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EMPIRICAL ASSESSMENT OF AGRICULTURAL PRODUCERS' PRICES POLICY IN A DEVELOPING ECONOMY

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ABSTRACT

The purpose of this paper is to suggest a methodology for agricultural producers' prices policies assessment in an open developing economy. The issue is here considered for countries with a "dual" agricultural sector, that is an agricultural sector composed of an industry oriented or export oriented subsector, and of a subsistence subsector producing mainly but not sufficiently for domestic consumption, the domestic demand gap being filled by means of imports. Assuming that decision makers want to stabilize in the long run both the real agricultural income and the real imports of the subsistence product, the unconstrained optimal prices of the two categories of products are derived, using a parsimonious specification of the agricultural income and the imports equations, and a quadratic unweighted loss function incorporating target values of real agricultural income and real agricultural imports. The prices formulas obtained are then used to set up an empirical assessment method of agricultural producers' prices policies, which is applied to a country with features considered in the theoretical analysis (Senegal).

INTRODUCTION

In many developing countries and particularly in African countries, agricultural producers' prices are often controlled by governmental agencies. The reason generally put forward by these official authorities to justify their intervention is the need for a stable real income for the producers, achievable through the disconnection between domestic agricultural products and their world markets. This so called real agricultural income stabilization objective of the national authorities seems however rarely achieved and their producers' prices control often results in agricultural real income stagnation or decrease in the long run. So, the 'rationality' of agricultural products pricing policies must be questioned. We examine this issue for a country with a 'dual' agricultural production, that is, producing mainly two agricultural goods, the first being almost entirely exported, and the second consumed domestically and also partially imported in order to satisfy the whole domestic demand. Within this framework, the agricultural products prices are supposed to be set rationally, that is so as to achieve the stabilization of appropriate variables relatively to targets or desired values predefined by national authorities.

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These 'optimal' prices are determined theoretically in the first part of the paper (second section), and the formulas obtained are used in the third section to experiment a statistical assessment methodology of the agricultural producers' pricing policy in a country presenting the features described in the theoretical framework. A summary and brief critic of the methodology is provided in the concluding section.

Theoretical estimation of agricultural producers' prices in an open dual developing economy

Let us consider an economy with an agricultural sector producing two primary goods: the first good is almost entirely exported, eventually after been processed; the second is locally consumed, and its production is less than the domestic demand, the gap being consequently filled by means of imports. The policymakers are supposed to want essentially the achievement of two goals: firstly, stabilize the total real agricultural income; secondly, reduce and stabilize the external trade burden generated by the complementary import of the second crop, by means of the implementation of an import substitution policy. To achieve these two objectives, the policy makers are supposed to have mainly two instruments under their control, namely the producer's prices of the two crops. Given this general economic framework, what would be the optimal producer's prices of the two

products? The answer to this question depends on the specification of the real agricultural income equations and the second crop import equation. The structural forms of these equations belong to the global structural model describing the entire economy. An exact specification of this model would be rather difficult. For this reason, we will work with the reduced forms of these equations, specified in the simplest (most parsimonious) manner. We indeed suppose that the real agricultural income depends linearly and only on the producers' prices of the two products and on the world price of the exported product, and that the real import of the second product depends on the two producers' prices. Formally, we have the following reduced form equations:

$$Y=\alpha_0+\alpha_1 p_1+\alpha_2 p_2+\alpha_3 p_3+u \quad (1)$$

$$M=\mu_0+\mu_1 p_1+\mu_2 p_2+v \quad (2)$$

Where Y=real agricultural income; M=real import of product 2 (domestically consumed);

p_1=producer's price of the exported product (product 1); p_2=producer's price of product 2; p_3=world price of product 1; α_i, i=0 to 3 and μ_j, j=0 to 2, are the coefficients; u and v are the random error terms.

The two equations are the supposed long term relations between real agricultural income and the three prices considered, and between real import of product 2 and the producer's prices. These specifications of the agricultural income and the cereals' import equations are clearly very parsimonious and omit many pertinent plausible explanatory variables. The consequence of these omissions ought to be analyzed with the usual diagnostic tests, before any implementation of the methodology suggested in this paper. Real agricultural income Y must depend positively on the producers' prices and the world price, so the coefficients α_i, i=1 to 3 are supposed positive. Cereals' import M is certainly a decreasing function of p_2 (μ_2 negative) and an increasing function of p_1 (μ_1 positive) in the long run (substitution of local production of product 2 to its import). Our purpose is to derive the optimal level of the producers' prices corresponding to known estimated values of the coefficients of the equations and to the stabilization objectives of the country's authorities relatively to desired levels Y* and M* of real agricultural income and real import of product 2. To formalize the decision problem faced by these authorities, we adopt a quadratic unweighted loss function $W=(Y-Y^*)^2+(M-M^*)^2$ assigning an equal importance to the two distinct objectives. Supposing that the coefficients in the two equations are known (estimated), the problem consists in minimizing W with respect to p_1 and p_2.

Replacing Y and M by their expression without the error terms in W, we obtain:

$$W=(\alpha_0+\alpha_1 p_1+\alpha_2 p_2+\alpha_3 p_3-Y^*)^2+(\mu_0+\mu_1 p_1+\mu_2 p_2-M^*)^2$$

The unconstrained minimization of W is straightforward. The system of two equations in two unknowns corresponding to the partial derivatives of W with respect to p_1 and p_2 gives the following optimal producers' prices, the system of equations' determinant $D = (\alpha_2\mu_1 - \alpha_1\mu_2)^2$ being strictly positive:

$$p_1^{\bullet} = \frac{-\mu_2(Y^* - \alpha_3 p_3 - \alpha_0) + \alpha_2(M^* - \mu_3)}{\alpha_2\mu_1 - \alpha_1\mu_2}$$

$$p_2^{*} = \frac{\mu_1(Y^* - \alpha_3 p_3 - \alpha_0) + \alpha_1(M^* - \mu_3)}{\alpha_2\mu_1 - \alpha_1\mu_2}$$

These formulas show that the 'optimal' producers' prices depend positively on the reference or stabilization target values of real agricultural income and real import of the subsistence good (product 2) and negatively on the world price p_3 of the exported product. We make the assumption that these reference values are fixed by the agricultural sector's authorities so as to yield positive optimal producers' prices. These theoretical 'optimal' producers' prices can be used as benchmarks to assess empirically the 'rationality' of agricultural pricing policies in countries presenting the features described above. An illustration of the feasibility of this approach is given in the second part of the paper.

Implementation of our assessment method for Senegal

The rationality of agricultural producers' prices policies in Senegal has been examined for groundnuts a long time ago by Raffinot and Nascimento (1985). These two authors constructed the theoretical producers' prices series of groundnuts, corresponding to the maximization of the government revenue and given the price elasticity of groundnuts' production. They compared these reference price series to the observed producers' price series for the period 1960-1982 and concluded that the Senegalese authorities' pricing policies were not rational. We intend here to conduct the same investigation with a different approach and for roughly the same period, so as to compare our results to those obtained by these authors. To do so, we rely on the theoretical results obtained above, and we retain two agricultural products presenting the features described in this framework. The first product is groundnut and the second is the couple (millet/rice) on domestic production side and the couple (wheat/rice) for import. These two couples correspond to product 2 (domestically consumed product) of our analytical framework. To simplify, we'll call these couples 'cereals' and we'll consider the unweighted mean producers' prices and import price of the compounded product called 'cereals' in our analysis, along with the producers' price of the exported product (groundnuts).

To assess the rationality of agricultural pricing policies in Senegal, we'll adopt the following strategy:

- Firstly, we postulate for Senegal the reduced form equation of real agricultural income and real import of crop 2 (cereals here), and we estimate these equations after the usual unit root and cointegration tests for their variables.
- Secondly, we made several plausible assumptions concerning the values of the unknown reference values Y* and M* retained by the agricultural sector's authorities, to meet their supposed stabilization objectives. These assumptions must be chosen in a conservative way, so as to

remain close to the historical observed levels of Y and M, as we don't know the exact preferences of the agricultural authorities.

- Thirdly, the theoretical producers' prices series are computed, using the supposed reference values series of Y and M constructed in 2. One natural way to reduce the uncertainty governing the choice of the reference values is then to drop the couple of reference values which give negative producers' prices for at least one of the crops and for one year at least. Only the meaningful theoretical producers' prices series, that is those containing exclusively positive values, are retained as possible benchmarks for our ex post evaluation exercise.

Estimation of the real agricultural income equation and imports of cereals equation

Our purpose here is to estimate the eventual long run relation between:

- the agricultural real income, the producers' price of the two concerned products, and the world price of the exported product, on one hand.
- cereals' imports and the producers' price of the exported product (namely groundnuts) and cereals, on the other hand.

If these long run relations (co integration relations) exist, the corresponding regression estimated coefficients can be used in our ex-post evaluation exercise, to derive the optimal producers' prices series.

The series used for our study are

- Real agricultural income, more precisely real domestic agricultural product.
- Real imports of rice and wheat, these two products representing the main imported cereals in Senegal.
- Producers' price of groundnuts.
- Producers' price of cereals, defined as the weighted mean price of millet and rice.
- Groundnuts' oil world price, as the exported crop here is groundnuts' oil.

These series are extracted or computed with inputs extracted from Duruflé (1994) and Boye (1991). Table 1 in the appendix gives the values of the Dickey-Fuller statistics of unit root test for the level and first difference of the five variables considered in the static regressions. According to these statistics, the five series are integrated of order one. Consequently, a long run relation will exist between real agricultural income and the three prices on one hand, and between real cereals imports and the two producers' prices only if these variables are co integrated. A Johansen co integration test does not reject the null hypothesis for the variables involved in the two regressions at the 5 percent significance level (the test L.R. statistics are respectively 16.45 for the agricultural income equation and 12.47 for the cereal imports equation, with critical values equal to 24.31 and 19.96 respectively. Both tests made no deterministic trend assumption.

The results obtained for the regressions' estimations, are given in tables 2 and 3 in the appendix. Although these results reveal bad individual estimates of the coefficients in the cereals' imports equation, the overall significance tests (F-test) of the regressions' coefficients give good results. To implement our suggested assessment methododology, we will use the prices' formulas derived above in our theoretical analytical framework, after having tested the stability of the estimated coefficients of the agricultural income and cereal imports equations. The stability hypothesis of the estimated coefficients of our two equation is not rejected both by the Chow's (1960) test and the Brown, Durbin and Evans' CUSUM (1975) (cumulative sum of recursive residuals) test. The Chow's test is performed by considering the sub-periods 1962-1973 and 1974-1987. The Fisher's statistic obtained are respectively 2.26 and 1.35, both values being less than the corresponding 5 percent critical values, F(4,18)=2.93 and F(3,15)=3.29 respectively. So the null hypothesis of estimated coefficients stability is not rejected by the classical Chow's test. This result is confirmed by the graphical CUSUM test of Brown, Durbin and Evans, based on the cumulative sum of recursive residuals (the graphics are not reproduced to save place). The second step of our assessment methodology, that is the choice of the reference values of the target variables, can now be done.

Choice of the reference values of the target variables and evaluation of the pricing policies

The supposed reference values of agricultural real income, denoted Y_t , are constructed according to the following cautious schemes:

- Y_t is the simplest naïve forecast of the observed real agricultural income series, that is: $Y_t = Y_{1t} = Y^*_{t-1}$
- Y_t is the third order moving average of the observed series, that is $Y_{2t} = \frac{\sum_{i=1}^{3} Y_{t-i}}{3}$
- Y_t is the greatest observed value of Y between the periods t-3 and t-1, denoted Y_{3t} .

Concerning the supposed reference values of cereals' imports M_t, three assumptions are also retained. The two first assumptions are the same as those made for Y_t , while the third one assigns M_t to be the smallest value of the observed series of cereals' imports M between the periods (t-3) and (t-1), denoted M_{3t} .

Combining the series of supposed target values of Y and M corresponding to our different assumptions, we obtain nine couples of "conditional" theoretical producers' prices with the prices' formulas established in second section. But the only valid couples of reference values within this set of nine couples are those giving positive producers' prices throughout the entire period of analysis, namely the four following couples:

(Y_3 , M_1), (Y_3 , M_2), (Y_3 , M_3), and (Y_2 , M_3).

We tried to complete these four couples of possible reference values with that corresponding to the best simple exponential

smoothing of Y and M. This last couple, despite its ex-post nature, could be interesting for our evaluation exercise because of its statistical optimality, which distinguishes it from the other couples considered. But, unfortunately, the positivity condition required for the resulting producers' prices is not always fulfilled for groundnuts. So, this last couple has been finally discarded. Because of the great disparity observed among the four theoretical producers' prices series selected, and without any objective criteria in hand, we suggest to summarize the four supposed theoretical series by two reference series, namely the series of minimum theoretical prices ("floor" reference prices), and the series of maximum theoretical prices ("ceiling" reference prices). These reference minimum and maximum prices are displayed in table 4 in the appendix, together with the observed prices. The observed series are almost systematically inferior to their corresponding maximum reference series for both crops.

This underestimation is not systematic when the benchmark series for the comparison is the minimum reference prices series, especially for groundnuts. So the producers' pricing policies of the authorities seem to meet some "minimal" stabilization objectives for several years, but seem far from aiming at any "maximal" or ambitious stabilization policies for the whole period of analysis. So our statistical assessment method give similar results to those obtained in Raffinot and Nascimento (1985) with a different approach, for groundnuts.
The small country situation with little impact on the world demand of groundnuts' oil and without a clear import's substitution policy for cereals, especially for rice, can explain the difficulty for Senegal to settle effective and permanent agricultural producers' price stabilization policies. Note however that the results obtained are only illustrative and concern a distant and rather short period of analysis. Implementation of the suggested methodology on a longer period would certainly give more reliable conclusions.

Conclusion

The purpose of this paper is to suggest a simple methodology for agricultural producers' pricing policies assessment in an open developing economy presenting some special features. Such policies are often implemented in African countries exporting some of their agricultural products and having little or no impacts on world markets, and thus trying to minimize the consequences of the uncontrolled fluctuations of world prices of these products on their agricultural producers' income. This issue is here considered for developing countries with a "dual" agricultural sector, that is an agricultural sector composed of an industry oriented or export oriented subsector, and of a subsistence subsector producing mainly but not sufficiently for domestic consumption, the domestic demand gap being filled by means of imports. Assuming that decision makers want to stabilize in the long run both the real agricultural income and the real imports of the subsistence product, the unconstrained optimal prices of the two categories of product can be easily derived, with a parsimonious specification of the agricultural income and imports equations and a quadratic unweighted loss function incorporating target values of real agricultural income and real agricultural imports. This framework can be used to assess the producers' prices policies of national agricultural sector authorities, in countries with features described above. Such is approximately the case for Senegal. The exported product in Senegal is groundnuts' oil, and the domestically consumed products are rice and millet, the demand gap of which are filled by rice and wheat imports. For the convenience of analysis within our framework, rice and millet are aggregated as 'cereals' with a unique producers' price, and so are imports of rice and wheat, aggregated as cereals' imports with a unique world price.

Our investigation for Senegal covers the period 1960-1987, which is far from being a recent one, our purpose being only to illustrate the feasibility of the methodology. This illustration relies on several simple but "credible" schemes for the choices of the "target variables" values present in the optimal producers' prices formulas. Finally, "floor" and "ceiling" producers' prices for groundnuts and cereals have been constructed from 1960 to 1987 and used as benchmarks to assess the rationality of producers' pricing policies of Senegalese authorities. Our conclusion is that these producers' prices policies achieved minimal stabilization objectives, that is, they compare favorably with the "floor" theoretical prices series, but they are far from being optimal relatively to the "ceiling" theoretical prices which suppose more ambitious but credible values for the target variables of the stabilization objective.

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Appendix

Table 1. Dickey-Fuller statistics of unit roots test

	Level	First difference
Real agricultural income	-4.39	-6.73
Real Cereals Imports	-2.4	-5.8
Groundnut's oil world price	-2.04	-4.86
Groundnut producers' price	1.39	-4.61
Cereals producers' price	4.06	-3.29

Table 2. Estimation results of the real agricultural income equation

Dependent Variable: PIBA
Method: Least Squares
Sample: 1962 1987

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.618622	0.045326	13.64836	0.0000
PPA	0.000516	0.002708	0.190504	0.8507
PPC	0.004915	0.003434	1.431337	0.1664
PMHA	-0.000947	0.000286	-3.309759	0.0032
R-squared	0.389155	Mean dependent var		0.641154
Adjusted R-squared	0.305858	S.D. dependent var		0.127916
S.E. of regression	0.106574	Akaike info criterion		-1.499319
Log likelihood	23.49115	F-statistic		4.671892
Durbin-Watson stat	1.988633	Prob(F-statistic)		0.011323

Table 3. Estimation results of the cereals' imports equation

Dependent Variable: IMPC
Method: Least Squares
Sample: 1962 1987

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.097826	0.017231	5.677214	0.0000
PPA	-1.03E-05	0.001071	-0.009574	0.9924
PPC	0.001508	0.001330	1.133280	0.2688
R-squared	0.318824	Mean dependent var		0.147308
Adjusted R-squared	0.259591	S.D. dependent var		0.049198
S.E. of regression	0.042334	Akaike info criterion		-3.378306
Log likelihood	46.91797	F-statistic		5.382559
Durbin-Watson stat	1.116092	Prob(F-statistic)		0.012092

Table 4. Smallest and greatest theoretical producers' prices, and observed producers' prices of cereals and groundnuts (1965-1987)

Obs	CTPMAX	CTPMIN	GTPMAX	GTPMIN	GPP	CPP
1965	15.43000	11.27000	30.94000	26.04000	21.00000	20.17000
1966	27.57000	17.15000	62.22000	36.72000	21.00000	20.22000
1967	35.83000	18.29000	60.90000	39.65000	17.00000	20.16000
1968	28.67000	19.99000	54.80000	35.20000	17.00000	20.23000
1969	25.06000	20.20000	40.60000	25.90000	17.00000	20.08000
1970	30.61000	23.06000	33.49000	8.990000	18.00000	20.26000
1971	30.64000	25.17000	45.18000	32.43000	22.00000	17.65000
1972	26.73000	10.32000	44.91000	6.660000	22.00000	18.01000
1973	28.42000	14.18000	50.59000	16.59000	24.00000	17.37000
1974	44.27000	22.30000	92.75000	37.50000	40.00000	17.30000
1975	33.57000	14.56000	55.82000	16.62000	40.00000	24.35000
1976	51.36000	19.24000	97.62000	29.62000	40.00000	32.25000
1977	75.19000	48.97000	165.7100	106.2100	40.00000	32.65000
1978	80.74000	64.42000	179.9900	145.9900	40.00000	35.47000
1979	71.76000	41.11000	158.2200	85.97000	43.00000	36.42000
1980	57.38000	37.06000	101.5800	50.58000	46.00000	40.28000
1981	74.75000	41.32000	142.3000	61.55000	60.00000	40.12000
1982	61.15000	28.85000	105.9200	29.42000	60.00000	48.73000
1983	78.20000	43.12000	126.2200	41.22000	50.00000	54.26000
1984	104.5700	85.38000	190.7300	143.8200	50.00000	58.41000
1985	100.8200	82.24000	165.7700	123.2700	90.00000	68.75000
1986	67.29000	36.55000	82.08000	5.580000	90.00000	72.83000
1987	63.91000	28.83000	95.65000	10.65000	90.00000	72.26000

Note: the column's head meaning

CTPMAX: Maximum value of the cereals' theoretical producer's price corresponding to the different couples of the reference variables target values.

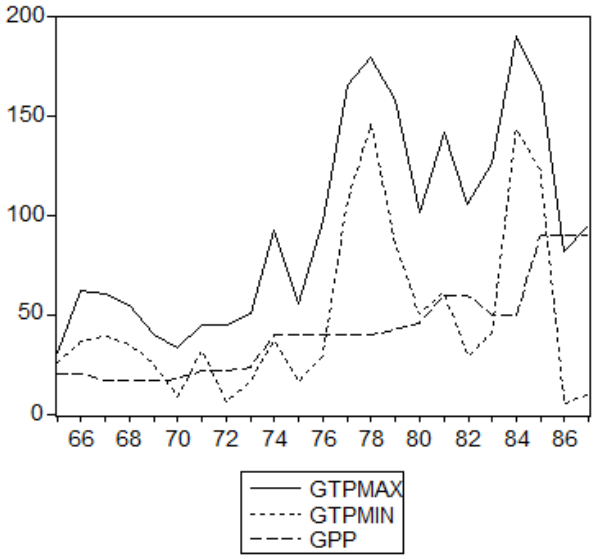
CTPMIN: Minimum value of the cereals' theoretical producer's price corresponding to the different couples of the reference variables target values.

GTPMAX: Maximum value of groudnuts theoretical producer's price corresponding to the different couples of the reference variables target values.

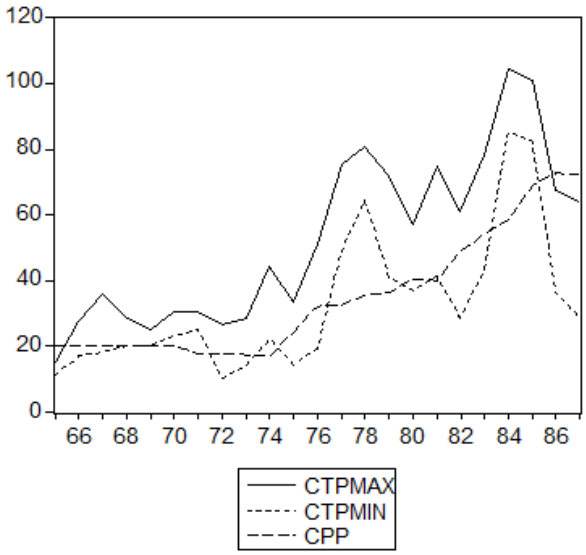
GTPMIN: Minimum value of groudnuts theoretical producer's price corresponding to the different couples of the reference variables target values.

CPP: Cereals observed producer's price.

GPP: Groundnuts observed producer's price.



Graphic 1. Smallest and greatest groundnuts theoretical producers' prices and observed prices



Graphic 2. Smallest and greatest cereal theoretical producers' prices and observed prices

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