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Economic Analysis of the Determinants of Citrus Exports in South Africa Post the Era of Trade Liberalisation

Abstract: The purpose of the study was to analyse the determinants of South African citrus exports post era of trade liberalisations using secondary data from 1996 to 2018. The Johansen Cointegration model was used to test the long-run relationship between the citrus export and the determinants in the post era of trade liberalisation and Ordinary Least Squares regression was used to determine the relationship between citrus export in South Africa and the selected determinants post the era of trade liberalisation. The results of the Johansen Cointegration model show the existence of a long-run equilibrium relationship between citrus exports and the determinants of South African citrus exports. The Ordinary Least Squares regression results provided evidence that citrus production and citrus world market prices are the major influencers of citrus export in South Africa. The Department of Agriculture and the Citrus Associations should make initiatives to ensure an increase in citrus production by promoting development programmes for the citrus producers.

Keywords: export, trade liberalisation, cointegration, citrus, stationarity.

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1. Introduction

The South African citrus industry is second to none in the Southern Hemisphere and accounts for more than 60% of the total exports destined to the world (Louise 2020). Compared to the global sector, the South African citrus industry is the 12th producer and accounts for 2.2 million tons annually (FAO 2021). The citrus industry remains the largest fruit producer in South Africa and is largely focused on the exportation of the fruits to the tune of 65% (Gianessi and Williams 2012). Some of the prospective markets for South African citrus fruits include China, the European Union, the United States, the Middle East, and Southeast Asia. These markets offer growing demand for a range of citrus varieties, and South African producers have been able to meet strict food safety and quality standards through investments in modern production and packing facilities. The European Union (EU) is the largest market for South African citrus, accounting for more than 40% of the country's exports. In 2020, South Africa exported over 900,000 metric tons of citrus to the EU, with oranges being the largest category (USDA 2022). Other citrus fruits that South Africa exports to the EU include lemons, limes, grapefruit, and easy peelers (USDA 2022). In South Africa, there have been efforts aimed at promoting free trade, exports subsidies and improving the overall efficiency of the citrus market network. These efforts may lead to the increase in the volume of citrus exports on annual basis (Raats 2017). Moreover, the subsequent increase of citrus exports will result in increasing aggregate demand which in turn will promote economic growth.

Improvement of aggregate demand will promote access of the South African citrus exports to the highly competitive global market. Although there is free trade agreement with the European Union that allows duty free access of citrus exports, the South African sector is challenged as a consequence of competition. Therefore, trade liberalisation is important to shift the focus from the volume production to the quality production. Trade liberalisation can promote openness and offer new opportunities for local producers to access international markets, potentially improving their performance and quality of exports. In the case of South Africa's fruit exports, trade liberalisation could address challenges such as declining prices and quality (Vink 2004). However, the impact of trade liberalisation can be complex and depends on various factors, and it is important to consider potential social and environmental impacts. While there may be limited research on the specific impact of trade liberalisation on South Africa's fruit exports, broader research on trade liberalisation in developing countries can provide insights.

Few studies carried out in developing countries (Phaleng 2020; Ahmad et al. 2018; Alipour et al. 2013) reported on the determinants of fruits exports in Africa and Asia, respectively. Both Burhan Ahmad and co-authors (Ahmad et al. 2018) as well as Hamidreza Alipour and co-authors (Alipour et al. 2013) studies were conducted in Pakistan and Iran while Lucius Tshwene Phaleng (2020) focused in South Africa. There is a negative influence of determinants such as inflation, importers foreign direct investment and ad-valorem equivalent on the fruit exports. While a decrease in those determinants would positively influence the fruit exports through genuinely repositioning the fruit industry and widening the destined markets (Phaleng 2020). Improvement in export prices for fruit exports can lead to an increase in export markets, as well as an increase in the yield per hectare. However, when prices decrease, the opposite effect may occur, which could potentially lead to a decrease in export markets and a decrease in the yield per hectare (Ahmad et al. 2018). A study conducted by Poulomi Bhattacharya (2019) found that domestic prices can have a negative impact on the competitiveness of fruit exports, which can in turn have a negative effect on the fruit export sector. This suggests that it is important to maintain competitive pricing to promote the growth and success of the fruit export sector. This is frequently followed by the threat that rising citrus exports pose from ongoing exchange rate volatility (Alipour et al. 2013). There is a relationship between exports and world price, trade openness and real effective exchange rate (Verter and Bečvářová 2014). Moreover, the fruit export industry exhibits competitive advantage and is more price-driven than volume driven because of positive association between volume of exports and trade openness (Boansi, Lokonon, Appah 2014).

Theoretical models of trade liberalisation and agricultural exports have been evolving over time, as scholars try to understand the complexities of these processes. One of the key theoretical frameworks used in this area is the general equilibrium model, which seeks to capture the interactions between different sectors of the economy as they respond to changes in trade policy (Das, Roberts, Tybout 2007). Scholars such as (Alessandria and Choi 2014) have extended this model to incorporate new features, such as uncertainty and firm growth dynamics, to better capture the real-world effects of trade liberalisation on agricultural exports.

In addition to the general equilibrium approach, other theoretical models have also been used to study the relationship between trade liberalisation and agricultural exports. The elasticity approach focuses on how changes in trade policy affect the price elasticity of exports, while the absorption approach looks at how changes in demand for exports are absorbed by changes in production and trade. The monetary approach, meanwhile, emphasizes the role of exchange rate dynamics in determining the effects of trade liberalisation on exports (Zakaria 2014).

Empirical studies (Ju, Wu, Zeng 2010; Ostry and Rose 1992) that have used these theoretical frameworks to investigate the impact of trade liberalisation on agricultural exports have produced mixed results. One reason for this is that different studies have used different time periods, data sets, and estimation techniques, making it difficult to compare their findings. Another challenge is that trade liberalisation measures can vary widely, from changes in tariffs and quotas to more subtle shifts in exchange rates or trade agreements. Nonetheless, the overall trend in the literature is towards a recognition that trade liberalisation can be a powerful driver of agricultural export growth in many contexts.

Therefore, understanding the determinants of citrus exports in a developing country is important considering the contribution of the citrus industry to the livelihoods of farmers, economic growth and the expansion of the citrus industry. Scholarly work focusing on this area is of important for policy makers and stakeholders. This study attempts to empirically analyse the determinants of citrus exports in South Africa post era of trade liberalisation from 1996 to 2018. The study adopted the descriptive statistics, Johansen Cointegration test and Ordinary Least Squares model, the remainder of the study comprises the materials and methods, succeeded by the results, discussion and conclusion.

2. Materials and Methods

2.1. Data issues

This study was conducted in South Africa. South Africa is a country at the southern part of the African continent and provide suitable climatic conditions to produce citrus. South Africa covers an area of 121.9 million hectares, of which over 80% is mainly used for agriculture (Mambo and Faccer [eds.] 2017). In addressing the set objectives of this study, annual secondary data from a period of 1996 to 2018 was collected from the Citrus Association, World Bank and the Economics FRED. The secondary data covered variables such as the quantity of citrus produced (ton) is the total produced citrus that were of high quality for the exports market, quantity of domestic citrus consumption (ton) this account for the quantity of citrus that was consumed in the local market, citrus world market price (rands/ton) is the average price of citrus in tonnage, quantity of world citrus exports (ton) is the total quantity of citrus that was exported in the world, trade openness index is a measure that reflects the degree to which a country is open to international trade. It is typically calculated as the ratio of a country's total trade (exports plus imports) to its Gross Domestic Product (GDP), real effective exchange rate is a measure of a country's currency exchange rate, adjusted for inflation relative to a basket of other currencies. The variables were disaggregated into quarters to cover a total of 88 observations.

The collected data was analysed using e-views 11 statistical package. The study carried out the Phillips-Perron test to test the stationarity of the data. This study applied multistage analysis. The first stage estimated the Johansen Cointegration model to investigate the long-run relationship between citrus exports and the factors that influence trade liberalisation. In the second stage of the analysis, this study applied an Ordinary Least Squares model to investigate the factors that have an influence on citrus exports in South Africa.

This study used the sum of a country's imports and exports as an indicator of trade liberalisation, as an increase in both may suggest a move towards freer trade practices. Trade liberalisation often involves the reduction or elimination of tariffs, quotas, and other barriers to trade, which in turn can lead to an increase in both imports and exports. This can be a positive sign for economic growth and development, indicating that a country is taking advantage of global markets and participating more fully in the international economy. However, it's important to note that the sum of imports and exports alone may not provide a complete picture of a country's trade policies and practices. To assess the effects of trade liberalisation, it is important to consider other variables that were applied in this study and were presented later in the analytical models.

2.2. Analytical models

This study applied the Phillips-Perron test which is a statistical test used in time series analysis to determine if a time series is integrated of order 1. It's like the Dickey-Fuller test, but it addresses the issue of higher order autocorrelation. This means that the process generating data may have a higher order of correlation than the test equation allows for. The Phillips-Perron test corrects for this issue in a non-parametric way and is robust against unspecified autocorrelation and heteroscedasticity (Davidson and MacKinnon 2004). Therefore, the model was expressed as follows:

$$\rho = 1 \text{ in } \Delta y_t = (\rho - 1) y_{t-1} + \mathcal{U}_t. \tag{1}$$

This study applied the Johansen Cointegration model as proposed by (Johansen 1988) to investigate the long-run relationship between citrus exports and the factors that influence trade liberalisation. In carrying out the Johansen Cointegration model the cointegration vectors were applied in a form of the trace and the maximum Eigenvalue tests. Both the trace and maximum Eigenvalue tests accounts for the rejection of the null hypothesis. With the maximal Eigenvalue testing the cointegration vectors of the null hypothesis against an alternative cointegrating vector, on the other hand the trace statistic tested the null hypothesis of no cointegrating vectors. Therefore, the model was expressed as follows:

$$LR_{trace}\left(\frac{r}{n}\right) = -T\sum_{i=r+1}^{n}\ln(1-\hat{\lambda}_i), \tag{2}$$

$$LR_{max}\left(\frac{r}{n}+1\right) = -T\ln(1-\hat{\lambda}_i). \tag{3}$$

Therefore, equation 2 will account for the trace while the equation 3 will account for the maximal Eigenvalue statistics. Where $\hat{\lambda}$ and T denotes the estimated values of the characteristic roots that are obtained and the sample size in the model, respectively.

During the second stage of the analysis, this study carried out the Ordinal Least Squares model to determine the relationship between the citrus export and the independent variables. The model was specified as follows:

$$lnQ_{CEX} = \beta_0 + \beta_1 lnQCProd + \beta_2 lnDCON + \beta_3 lnCWMP + \beta_4 lnQWCEX + \beta_5 lnTOPEN + \beta_6 lnREER + U_t, \tag{4}$$

where: lnQ_{CEX} is the natural log of annual quantity of citrus export; *lnQCProd* was used as the natural log for the quantity of citrus produced (tonnes); *lnDCON* was the natural log of domestic consumption of citrus products (tonnes); *lnCWMP* was the natural log for the citrus world market price; *lnQWCEX* denote the natural log for aggregate of world citrus export (tonnes) proxied for international market size for exports; *lnTOPEN* represents the natural log of trade openness index ((Exports+ Imports)/(Nominal GDP)) × 100, is an indicator of trade liberalisation, *lnREER* is the natural log of real effective exchange rate measured for the value of domestic currency as against foreign currencies, *R* represent rand, which is the South African currency.

3. Results and Discussion

This section presents and provide empirical and descriptive discussion of the results of this study. It starts with the presentation of the descriptive statistics, followed by the stationarity test. Therefore, the empirical results of the Johansen Cointegration model and the Multiple Regression model were presented. The choice of the independent variables and on how they affect exports was chosen based on the contribution of existing literature (Phaleng 2020; Boansi, Lokonon, Appah 2014). These studies focused on the determinants of exports using different agricultural crops. We therefore contributed to the body of knowledge by applying what they contributed using available statistical tools applied in this study.

3.1. Descriptive statistics

As illustrated in Table 1 the descriptive statistics of the variables used in this study. Overall, the average market price of R183187.35 was paid in the world for citrus and average standard deviation of R12992.97. On the other hand the average domestic consumption of citrus is 167996.39 tonnes with a standard deviation of 45257.17 tonnes. The average trade openness is 56.89% with a standard deviation of 6.70% per year. The average citrus production is 2038112.87 tonnes per year in South Africa with a standard deviation of 406739.95 tonnes per year, this figure is way ahead of the total consumption that was recorded above. The world citrus export quantity is from all the exporters is on average of 10313304 tonnes per year with a standard deviation of 1564667.16 tonnes per year. These statistics covers the entire volume of data in all citrus exporting countries. It is worth noting, that the real effective exchange rate was an average of 89.82% per year with a standard deviation of 14.40% per year.

Table 1. The descriptive statistics of the citrus industry dataset

Tabela 1. Statystyki opisowe zbioru danych przemysłu cytrusowego

Variable	*CWMP*	*DCON*	*TOPEN*	*QCProd*	*QWCE*	*REER*
Mean	18387.35	167996.39	56.89	2038112.87	10313304	89.82
Maximum	47200.00	306950.0	72.87	2790431	13203000	118.14
Minimum	6293.00	134445.0	46.67	1263010	7847000.	61.90
Std. Dev.	12992.97	45257.17	6.70	406739.95	1564667.16	14.40

Source: Own calculation based on the orange dataset.
Źródło: obliczenia własne na podstawie zbioru danych dotyczących pomarańczy.

3.2. Stationarity test

According to Clive W. Granger and Paul Newbold (1974) give the idea that the macroeconomic data as a rule contained stochastic trends, and this data is characterised by unit root, they also suggest that using these variables in econometric models may lead towards spurious regressions. Stationarity can be achieved by repeated differencing, thereby overcoming the problem of spurious regression (Perman 1991).

Table 2 presents the results of the unit root test from the Phillips-Perron test. The results showed that quantity of domestic consumption is stationary at levels with constant at 5% significant except other remaining variables which are non-stationary at level. Therefore, the null hypothesis of unit root could not be rejected at this level since not all series except quantity of domestic consumption of the test

Table 2. Phillips-Perron stationarity test

Tabela 2. Test stacjonarności Phillipsa-Perrona

Variables	Critical value (5%)	*T* statistic	*P* value	Verdict
lnQCProd	–2.8951	–3.2656	0.0196	Stationary
lnQDCON	–2.8951	–3.8692	0.0034	Stationary
lnQWCE	–2.8951	–3.8968	0.0031	Stationary
lnREER	–2.8951	–4.3177	0.0008	Stationary
lnCWMP	–2.8951	–4.5269	0.0004	Stationary
lnTOPEN	–2.8951	–4.1378	0.0014	Stationary

Source: Own calculations based on the orange dataset.
Źródło: obliczenia własne na podstawie zbioru danych dotyczących pomarańczy.

statistics were greater than the relevant critical values. Hence the null of the presence of unit root is accepted. However, the hypothesis of unit root in all series was rejected at 5% level of significance for all series after first difference since the Phillips-Perron test statistics are greater than the respective critical values.

3.3. Johansen Cointegration

The lag order selection criterion to select an optimal lag length was used for Johansen Cointegration analysis. The lag order selection criterion in e-views for lag selection include Sequential modified LR test statistics (LR) each at 5% level, Final Prediction Error (FPE), Akaike Information Criterion (AIC), Schwarz information criterion (SC) and Hannan-Quinn information criterion (HQ). According to the results in the table 3 LR, FPE, AIC and HQ are suggesting 6 lags as optimum while only SC is representing 2 lags as optimum therefore, this study will use 6 lags as optimum since four criterions selected 6 lags while only 1 criterion selects 2 lags.

Table 4 present the estimates of both trace statistic and maximal Eigenvalue tests for cointegration between the variables in the models. The maximal Eigenvalue and trace tests show that the null hypothesis of no cointegration vectors is rejected at 5% significance level, on the other hand the alternative hypothesis of the existence of a long run equilibrium relationship between all the variables in the model is accepted.

Trace test is unable to reject at most 6 null hypotheses thus suggests that there exists at least 5 cointegration relations. Max-Eigenvalues test is unable to reject null hypothesis at most 6 which means according to max Eigenvalues test there is at least 5 cointegration relation that exists between the variables.

Table 3. The lag order results for the Johansen Cointegration

Tabela 3. Wyniki kolejności opóźnień dla modelu kointegracji Johansena

Lag	*LogL*	*LR*	*FPE*	*AIC*	*SC*	*HQ*
0	1083.720	NA	9.28	–26.26147	–26.05601	–26.17898
1	1905.289	1482.832	6.11	–45.10461	–43.46100	–44.44473
2	2114.965	342.6407	1.24	–49.02353	–45.94176*	–47.78625
3	2133.191	26.67290	2.81	–48.27296	–43.75302	–46.45827
4	2164.361	40.29210	4.94	–47.83806	–41.87997	–45.44598
5	2382.523	244.7677	9.99	–51.96398	–44.56772	–48.99449
6	2476.977	89.84673*	4.74*	–53.07262*	–44.23820	–49.52573*
7	2515.320	29.92613	1.09	–52.81269	–42.54011	–48.68840

*Indicates the selected optimal lag length based on each criterion.

Source: own calculations based on results from e-views.
Źródło: obliczenia własne na podstawie wyników badań e-view.

Table 4. Johansen Cointegration estimates

Tabela 4. Wyniki testu Johansena

Hypothesised No. of CE(s)	**Eigenvalue**	**Trace test**		**Maximum Eigenvalue**	
		Statistic	0.05 Critical value	Statistic	0.05 critical value
None *	0.749980	299.0848	125.6154	113.6695	46.23142
At most 1 *	0.485943	185.4153	95.75366	54.56453	40.07757
At most 2 *	0.431591	130.8508	69.81889	46.32299	33.87687
At most 3 *	0.386854	84.52779	47.85613	40.11044	27.58434
At most 4 *	0.285554	44.41736	29.79707	27.57231	21.13162
At most 5 *	0.165763	16.84504	15.49471	14.86149	14.26460
At most 6	0.023899	1.983553	3.841466	1.983553	3.841466

* Denotes rejection of the hypothesis at the 0.05 level.

Source: own calculations based on results from e-views.
Źródło: obliczenia własne na podstawie wyników badań e-view.

3.4. Normality test

The normality of data is tested using that the Jarque-Bera statistic.

H0: The residuals are normally distributed.
Ha: The residuals are not normally distributed.

The decision rule: If P-value of the Jarque-Bera is less than 0.05 (5%) we reject the null hypothesis that the residuals are normally distributed and accept the alternative that states that they are not normally distributed. The test results of the study are that the Jarque-Bera test statistic is 0.539 and the respective P-value is 0.764 which is greater than 0.05, hence it can be said that the residuals are normally distributed and hence null hypothesis is accepted. This indicate that the OLS model can be opted instead of the VECM as illustrated in table 5 below.

Table 5. Jarque-Bera test

Tabela 5. Test Jarque-Bera

	Test statistic	***P* value**
Jarque-Bera	0.539091	0.763726

Source: own calculations based on results from e-views.
Źródło: obliczenia własne na podstawie wyników badań e-view.

3.5. Ordinary Least Squares

Table 6 indicates that 97.26% variation in quantity of citrus export is explained by quantity of citrus production, quantity of domestic consumption, quantity of world citrus export, real effective exchange rate, trade openness and citrus world market price. The Durbin-Watson statistic value indicates availability of autocorrelation in the residuals of time series regression. The closer to 2 the value of the Durbin-Watson statistic is, it can be considered that there is no autocorrelation. The analysis of the study indicate a Durbin-Watson statistic is 2.04 and hence, can be concluded that there is no autocorrelation.

The results indicate that quantity of citrus production and citrus world market price were statistically significant whereas the remaining variables were statistically insignificant. The variables display the correct sign according to literature except for trade openness, this might be attributed to the different variables and period that were applied in this study. The quantity of citrus production

Table 6. OLS estimates

Tabela 6. Wyniki estymacji metodą OLS

Dependant variable: ***lnQCEX***				
Variable	Coefficient	Std. Error	*t*-Statistic	Prob.
lnQCP	0.929085	0.156440	5.938909	0.0000
lnQDCON	–0.125613	0.085977	–1.460994	0.1634
lnQWCE	0.008190	0.206234	0.039712	0.9688
lnREER	0.096258	0.104132	0.924382	0.3690
lnTOP	–0.076219	0.184841	–0.412349	0.6856
lnCWMP	0.178302	0.058583	3.043575	0.0077
C	0.038666	0.400070	0.027617	0.9783
R-squared	0.972639	Mean dependent var		6.092232
Adjusted *R*-squared	0.962378	S.D dependent var		0.132321
SE of regression	0.025666	Akaike info criterion		–4.241545
Sum squared resid	0.010540	Schwarz criterion		–3.895960
Log likelihood	55.77777	Hannan-Quinn criterion		–4.154631
F-statistic	94.79399	Durbin-Watson stat		2.044339
Prob (*F*-statistic)	0.000000			

Source: own calculations based on results from e-views.
Źródło: obliczenia własne na podstawie wyników badań e-view.

is statistically significant and highly positive impact on the citrus exports in South Africa. The coefficient of citrus production is 0.929 therefore, an increase in citrus production will lead to an increase in citrus exports from South Africa, holding other variables constant since the coefficient is positive. The world market price of citrus is statistically significant, and the coefficient displays the correct sign that is in line with the literature. The citrus world market price has positive impact on the citrus export therefore an increase in the citrus world market price will lead to an increase in the quantity of citrus exported from South Africa since the coefficient is positive.

The results of quantity of citrus production and citrus world market price have a positive relationship with citrus export, and they are similar and in line with the study of the analysis of some drivers of Cocoa export in Nigeria in the era of trade liberalisation by Nahanga Verter and Věra Bečvářová (2014) and the study of the determinants of agricultural export trade: case of fresh pineapple exports from Ghana by David Boansi, Boris O.K. Lokonon and John Appah (2014).

4. Conclusion

The study analysed the determinants of citrus export in South Africa in the era of trade liberalisations. The study used time series data from 1996 to 2018 and it was disaggregated into quarters. The results indicate the existence of a long-run equilibrium relationship between citrus exports and the determinants such quantity of citrus production, real effective exchange rate, the citrus world market price, domestic consumption of citrus and trade openness.

The OLS regression results provide evidence citrus production and citrus world market prices are the major influencers of citrus export in South Africa. The results show a positive relationship between citrus export and citrus world market price and citrus production in South Africa, the implication is that more citrus will be exported when the trade price is high and when citrus production in South African increases more citrus will be exported. We therefore recommend that the production of citrus be expanded by introducing programmes that will promote the introduction of new citrus growers and improvement of current production scales.

The results revealed citrus production and citrus world market price are the major drivers of citrus export during the era of trade liberalisation therefore it is recommended that the Department of Agriculture and the Citrus Associations should make initiatives to ensure an increasing in citrus production by deploying the agricultural extension service for the development programmes to the citrus producers, they should also ensure that the citrus production area in the citrus black spot free should be expanded. Investment on research and development of high yielding and more resistant varieties can help increase the South African citrus export. In addition, the international market access should be maintained and secure as many international citrus export markets as possible.

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Analiza ekonomiczna uwarunkowań eksportu owoców cytrusowych z Republiki Południowej Afryki po okresie liberalizacji handlu

Streszczenie: Celem badania była analiza uwarunkowań eksportu owoców cytrusowych z Republiki Południowej Afryki (RPA) po okresie liberalizacji handlu z wykorzystaniem danych wtórnych pochodzących z lat 1996–2018. Aby zbadać relację między eksportem owoców cytrusowych a jego determinantami w długim okresie wykorzystano model kointegracji Johansena oraz klasyczną metodę najmniejszych kwadratów (Ordinary Least Squares – OLS). Wyniki modelu kointegracji Johansena potwierdziły istnienie długookresowej równowagi między eksportem owoców cytrusowych z RPA a jego wybranymi determinantami. Z kolei analiza metodą OLS udokumentowała, że głównymi czynnikami wpływającymi na eksport owoców cytrusowych była wielkość produkcji oraz poziom cen na rynkach światowych. Inicjatywy służące zapewnieniu wzrostu produkcji oraz wspierające rozwój działalności producentów owoców cytrusowych powinny być podejmowane przez ministerstwo właściwe do spraw rolnictwa oraz przez stowarzyszenia branżowe.

Słowa kluczowe: eksport, liberalizacja handlu, analiza kointegracji, owoce cytrusowe, badanie stacjonarności.