Global price transmission in Senegal's groundnut markets: can smallholders benefit from high international prices?

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Abstract

In this paper, we seek to know whether the smallholders in Senegal can benefit from the high world prices. By means of Enders and Siklos (2001) approach, we analyzed the asymmetry of price transmission from the global market to the Dakar market which is the central market in Senegal. Moreover, the transmission from the central market to the local markets is studied. Our findings show that the groundnuts national central market is not integrated to the international market. Otherwise, the transmission between the central market and local markets of groundnuts is symmetric. Furthermore, it takes two months for a shock to be fully transmitted to local markets. Thus, it will be possible for the smallholders to benefit from the high world groundnut prices as the local markets and the central market are well integrated if this later and the international one are integrated.

Keywords: Groundnut, Global market, national markets, smallholders, asymmetry of price transmission.

1 Introduction

Groundnuts have remained Senegal's premier export crop (Master, 2007). According to Cissé et al. (2005) around 73% of the households living in rural areas partly gain their income from the groundnut production. Furthermore, in Senegal, the groundnut constitutes about 80% of the producer's cash income and export earnings (Sylla, 2010). The groundnut marketing, thus, plays an important role in the Senegalese economy and contributes importantly to the living conditions of the rural population. However, although the groundnut production employs a large share of the active population in rural area, the value added of this activity represents only around 3% of total value added (Cissé et al. 2005). Studies have partly linked the low income of the groundnut farmers to the heavy government intervention in the sector (Badiane et al. 1997, 2010).

The groundnut production in Senegal is first purchased by the local processing company (around 25%) and also Farmers are compelled to sell the surplus in the parallel (unofficial marketing channel) market at a lower price to at least gain profit from its production. It is exported or consumed as boiled, grilled, peanut butter, flour, and processed locally in oil using small processing machines. The main actors of the sector are producers, intermediaries and industrial. Exports valued $4 million (5,515 tons) covering 2006 to 2010 (4 years) with United Kingdom (58%), Netherlands (24%) and Mauritania (10%) being the main importers of groundnut (Sylla, 2010). After a long period of intervention, the Senegalese government has been engaged in a process of liberalization of the groundnut market (Badiane et al. 2010).

In recent years, agriculture commodities prices are increasing more and more. For example, the global food crisis of 2007–2008 was characterized by a dramatic increase in the prices of agricultural commodities in international markets. Between January 2007 and March 2008, the food price index of the Food and Agriculture Organization (FAO) rose by 61%. Staple food crop prices rose even more steeply: Over the same period, the prices of wheat and rice doubled, while that of maize increased by 42%. Since then, food prices have declined somewhat, but prices remain significantly higher than the average in 2006. For example, the average price of rice in 2009 is 90% higher than the average level in 2006. Many studies have shown that the commodities prices spikes have an asymmetric impact on the households' welfare as some household are net buyers and others net sellers.

Given that the groundnut is a cash crop, this study aims on the one hand to find out whether the process of liberalization is completed in terms of market integration between the central market and the international one. On the other hand, it consists to analyze the asymmetry of groundnut prices transmission from the central market to local ones. Determining the existence of asymmetries in price transmission in the groundnut sector is important for understanding whether small producers can actually benefit from higher world market prices. Furthermore, an understanding of price transmission mechanisms can inform policymakers on the type of intervention that can be done to maximize groundnut producers' income. The analysis is conducted in two steps. Firstly, we study how the groundnut price at the global level affects the groundnut prices in the central market[2] located in Dakar. Second, we consider the groundnut prices transmission from the central market to local markets located in Kaolack and Fatick which supplies are mainly composed by smallholders' productions.

This paper continues as follows. After the introduction, the second section is devoted to the Methodology and the third one to the descriptive analysis. In the fourth sections the findings are presented. In the last section, we draw some conclusion regarding the liberalization process and the asymmetry of price transmission.

[2] See Badiane et al., (2010) for the procedure of determining the central market.

2 Methodology

To study the mechanism through which the groundnut prices are transmitted across markets, we based ourselves upon the cointegration theory. In particular, we apply the methodology proposed by Engle and Granger (1987) to test the existence of a long-run or a cointegration relationship between two series. Enders and Granger (1998) and Enders and Siklos (2001) suggest the modification of the Augmented Dickey Fuller test conducted on the residuals of the estimations of the cointegration relation. The main objection that can be raised against the Engle and Granger approach (1987) is that their specification cannot take into account the asymmetry of transmission as the authors assume that the speed of adjustment is the same for all type of shocks which may not always be the case. Many econometric methods exist to take into account this phenomenon. In this study, we have chosen to focus on the Threshold cointegration approach to analyze price transmission following Hassan and Simioni (2004).
The first step in the analysis of the price transmission mechanism is the investigation of the dynamic properties of the price series in order to understand if price pairs are integrated in the same order by testing the presence of unit roots. The Augmented Dickey-Fuller (ADF) test is the most popular test applied for this purpose. We run the ADF with and without a time trend and a constant term for a number of lags varying from two to twelve (which is the time period of the series).

let P_t^l and P_t^c respectively, be the groundnut price in the local market and central market of groundnut in log-level. Assume that the two series of prices are integrated in order one. The steps of estimation as describe by Hassan and Simioni (2004) are follows:

Step 1: we estimate the following relation: $P_t^l = \alpha + \beta * P_t^c + \mu_t$ (1)

Where α and β are the parameters and μ_t is the error term. Let μ_t^{est} be the value of the error term estimated.

Step 2: we then estimate the following relation:

$$\Delta\mu_t^{est} = \rho_1 \mu_{t-1}^{est} I(\mu_{t-1}^{est} \geq 0) + \rho_2 \mu_{t-1}^{est} I(\mu_{t-1}^{est} < 0) + \sum_j \varphi_j \Delta\mu_{t-j}^{est} + \varepsilon_t \quad (2)$$

where $I(A) = 1$ if the condition is satisfied and 0 if not. The lag order used is first selected assuming that the ε_t estimated are white noise. To test whether this property holds, we use the Ljung-Box test (Bourbonnais and Terraza, 2010). The choice of lag order for the model is

particularly important. A key issue is thus the identification of the correct number of lags to include in the model. In fact, both under and over parameterization can create problems, respectively, of misspecification and unnecessary reduction in the degrees of freedom. The relevant lag order was chosen here through the minimization of the Akaike information criterion. The procedure of selection is to estimate all the autoregressive distributed lags from 1 to h (h is frequency of data).There are various types of information criteria. But, the main ones used are: The Akaike Information Criteria and The Schwarz Information Criteria (Bourbonnais and Terraza, 2010).

Step 3: we use the Fisher Statistic to test the null hypothesis of absence of stationarity of the series μ_t^{est}, in others terms $\rho_1 = \rho_1 = 0$. The null hypothesis is equivalent to the hypothesis of absence of a cointegration relation between the two prices. If this hypothesis is rejected, the two series are cointegrated. The critical values of this test are given by Enders and Siklos (2001). It is important to note that the usual Engle and Granger approach (1987) of testing the existence of a long-run relationship corresponds to the test of null hypothesis ρ=0 when $\rho_1 = \rho_1 = \rho$ in equation (2). In fact, it is the generalization of the long-run relationship test or the Augmented Dickey Fuller test in order to detect the non-stationarity of the series.

Step 4: if the null hypothesis when $\rho_1 = \rho_1 = 0$ is rejected, it is possible to test if the adjustment is symmetric or the null hypothesis when $\rho_1 = \rho_1$ by using the usual Fisher test.

Step 5: If the null hypothesis of symmetry is rejected, then the short-term dynamic between the two series may be specified by the following error correction mechanism:

$$\Delta P_t^l = \delta_1 \mu_1^+ + \delta_2 \mu_2^- + \sum_j \lambda_{1j} \Delta P_{t-j}^l + \sum_j \lambda_{2j} \Delta P_{t-j}^c \qquad (3)$$

Where $\mu_{t-1}^+ = \mu_{t-1} I(\mu_{t-1} \geq 0)$ and $\mu_{t-1}^- = \mu_{t-1} I(\mu_{t-1} < 0)$

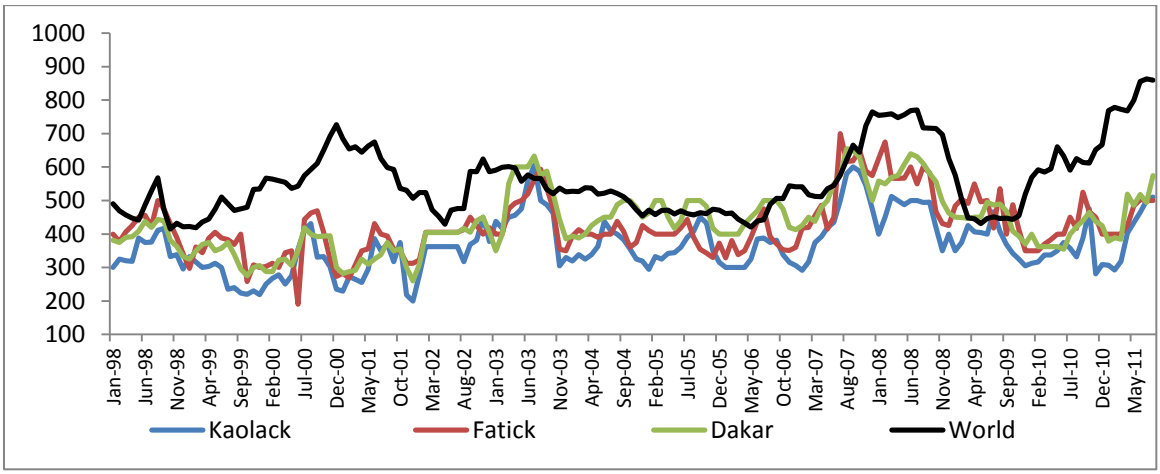
If the null hypothesis of symmetry is not rejected, then the short-term dynamic may be represented as the initial approach of Engle and Granger (1987).

3 Data source and Descriptive Statistics

We use monthly data from January 1998 to august 2011 for international and local markets. The world price comes from the International Monetary Fund database and the national ones from the *Système d'Information des Marchés du Sénégal*. In order to work in the same currency we convert the international groundnut price which is in dollar into FCFA. So the exchange rate between the dollar and the FCFA is used. These data come from Econ Stats. As mentioned above the main Senegal's markets of groundnut are Kaolack and Fatick ones where are the majority of the producers and Dakar. For the later it is the price average that is used for Tilene, Castors, Gueule Tapée and Thiaroye.

The following figure displays the evolution of groundnut price per kg for national and international markets. It appears that the Global price of groundnut is higher than local ones more especially from May 2009 to August 2011.

Figure 1: International and national groundnuts prices



Source: Author.

Table 1 displays some descriptive statistics for the data series. For each region we have around 164 observations. World market seems to have the highest price average. In fact, during the period from January 1998 to December 2011, the average price of one kilogram (kg) of groundnut in the world market is 559 FCFA while the Dakar one is around 435 FCFA, the highest among national markets. In terms of volatility, the coefficient of variation shows that the world market is less volatile than national ones. In fact, the International groundnut price coefficient of variation is 19% while Dakar and Fatick ones are 20%. But Kaolack's one is the most volatile with a coefficient of variation of 22%.

Table 1: Summary Statistics

Variable	Obs	Mean	ST[1]	CV[2]	Min	Max
kaolack	164	367	82	22%	200	605
fatick	164	423	86	20%	190	700
dakar	164	435	89	20%	260	655
world	164	559	106	19%	415	863

Source : Author ; [1]Standard-deviation; [2]Coefficient of variation.

4 Findings

In Annex 1, the results of the Augmented Dickey-Fuller test on the price series before and after differentiation are presented. The test shows that the null hypothesis of the presence of unit roots in the series can be accepted at the significance level of 1% and 5%. This denotes that the series are non-stationary. But, after the first differentiation, the test statistics show that the null hypothesis of presence of unit roots is rejected. Therefore, we conclude that our series are first difference stationary or in other words, they are integrated in order one.

As the series are integrated in the same order, we have to estimate the residuals of the three models. The first (Model 1) is for the price transmission between Dakar and the world market price. The second (Model 2) specifies the type of transmission between Dakar and Kaolack assuming that Dakar is the central market. The last one (Model 3) describes the transmission between Fatick and Dakar. As previously mentioned, we conduct the test of the optimal lag choice by considering the Information Criteria. The AIC gives us the optimal lag order for the threshold equations (see annex 1).

Table 2 presents the value of the AIC enabling us to choose the optimal lag order and its value. The tests of cointegration and symmetry, given by the Fisher statistic and Enger and Siklos (2001), are also displayed. It appears that the best lag order to include in the threshold model for the price transmission between the global market and the central market of Dakar is one.

The co-integration test shows that there is no a long-run relationship between the groundnut price on the world market and on the Dakar's one. Thus, the error correction specification is not valid and we will model the relation in first order difference. For the case of price transmission from Dakar to Kaolack, the test detects a cointegration relation (Φ=18.84>6.01). But the symmetry test accepts the null hypothesis of absence of asymmetry. It is important to note that the optimal lag order is one. We therefore use the standard Engle and Granger representation to model the relation between Dakar and Kaolack groundnut's prices. A similar result is found for the price transmission from Dakar to Fatick. It appears that the Engle and Granger short dynamic representation is the most appropriate because of the presence of cointegration (Φ=18.19>6.01) and symmetry (p-value=0.5890).

Table 2: Cointegration and symmetry tests

Models	AIC	Lag order	H°: No co integration $\rho_1 = \rho_2 = 0$	H°: symmetry $\rho_1 = \rho_2$
World-Dakar	-349.6	1	ρ_1= -0.093(-1.39)[1] ρ_2= -0.123(-2.09) Φ=5.60 [2]Critical value 5% =6.01	
Dakar-Kaolack	-282.2	1	ρ_1= -0.624(-4.70) ρ_2=-0.283(-2.09) Φ=18,84 Critical value 5% =6,01	F-statistic (p-value)=0.1232
Dakar-Fatick	-297.7	1	ρ_1=-0.438(-2.89) ρ_2=-0.560(-4.34) Φ=18.19 Critical value 5% =6,01	F-statistic (p-value)=0.5890

Source: Author's calculations, [1]Student t-test for ρ1= 0; [2]From Engle and Siklos table (2001)

We now model the groundnut price transmission mechanism between the various markets.

Table 3 displays results for the transmission from the world market price to the groundnut price in Dakar. The Fisher-Statistics shows that the model is globally significant (F (2, 158) =2.81>2.6) at 5%. According to the ARCH test at 5% (Chi-squared (1) = 2.598<3.841), the error terms are not autoregressive conditional heteroskedastic. The residuals are normally distributed as shown by the Shapiro Francia test (p-value=0.0802). The residuals are also homokedastic as the Breusch-Pagan illustrates (p-value=0.7279). Finally, in order to test higher order serial correlation, we apply the Breusch-Godfrey test, which confirms the absence of autocorrelation (p-value=0717). The model shows that Dakar's groundnut price of the previous month influences significantly the current price. An increase of 10% in the price of the previous period generates a 2% increase in the actual price.

Table 3: Regression results for Dakar

ΔDakar(t)	Coefficients
Δ Dakar(t-1)	0.206(0.034)***
ΔWorld(t)	-0.041(0.069)
ΔWorld(t-1)	0.155(0.021)*
Constant	0.020(0.009)**
Adj R-squared	0.10

Source : Author's calculations

There is no instantaneous price transmission from world market to Dakar market. But the previous month world price affects positively Dakar groundnuts price at 10%. The low transmission from the world market price to Dakar's market price may be related to the policy

framework in place according to which the government sets the groundnut price independent of the prevailing world market prices. This result is important because it points out that the liberalization process is not yet complete in Senegal and the removing of distortions can increase the groundnut price in Dakar. The world market prices are higher than those that have currently prevailed in the Dakar market. This Distortion is a kind of implicit subsidy by the government to its new private owners to the disadvantage of groundnut farmers in the country. Therefore, the liberalization of these policies should be expected to redistribute transfers in favor of producers as stated by Badiane et al. (2010).

Table 4 shows results from the regression of the groundnut prices in Kaolack on Dakar prices. The Fisher-Statistic shows that the model is globally significant (F (4, 157) = 24.29>2.45) at 5%. In addition, we find no autocorrelation of error terms according to the Breusch-Godfrey test at order 2. The Breusch-Pagan test reveals that the errors are not homoskedastic. We therefore estimate a robust standard error least squared regression. This procedure does not change the values of the coefficients. It is important to point out that the error correction specification is applicable.

Table 4: Regression results for Kaolack

ΔKaolack(t)	Coefficients
Residuals (t-1)	-0.453(0.032)***
ΔKaolack(t-1)	-0.091(0.001)
ΔDakar(t)	0.828(0.101)***
ΔDakar(t-1)	0.068(0.008)
Constant	0.053(0.007)*
Adj R-squared	0.14

Source : Author's calculations

In fact, the coefficient of the residual lag is negative, less than one in absolute value and significant. This means that there is a long-term relation between the groundnut prices in the markets of Kaolack and Dakar. In the case of divergence, around 45% of the gap is corrected each month. In other words a disequilibrium is corrected after 2,2 months. In terms of short-term transmission it is thus clear that there is a strong contemporaneous transmission between the two markets. In fact, 10% of the increase in Dakar's price leads to an 8% increase in Kaolack's price. However, the last period price in Dakar and Kaolack has no impact on the current groundnut price in Kaolack.

Table 5 shows the results for the relationship between groundnut prices in Dakar and those in Fatick. Similar to the two others, this regression is globally significant (F (4, 157) = 7.82>2.45). Like in the previous model for Kaolack, we find no autocorrelation of error terms according to the Breusch-Godfrey test (p-value=0.8665) at order 2. The Breusch-Pagan test shows that the errors are not homokedastic so, again, we estimate a robust standard error least squared regression. The error correction mechanism appears appropriate. In fact, the coefficient of the lag residuals is negative significant and less than 1 in absolute value. This result reveals that a long-term relation between groundnut's prices in Fatick and Dakar's groundnut markets does exist. In this case the speed of adjustment is slightly higher compared to Kaolack's market. We find that around 48% of the disequilibrium between the two markets is corrected each period in case of divergence.

Table 5: Regression results for Fatick

ΔFatick(t)	Coefficients
Residuals(t-1)	-0.484(0.037) ***
ΔFatick(t-1)	-0.111(0.002)
ΔDakar(t)	0.550(0.047) ***
ΔDakar(t-1)	0.195(0.029)*
Constant	0.156(0.001)*
Adj R-squared	0.29

Source: Author's calculations

In the short-term, Fatick's past prices have no effect on the current prices. However, there is instantaneous transmission of Dakar's price to Kaolack's one. In fact, 10% of the increase in Dakar's price leads to a 5.5% of increase in the Fatick market. Dakar's last period price also has an effect on Fatick's current price. An increase of 10% in Dakar's last period price causes an increase of around 2% in Fatick's present groundnut price.

5 Conclusion

In this paper we apply the Ender and Siklos (2001) approach to analyze the global price transmission to Senegal groundnut markets. The first transmission is from the world to Dakar market by making the assumption of small country. The analysis shows that there is no a long-run relationship between the world groundnuts price and Dakar's one. The second transmission is between Dakar and Kaolack by assuming that Dakar is the central market. It appears that there is a cointegration relationship between Dakar groundnut price and Kaolack's one. However, the test of symmetry shows that the price transmission is symmetric. Furthermore a disequilibrium is corrected after 2,2 months. The last transmission is Between Dakar and Fatick. It appears that the groundnut price in Dakar and Fatick one are cointegrated. However, the transmission is symmetric between the two markets. Moreover, around 48% of the disequilibrium between the two markets is corrected each period in case of divergence. So, it will be possible for smallholders to benefit from high world groundnut prices if the process of groundnut sector liberalization is finalized in other words by connecting the national markets to global one.

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Annexes:

Annex 1: Unit root test

DFA before difference				
Series	Stat.	V.Crit. at 1%	V.Crit. at 5%	V.Crit. at 10%
Wmprices	0.662	-2.592	-1.950	-1.614
Dakar	0.255	-2.592	-1.950	-1.614
Kaolack	0.197	-2.592	-1.950	-1.614
Fatick	-0.015	-2.592	-1.950	-1.614
DFA after difference				
Séries	Stat.	V.Crit. at 1%	V.Crit. at 5%	V.Crit. at 10%
Wmprices	-9.898	-2.592	-1.950	-1.6
Dakar	-10.182	-2.592	-1.950	-1.614
Kaolack	-12.775	-2.592	-1.950	-1.614
Fatick	-16.495	-2.592	-1.950	-1.614

Source : Author's calculations.