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# Transmission of price shifts in the context of structural adjustment: An empirical analysis for staple food after the devaluation of the franc CFA in Ivory Coast

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## Abstract

This article analyses price shifts after currency devaluation in the Ivory Coast using a time-series modelling approach. Model results identify the liberalisation of the import-rice sector as the key factor for the transmission of price effects. Fixation of the imported rice price as a social compensatory measure hindered the adjustment of prices in the first year after the devaluation. As soon as the price controls on imported rice were lifted, prices changed in favour of tradable goods. The findings in this paper hint at a possible trade-off between the protection of vulnerable groups during the process of adjustment and the intended incentive effect. ©2000 Elsevier Science B.V. All rights reserved.

*Keywords:* Agricultural sector; Devaluation; Liberalisation; Time-series model

## 1. Introduction

An important target of structural adjustment policies is to create a macroeconomic setting that favours the production of tradable goods. An overvalued exchange rate has proven to be a main obstacle for achieving sustainable growth rates in the agricultural sector of developing countries (Schiff and Valdez, 1992). However, critics of currency devaluation indicate negative social consequences. Inflationary tendencies are most prominent in those goods and services that are essential to the survival of the urban poor. The whole adjustment process can be jeopardised if a change in the monetary regime is not accompanied by the implementation of social compensatory measures (Vivian, 1995). The formulation of those measures, neverthe-

less, calls for a more detailed empirical analysis dealing with the development of the adjustment process itself (Jütting, 1997).

From this background, the empirical analysis of price shifts after 50% devaluation of the franc CFA against the French franc in January 1994 is a very interesting case study.<sup>1</sup> We can expect relative price changes in favour of tradable goods, but we must also take into account sector-specific conditions. To reduce negative social consequences, especially for the urban poor, the Ivorian government fixed the price for imported rice to guarantee a minimum access to food for the poor. A fundamental question now is how prices for staple food reacted after the devaluation and after

<sup>1</sup> Franc CFA (F CFA) is the common currency of the African Franc zone, which currently includes 14 West and Central African member countries. Whereas the F CFA has been pegged to the French franc for more than 40 years, it is today pegged to the Euro.

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the lifting of the price fixation one year later. Against this background, the intention of this paper is to identify factors that explain the transmission of price shifts after economic shocks.

The outline of the paper is as follows: first, the specific situation in the Ivory Coast and the sectoral setting is characterised. Following that, time-series models will be introduced to analyse to what degree and how prices succeeded in adapting to the new policy framework. Finally, the empirical results of the econometric modelling will be discussed in the context of the identified effects of the implemented market and price policies.

## 2. Structural adjustment measures in the Ivorian rice sector and expected development of staple food prices after the F CFA devaluation

Today, the agricultural sector accounts for 30% of GDP, two-thirds of foreign exchange earnings and two-thirds of the labour force in the Ivory Coast.<sup>2</sup> The Ivory Coast is mainly self-sufficient in food. The development of the staple-food sector has been very dynamic, and increasing demand could be satisfied for all products, with the exception of rice. The main reason for this is the Ivorian rice policy. Whereas production of locally traded goods, such as plantain, cassava and yams, was not influenced by Ivorian agricultural policies, the rice sector was heavily influenced by the state. Supporting local production and at the same time providing consumers with a cheap staple food has been the main aim of the rice policy. To do this, the Ivorian government has controlled production, processing, trade and imports.

The situation in the Ivory Coast's rice sector prior to the devaluation consisted of a strongly increasing demand for rice in comparison to a moderately increasing supply. Production rose from approximately 500 000 t of paddy<sup>3</sup> in the middle of the 1970s to more than 650 000 t per year in the beginning of the 1990s. After hulling, approximately 420 000 t of rice is produced yearly. The demand for hulled rice rose in the same time period from almost 300 000 t per year to more than 700 000 t per year, leaving about 300 000 t

per year to be imported. Various qualities of rice are traded in the Ivory Coast, of which the imported rice, *riz de grande consommation*, is the most significant in terms of market share (Hirsch, 1993).<sup>4</sup>

To sum up, the Ivorian rice policy had been contradictory in several ways. The official goal of self-sufficiency by the year 2000 was undermined by the overvalued exchange rate, which resulted in high rates of implicit taxation of producers due to official pricing policies that effectively subsidised consumption of cheap import rice. This led to increased rice imports and lower prices relative to competing staple foods. In addition, a transport *péréquation* that subsidised import rice in the interior and had guaranteed a uniform consumer price for all regions, was discouraging domestic production (World Bank, 1994).

In the beginning of the 1990s, under the framework of the first agricultural sector adjustment program, first steps were taken towards liberalisation. These measures, however, were limited to the realms of production and processing. The price of imported rice was fixed at 160 F CFA/kg at the time of the devaluation. In January 1994, the price of imported rice was raised to 175 F CFA/kg, and beyond that remained completely disconnected from world markets and other influences (Hirsch, 1993).

A far-reaching liberalisation of the import-rice sector took place in February 1995, one year after the devaluation. The transport *péréquation* was revoked; the CGPP<sup>5</sup> dissolved; and the price for the imported rice, *riz de grande consommation*, was increased by more than 30%, from 175 F CFA/kg to 230 F CFA/kg. A different situation existed in the local rice market, which was fully liberalised at the end of the 1980s so that the price was freely determined by local supply and demand.

Under the described conditions of the Ivory Coast's rice sector, the expected price shifts of the devaluation can be characterised as follows:

- No change in price for imported rice which is fixed by the state.

<sup>2</sup> An overview of the role of the agricultural sector in the development process of African countries is given by Jütting (1999).

<sup>3</sup> Unhulled rice will be referred to as 'paddy'.

<sup>4</sup> The imported rice, *riz de grande consommation*, represents approximately 90% of total imported rice, and is, for the most part, consumed in the cities. The local rice, on the other hand, finds its outlet predominantly in rural markets.

<sup>5</sup> Caisse Générale de Péréquation des Prix: A price-equalization fund that controlled the trade of import rice and equalized regional as well as seasonal price differences.

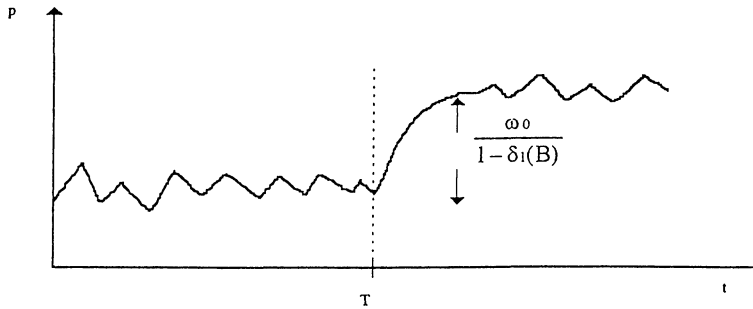


Fig. 1. Gradual and permanent impact of an intervention upon a time series. (Source: Leone, 1987, p. 469)

- A price increase for local rice, where the market is not regulated. Local rice constitutes a traded product and one cannot expect, a priori, a complete decoupling of local rice prices from general price developments caused by the devaluation.
- No change, or only moderate change, in price for the non-tradables, cassava, plantain and yams.

### 3. Analysis of policy interventions with time-series models

Time-series models are usually used for forecasts when little is known about the determinants of the variable of primary concern. They account for pattern in the past movements of a variable and use that information to predict its future movements. Therefore, time-series models do not require the distinction between exogenous and endogenous variables, as opposed to econometric models. ARIMA (Auto-Regressive Integrated Moving Average) models are a central group within the time-series models, and have proved their capacity in varying areas of application. An expansion of the simple ARIMA model is the intervention analysis, that was, in great part, developed by Box and Tiao (1975). The purpose of these methods is to build a stochastic time-series model that can project the impacts of an intervention upon a process. It is requisite for the use of these models that the researcher can determine the starting point of the intervention, and has a general idea as to its workings upon the time series being investigated (Vandaele, 1983).

Intervention models consist of two components: a deterministic intervention variable and a stochastic ARIMA model. Models of the following type will be

utilised (Mills, 1990):

$$Z_t = \mu + \frac{\omega(B)}{\delta(B)} I_t^T + \frac{\theta(B)}{\phi(B)(1-B)^d} a_t \quad (1)$$

with:  $\omega(B) = \omega_0 - \omega_1 B - \dots - \omega_m B^m$  and  $\delta(B) = 1 - \delta_1 B - \dots - \delta_r B^r$

$Z$	dependent variable
$\mu$	mean value
$\omega(B)$	numerator polynomial for the intervention
$\delta(B)$	denominator polynomial for the intervention
$I$	intervention variable
$T$	starting point of the intervention
$\phi$	coefficient of the autoregressive (AR)-parameter
$a$	error term
$\theta$	coefficient of the moving average (MA)-parameter
$B$	backshift operator
$d$	degree of differencing

The intervention variable  $I_t$  is a series of (0,1) data analogous to the use of dummy variables in the regression analysis. With  $I_t$ , it is possible to determine the starting point, the length, and the characteristics of the intervention. The impact of the intervention upon the process can be modelled as permanent or temporary.

If the intervention is assumed to be permanent, 'step' type of intervention variable is used. This means that  $I_t = 0$  for all time periods up to the change and  $I_t = 1$  elsewhere.

$$I_t = S_t^{(T)} \text{ with } S_t^{(T)} = \begin{cases} 0, & t < T \\ 1, & t \geq T \end{cases} \quad (2)$$

A permanent increase in the process level can be modelled in two ways: abrupt or gradual. Fig. 1 shows a gradual adaptation after an intervention at point  $T$ .

The change of the process level after an intervention can be measured as follows (McCleary and Hay, 1980):

$$\text{change of process level : } \sum_{k=0}^{\infty} \delta_1^k \omega_0 = \frac{\omega_0}{1 - \delta_1} \quad (3)$$

When the intervention is assumed to be ‘pulse’ type, then  $I_t = 1$  at the time of the intervention, and  $I_t = 0$  elsewhere would be the appropriate form of the model approach.

$$I_t = P_t^{(T)} \text{ with } P_t^{(T)} = \begin{cases} 1, & t < T \\ 0, & t \neq T \end{cases} \quad (4)$$

The selected ARIMA and intervention models for the analysis of price shifts after the F CFA devaluation fulfil the following criteria:

- The time series must be stationary. Several techniques exist to prove the stationarity. Here, a visual inspection of the original data set, a plot of the residuals, the autocorrelation function (acf) as well as the size of the AR-coefficient is used as an indicator. In case of non-stationarity, it is possible to induce stationarity by transforming (differences and/or logarithmics) the original data set.
- The model is parsimonious.
- The estimated coefficients are significantly different from zero at the 95% level and are invertible.
- The residuals of the estimated models indicate no autocorrelation with a 95% level of confidence, according to tests of Ljung and Box (1978).

In order to choose a model, the variance of the residuals (VAR) and the sum of squared errors (SSE) will be consulted to help determine the worth of the model.<sup>6</sup> Furthermore, these criteria are used to analyse the ‘robustness’ of the model: no substantial changes in VAR and SSE values, as well as in the estimated coefficients, characterise a robust model structure. Otherwise, it is presumed that the data-generating process has changed. In this context, a change in value of a coefficient larger than 0.1 will be seen as an indication of a necessary adaptation of the model structure (Pankratz, 1983).

The database used consists of average monthly prices from January 1990 through November 1995

from the three Abidjan markets, Adjamé, Abobo, and Treichville and Bouaké, in the following named as consumer markets. These are urban markets where the urban population demand food. On the contrary, the so-called producer markets Abengourou, Korhogo, Odienné and Yamoussoukro are located in rural areas. The distinction between consumer and producer markets seems to be useful to identify regional effects of price adjustment.

## 4. Empirical results

### 4.1. Quantification of price shifts

In the following, the impact of the policy interventions, ‘devaluation’ and ‘liberalisation of the import-rice sector’, on the development of local rice prices is analysed. The actual price development for local rice prices is presented in Fig. 2, taking the Odienné and Abidjan-Adjamé markets as examples.

The actual, visible price developments in Odienné appear to contradict the hypotheses concerning the course of adjustment of local rice prices. No pronounced price shifts can be observed after the devaluation. In contrast, a strong increase in prices is visible after the liberalisation of the import-rice sector. In the following, it will be observed if the calculations with the ARIMA and intervention models lead to similar results.

After the identification of a changing data-generating process, it will be attempted to quantify these changes with intervention modelling. It shall proceed from the theory that liberalisation has contributed to a constant elevation of price levels for local rice, and that these increases first took effect in March 1995, rather than in February. In that regard, all models will be analysed to determine if the presumed alterations of price levels are significant, and whether an abrupt, or a gradual, adaptation to the new framework of conditions occurs. Table 1 shows results from the Odienné market.

In Odienné, the pure ARIMA model without an intervention variable, as presented in Table 1, generates non-satisfactory results. With a  $t$ -value of 1.8, it has a non-significant MA-parameter, and the model is, therefore, dropped. On the contrary, estimated intervention models are useful to describe the

<sup>6</sup> Several criteria are available to check for the goodness of fit of the estimation (e.g.,  $\chi^2$ -MSE). Mills (1990) discusses different model selection criteria, such as AIC and BIC.

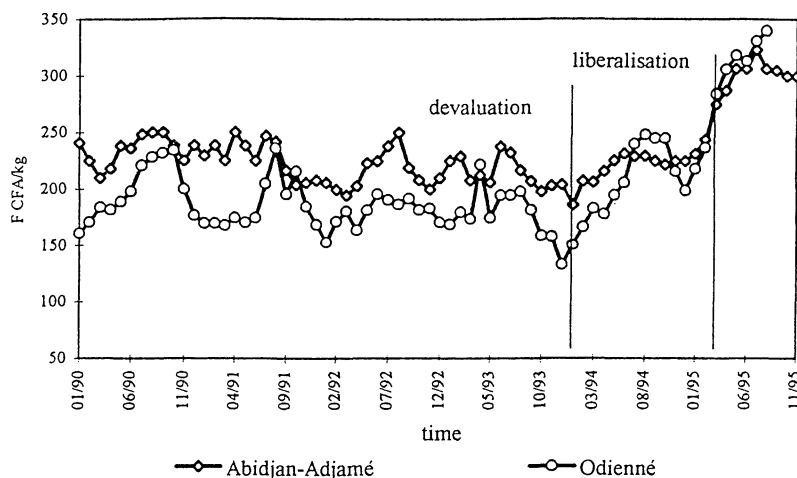


Fig. 2. Price changes for local rice for Odienné and Abidjan-Adjamé markets (January 1990–November 1995)

Table 1

Intervention and ARIMA modelling of the local rice market in Odienné (January 1990–August 1995)<sup>a</sup>

Hypothesis	Model specification <sup>b</sup>	VAR	SSE
Without intervention	$Y_t = 216.1^{(5.18)} + \frac{1 - 0.26^{(1.82)} B^8}{1 - 0.95^{(17.91)} B} a_t$	348	22 610
Abrupt intervention <sup>c</sup> 'step'	$Y_t = 194.4^{(21.41)} + 77.4^{(4.31)} S_t + \frac{1 - 0.36^{(2.68)} B^8}{1 - 0.84^{(10.31)} B} a_t$	290	18 575
Gradual intervention <sup>c</sup>	$Y_t = 190.6^{(38.69)} + \frac{71.3^{(4.25)}}{1 - 0.5^{(3.54)} B} S_t + \frac{1 - 0.38^{(2.93)} B^8}{1 - 0.73^{(7.83)} B} a_t$	263	16 330

<sup>a</sup> Source: own computation.

<sup>b</sup> *t*-values in parentheses.

<sup>c</sup> With  $S_t = 0$  for  $t < \text{March 1995}$  and  $S_t = 1$  for  $t \geq \text{March 1995}$ .

data-generation process. All of the estimated coefficients are significant and there is no sign for autocorrelation in the residuals. The intervention model in which the adaptation of local rice prices is depicted gradually (line three of Table 1), is found to be superior to the abrupt intervention model when the values for VAR and SSE are compared (row two of Table 1). After selecting the 'gradual intervention model', one can proceed with the interpretation.

An intervention variable measures the impact of an intervention for a given time period, as well as the aggregate effect, which means the change of the process level. The results presented in Table 1 for the Odienné market for local rice can be interpreted as follows: rice prices show a monthly increase of 71.3 F CFA/kg in March 1995, 107 F CFA/kg in

April 1995, and 141.5 F CFA/kg after half a year in comparison to the pre-intervention level. The total increase in the change in process level is estimated to be

$$\frac{71.3}{1 - 0.5} = 142.6$$

The new equilibrium level after the intervention is the mean value plus the calculated change in the process level:

$$190.6 \text{ F CFA/kg} + 142.6 \text{ F CFA/kg} \\ = 333.2 \text{ F CFA/kg.}$$

In Fig. 3, the actual price development and the path of the price adaptation is illustrated. From the graph, it

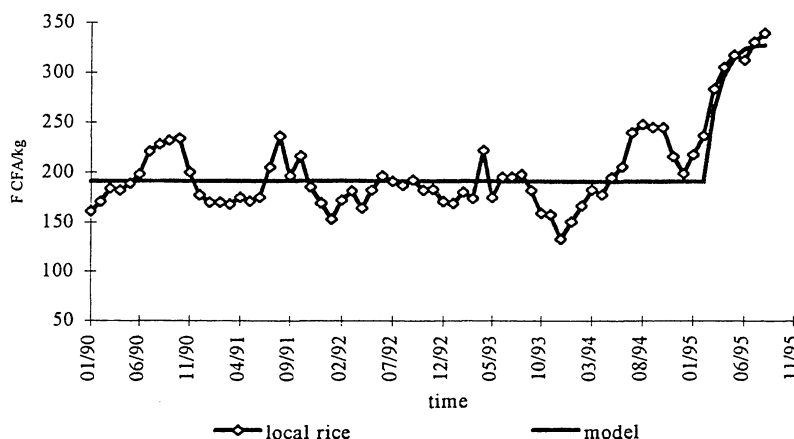


Fig. 3. Path of local rice price adaptation in Odienné (January 1990–August 1995).

becomes clear that the price adjustment in Odienné is permanent, and prices change gradually, not abruptly.

For all other markets alike, intervention models are superior to the pure ARIMA models. Moreover, a gradual impact intervention model leads to better results than does an abrupt impact intervention model.

Table 2 presents the results for local rice differentiated between consumer (urban) and producer (rural) markets. It shows the equilibrium price level before and after the economic shock occurred, as well as the deducted increase in rice prices.

If one compares the results between the rural and urban markets, a larger price shift in the rural markets will be observed. The calculated increase in the price of local rice totals approximately 50% in the rural markets, and approximately only 30% in the urban markets. To understand this disparity, the elimination of the transportation *péréquation* for imported rice during the process of liberalisation must be taken into consideration. Through the elimination of this subsidy, the price of imported rice increased dramatically in the rural markets than in the Abidjan markets.

#### 4.2. Discussion of the results

The summary of the empirical results presented in Table 3 shows the limited effect of the devaluation on the development of staple-food prices. Only for plantain do the models estimate a significant price increase in two consumer markets, while the model results for plantain and cassava are in line with the expectations.

However, this does not apply to the effects of the devaluation on local rice prices. The intended price shift in favour of tradable goods, such as local rice, did not take effect. The price fixation on imported rice, implemented as a social compensatory measure, had a more pervasive influence on the development of local rice prices than expected. Only after the liberalisation of the import-rice sector, did local rice prices adjust to the new market situation.

The liberalisation of the import-rice sector not only influenced the price development of local rice, but also of plantain, and, in a reduced fashion, that of cassava as well (Table 3). A temporary change in the consumer demand of staple food would be an intuitive explanation. Obviously, consumers substituted plantain and, to a less extent, cassava for imported and local rice.

As Table 3 depicts, for all local rice and plantain, the price effect is stronger in rural than in urban markets. A reason for the regional differences in the price adjustment path could be the abolishing of the transport *péréquation* in the context of the liberalisation in the import-rice sector. After the removal of the subsidy, the artificially created advantage for imported rice in regions far away from the coast disappeared.

#### 5. Conclusion

This paper analyses the transmission of price shifts in the context of structural adjustment using the devaluation of the F CFA and its impact on staple-food prices in the Ivory Coast as a case study. ARIMA and

Table 2  
Estimated shift of rice prices after the liberalisation of the import-rice sector<sup>a</sup>

Markets	Equilibrium price level after the intervention	Average price level before the intervention ( $\mu$ )	Shift of local rice prices $\frac{\omega_0}{1 - \delta_1(B)}$	
	$\mu + \frac{\omega_0}{1 - \delta_1(B)}$		F CFA/kg	F CFA/kg in % v $\mu$
Producer markets				
Abengouru	308.2	208.9	99.3	48
Korhogo	X <sup>b</sup>	X	108.3	X
Odienné	333.2	190.6	142.6	75
Yamassoukrou	329.5	218.2	111.3	51
Consumer markets				
Bouaké	X	X	64.0	X
Abidjan-Adjamé	305.8	223	82.8	37
Abidjan-Abobo	284.1	215.8	68.3	32
Abidjan-Treichville	313.0	236.0	77.0	33

<sup>a</sup> Source: own computation using OCPV data.

<sup>b</sup> After differencing,  $\mu$  is no longer significant and is dropped.

Table 3  
Significance, degree and path of price adjustment in the staple-food sector<sup>a</sup>

Products	Devaluation	Price adjustment path	Liberalisation	Price adjustment path
Local rice	no effect	–	permanent increase	gradual; stronger reaction in rural than in urban markets
Plantain	permanent in two urban markets	abrupt	temporary increase	abrupt; stronger reaction in rural than in urban markets
Cassava	no effect	–	mixed effects	abrupt

<sup>a</sup> Source: own calculations.

intervention models are used to measure the impact of two economic shocks — devaluation and trade liberalisation of the import-rice sector — on the prices of local rice, plantain and cassava. The results indicate that the devaluation itself has not brought about the expected price changes for tradable goods. Only the trade liberalisation of the import-rice sector one year after the devaluation has led to a substantial and permanent increase in local rice prices. Given these results, market and price instruments are the key factors in explaining the transmission of prices. As soon as prices could change, price shifts in the staple-food sector are mainly dependent on substitutional and spatial effects.

The findings in this paper hint at a possible trade-off between the protection of vulnerable groups during the process of adjustment and the intended incentive effect. While the rice consumers obviously profited from the price fixation until the trade liberalisation, rice producers came out on the losing side as the product price

of rice remained the same. More research is needed to investigate the effectiveness and efficiency of social compensatory measures. To do so, more in-depth studies are needed to analyse the effect of social compensatory measures on the production side, including quantity effects, as well as on the consumer behaviour of poor people.

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