The trade effects of technical barriers on South Africa's orange exports

Tinashe Kapuya
The Agricultural Business Chamber (Agbiz)
Grain Building, 1st Floor, 477 Witherite Road ,The Willows,
Pretoria, South Africa, 0184
Emails: tinashe@agbiz.co.za
tinashekapuya@gmail.com

Abstract

The paper employs a gravity model to measure the trade effects of technical barriers in South Africa's major markets for oranges. The gravity model estimation is backed by a price-wedge framework that identifies technical barriers (equivalent to tariffs) that could be restricting South Africa's orange exports. The simulation of the gravity equation shows that removing technical barriers will have a 0.1% increase in South Africa's orange exports to the EU, suggesting that the growth potential of the EU market is somewhat limited by some additional factors other than technical barriers. Nonetheless, reducing technical barriers still has a fairly significant impact in South Africa's other major markets, particularly China, the United States, Canada and Russia. This is an important result, not only because the analysis generally affirms the tightening of technical barriers in key markets, but also because the cross sectional idiosyncrasies of technical barriers across major export markets are unpacked.

Keywords: non-tariff measures, orange exports, South Africa, gravity model

JEL Classification: F17, Q17.

1. Introduction

The proliferation of technical barriers (i.e. sanitary and phyto-sanitary (SPS) and other non-tariff measures (NTMs))[1] is a global phenomenon that represents a key obstacle to South Africa's agricultural exports (Gebrehiwet, Ngqangweni and Kirsten, 2007). For instance, according to a recently published report, the United States imposed an additional two days of cold treatment to the mandatory 22 days for South African citrus exporters to control for the false codling moth (FCM) (Trade and Industry Policy Strategies, 2013). On another note, the European Union (EU) in 2013, announced that it was adopting stricter restrictions on the number of allowable citrus black spot (CBS) interceptions, capping them at a maximum of five, against 36 that were found in South African citrus exports in 2012 (Chadwick, 2013). Within this new regulatory framework, exceeding five CBS interceptions would trigger additional restrictions, the extreme measure being a ban on South Africa's citrus exports into the EU (van de Geer, 2013). The adoption of such stringent NTMs presents a formidable challenge for South African citrus exporters, who have to comply with higher standards to a great cost.

Citrus represents the largest export sub-sector in the South Africa agricultural economy, and oranges constitute 70% of total citrus export output (Ntombela and Moobi, 2013). South Africa is a leading global exporter of oranges, with over half of its exports destined for the EU and Russia. However, the growing number of technical barriers in South Africa's leading export markets threatens the country's export position, with a growing concern on the potential impacts of NTMs on the industry's future revenue streams. In South Africa's major export markets, public policies and regulations on fresh fruit are increasingly shaped by public opinion, civic organization and pressure groups with an awareness on high food quality standards. While compliance to ever-increasing standards remains important for South Africa's citrus exporters, it is also crucial to have an informed dialogue on the trade implications of NTMs in South Africa's major trade partners.

This paper evaluates the trade effects of the adoption of NTMs in South Africa's 33 major export markets for oranges (shown in Table A1). To put the analysis into context, the paper first explores the structure and key trends in South Africa's export markets. This is followed by a brief discussion of the basic calculation of the tariff equivalent of NTMs that South Africa faces in specific major markets. The paper incorporates the tariff equivalent into a gravity model, prefaced by a description of the data, and a discussion of the results. The paper closes with some conclusions and summary of key points.

2. South Africa's orange export trends

As of 2012, South Africa exported a 1.1 million tons of oranges, representing 28% of overall global orange exports (Ntombela and Moobi, 2013). South Africa exports more than Egypt, the

[1] In this paper, the terms technical barriers, SPS, and NTMs will be used interchangeably to mean the same thing.

EU, the United States, Turkey and China, countries that are also among the largest orange producers in the world (see Table 2).

South Africa's position amongst the world's largest producers and exporters of oranges essentially reflect the country's global competitiveness, even in the wake of increasingly stringent world market conditions. This is confirmed by Ndou's (2012) thesis which argues that in spite of the shifting health and environmental standards in its overseas markets, South Africa remains fairly competitive. South Africa's competitiveness, however, is coming under increasing pressure owing to stagnating global consumption and rising costs of production, particularly those associated with meeting increasing quality standards (Edmonds, 2013; Chadwick, 2013).

Table 1: Top 10 Global Exporters of Fresh Oranges ('000 tons)

Country	**2008-09**	**2009-10**	**2010-11**	**2011-2012**	**2012-13**
South Africa	869	1,045	942	1,065	1,173*
Egypt	774	850	1,000	900	1000
United States	493	670	750	695	689
EU	236	272	318	305	350
Turkey	256	209	389	357	250
Australia	134	89	85	120	90
China	155	158	92	129	85
Hong Kong	53	62	70	67	70
Morocco	305	161	175	138	70
Argentina	137	157	125	85	40
Other	93	97	71	61	73
Total	3,505	3,770	3,967	3,922	3,817

Source: United States Department of Agriculture Foreign Agricultural Services (2013); *International Trade Centre (2014)

Although Table 1 shows that South Africa's leading exporter of oranges, the trends do not fully comprehend the level of NTMs that exporters are facing in global markets. Most major markets are implementing various forms of technical barriers to control for plant and fruit diseases. Of note, the EU – South Africa's biggest export destination for fresh oranges – has instituted new NTM measures to control for CBS targeting citrus exports from South Africa, on the basis of a scientific report from the European Food Safety Authority (EFSA). South African citrus exporters – through the Citrus Growers Association (CGA), the South African Department of Agriculture, Forestry and Fisheries (DAFF) and the Perishable Products Export Control Board (PPECB) – have put in place the requisite policy and regulatory frameworks to align the sector's export structure supply chains with the new phyto-sanitary measures.

South Africa's major orange export markets are shown in Table 2. In terms of volume, the EU27 market constitutes between 37% and 46% of South Africa's total export for fresh oranges over the period 2007-08 and 2012-13. The Middle East countries (i.e. United Arab Emirates, Saudi Arabia and Kuwait) consume between 20% and 25% of South Africa's fresh orange exports, making that region the second biggest consumer of South African oranges after Europe over the same period. Russia consumed between 15% and 19%, making the Eastern European country one of South Africa's key overseas markets. In 2013, South Africa's top 4 export markets – EU27, Russia, United Arab Emirates (UAE) and Saudi Arabia accounted for 78% of total fresh oranges, making South Africa's market structure extremely concentrated among a three regions (i.e. Europe, Eastern Europe and the Middle East).

Table 2: Top 10 Global Export Markets for South Africa's Fresh Oranges ('000 tons)[2]

Country/Region	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13
EU27	448	359	433	359	419	454
Russian Federation	186	140	198	175	201	222
United Arab Emirates	102	98	138	122	120	132
Saudi Arabia	78	106	104	79	94	107
Kuwait	14	22	35	30	33	51
United States	33	28	35	37	38	41
Mozambique	43	32	40	18	35	35
Canada	32	30	27	30	35	35
Bangladesh	8	10	18	32	30	31
China	4	5	7	12	18	25
Others	22	121	62	81	74	41
Total	971	952	1,097	975	1,065*	1,173

Source: International Trade Centre (2014); *United States Department of Agriculture Foreign Agricultural Services (2013)

Given South Africa's export market structure, it is critical to identify the extent to which NTMs impact on the country's trade potential in orange exports. Despite the general belief that stringent SPS requirements in the export markets are impacting negatively on the country's trade potential, there is little understanding with regards to the extent of the trade foregone as a result of these growing standards.

3. Methodological Framework

3.1 The Price-Wedge Analysis

3.1.1 The conceptual basis

In order to inform the discussion on extent to which NTMs are negatively affecting South Africa's trade, the paper estimates the level of trade foregone due to technical barriers applied by major trading partners. Therefore, a price wedge methodology is used in this instance to measure the cost of technical barriers. The price wedge framework has been extensively applied in empirical analyses of technical barriers (Calvin and Krissoff, 1998; 2005). The method recognizes that phyto-sanitary technical barriers can alter relative prices between world and domestic markets, thus creating a price wedge between potential traders. In this paper, a technical barrier is defined as any import standard or regulation that affects South Africa's

[2] Outlined here are 10 major export destinations for South Africa's orange exports, for summary purposes. However, the paper considers a total of 33 countries, including the EU as separate states.

orange exports, be it on the grounds of the importer's concern and valuation for safety, health, food quality, and/or the environment.

A key assumption of the price wedge method is product homogeneity. However, in this case, different specifications of oranges (i.e. size, colour, acidity, sweetness etc.) are suited to different export markets. Such a fine gradation, though useful, is not reflected in the available trade data. The paper therefore makes the simplifying assumption that the average South African orange is equivalent to a high quality orange in the world market. As such, market demand of a homogenous fresh orange product, by implication, entails that South African oranges are perfectly substitutable with those available in the world market.

Figure 1 illustrates the price wedge (or tariff equivalent) methodology. For ease of exposition, the paper first assumes that international markets allow no imports. In this case, country *i* domestic price per tonne in of oranges is P_e. In a reverse scenario where country *i* trades but does not impose any import restrictions (no technical barriers or tariffs), then the law of one price would prevail. In this case, for like products, the domestic prices in country *i* would equal global prices (P_w)[3] adjusted for transaction and transportation costs.

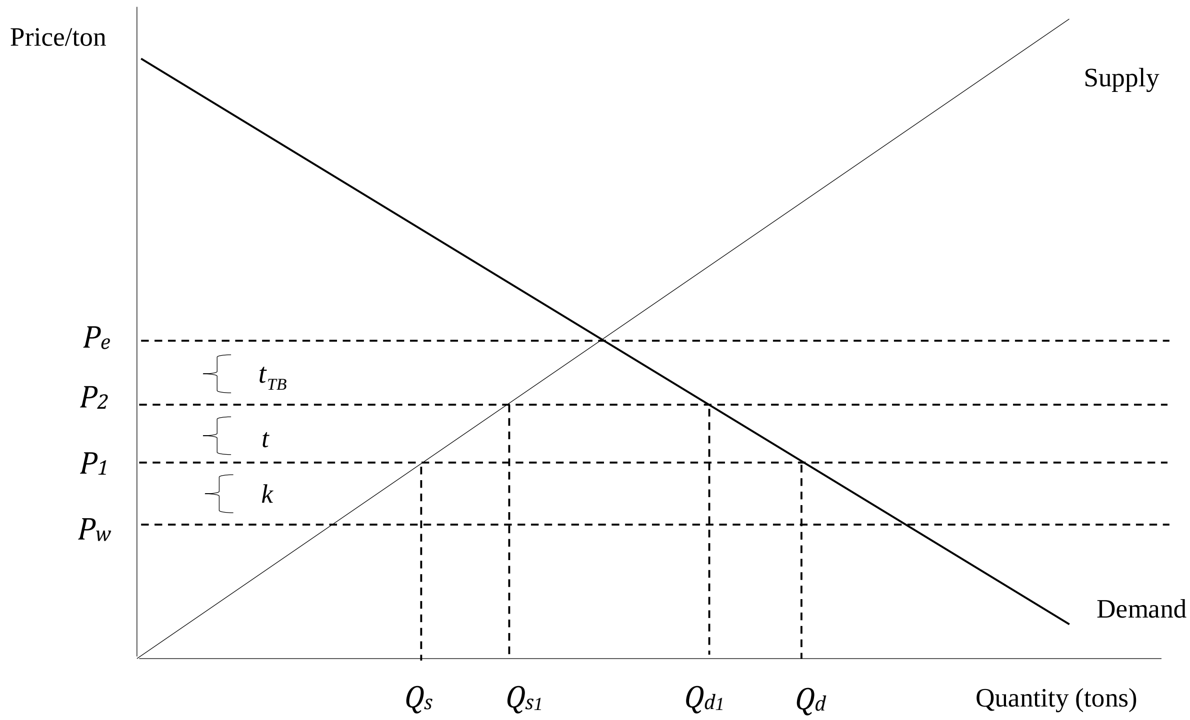

Figure 1: Conceptual Derivation of the Price Wedge
Source: Calvin and Krissoff (1998; 2005)

[3] Given the dominance of South Africa in the global export market, The South Africa export price (f.o.b. price in US$ per metric ton) is adopted as a reasonable proxy for world prices (P_w).

If we assume that the South Africa export parity price (f.o.b. price in US$ per metric ton) reasonably approximates the 'shadow' world price (P_w) (by virtue of the country being a major global player in the export market), then the world price in country *i* would be written as: $P_1 = P_w + k_{ij}$; where P_1 is the price per ton of a South African orange delivered to country *i*; P_w is the price per ton of a South African orange in country *i*, produced with standard industry operating practices that would allow fresh oranges to be exported to most countries with a standard risk management system phyto-sanitary certificate. Let k_{ij} represent transaction and transportation costs to country *i* per ton of oranges. In this situation, country *i* would import the difference between consumer demand and producer supply evaluated at P_1 or Q_d less Q_s, the free market solution.

That said, $P_2 = P_w + t_{ij} + k_{ij}$ where P_2 would be the cost of delivering a ton of South African oranges to country *i* with a tariff *t*; where *t* is the additional per-ton cost of an orange associated with the tariff. Country *i* producers would sell their product at P_2 and country *i* consumers would pay this price for both domestic and imported oranges. Country *i* producers would supply less to the domestic market than under the no trade scenario and consumers would purchase more. While it is possible that the tariff may create a price wedge sufficient to eliminate excess demand, Figure 1 illustrates a scenario where the tariff reduces but does not eliminate trade.

A phyto-sanitary measure acts as a barrier to trade, similar to a tariff. It increases the price wedge between world and country *i* market and can be measured as a tariff equivalent of the technical barrier (t_{TB}). This adds to the cost of delivering a fresh South African orange to country *i*. No South African orange grower would participate in an export program and ship to country *i* unless the price they received for their commodity covers the additional cost of complying with the phyto-sanitary measure in that particular market. Let P_e equal the price per ton of South African apples in country *i* market with a tariff and after compliance with the phyto-sanitary measures. In the case of Europe, P_e would be the CIF France import parity price given by the International Monetary Fund (IMF) orange price index. Similarly, the equilibrium price P_e for each country *i* is shown by Equation 1, and the t_{TB} can be reasonably estimated by Equation 2 as shown below:

Equation 1: $$P_e = P_w + k_{ij} + t_{ij} + t_{TB}$$

Equation 2: $$t_{TB} = P_e - P_w - k_{ij} - t_{ij}$$

Figure 1 is a good representation of the current situation in South Africa's major export markets where phyto-sanitary barriers are becoming a formidable barrier to trade. In fact, most of South

Africa's major markets have zero-rated tariffs, except China (11%), Bangladesh (25%), Mozambique (20%) and Russia (5%). Thus, most of the trade barriers that South Africa experiences in its major markets are technical barriers and NTMs. In measuring these technical barriers and NTMs, a fundamental challenge lies in estimating the different varieties of oranges (and consequently the various associated price relationships). The paper's assumption of product homogeneity in the supply chain is such that price differentials are not reflective of quality differences[4]. Nonetheless, deriving costs of technical barriers is estimated by calculating the costs of delivering a South African orange to a wholesale market in country *i* without the NTMs, starting with the c.i.f. price minus the South African f.o.b. orange price minus tariff as shown in Equation 2.

3.1.2 A look at the data

The derived price wedge trend for South Africa's major markets over the period 2007-08 and 2011-12 is shown in Table 3. The values of the price wedge vary substantially each year, with this variation being partly explained by the fact that the price differentials are a function of marketing costs, exchange rate, market prices between South Africa and country *i*[5]. The price wedge for South Africa's oranges in the EU ranges from US$584/ton and US$906/ton, with an average of US$713/ton over the 5 year period between 2007-08 and 2011-12.

Table 3: Price wedge of the technical barriers for South African oranges in its top export markets (US$/ton), 2008-2012

Country/Region	2007-08	2008-09	2009-10	2010-11	2011-12	Average
EU27	906	693	780	604	584	713
Russian Federation	239	233	367	332	215	277
United Arab Emirates	173	106	209	230	170	178
Saudi Arabia	123	155	220	230	150	176
Kuwait	169	172	241	210	156	190
United States	503	486	574	461	376	480
Mozambique	60	75	94	21	13	53
Canada	119	147	209	265	194	187
Bangladesh	63	85	88	112	90	88
China	119	147	209	265	194	187

Source: Author's calculations, International Trade Centre (ITC) (2013), BFAP (2014)

In Table 4, the price wedge is expressed as a percentage of the c.i.f. prices, and this calculation is explained in more detail in Equation 7 in the next sub-section. The tariff equivalent of technical barriers reflects that South African exporters of fresh oranges incur costs of between

[4] However, the reality is that different country markets do not share common grading or sizing standards of various orange varieties. The assumption made here is to simplify the analysis making all oranges destined for various markets comparable.

[5] Therefore, the variation in the price wedge does not reflect changes in phyto-sanitary requirements, but reflects the variation in the costs that exporters have to incur to meet the technical barriers.

67% and 82% of the price per unit in order to meet technical standards set in the EU over the period between 2008 and 2012. Russia and the United States also have fairly high costs of technical barriers, in the region of between 44% and 65% over the same period. Bangladesh is among South Africa's major markets with the lowest technical barriers, which average 18% of the price per unit between 2008 and 2012.

Table 4: Tariff equivalent of the technical barriers for South African oranges in its top export markets (%), 2008-2012

Country/Region	2007-08	2008-09	2009-10	2010-11	2011-12	Average
EU27	82%	76%	75%	68%	67%	74%
Russian Federation	65%	55%	68%	56%	44%	58%
United Arab Emirates	40%	29%	40%	39%	33%	36%
Saudi Arabia	33%	37%	41%	39%	31%	36%
Kuwait	40%	39%	42%	37%	32%	38%
United States	60%	58%	58%	52%	49%	55%
Mozambique	35%	44%	50%	5%	4%	28%
Canada	26%	29%	32%	39%	30%	31%
Bangladesh	16%	19%	18%	19%	16%	18%
China	29%	32%	35%	37%	32%	33%

Source: Author's calculations, International Trade Centre (ITC) (2013), BFAP (2014)

For the sake of clarity, Figure 1 plots the data of the tariff equivalent technical barriers and the baseline exports for South Africa's top 33 fresh orange markets. What can be observed from this preliminary eyeball evidence is that in all of South Africa's markets for fresh oranges, there is a negative relationship between exports and the level of technical barriers.

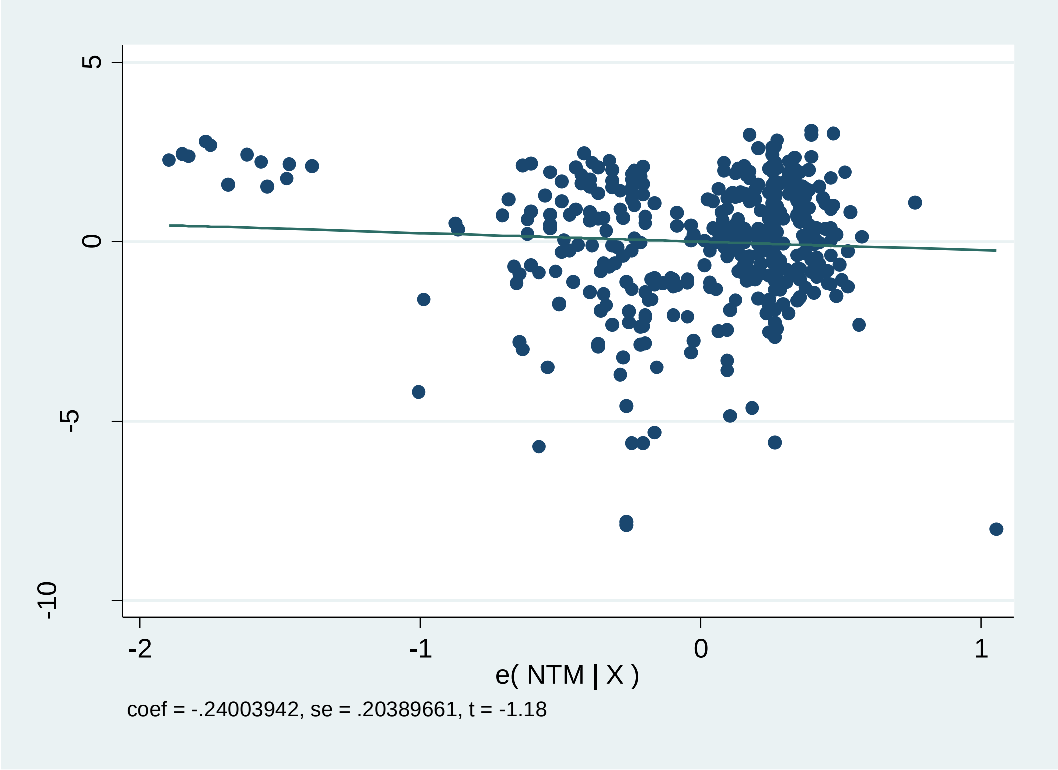

Figure 1: OLS regression plot of the tariff equivalent technical barriers and orange exports in South Africa's top 33 export markets (2001-2012)
Sources: ITC (2013); Author's calculations

In addition, Table 5 displays a correlation matrix of the panel of variables used in the analysis. The technical barriers (NTMs) present a negative correlation with fresh orange exports in the sample. This is a step further from Figure 1 above, and similarly, indicates a negative statistical relationship between technical barriers and exports during the period investigated.

Table 5: Correlation Matrix of South Africa's fresh orange exports to 33 top markets, 2001-2012

	Exports	GDP_i	SA GDP	NTMs	Tariffs	EU	SADC	Distance
Exports	1							
GDP_i	0.3942	1						
SA GDP	0.2868	0.0704	1					
NTMs	**-0.0594**	0.0189	0.3772	1				
Tariffs	-0.2889	-0.0613	-0.0334	0.0242	1			
EU	0.0665	0.3126	-0.0103	0.0709	-0.3554	1		
SADC	-0.0611	-0.5292	-0.0030	-0.1728	0.0859	-0.2204	1	
Distance	0.0055	0.6757	-0.0036	0.1578	0.0589	0.1097	-0.5187	1

Source: ITC (2013)

In the preliminary, this initial inspection of the data, with all its caveats, shows a negative and statistically significant relationship between technical barriers and exports, which in turn, indicates an economic relationship between these variables (i.e. that more technical barriers contribute to less exports). Given the initial evidence (i.e. firstly, the OLS regression line and secondly, the correlations which indicate a significant negative statistical relationship between technical barriers and exports in the panel), the paper, attempts to measure the impact of the technical barriers by looking at the trade foregone due to higher NTMs in South Africa's major export markets.

3.2. The Gravity Model

3.2.1 The Model Framework and Specification

The estimated price wedge and tariff equivalent of technical barriers to South Africa's orange exports allows for the use of several years of data on observed prices to approximate the trade effects of the technical barriers within the framework of a gravity model. Using a panel data of 33 major export destinations for South African oranges, the tariff equivalent variable is incorporated into a gravity equation, having as background, trade variation, market size, tariffs, and exchange rates across different major markets.

In reviewing methodologies utilised for quantifying broader tariff and non-tariff barrier impacts on trade, Beghin and Bureau (2001) noted that the estimation of trade forgone (due to stringent

SPS regulation) is an alternative approach to capture the trade impacts of NTMs. Therefore, gravity models are an alternative analytical tool that can be used for capturing the trade effects of technical barriers (Gebrehiwet, Ngqangweni and Kirsten, 2007). The gravity model has been cited as one of the most successful and widely used tool for empirical analysis of trade flows between countries (Moenius, 1999; Mahe, 1997; Jordaan and Heita, 2007; Kepaptsoglou *et al*., 2010).

The gravity model possesses several distinct advantage over the other comparable methodologies of estimating bilateral trade flows. Firstly, gravity models require relatively limited amount of data; hence, it can be estimated with parsimonious data in contexts where data is scarce and costly to obtain. Secondly, gravity models have been improved over time to more amply capture theoretical considerations (Head, 2000). Thirdly, the gravity model is able to estimate trade flows that reflect the influence of trade-enhancing and trade-inhibiting effects of regulations which are associated with distinct forms of NTBs (Beghin and Bureau, 2001). It is primarily for these key reasons that the gravity model is identified as one of the most useful empirical tools in estimating the effects of protection on trade volumes. The theoretical foundation of gravity models postulate a basic Newtonian functional form as follows:

Equation 3: $$X_{ij} = \frac{\phi Y_i^{\alpha} Y_j^{\beta}}{D_{ij}^{\sigma}}$$

where X_{ij} represents bilateral trade flows (exports), Y_i is the GDP (economic mass of country *i* (i.e. South Africa), Y_j is the GDP of country *j* (partner), D_{ij} is the distance between countries *i* and *j*. The stochastic log-linearised version of the basic gravity model of bilateral trade is as follows:

Equation 4: $$logX_{ij} = log\phi + \alpha logY_i + \beta logY_j - \sigma logD_{ij} + \varepsilon_{ij}$$

Where ε_{ij} represents the white-noise error term. In their augmented version, gravity models have been further developed to include a vector of trade enhancing or trade restricting variables (z_{ij}) affecting bilateral trade as follows:

Equation 5: $$logX_{ij} = log\phi + \alpha logY_i + \beta logY_j - \sigma logD_{ij} + \sum_h \varphi z_{ijh} + \varepsilon_{ij}$$

Where z_{ij} represents the sum of preferential trade dummy variables and takes the value of one when a given criterion is fulfilled (for instance being a member of a preferential trade agreement). The significance of z_{ij} is in capturing trade creation and trade diversion effects in of these trade agreements (Ghosh and Yamarik, 2004:215; Cernat, 2003:9). In keeping with these advances, the specification of the gravity model applied in this paper holds the following functional form:

Equation 6: $x_{ij} = \beta_0 + \beta_1 y_i + \beta_2 y_j + \beta_3 ntm_{ij} + \beta_4 t_{ij} + \beta_5 d_{ij} + \beta_6 sadc + \beta_7 eu + \varepsilon_{ij}$

where the lower-case letters representing the logarithm of respective variables (i.e. exports, GDPs, technical barriers (non-tariff measures, MTNs), tariffs, and distance; with *sadc* and *eu* represent dummy variables for SADC Free Trade Agreement (FTA) and the EU Trade and Development Cooperation Agreement (TDCA), respectively). In specifying the dummy variables, South Africa's participation in the two aforementioned trade agreements was considered. Thus, a trading partner was assigned a value of 1 if trading partner belongs to the SADC FTA, and 0 otherwise; while another vector of dummy variables were assigned a value of 1 if a trading partner belongs to the EU, and 0 otherwise.

3.2.2 The Variables and Data Description

The dependant variable, *exports* (x_{ij}) is given as the real value of South Africa's orange exports to country *i*, given as annual estimates in US$ millions. The trade flow of citrus from South Africa to 33 of its top export destinations is obtained from the ITC database. The ITC's Harmonised Classification (HS) Code for oranges refers to "H080501: oranges, fresh or dried".

The gross domestic product (GDP) for the importing country (y_i) and for South Africa (y_j) are expressed in real terms as US$ millions. Data for GDP was obtained from the IMF (2013) database. The relationship between exports and both GDP measures is expected to be positive. A higher GDP in South Africa means a higher production capacity which in turn translates into the ability of the South African economy to export more (supply side). On the other hand, a higher GDP for a trading partner means a higher absorption capacity, and thus the trading partner country is able to import more (demand side).

Distance (d_{ij})[6] was used as a proxy for transport cost between countries. Distance is measured between Pretoria and the capital cities of each country, which was obtained from the web the gravity database at CEPII (www.cepii.org). Being a proxy for transportation costs, distance is normally expected to be negatively related to the flow of exports (i.e. the higher the distance, the higher the costs involved in trading and therefore a negative effect on trade flows).

Bilateral *tariffs* (t_{ij}) applied to South African oranges in each respective market was used to control for tariff barriers. Bilateral tariffs are available in the Trade Analysis Information System (TRAINS) database. Important to note is the fact that the TRAINS data has missing

[6] Distance can also be used as a proxy for the risks associated with the quality of citrus since it is a perishable product and the cost of the personal contact between producers/suppliers and consumers.

values in the annual tariffs applied by importing countries. The data was complemented by informed perspectives from industry experts that helped triangulate data and fill the missing gaps. This allowed the paper's estimations to appropriately capture the influence of tariff protection. Tariff and technical barriers, with their trade restricting effects, are expected to be negatively related to exports

The tariff equivalent of technical barriers (ntm_{ij}) was quoted from the estimation methodology outlined in section 3.1 and incorporated into the model. The data used in the estimation of the tariff equivalent was sourced from the ITC (2014). The tariff equivalent of technical barriers capture the non-tariff barriers (NTBs) that may distort and restrict South Africa's orange exports. The tariff equivalents, (i.e. implicit tariffs or implicit protective rates) are calculated as follows:

Equation 7: $$ntm_{ij} = \left[\frac{(P_m^c - P_d^x)}{P_m^c} \right] * 100$$

Where P_m^c is the (c.i.f.) invoice prices for South African oranges paid by the importer in country *i*, inclusive of transport costs but excluding tariffs; P_d^x is the (f.o.b.) invoice price received by a South African exporter of oranges from the domestic market, exclusive of transport costs. The f.o.b. prices and estimates for transactions costs (i.e. shipping freight rates and insurance costs) in the cost build-up of c.i.f. prices were sourced from the Bureau for Food and Agricultural Policy (BFAP).

A positive (negative) coefficient of $sadc$ indicates that there is more (less) intra-regional trade between South Africa and its SADC trading partners in the country sample considered, and thus, evidence of trade creation (diversion). Similarly a positive (negative) eu coefficient indicates trade creation (diversion) between South Africa and the EU, and hence trade creation (diversion). The signs indicate the openness of $sadc$ and eu to South African orange exports from the rest of the world. A summary of the variable definitions and the expected signs is displayed in Table 6.

Table 6: Variables used in the model

Variable	Description	Source	Expected Sign
x_{ij}	Natural log of South Africa's real orange exports	ITC	
y_j	Natural log of real South Africa's GDP	IMF	+ve
y_i	Natural log of real importing county's GDP	IMF	+ve
ntm_{ij}	Natural log of the tariff equivalent of South African oranges	Derived	-ve
t_{ij}	Natural log of tariffs applicable to South African oranges	TRAINS	-ve
d_{ij}	Natural log of distance between both countries	CEPII	-ve

eu	Dummy variable for EU Trade and Development Cooperation Agreement (TDCA)	n/a	-ve or +ve
sadc	Dummy variable for SADC Free Trade Agreement (FTA)	n/a	-ve or +ve

Source: Various Sources

4. Empirical Strategy and Results

Given the background of the price wedge and gravity model methodological frameworks, static gravity models (i.e. the standard Pooled Ordinary Least Squares (POLS), the Fixed Effects (FE), and the Random Coefficients (RC)) are estimated in order to address fundamental econometric issues, and thus attain more reliable and informative estimates. The estimated augmented gravity model is outlined in Equation 8 as follows:

Equation 8: $x_{ij} = \beta_0 + \beta_1 y_i + \beta_2 y_j + \beta_3 ntm_{ij} + \beta_4 t_{ij} + \beta_5 d_{ij} + \beta_6 sadc + \beta_7 eu + \varepsilon_{ij}$

where x_{ij} is the natural log of South Africa's real orange exports, y_j is natural log of real South Africa's GDP, y_i natural log of real importing county's GDP, ntm_{ij} natural log of the tariff equivalent of South African oranges, t_{ij} natural log of tariffs applicable to South African oranges and d_{ij} natural log of distance between both countries. The terms $sadc$ and eu represents two trade agreements that South Africa is party to, namely, the Southern African Development Community Free Trade Agreement (SADC FTA) and the European Union Trade and Development Cooperation Agreement (EU TDCA). Lastly, ε_{it}s are random error terms.

Firstly, the specification of equation 8 was determined by a number of tests to check if the appropriate variables were included. Using the Ramsey RESET test, the paper failed to reject the null hypothesis and concluded that there were no omitted variables in the model. A Bayesian Model Average (BMA) reflected that, out of a possible 32 764 models, importer GDP, South Africa's GDP, NTMs (technical barriers), tariffs, distance, as well as the SADC and EU variables have high inclusion probabilities of above 0.7 (see Table A2 in the Appendix), further justifying the theoretical motivation of selecting these specific variables.

Secondly, Table 7 columns one, two and three report the baseline estimates of explanatory variables on South Africa's orange exports using the Pooled Ordinary Least Squares (POLS), Random Coefficients (RC) and Fixed Effects (FE), respectively. The POLS baseline estimates show that the importer GDP, South Africa's GDP, tariffs, NTMs and distance all have a statistically significant effect on South Africa's orange exports, with the latter three variables having a negative effect in all the presented models. The SADC and EU variables are showing negative estimates, reflecting that there is less exports between South Africa and the SADC and EU, with the latter statistically significantly across all models. Finally, the F* and Likelihood Ratio (LR) tests indicate that there is some evidence of country level fixed effects, and heterogeneity of intercepts and slopes, which justifies the use of the FE and RC estimators.

More importantly, after estimating the regression-based Hausman test and rejecting the null hypothesis of exogeneity, the paper makes use of the FE estimator. Above all, these results are also interesting in their own right because, firstly they take into account country level heterogeneity which, through the Hausman test, indicates that there are idiosyncrasies that distinguish between country market characteristics. Therefore the use of the FE estimator is well justified on both theoretical and statistical grounds in this case. In the FE estimator, tariff and non-tariff measures both present their expected signs in the FE model.

Table 7. Impact of Technical Barriers on South Africa's orange exports, 2001-2012

	POLS (1)	RC (2)	FE (3)
y_j	0.68 (12.84)***	0.82 (6.14)***	1.67 (5.49)***
y_i	2.23 (6.04) ***	2.63 (6.31)***	2.18 (4.03)***
ntm_{ij}	-0.36 (2.04) **	-0.95(-.2.77)***	-1.44 (-3.12)***
t_{ij}	-0.03 (-6.19) ***	-0.04 (-3.48)***	-0.06 (-2.91)***
d_{ij}	-5.63 (-7.38) ***	-6.53 (-3.18)***	
eu	-1.60 (-3.07) ***	-1.03 (2.37)***	
$sadc$	-0.81 (-5.06) ***	-1.85 (-1.28)	
Constant	-13.26 (3.16)***	13.89 (1.41)	-20.11 (-5.83)***
Observations	393	393	393
R^2	0.44	0.42	0.23
Hausman test			-3.91***
F test	70.99***	19.05***	
F*			2.97***
LR		18.92	
Wald test		110.28	

Source: Analysis Results

Notes: 1. Figures in brackets are t-values.
2. Figures with * imply significant at 10 per cent; those with ** imply significant at 5 per cent; and those with *** imply significant at 1 per cent.

From the FE estimations, technical barriers present a clear negative and statistically significant effect on the level of South African orange exports, which confirms early evidence about the adverse role of NTMs in restricting trade. For instance, every percent increase in the tariff equivalent of technical barriers, South Africa's orange exports decline by 1.4% per year in the fixed effects estimation. Essentially, the results show that various forms of technical barriers, including CBS and FCM measures, play a critical role in reducing the potential exports of South Africa's oranges to its major markets. Interestingly enough, in the FE estimations, the tariff measures, though significant, have far less of an impact than non-tariff measures. This, of course, shows the growing significance of technical barriers in global trade which are increasingly restrictive of South African orange exports. Estimations one, two and four, show that the SADC and EU, by virtue of their high levels of technical barriers or NTMs, have essentially diverted South Africa's orange exports away from these SADC and EU markets, despite South Africa enjoying preferential market access in the respective trading blocs.

In a nutshell, the estimates reported above indicate that technical barriers present a critical trade restriction whose application, if applied justifiably and in moderation, can improve trade. Moreover, a higher tariff equivalence of technical barriers, though ostensibly applied to increase food safety and quality, can significantly decrease the likelihood of exports. Ultimately, what is stressed here is not only the significance of technical barriers, but also the need for effective but relaxed mechanisms that enforce food quality while promoting trade growth.

5. Simulation Results of Trade Effect Estimations

The established negative relationship between exports and the level of NTMs is simulated using the FE model. The simulation methodology helps to assess the difference between the orange trade flows that would have occurred if South Africa's trading partners adopted more lenient technical barriers over the period 2001-2012, *ceteris paribus*. This *ex post* simulation gives an insight into the potential impact of NTMs on South Africa's exports in its major markets. Table 8 through 10 outline the trade effects of reducing the level of technical barriers by 25%; 50% and 100%, respectively. The trade effects presented in Tables 8 through 10 show the percentage increase in South Africa's orange exports to its major selected markets.

Table 8. Trade Effects linked with a 25% Reduction in Technical Barriers, 2001-2012 (*ex post* estimation in %)

	β_3 = -1.08											
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
EU15	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Russia	60.6	61.7	59.4	58.6	58.7	59.7	60.5	61.8	60.4	59.5	59.7	60.4
UAE	33.3	36.4	32.0	29.9	30.1	31.7	32.6	35.7	35.6	32.6	32.7	35.1
Saudi Arabia	41.7	44.6	39.4	36.5	36.6	37.6	38.3	41.7	42.7	40.9	41.4	44.1
Kuwait	16.7	19.8	17.0	15.8	16.3	17.4	18.3	21.2	19.7	17.0	17.7	19.7
United States	66.4	66.5	66.3	66.1	66.1	66.1	66.1	66.2	66.2	66.1	66.1	66.2
Mozambique	0.0	0.0	0.0	0.3	0.3	0.2	0.3	0.3	0.3	0.1	0.4	0.6
Canada	59.7	60.9	59.2	58.3	58.6	59.3	59.7	60.6	60.3	60.0	60.1	60.7
Bangladesh	22.3	25.4	20.2	17.7	16.6	16.8	17.2	19.8	21.2	19.3	18.6	20.0
China	58.3	60.3	57.9	56.7	57.1	58.4	59.6	61.4	62.1	61.7	62.1	63.0

Source: Analysis Results

Table 9. Trade Effects linked with a 50% Reduction in Technical Barriers, 2001-2012 (*ex post* estimation in %)

	β_3 = -0.72											
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
EU15	0.05	0.05	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.02
Russia	61.7	63.1	60.4	59.4	59.5	60.4	61.2	62.6	61.5	60.4	60.5	61.3
UAE	35.5	38.9	33.4	30.9	31.1	32.7	33.6	37.1	36.9	33.6	33.6	36.1
Saudi Arabia	42.7	45.7	40.0	37.0	37.0	38.0	38.7	42.2	43.1	41.2	41.7	44.4

Kuwait	19.1	22.5	18.4	16.7	17.1	18.2	19.1	22.3	20.9	17.9	18.5	20.6
United States	66.5	66.6	66.3	66.1	66.1	66.1	66.1	66.3	66.3	66.1	66.1	66.2
Mozambique	3.0	3.9	2.5	2.1	2.1	2.2	2.3	3.1	3.2	2.3	2.5	3.1
Canada	60.0	61.2	59.4	58.5	58.7	59.4	59.8	60.7	60.4	60.1	60.2	60.8
Bangladesh	24.8	28.3	21.8	18.9	17.8	18.0	18.6	21.5	23.0	20.6	19.8	21.6
China	59.1	61.0	58.3	57.1	57.5	58.7	59.8	61.7	62.3	61.9	62.3	63.1

Source: Analysis Results

Table 10. Trade Effects linked with a 100% reduction in Technical Barriers, 2001-2012 (*ex post* estimation in %)

	$\beta_3 = 0$											
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
EU15	0.10	0.10	0.06	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.03	0.03
Russia	63.9	65.7	62.3	60.9	61.0	61.9	62.6	64.2	63.9	62.3	62.2	63.2
UAE	40.0	43.9	36.1	32.9	33.0	34.8	35.7	39.7	39.7	35.6	35.3	38.0
Saudi Arabia	44.8	47.9	41.3	37.9	37.8	38.8	39.6	43.1	44.1	41.9	42.4	45.1
Kuwait	23.8	27.8	21.1	18.6	18.9	20.0	20.9	24.5	23.3	19.7	20.1	22.5
United States	66.5	66.7	66.4	66.2	66.2	66.2	66.2	66.3	66.3	66.2	66.1	66.2
Mozambique	9.5	13.1	7.3	5.7	5.5	6.1	6.4	8.7	8.9	6.7	6.7	8.1
Canada	60.6	61.9	59.8	58.8	59.0	59.7	60.0	61.0	60.7	60.2	60.3	61.0
Bangladesh	29.9	34.3	25.1	21.3	20.2	20.6	21.2	24.9	26.4	23.2	22.4	24.8
China	60.8	62.5	59.3	57.8	58.1	59.2	60.3	62.2	62.8	62.2	62.5	63.4

Source: Analysis Results

The results show that reducing NTMs by 25% could have potentially led to an increase in South African orange exports, the greatest being achieved in the Canada, Russia and China – which range from between 60% and 64% over the period 2001 and 2012. Middle East markets (i.e. UAE, Saudi Arabia and Kuwait) and Bangladesh are amongst major markets where a reduction in technical barriers could achieve a fairly strong increase in South African orange exports. In Mozambique, reducing technical barriers can lead to a modest growth in orange exports, averaging 8%.

Eliminating technical barriers associated with exporting oranges to the United States reduces South Africa's export potential by an average 66%, the largest among all major markets. This implies that the negative impact of technical barriers in the United States is fairly large and significant. Despite the preferential trade agreement under the Africa Growth Opportunity Act (AGOA) which ensures duty-free quota-free access of fruit export, technical barriers to trade, particularly those associated by the standard operating procedure in the citrus export programme, as well as pre-shipment inspections, are costly for exporters. Of particular note, the additional 2 days imposed on the mandatory 22 days of cold treatment for South African citrus exporters to control false codling moth (FCM) has been cited as one of the key phyto-sanitary measures that have added to costs, in addition to the fairly long distance between South Africa and the United States.

All in all, the simulation analysis reflects that an eradication of technical barriers will increase South Africa's orange exports into the EU by an average 0.1%, a reflection that the growth potential of the EU market is somewhat limited by some additional factors other than technical barriers[7]. It is not clear why this is the case, but a fair supposition could suggest that growth in the EU market could be constrained by factors such as stagnating consumption (perhaps instigated by the regional economic recession) coupled by an overall structural shift of South African exporters that are now actively seeking alternative markets in the Middle East, Africa and Asia, among other emerging markets (see Kapuya *et al*, 2014). However, outside of the EU, technical barriers still have a fairly significant impact in South Africa's export growth potential. The point to make is that while there is an essential level of technical barriers that ensure an increase in food quality and safety, stricter NTMs tend to be more restrictive and curtail South Africa's potential orange exports.

6. Summary and Conclusions

Using a stylized framework, the paper employed a gravity model to measure trade effects of technical barriers in South Africa's major markets for oranges. The gravity model estimation was backed by a price-wedge framework that identified technical barriers (equivalent to tariffs) that could be restricting South Africa's orange exports. The analytical framework of interfacing the price-wedge tariff equivalent in a gravity model was admittedly simple. In order to estimate the trade effects, a simulation was run for various levels of technical barrier restrictions.

Technical barriers and trade costs were expectedly trade inhibiting since they restrict market access. Thus, the econometric estimation of the gravity equation indicated a negative impact of technical barriers on South African orange exports. However, the results showed that an eradication of technical barriers will increase South Africa's orange exports into the EU by 0.1%, a reflection that the growth potential of the EU market is somewhat limited by some factors other than technical barriers. Nonetheless, reducing technical barriers still has a fairly significant impact in South Africa's other major markets. This is an important result, since the analysis of trade generally affirms the tightening of technical barriers in key markets, particularly in China and the United States.

The results presented in this paper could be particularly helpful in assessing the impacts of *ex ante* regulatory measures, that is to say, before the effective implementation of restrictive trade policies in major markets. The gravity and experimentation results outlined in this paper could be used as a basis for anticipating market reactions and regulatory adjustments in export markets and achieve quantified analyses directly usable for public policy. It is hoped that the methodology of combining a price-wedge and gravity model will enlighten decision makers on the consequences of technical barriers in key markets. An area of future research that could

[7] Though this growth is low, it is important to note that it is coming off a very high base. Therefore, a less than 0.1% growth actually represents a fairly large magnitude in actual exports.

extend from the results of this analysis is the impact of these technical barriers on consumer welfare.

References

1. Bergstrand, J.H. 1985. The gravity equation in international trade: Some microeconomic foundations and empirical evidence. *Review of Economics and Statistics* 67(3):474–480.

2. BFAP (Bureau for Food and Agricultural Policy).2014. Unpublished Citrus Price Statistical Database. Pretoria.

3. Calvin, L., and Krissoff, B. 1998. Technical Barriers to Trade: A Case Study of Phyto-sanitary Barriers and U.S.-Japanese Apple Trade. *Journal of Agricultural and Resource Economics* 23, no. 2: 351-366.

4. Calvin, L., and Krissoff, B. 2005. Resolution of the U.S.-Japan Apple Dispute New Opportunities for Trade. *United States Department of Agriculture Electronic Outlook Report*. The Economic Research Service: FTS-318-01.

5. Cernat, L. 2003. Assessing South-South regional integration: same issues, same metrics. *Policy Issues in International Trade and Commodities Study Series*, No. 21.

6. Chadwick J. 2013. Citrus black spot (CBS) – Commitment to compliance. *The CEO's Desk*, Citrus Growers Association (CGA) 25:13.

7. Cheng, I.H. and Wall, H.J. 2005. Controlling for heterogeneity in gravity models of trade and integration. *Federal Reserve Bank of St. Louis Review* (Jan):49–63.

8. Edmonds J. (2013), Global Citrus Scan. *Brazil: Time to tap into domestic orange juice market.* Citrus Growers Association (CGA). 21:1–2.

9. Egger, P. 2000. A note on the proper econometric specification of the gravity equation. *Economic Letters* 66:25–31.

10. Evenett, S.J. and Hutchinson, W.K. 2002. The gravity equation in international economics: Theory and evidence. *Scottish Journal of Political Economy* 49(5):489–490.

11. Egger, P. 2002. An Econometric View on the Estimation of Gravity Models and the Calculation of Trade Potentials. Oxford. 297-312

12. Gebrehiwet, Y., Ngqangweni, S. and Kirsten, J.F. 2007. Quantifying the trade effect of sanitary and phytosanitary regulations of OECD countries on South African food exports. *Agrekon* 46(1):23–39.

13. Ghosh, S. and Yamarik, S. 2004. Does trade creation measure up? A re-examination of the effects of regional trading arrangements. *Economics letters*, 82(2004):213-219.

14. Jordaan, A.C. and Eita J.H. 2007. Determinants of South Africa's exports of leather products. University of Pretoria. Working Paper (Oct) 2007-21.

15. Kapuya, T., Chinembiri, E.K. and Kabala M.W. 2014. Identifying strategic markets for South Africa's citrus exports. *Agrekon: Agricultural Economics Research, Policy and Practice in Southern Africa*, 53:1, 124-158.

16. Kepaptsoglou, K., Karlaftis M.G., and Tsamboulas D. 2010. The Gravity Model Specification for Modeling International Trade Flowsand Free Trade Agreement Effects: A 10-Year Review of Empirical Studies. *The Open Economics Journal*, 2010, 3, 1-13

17. Helmers, C. and Pasteels, J.M. 2005. Trade Sim (third version), A gravity model for the calculation of trade potentials for developing and economies in transition. *ITC Working Paper*, 1–3. Geneva: International Trade Centre.

18. Mahe, L.P. 1997. Environment and Quantity Standards in the WTO: New Protectionism in Agricultural Trade, A European Perspective. *European Review of Agricultural Economic*s, 24: 480-503.

19. Moenius, J. 1999. *Information versus Product Adaptation: The Role of Standards in Trade.* Working paper, University of California, San Diego.

20. Ndou, P. 2012. The competitiveness of the South African citrus industry in the face of the changing global health and environmental standards. Ph.D. Thesis. Alice South Africa: University of Fort Hare. Available at: http://ufh.netd.ac.za/bitstream/10353/477/1/Ndouthesis.pdf (Accessed 15 July 2013).

21. Ntombela, S. and Moobi, M. 2013. *South African fruit trade flow*. Pretoria, South Africa: NAMC.

22. Trade and Industry Policy Strategies (TIPS). 2013. Benefits of Africa Growth Opportunity Act (AGOA) to South Africa. The Department of Trade and Industry (the dti). Unpublished Draft. pp 69.

23. USDA-FAS (United States Foreign Agricultural Services). 2013. *Citrus: World markets and trade.* Washington DC: USDA-FAS. Available at: http://www.fas.usda.gov/psdonline/circulars/citrus.pdf (Accessed 10 August 2013)

24. van de Geer, R (2013). Press Release: *SA-EU citrus trade stays in the limelight*. 30th August 2013. EU Embassy to the Republic of South Africa. European Union. Pretoria, South Africa.

Table A1: Sample Countries: South Africa's top 33 markets for Oranges (2001-2012)

Country	Code		Country	Code
European Markets				
Belgium	BEL		Lithuania	LTU
France	FRA		Netherlands	NLD
Germany	DEU		Portugal	PRT
Greece	GRC		Spain	ESP
Ireland	IRL		Sweden	SWE
Italy	ITA		United Kingdom	GBR
Eastern Europe				
Russia	RUS		Ukraine	UKR
Middle East markets				
Saudi Arabia	SAU		Oman	OMN
Kuwait	KWT		Qatar	QAT
Iran	IRQ		United Arab Emirates	ARE
Bahrain	BHR			
Far East Markets				
Bangladesh	BGD		Singapore	SGP
Malaysia	MYS			
Asian Markets				
China	CHN		Japan	JPN
Taiwan	TWN		Korea	KOR
Hong Kong, China	HKG			
African Markets				
Mauritius	MUS		Mozambique	MOZ
North American Markets				
Canada	CAN		United States of America	USA

Table A2. Log-Level Regressions to Explain South Africa's orange exports (2001-2012)

Variable	Posterior Inclusion Probability	Posterior Mean
Importer GDP	1.00	0.68
South African GDP	0.95	1.79
Importer Population	0.06	0.02
South African population	0.28	1.43
Non-Tariff Measures	0.70	-0.11
Tariffs	1.00	-0.03
EU Dummy	0.96	0.76
ASIA Dummy	0.09	0.03
Middle East Dummy	0.15	0.07
NAFTA Dummy	0.09	0.04
SADC Dummy	0.75	-1.26
Distance	1.00	-5.45
Colonial Relationship	0.05	-0.01
Common official language	0.08	0.01
Sample Size	393	
Number of models estimated	32768	

Source: Analysis Results