & Korsten, 1996).

4.2 Modelling approach

The gravity equation came into use in social sciences in the 1860s when H. Carey (1871) first applied Newtonian Physics to the study of human behaviour. Recently gravity models achieved empirical success in explaining various types of interregional and international flows with regard to labour migration, commuting, customers, hospital patients and international trade. Timbergen (1962) and Pöyhönen (1963) were the first researchers to propose the gravity model to investigate trade flows. In its basic form, the volume of trade between two countries is assumed to be positively related with their sizes, as measured by their respective national incomes, and negatively related with the transportation costs between them, as measured by the distance between their centres of economic activity. Linneman (1966) expanded the model and included population as an additional measure of country size. This expanded gravity model is known as the augmented gravity model. It is also common to specify the augmented gravity model using per capita income, which capture the same effect as the inclusion of national incomes and population. Gravity models became popular in trade literature because of its

empirical success in predicting the bilateral trade flows of different commodities and under different circumstances. Deardorff (1984) states that gravity models are "extremely successful empirically" judging by their ability to explain variance in bilateral trade volumes. The gravity model fitted in this study takes the form shown below (Equation 1). Note that all variables are converted to logarithm.

$$y_{it} = \beta x_{it} + \alpha_i z_i + \varepsilon_{it} \qquad [1]$$

Where, y_{it} is the logarithm of bilateral export, β is a (1 × k) coefficient matrix, x_{it} (k × 1) matrix of explanatory variables in logarithms, which include per capital income of South Africa (GDPPCSA), per capital income of importing countries (GDPPCREST), distance (DST), real effective exchange rate (REER), and Maximum Residue Level (MRL) representing maximum level of Prochloraz imposed by importing country *i* on avocados exported by South Africa. Prochloraz MRLs are expressed in Mg/Kg; α_i is a (1 × n) matrix of intercepts, z_i is a (n × 1) matrix of dummy variables representing individual heterogeneity among units, *k* is the number of explanatory variables excluding the constant term, and *n* is the number of individual units[6].

Our assumption regarding the unobserved time invariant individual effect, which is represented by α_i in Equation 1, determines our choice of a particular model from pooled ordinary least squares (POLS), fixed effect (FE) and random effect (RE) models.

FE models assume that z_i in Equation 1 is correlated with the explanatory variables x_{it}. Failure to account for this may give rise to biased and inconsistent estimators for β. FE models solve this problem by including a group specific constant term (i.e. α_i) in the regression equation and estimating the resulting equation using LSDV (least squares with a dummy variable for each of the country pairs).

In the RE models, z_i is assumed to be strictly uncorrelated with x_{it}. This allows the researcher to consider the unit specific constant terms or a measure of individual heterogeneity (i.e. $\alpha_i's$) as randomly distributed across cross-sectional units. This may be done by substituting $\alpha_i z_i$ in equation 1 with a constant term α (i.e. $\frac{1}{n}\sum_{i=1}^{n}\alpha_i z_i = \alpha$) and u (i.e. $\alpha_i z_i - \alpha = u_i$) to get

[6] *The choice of variables is similar to other studies that used gravity models to explain trade patterns. See for example Otsuki et al. (2001); Bergstrand, (1985); Bun & Klaassen, (2002); Taha (2004).*

$y_{it} = \beta x_{it} + \alpha + (u_i + \varepsilon_{it})$ which could then be estimated using FGLS (Feasible Generalised least square).

If the null hypothesis that the coefficients in the matrix α_i are jointly equal to zero is rejected using an F-test[7] then the individual groups would be regarded as similar, i.e. not heterogeneous. This makes POLS to be an efficient estimator. Otherwise, either the FE or the RE model would be an efficient estimator. The choice between the two would be made by applying a specification test devised by Hausman which tests for orthogonality of the random effects and the regressors. This can be more formally written as:

$$W = \chi^2[K-1] = [b-\hat{\beta}]'\hat{\psi}^{-1}[b-\hat{\beta}],$$

Where: ψ is estimated covariance matrices of the slope estimator in the FE model and the estimated covariance matrix in the RE model excluding the constant term, b is the covariance matrix of the slope estimator in the FE model and β is the covariance matrix of the slope estimator in the RE model, W has a chi-square distribution with K-1 degree of freedom (Green, 2000)

5. Determination of the most appropriate model

To select an efficient estimator among the three available models namely, POLS, FE and RE models, the significance of individual effects jointly (measures of heterogeneity) was tested using an F-test. According to the results found, the individual effects are not jointly equal to zero. Therefore, POLS was considered to be an efficient estimator in this study. This result was obtained after first order autocorrelation problem was detected in the first round of estimation. After the first order autocorrelation problem was corrected, the result was further subjected to additional tests to check whether the following assumptions are still valid, i.e. no higher order autocorrelation problem, no heteroscedasticity problem, and that the residuals are normally distributed. Test results indicated that the assumptions still hold.

Moreover Equation 1 was used to estimate a POLS model. The coefficient for the MRL will then be used to simulate estimates for additional revenue that would have been obtained had importing countries applied harmonized CODEX MRLs for Prochloraz of 5mg/kg instead of their national Prochloraz

[7] $F(n-1, nT-n-K) = \dfrac{(R^2_{FE} - R^2_{POLS})/(n-1)}{(1-R^2_{FE})/(nT-n-K)}$, *Where R^2_{FE} indicates measure of goodness of fit obtained from the fixed effect model, R^2_{POLS} indicates measure of goodness of fit obtained from the pooled least squares (Green, 2000).*

MRL levels. Equation 1 can be written in a Cobb-Douglas format as $Y_{it} = e^{\alpha_i z i} X_{it}^{\beta}$, where Y_{it} is the antilog of y_{it} and X_{it} is the antilog of x_{it}. From this equation, revenue foregone due to the stringent MRLs may thus be calculated as $dY_{it} = \frac{\partial Y}{\partial X} dX = \beta e^{\alpha_i z_i} X^{\beta-1} dX = \beta \frac{Y}{X} dX$.

6. Results and discussion

Table 3 shows the results of the POLS model. The R^2 indicates that 37 per cent of the variation in the export value of South African avocados can be explained by the explanatory variables included in the model. The F-test confirms that the included explanatory variables together influence the dependant variable. The Durbin-Watson test shows that there is no first order correlation problem.

The MRL variable is significant at the 10 per cent level and has the expected sign. This implies that less stringent MRL levels contribute towards increased trade flows. Hence, should current Prochloraz MRL levels be relaxed, at least to the CODEX level, it would result in increased exports of avocados to the countries included in the analysis. The coefficient for the variable GDPPCREST, which is calculated by dividing GDP by population, is expected to be positive and significant. But contrary to our expectation, GDPPCREST was found to have a negative influence on trade flows. GDP is expected to have a positive influence on trade flows but according to Cheng & Wall (2005) the literature has not tended to find a consistent sign for population. Hence, the denominator in the per capita GDP calculation (i.e. population) could take any sign, which probably explains the negative sign of the GDP per capita variable.

The variables DST, REER, and GDPPCSA have the right sign, but are not significant. The fact that REER is not significant is indicative that exports of avocados are not affected by variations in the exchange rate, which may be due to the export orientation of the industry and that the domestic absorption capacity of the domestic market for avocados is limited, i.e. even if the exchange rate does not favour exports there are limited opportunities to redirect exports to the domestic market. The results do not reveal anything about the profitability of exports and hence the effect of exchange rate variations on the profitability of exports needs further investigation. The fact that GDPPCSA is not significant supports the notion of a limited domestic market for avocados. This has implications in that more emphasis should be put on developing the domestic market for avocados.

Table 3: Results of the POLS model

Variable	Coefficients	T-ratio
Intercept	-0.2658***	-1.7323
GDPPCSA	-2.9932	-0.8517
GDPPCREST	-21.3158*	-3.2533
MRL	0.2637***	1.7969
REER	-0.8353	-0.4740
DST	-0.0180	-0.4431
R^2	0.37	
F	2.51***	
DW	1.88	

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

As mentioned the result obtained for the MRL variable was used to estimate the revenue foregone due to more stringent Prochloraz MRL levels than the CODEX level for Prochloraz (refer to Table 2). Table 4 shows the results if the Prochloraz MRL levels for the countries in question are relaxed to the CODEX Prochloraz level. The largest gains will be experienced in France and the Netherlands. On average, the gains to the South African avocado industry would be US$ 15 million.

Table 4: Revenue foregone (millions)

Country	Real Export Value (Rands)	The effect of change to CODEX (Rands)	Change to CODEX (US Dollar)
France	27.12	112.06	13.68
Netherlands	24.53	640.38	75.78
Greece	0.12	3.08	0.41
Switzerland	0.25	6.51	0.79
Italy	0.21	5.45	0.80
Spain	0.05	1.39	0.19
Average		128.15	15.27

7. Conclusions

This study investigated the impact of country specific MRLs that are more stringent than the MRLs set by CODEX on avocado exports by South Africa to the EU with specific reference to Prochloraz. The results revealed that the more stringent Prochloraz MRL indeed have an impact on avocado exports to the EU. The simulation results show that the revenue foregone due to the more stringent Prochloraz MRL levels is US$15.27 million. In relative terms this is significant, and should the Prochloraz MRL levels be relaxed to the CODEX levels the contribution of the avocado industry to the gross domestic value of agricultural products would increase significantly.

However, there is a bone of contention that must be dealt with in that Vinggaard *et al.* (2005) have shown that abnormal levels of Prochloraz have

negative consequences during the gestation resulting in, amongst others, disturbances in androgen and estrogen hormone levels resulting in reduced weights in reproductive organs, malformation of male sexual organs and in cases of high dosage exposure, male animals displayed the partial formation of female sexual organs. It was further found by Noriega *et al.* (2005) that exposure to abnormal levels of Prochloraz during and after lactation resulted in, amongst others, decreases in prostate and testis weights; and reduced spatial development of young children. Given the seriousness of the effects that abnormal levels of Prochloraz may have, the question arises why there are anomalies in the application of Prochloraz MRLs between countries and whether the CODEX MRL already account for these dangers.

Three specific recommendations come from this paper, namely (i) that in depth analysis should be done with respect to the anomalies prevailing for Prochloraz MRLs to provide a proper scientific basis for applying them, (ii) much more attention should be given to the development of the national market for avocados, and (iii) other markets than the EU market should be explored for exports.

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