Analysis of food self-sufficiency in rice in Senegal

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Abstract

Since the end of the crisis of high food (including rice) and fuel prices in 2008, the issue of coverage of rice needs through domestic production alone reappears in Senegal, rice is the main cereal consumed by Senegalese. This study aims to analyze in a context of high dependence on imports the question of self-sufficiency in rice. Using data on agricultural statistics, external trade and a descriptive analysis, it appears that the local rice sector is not competitive in terms of production costs, the consumer price and quality. By an error correction model, this study reveals that in the long-term decline massive rice imports in favor of domestic production. But in the short term, increased production leads as that of imports showing that changing consumption habits is not immediate from the population. The study also revealed that the plantings and the producer set by the state, influenced rice production in contrast to rainfall and prices in the international market.

Key Words: ARDL, competitiveness, error correction model, production

1. Introduction

Agricultural-based economy, Senegal is a country with high rice consumption (1 million tonne of white rice per year[1]). However, the national rice production cannot meet the needs of the population. Therefore only rice imports from Asia (FCF 600 billion per year[2]) can meet this demand. Senegal is then described as a no-self-sufficient in rice and vulnerable to shocks in the international market of this cereal. Following the soaring price of rice on the world market in 2008, which led to rising prices in the domestic market and "riots", the Senegalese government has taken a number of measures including the implementation the NRSP (National Rice Self-Sufficiency Program). This program was designed to achieve a rice production up to 1 million tonne for 2012.
The objective of this study is to analyze the current context of globalization, if it is wise for Senegal to produce rice and how local production can meet the requirements. In a specific way, it's to analyse the competitiveness of local rice, to determine the factors that influence local rice production and to analyze the dynamics between production and imports of rice. In order to achieve this, the use of descriptive statistics and time series econometrics was necessary. The analysis was conducted using information on the rice sector and the trade balance in rice produced in Senegal. The data comes in part from the NASD[3] and OSIRIZ. Data on rainfall areas of rice were provided by the National Agency Rainfall and Meteorology of Senegal (ANAMS). Annual statistics on the price of rice on the world market have been extracted from the database of UNCTAD[4]. This variable is used as a proxy for the price of Thai rice 100% broken. The data are annual and cover the period 1980-2010.

2. Methodology

To achieve the objectives set out above, the methodology is essentially a descriptive analysis of the rice sector and the econometric analysis. The economic analysis uses tools of cointegration: Pesaran et al. (2001) and Johansen (1988, 1991). Also, it will analyze the dynamic between production and

[1] National Agency of Statistics and Demography (NASD).
[2] National Agency of Statistics and Demography (NASD).
[3] National Agency of Statistics and Demography (NASD).
[4] United Nation Conference on Trade and Developpement.

imports of rice and then conclude by looking at whether it is possible for Senegal to achieve its goal: To be self-sufficient in rice in 2012.
Before estimating models, cointegration tests were made. Thus, a better specification of the equations could be obtained while avoiding "spurious regressions." The error correction models were mainly used. The three major phases of the methodology are:

- Step 1: Study of the stationarity

This step is essential[5]. It is possible that the order of integration of the variables is not convincing from a single unit root test as it is a small sample size. InTime series, the non-stationary series are distinguished from stationary series by the fact that they have a trend, seasonal fluctuations or non-constant variance over time. Although there are several unit root tests, three were primarily used: ADF (1981), PP (1988) and KPSS (1992).

- Step 2: Study of the cointegrating variables

In 1981, Granger introduced the theory of cointegration which allowed to statistically defining the economic concept of long-term relationship between the variables. However, the approach of Granger does not distinguish multiple cointegrating vectors. To overcome this problem in 1988, seven years later, Johansen suggested a multivariate approach based on the method of maximum likelihood. Considering at least two (2) variables, we are interested in the following null hypothesis: there are **k** cointegrating relationships between the variables. To determine **k**, Johansen proposed trace test and the maximum eigenvalue test. The trace test does not indicate which variables are cointegrated. The cointegration test used for modeling based on rice production is the Pesaran et al (2001). This test procedure eliminates the restrictive framework of Engle and Granger (1987) for which the cointegrating relationship between the series can only exist if they are cointegrated of the same order, and exceed that of Johansen (1988, 1991).

- Step 3: Estimation and diagnostic tests

This step was set to estimate the models by OLS and to do tests on model residuals (normality test, homoscedasticity test and autocorrelation test).

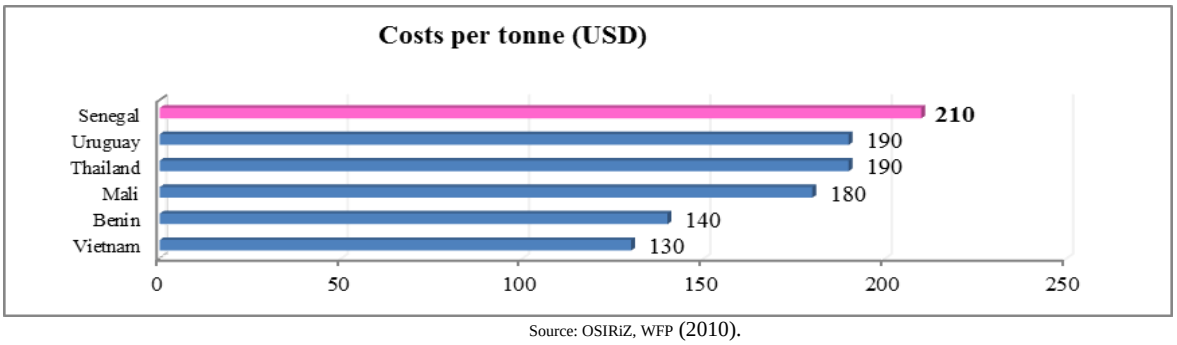
3. Results

The results are presented in three parts according to the specific objectives of the study.

- Analysis of competitiveness

The production cost per tonne[6] of paddy rice from Senegal was compared to the production costs of its suppliers than those of other countries. Vietnam ($ 130) and Thailand ($ 190) producing paddy at a lower cost compared to Senegal. Asian production costs are low compared to the local Senegalese rice, between $ 20 and $ 80 difference (see Figure 1).

Figure 1: Comparison of production costs per tonne of paddy (in USD)



Source: OSIRiZ, WFP (2010).

Asian producers have therefore the advantage of being able to market their products at lower prices. This is true on the domestic market. In fact, the average price of an imported kilogram of rice has been for the last twenty years, below that of the local one: 213 CFA francs against 250 CFA francs[7]. Local broken rice is not competitive at production costs.

[5] A linear regression with no-stationary variable is invalid. The distribution of the regression parameters does not follow a Student but a Brownian motion. In addition, the stationarity also plays an important role in the prediction of time series for the prediction interval is different depending on whether the series is stationary or not.
[6] The comparative costs do not include the costs of processing or marketing costs. It is specifically costs to yields per hectare.
[7] Commissioner for food security (2010).

In addition, the merchant Senegalese rice is unscented while imported rice is partly (broken and whole). In addition, the unscented imported broken rice is a clear white color while the local broken rice is a dirty white which, in addition lacks of homogeneity. Also, the local rice is not available all year round while the broken rice is imported. Local rice is only available during campaigns June-July and October-December for rice under rain, and February-March to June-July for the off-season campaign that takes place mostly in the River Valley north. In terms of quality and availability, the local broken rice is uncompetitive compared to imported rice from Asia, although it has a higher nutritional value[8].

- Determinants of rice production

The model is built with four variables that might explain the local production of white rice. It is the rainfall (rainfall cumul in rice areas), rice areas planted (sup), the price of rice on the world market, the producer price set by the state (prix2); these variables are specified in logarithms. The production and the world rice price are found to be integrated of order one (1) while the other variables are stationary. An analysis of cointegration between these variables is imposed to clearly identify the true relationship between the variables, seeking the existence of at least one cointegrate vector and eliminating the effects if any. ARDL and a model were estimated. The results are summarized in table 1 below.

Table 1: Cointegration test of Pesaran et al. (2001)

Testing for existence of a level relationship among the variables in the ARDL model				
F-statistic	95% Lower bound	95% Lower Bound	90% Lower Bound	90%Upper Bound
2,2701	2.6651	6.988	2.1328	3.3187
W-statistic	95% Lower bound	95% Lower Bound	90% Lower Bound	90%Upper Bound
11,3503	13.3254	19.9399	10.6642	16.5963

Source: Our tests.

The optimal model is ARDL (1, 0, 0, 1, 1). The test statistic is less than the lower limit of the interval. There is no cointegration in the variables. The initial model is estimated by OLS. However, the coefficients of the rainfall and the difference between the world rice price between years is not significant. This has led to the estimation of a new model with the variables for which coefficients are significant, that is to say, the variables that explain the level of production. Table 2 summarizes the results of the second estimates.

Note: The residual diagnostic tests reveal no problem.

Table 2: OLS estimation of the production model

Dependent variable: D(LYR)		**Method: OLS**		
Sample (adjusted): 1981-2010		Included observations: 30 after adjustments		
Variables	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
lsup	0.743	0.195	3.809	0.00
lprix2	-0.259	0.119	-2.168	0.039
c	-7.166	1.972	-3.636	0.001
R-squared	0.350	Mean dependent var		0.075
Adjusted R-squared	0.302	S,D, dependent var		0.254
S.E. of regression	0.212	Akaike info criterion		-0.170
Sum squared resid	1.213	Schwarz criterion		-0.030
Log likelihood	5.553	F-statistic		7.270
Durbin-Watson stat	2.262	Prob (F-statistic)		0.003

Source: Our estimates.

- Analysis of the relationship between imports and rice production

This analysis involves the estimation of a specific model where the dependent variable is imports. This model accounts for the dynamics of imports (mr), production (yr) and consumption (cons) of rice; these variables are specified in logarithms. Model variables following processes I (1). We then proceed to the Johansen (1988, 1991) cointegration test to verify the existence of a cointegration

[8] Zougrana S., « Nutritional Value of local rice », presentation s14-s16, May 2012.

relationship between the variables. All tests of the study are made at 5%. The results are in the following table.

Table 3: Johansen cointegration test (1988, 1991)

Included Obervations: 29 Series		**Series: lmr lyr lcons**		Lags interval: 1 to 1	
Selected (0,05 level*) Number of Cointegrating Relations by Model					
Data Trend	None	None	Linear	Linear	Quadratic
Test Type	No intercept	Intercept	Intercept	Intercept	Intercept
	No trend	No trend	No trend	Trend	Trend
Trace	0	1	1	1	1
Max-Eig	0	1	1	1	1

Source: Our estimates.

Variables are cointegrated of order 1. The error correction model is validated. The residues from the estimated long-term model are stationary. Over the residium from the long-term estimate is white noise.

Table 4: OLS estimation of the long-term dynamics

Dependent variable: lmr		**Méthode: OLS**		
Sample (adjusted): 1981-2010		Included observations: 30 after adjustments		
Variables	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
lconsr	1.16	0.026	44.687	0.000
lyr	-0.108	0.026	-4.197	0.000
c	-1.064	0.255	-4.167	0.000
R-squared	0.991	Mean dependent var		13.06
Adjusted R-squared	0.991	S,D, dependent var		0.477
S.E. of regression	0.045	Akaike info criterion		-3.286
Sum squared resid	0.056	Schwarz criterion		-3.148
Log likelihood	53.931	F-statistic		1693.826
Durbin-Watson stat	2.082	Prob (F-statistic)		0.000

Source: Our estimates.

The conclusion is that in the long term, improving the level of local production of white rice has a negative impact on rice imports unlike consumption. The long-term relationship:

$$\boldsymbol{lmr_t = -0.108250 ly_{rt} + 1.160630\ lcons_{rt} - 1.064356 + \mu_t}$$

Indeed, if the local production of rice increases by 20%, imports will decrease by about 2.2%, while an increase of the same magnitude of consumption results in an increase of 23.21% on imports. The short-run relationship:

$$\boldsymbol{d(lmr_t) = -0.042090 d(ly_{rt}) + 1.1229981 d(lcons_{rt}) - 0.826541 \mu_t(-1) - 0.015140}$$

These results give rise to comments.

4. Discussion

The analysis of the competitiveness of the rice sector in Senegal shows that the production of white rice is more expensive to the Senegalese producer than comparing to the Asian producer. Same result regarding the visual quality of the rice. This lack of competitiveness could be due to difficulties in rice production that would constitute an obstacle to the effective coverage of national consumption. Indeed, there are malfunctions in the supply of inputs (failure, delay distribution problem), facilities and obsolete irrigation equipment in the production process of the Senegalese rice. But rice is a cereal which demands very specific climate and human means. Irrigated rice is the most common mode of production in Senegal but it is less developed compared to the flooded rice fields and irrigated in Vietnam and Thailand.

The cointegration test of Pesaran et al. (2001) showed that there is no long-term relationship between the local productions of white rice planted area, the price of rice on the international market, the

producer price of rice and rainfall. In other words, it is impossible to conclude on the interdependencies between these variables in the long run. After the first estimation of the equation, the word rice price and rainfall were removed from the model. Rainfall does not have a direct impact on rice production in Senegal. Indeed, most of the local production is irrigated, irrigated rice in the north, unlike the production south based on upland rice. In addition, it is understandable that the international price of rice does not impact the level of local production since Senegal is not actually an exporter but a re-exporter of rice imported into Mauritania and Gambia. It would be clever to Senegalese producer reflect the world market prices because in a bull, imported rice will be less competitive than the local rice on the domestic market. The result of the new estimate is as follows:

$$\Delta ly_{rt} = -7.166186 + 0.742782 lsup_t - 0.258697 lprix2_t + \mu_t$$

Only the expected area planted sign is checked and so have a positive impact on the level of production. When planted area increased by 10%, production increased by approximately 7.43%. This assertion is supported by graphical analysis of the production and area especially after 2008 with the advent of GOANA[9]. In turn, the expected producer price sign is negative. In other words, when the state set a price at the beginning of the campaign lower than last season's prices, production increases. For example, if the producer price down 10%, the production of white rice increases by about 2.59%. This behavior is justified by the fact that the state subsidizes upstream part of the production.

In sum, in order to increase their level of production, Senegalese farmers do not take into account changes in the price of rice on the international market. Rather, it is the price of a kilogram of white rice fixed by the state encourages them to produce rice. Indeed, the Senegalese rice producer is mainly for the domestic market, so he is more interested in the price on the domestic market. Arbitration producer is between the cost of production and the price that the state offers it. Thus, over the years an increase in local rice production would lead to a decline in imports, which contributes less than currency losses for the state. In addition, short-term, a strong variation of the level of production would result in a small change in the level of imports. Imports therefore might not be reduced any time soon.

5. Conclusion

This study aimed to perform an analysis of the food self-sufficiency through an analysis of rice production in a context of dependence on imports. Although she has identified that part of the question, this study showed if the conditions were met for Senegal to be self-sufficient in rice.

The implication is that it is not advantageous for Senegal to produce rice rightful more expensive in terms of cost that the local rice is more nutritious. In addition, rainfall and international rice prices do not determine the production of rice. The study also identifies areas sown and the producer price as levers that the state should play in raising the level of production. Food self-sufficiency in rice is well grounded, which cannot be achieved in the short term.

Today, in a context of globalization, turning back on the world can be an inappropriate decision. For food self-sufficiency in rice also means to be very vulnerable to its own shortcomings, such as climate change. In a context where rice imports now account for nearly two-thirds of consumption, there is no guarantee that the white rice product can be completely consumed by the Senegalese families. One issue is to produce its rice, another is to meet its rice needs. Thus, over the years an increase in local rice production would lead to a decline in imports, which contributes less than currency losses for the state. In addition, short-term, a strong variation of the level of production would result in a small change in the level of imports. Imports therefore might not be reduced any time soon. From the foregoing, in terms of recommendation, the State could:

- Improve the quality of local rice by putting on the market, a product that meets the tastes and preferences of consumers.
- Conduct a campaign to promote the consumption of local rice through a good communication policy;
- Support farmers by making sown land to them and making price incentives at the beginning of each season;
- Support farmers and their cooperatives providing adequate agricultural equipment and quality inputs.

[9]Great Agricultural Offensive for agriculture and abundance.

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