Determining integration in potato markets of South Africa

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Abstract:

This paper looks at potato prices in four big fresh produce markets in South Africa, namely, Tshwane, Durban, Johannesburg and Cape Town. It starts by giving an overview of potato industry, its importance and performance of the markets over time. Its contribution in economy of South African includes creation of job opportunities, export earnings for the country, empowerment of traders in the informal sector, food to neighbouring countries, improved welfare of the general population through productivity increases, opportunities for emerging small-scale farmers and income generation in small towns and rural areas. The paper focuses on determining integration in potato markets using weekly potato data from January 2013 to December 2017 by using Cointegration which is run using Eviews. The results show that prices tend to converge towards one price in the long run. The paper also suggests policy implications that will assist smallholder potato farmers as they get exposure to the big formal markets. It also concludes that understanding the market integration will benefit potato consumers, traders and producers. In turn, farmers’ livelihoods and food security will be improved as the farmers operate in an environment they understand.

Keywords: fresh produce markets, market integration, cointegration.
Measuring market integration with potato prices in four big fresh produce markets of South Africa

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1. INTRODUCTION

Prices are repeatedly used as effective signals for allocating scarce resources and in effect stimulate agricultural productivity and economic growth (Barrett, 1996). They are normally used as tools while undertaking economic analysis of markets. In the absence of any information on the markets decision makers find it difficult to allocate their limited resources in a production system. Possessor of valuable information on prices profits from knowing it. The person who is closest to the information at the time it is produced is the one who benefits from implementing it. This paper looks at the data on potato prices in four big fresh produce markets in South Africa, namely, Tshwane, Durban, Johannesburg and Cape Town.

Overview of potato industry

South Africa is the second largest exporter of potatoes in Africa, accumulating over R2 billion in export revenues over the past years Trade Intelligence Report (2015). Over the past decade, yields have increased by over 20% (Bureau for Food and Agricultural Policy (BFAP), 2015). In 2015/2016 period total potato production has increased by 43% (Potato South Africa (PSA), 2016). Almost all of South Africa’s commercial potatoes and potato seed exports are destined for the African market, making the continent an important source of growth for the sector. Meanwhile potato production is set to reach 2.7 million tons over the next decade, up to 23% from the current levels of 2.2 million tons (Trade Intelligence Report, 2015).

Potatoes are planted throughout the year in South Africa and sold at any fresh produce markets of South Africa. The potato market is divided into five segments, in terms of distribution, 35% is taken up by the formal market, 29% by the informal market, 20% goes to processing, 8% is exported and 8% is earmarked for the production of seed potatoes (CHIPS, 2017). The commercial potato exports have been growing at an average of 12% per annum. In 2016 the average market price for potatoes increased by 63% to R47, 80 per 10kg bag. There has been a prolonged increases in the prices of inputs such as fertilizer, diesel and electricity (BFAP 2017). The increases triggered a rise in total production cost of potatoes. According to PSA (2016) there was a fall in production due to severe drought and heat conditions and resulted in significant increases in prices at the time. In early 2016, potato prices rose to the highest levels in history, as a result of an under supply on the markets due
to the unfavorable climate. CHIPS (2017) reported indexes as follows: that the producer price index compounded annual growth rate was 7.7% (while 2014-2015 was 16.2%). The fertilizer price index was 10% (2014-2015 was 3.4%), the fuel price index was 9.3% (2014-2015 was 3.8%) and the chemical price index was 6.4% (2014-2015 was 4%). Potato consumption is increasing for both fresh and processed potatoes. Supply of potatoes tend to increase from January to March resulting in lower prices. The increase in per capita consumption was estimated at close to 40 kg per annum in 2016.

Formal market is the biggest outlet for South African potatoes. Slightly more than a third of the national crop is marketed by the formal marketing channel (DAFF, 2015). The markets are used throughout the industry to set prices for potatoes. Almost 50% of the potatoes traded on the fresh produce markets are distributed in the informal trade sector (PSA, 2016). This creates a fully dynamic functioning free market mechanism. When supply increases, the price immediately drops. On the other hand when the supply diminishes, the price increases.

Importance of potato to smallholder farmers
NAMC and COMMARK Trust (2006), showed that the potato industry makes a huge difference in the lives of many rural communities, providing about 50 000 jobs on primary farm level. This represents nearly 10% of jobs in primary agriculture. The report further showed that in general, the potato industry contributes the following to the South African economy: Creation of job opportunities, large downstream and upstream effect through industry linkages, export earnings for the country, empowerment of traders in the informal sector, food to neighbouring countries, improved welfare of the general population through productivity increases, opportunities for emerging small-scale farmers and income generation in small towns and rural areas.

While there is plenty of literature with statistics on commercial potato producers, less is documented about smallholder potato producers. As smallholder take their produce to small markets which are flawed with challenges they miss out on participating in big fresh produce markets. Lyne, et al. (2009) reported that commercialisation of agriculture is occurring so rapidly in some countries, while in others there is stagnation or even return to subsistence agriculture on a large scale. Lyne, et al. (2009) also stated that agriculture can produce food for consumers and income for smallholders and farm workers, but it can only do so if farmers have access to reliable markets.
Strengthening smallholder farmers’ human and institutional capacities to take advantage of trade and investment opportunities that the big markets offer will contribute to economic and social development and poverty reduction. Lately, there is an increased drive about transformation and empowerment efforts in different industries by government and some commodity groups share the same sentiment. PSA for instance, has a transformation thrust of enterprise development programme that aims at assisting in setting up, supporting and growing viable new black owned potato producing enterprises. There are efforts to balance participation in large potato fresh produce markets so that it does not remain skewed towards the needs of large commercial farmers.

This paper is an addition to efforts and attempts to improve information base for the potato producers in South Africa. Understanding the status of value chain development and the degree of market integration is important to improve food security, as well as people’s livelihood in rural areas (Mumbeya, 2011).

The paper focuses on the behaviour of the four big fresh produce market potato market and seeks to understand if there is integration. Spatial market integration has been widely used to indicate the overall performance of the market. The study seeks to specifically:

1. Determine integration in potato markets using Cointegration
2. Suggest policy implications that will assist smallholder potato farmers to participate in the formal markets.

Mumbeya (2011) conducted a study which aimed to test the performance of cassava markets in the Democratic Republic of Congo. A market integration analysis was conducted to consider whether food policy focusing on those two reference marketplaces would be sufficient to stabilise the cassava supply nationwide. Using Cointegration techniques, an error correction mechanism and an index of market connection, the findings established that among the 11 pairs of trading markets, 6 of them were segmented, meaning that price changes in the reference markets were not fully transmitted to the regional markets.

2. ANALYTICAL FRAMEWORK
Understanding the status of value chain development and the degree of market integration is important to improve food security, as well as people’s livelihood in rural areas (Mumbeya, 2011). Market integration is considered an important determinant of food flow, availability, accessibility and price stability. Market integration is a result of the action of the traders and the environment where the operations takes place, which is determined by the available infrastructure for trading and the policies that could affect price transmission (Du Preez, 2011).

Market integration has recently received considerable attention, particularly in developing countries, because it lends itself as tool to government when policy related questions such as government intervention in markets arise. In principle, market integration relates to the concept of efficiency because of its concerns with the free flow of goods, information and eventually prices over space, form and time. Alternatively, if there is price transmission from one market to another, the two markets are said to be market integrated.

Several methods to test existence and degree of market integration among markets exist including Simple Bivariate Correlation Coefficients, Multivariate Regression methods, Ravallion method and Cointegration and Error Correction Model (ECM). However, some of the early approaches have been unreliable or inadequate to measure spatial price relationship correctly. Because many economic time series are non-stationery, cointegration techniques has been widely been used in time series analyses. This technique has also been adopted for this study to check for the existence of market integration between the four big South African fresh produce potato markets.

Cointegration and ECM:
Even though cointegration is a solution to non-stationarity of the series through establishing an existence of long-run equilibrium between two or more series, it has many applications in applied economics. Since existence of long run equilibriums implies that two or more series are cointegrated, in applied economics this is sometimes believed to be equivalent to existence of market integration. There are several steps which need to be performed on the price series under examination to put cointegration technique into application, as developed by Engler and Granger.
The first step is to test for the order of integration of the series i.e. the number of times the series need to be differenced before it becomes stationery. A series is said to be integrated of order d, I(d) if it has to be differenced d times for it to become a stationery series. Augmented Dicky Fuller (ADF) test is normally used to test for the order of integration of a series where null hypothesis suggests that as series is non-stationery and the alternative hypothesis suggests otherwise. If ADF has been performed in all the series to be included in regression equation and the series are stationery, then OLS procedures are valid. However, if the series one or more series to be included in the equation is non-stationery OLS becomes invalid.

Therefore, assuming that one or more series is non-stationery, Engler-Granger suggest the following step to test existence of long run relationship among the series. Engler-Granger Cointegration test is a test on the residual of the cointegration equation. If the residuals of the long-run equilibrium relationship are stationery, cointegration is said to exist. Therefore, the third step is to test for stationarity of residuals from the cointegration equation using and ADF test is for a single series. In a case where the cointegration equation is formed by two or more series, Engler-Granger single equation cointegration test has to be used. This is because the p-value of from the ADF test on the residual will not be correct to use for inference, as it is the based on the MacKinnon (1996) response surface critical values for a single series. Since the residual represents the linear combination of the variables in the long-run relationship, the appropriately calculated critical values should be based on this fact.

3. METHODOLOGY

3.1 Data Sources and Types
This study used time series data on potato obtained from PotatoSA. The weekly data starts from January 2013 to December 2017.

3.2. Methods of Data Analysis
Econometric methods of data analysis used are: Augmented Dicky Fuller and Engel Grange Cointegration tests which are specified above to examine potato market integration of Cape Town, Johannesburg, Durban and Tshwane fresh produce markets.

The four price series were first tested for stationarity using data plots, correlograms and formal unit root tests like Augmented Dicky Fuller test. After they were found to be non-
stationery series (i.e. AR(1)), cointegration technique was used to search a long run relationship between these variables. Even though in the principle of Cointegration is a solution to non-stationarity of series, empirically it has been used to test for market integration amongst Fresh Produce markets. Johannesburg market, which is the biggest market, was regressed against Durban market, Cape Town Market and Tshwane market in the model.

4. RESULTS AND DISCUSSIONS

4.1 Stationarity test

In econometric analysis, stationarity and non-stationarity of data were checked first before other techniques like cointegration can be employed. One of the most important assumptions made in cointegration relationships is same order of integration of the data. To test for stationarity of weekly time series of price for potato at Johannesburg, Durban, Cape Town and Tshwane market from January 2013 to August 2017, ADF test is performed with a trend and intercept.

Table 1: Stationarity test for potato prices at Johannesburg, Durban, Cape Town and Tshwane market

<table>
<thead>
<tr>
<th></th>
<th>Johannesburg market</th>
<th>Durban Market</th>
<th>Cape Town market</th>
<th>Tshwane market</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADF test statistic &amp; (P-values)</td>
<td>-15.45 (0.000)</td>
<td>-16.19 (0.000)</td>
<td>-14.18 (0.000)</td>
<td>-15.74 (0.000)</td>
</tr>
<tr>
<td>Null hypothesis</td>
<td>Rejected</td>
<td>Rejected</td>
<td>Rejected</td>
<td>Rejected</td>
</tr>
<tr>
<td>Stationary status</td>
<td>Stationary</td>
<td>Stationary</td>
<td>Stationary</td>
<td>Stationary</td>
</tr>
</tbody>
</table>

Results presented on Table 1 show that after taking the first difference of potato prices at Johannesburg, Durban, Cape Town and Tshwane market, they became stationary as confirmed by using ADF test. Therefore, for both variables the null hypothesis of the unit root is rejected at conventional levels (1%, 5% & 10%) of significance at their first difference. It can be concluded that, the unit root test reveals that the price variables used in
Johannesburg, Durban, Cape Town and Tshwane market for potato prices are stationary at the ADF unit root tests. In order to continue with the analysis, all variables in each model should be integrated in the same order which are these variables are integrated at the first order 1. Due to this reason, the analysis will continue with the co-integration technique to assess if there is long-run relationship between prices in these markets.

Cointegration equation

To test for the presence or absence of co-integration between Johannesburg, Durban, Cape Town and Tshwane market regarding potato prices in the period under consideration Engler-Granger method was used. One of the conditions for testing co-integration for time based data is that time series must be non-stationary in nature and both series must be integrated of the same order.

It has been already identified that Johannesburg, Durban, Cape Town and Tshwane fresh produce potato market price series are stationary at 1%, 5% and 10% levels of significance hence are integrated of at order one. The long run equilibrium relationship at Johannesburg, Durban, Cape Town and Tshwane market were estimated by regressing the four market prices and saving the residual. The residual was also tested to establish if it was stationary or not. If it was stationary, it would confirm the presence of integration between Johannesburg, Durban, Cape Town and Tshwane market for potato prices in long term.

Table 2: The logarithmic regression of Johannesburg by Durban, Cape Town and Tshwane market potato prices

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>LNDURBAN</td>
<td>0.691230</td>
<td>0.033134</td>
<td>20.86181</td>
<td>0.0000</td>
</tr>
<tr>
<td>LNCAPETOWN</td>
<td>0.053571</td>
<td>0.027957</td>
<td>1.916165</td>
<td>0.0565</td>
</tr>
<tr>
<td>LNTSHWANE</td>
<td>0.252159</td>
<td>0.026842</td>
<td>9.394275</td>
<td>0.0000</td>
</tr>
<tr>
<td>C</td>
<td>0.020834</td>
<td>0.067891</td>
<td>0.306870</td>
<td>0.7592</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.932501</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Adjusted R-squared | 0.931704
---|---
S.E. of regression | 0.064032
Akaike info criterion | -2.643478

After running the regression and saving the residuals, the next step was conducting stationarity test for the predicted residuals by using ADF test. However, since there were more than two series in the cointegration equation Engle-Granger Cointegration test was used because the p-value of from the ADF test on the residual would not be correct to use for inference, as it is based on the MacKinnon (1996) response surface critical values for a single series. Since the residual represents the linear combination of the variables in the long-run relationship, the appropriately calculated critical values should be based on this fact.

Based on economic theory, once a set of variables that form a cointegrated relationship has been found, discussion of statistical inference using standard errors, t-statistics, F-statistics and p-value should be avoided. This is because Engle-Granger showed that when performing OLS on non-stationary data, the standard error, and therefore t-statistics will be biased because the sampling distributions of non-stationary data are non-standard with “fat tails”), and therefore statistical inference relying on asymptotic theory is invalidated. The F-distribution will also be non-standard and therefore the F-statistic (to test for joint significance of all independent variables) can also not be used for statistical inference. The same applies to R-squared and Adjusted R-squared statistics.

Therefore, In the empirical result above, the focus would be on the following: firstly, whether the residual (blue line in graphical depiction) is stationary (I(0)), in which case we will conclude that the variables included form a cointegrated relationship. The next important question to ask then is whether the signs and magnitudes of the coefficients are in accordance with expectations based on economic theory. It is important to note that the statistical significance of the coefficients of the long-run relationship are not discuss.
Figure 1: Residuals

Figure 1 depicts the residuals from the long run equation. The graph shows stationery residuals. The next step is to perform a formal unit root test on the residuals to prove if indeed they are stationery.

Table 3: Engle-Granger Cointegration test

<table>
<thead>
<tr>
<th>Dependent</th>
<th>tau-statistic</th>
<th>Prob.*</th>
<th>z-statistic</th>
<th>Prob.*</th>
</tr>
</thead>
<tbody>
<tr>
<td>LNJHBG</td>
<td>-13.68855</td>
<td>0.0000</td>
<td>-217.8019</td>
<td>0.0000</td>
</tr>
<tr>
<td>LNDURBAN</td>
<td>-12.56220</td>
<td>0.0000</td>
<td>-195.7410</td>
<td>0.0000</td>
</tr>
<tr>
<td>LNCAPE TOWN</td>
<td>-6.313055</td>
<td>0.0000</td>
<td>-76.66730</td>
<td>0.0000</td>
</tr>
<tr>
<td>LNTSHWANE</td>
<td>-7.591649</td>
<td>0.0000</td>
<td>-151.4820</td>
<td>0.0000</td>
</tr>
</tbody>
</table>


**Number of stochastic trends in asymptotic distribution

The null hypothesis is that series are not cointegrated and the alternative hypothesis is that series are cointegrated. Based on the results above, LNJHBG, LNDURBAN, LNCAPE TOWN, LNTSHWANE form a long-run cointegration relationship when inference
is made at conventional levels (1, 5 or 10% levels of significance) against the P-value of the dependent variable (0.000). It can be concluded that the three series are cointegrated at conventional levels. Therefore, a conclusion can be made that market integration exist in the four biggest markets of South Africa (i.e. prices tend to converge towards one price in the long run).

CONCLUSIONS AND IMPLEMENTATIONS
When markets are integrated traders cannot exploit the market to their benefit and farmers will be able to benefit too. This will enable the farmers to produce in an environment they understand while potato consumers will benefit from effective prices and society as a whole will be better off. When the playing field is levelled in terms of removing bottlenecks (including information asymmetry) then smallholder potato farmers will confidently participle in the formal fresh produce markets and their livelihoods status will be improved significantly.

Agricultural production for markets reduce consumption expenditure and helped household to accumulate cash savings or invests in assets (Lyne and Hendricks, 2006). The assets of the smallholder farmers who would start producing for big formal markets after they have been introduced to such markets are expected to experience change in the way they spent their income and accumulate assets. Such assets are likely to protect their households from income shocks.
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