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Determinants of Inflation in Mozambique

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Abstract

Mozambique's inflation rate was consistently high until 1995, and then plunged in 1996 to 17 percent from 70 percent in 1994. This paper suggests that Mozambique's inflation pattern is a combination of a "fundamental" trend set by economic policies, seasonal behavior that follows closely that of agriculture, and a collection of irregular events that corresponds mainly to agroclimatic conditions. The empirical results show that the marked tightening of monetary policy in 1996 was the ultimate reason for the control of inflation in 1996, and hence seems to correspond to a change in the "fundamental" trend of inflation that may have long-lasting effects.

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SUMMARY

The rate of inflation in Mozambique was consistently high until 1995, then plunged in 1996 to 17 percent from 70 percent in 1994. This paper tries to explain the behavior of inflation in Mozambique through three different approaches. The first one decomposes inflation into three components: a trend, a seasonal, and an irregular component. The second approach derives a theoretical model of inflation determination and estimates a reduced-form equation. The third analyzes the transmission mechanism embedded in the system by estimating a multivariate dynamic system. The policy implications of the results are discussed.

The combined analysis of the three empirical exercises suggests that the rate of inflation in Mozambique is a combination of a "fundamental" trend set by economic polices, a seasonal behavior that follows closely that of agriculture, and a collection of irregular events that corresponds mainly to agroclimatic conditions. The results show that the marked tightening of monetary policy in 1996 was the ultimate reason for the decline of inflation in that year. The control of monetary expansion had the added effect of helping to stabilize the metical, thus contributing twice to the containment of inflation. This turnaround was achieved despite the serious floods in the first quarter of 1996 that pushed up accumulated inflation to 10 percent in February. Thus, it seems that Mozambique has experienced a change in the "fundamental" inflation trend that may have long-lasting effects.

I. Introduction

The rate of inflation in Mozambique was consistently high until 1995, then plunged in 1996 to 17 percent from 70 percent in 1994. This paper tries to explain the behavior of inflation in Mozambique though three different approaches. The first one decomposes inflation into three components: a trend that represents underlying inflation, a seasonal component that follows closely the agricultural season, and an irregular component. The second approach derives a theoretical model of inflation determination and estimates an inflation equation. The third analyzes the transmission mechanism embedded in the system by estimating a multivariate dynamic system. The policy implications of the results are discussed.

II. Composition and Structure of the CPI

The Consumer Price Index (CPI) for Maputo compiled by the National Planning Directorate (DNP) was the official price index in Mozambique until December 1996. In 1995 the National Statistics Institute (INE) started the compilation of an alternative index, with an updated and improved basket of goods that is deemed to better represent the reality of the evolution of purchasing power for the average Mozambican consumer, and this new index became the official price index starting January 1997. However, for reasons of data availability, our analysis was performed with the DNP index[2].

Mozambique's CPI was introduced in 1989 as a first attempt to estimate inflation based on a survey of family expenditure in the Maputo area. It covers 1,060 products, and the weights are those derived from an August 1984 expenditure survey of randomly selected households.[3] For this reason, the index covers only goods and services offered in Maputo and is highly dependent on the price of a few staples that are subject to strong seasonality, especially tomatoes and cabbage, which together account for 10 percent of the CPI.

The components and weights of the DNP CPI basket appear in Table 1. Foodstuffs dominate the CPI, representing almost 75 percent of the consumption basket with fruits and vegetables alone representing 22 percent. Consequently, factors affecting food prices dominate movements in the CPI. These factors include mainly agroclimatic conditions, domestic inputs, and import prices, with rainfall playing a crucial role. Given the importance of imports from South Africa for the supply of foodstuffs, the evolution of the exchange rate, especially the metical/rand exchange rate, may also play an important role in the behavior of the CPI.

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[2]The evolution of both indices showed initially some divergences, but converged significantly during 1996. Hence, the policy implications of this paper can be extrapolated to explain the behavior of the new index.

[3]See "Preços ao Consumidor e Nível de Consumo," Comissão Nacional do Plano, Direcção Nacional de Estatística, DNE/DD/SER, B/11, November 1985.

Table 1. Mozambique: DNP Consumer Price Index Basket

(In percent)

Food, beverages, and tobacco:	73.78
Meat and fish	16.07
Milk, eggs, and oil	23.83
Fruits and vegetables	21.51
Sugar, beverages, and tobacco	8.93
Clothing and shoes	12.77
Residential and comfort	5.91
Health	0.49
Transportation and communications	2.10
Education and leisure	2.06
Other goods and services	2.88

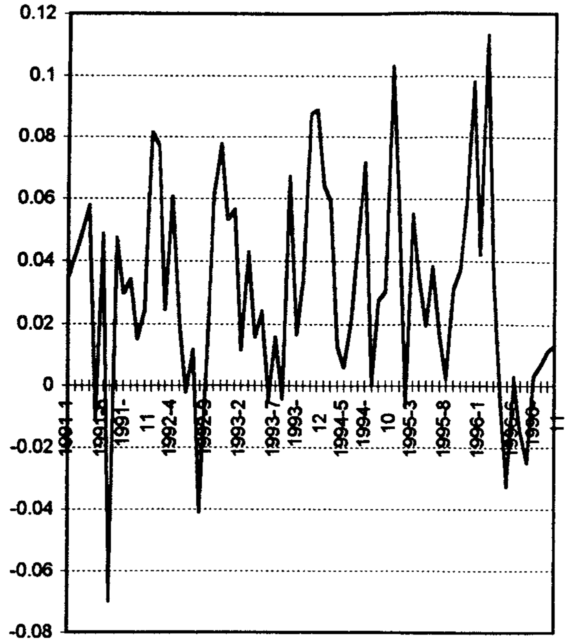
Source: National Planning Directorate.

III. The Evolution of Inflation During 1990-96

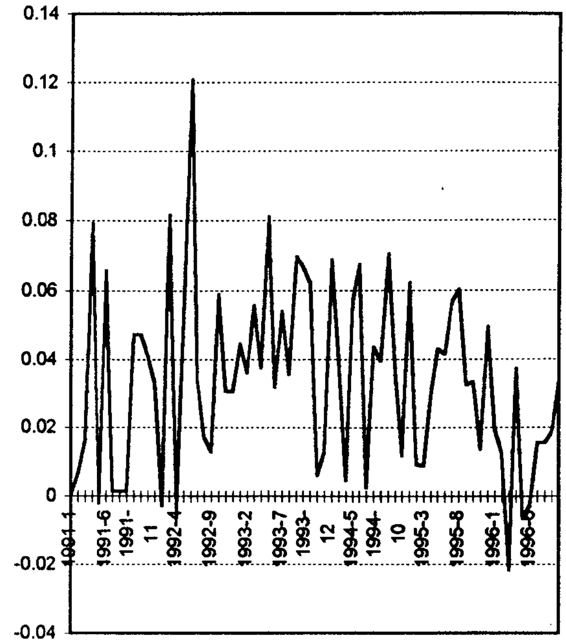
Inflation, as measured by changes in the CPI for Maputo, increased sharply between 1989 and 1994, but this trend was reversed in 1995. Table 2 presents data on some of the factors likely to have influenced the inflationary process in Mozambique. Inflation fell from 163 percent in 1987 to 35 percent in 1991, but accelerated again in 1992. A large budget deficit and slow GDP growth were behind the 47 percent inflation rate in 1990. The reduction of this deficit and the contention of money growth reduced inflation by 12 points in 1991. However, the important depreciation of the metical in 1991, the excessive monetary expansion in 1992, and the 153 percent rise in fresh produce prices, owing to the severe drought that affected the country and contributed 22 percentage points to the inflation rate, raised inflation again to 54 percent. In 1993, the inflation rate declined, helped by the strong growth in GDP and tighter fiscal policy. However, inflation peaked again in 1994 at 70 percent, reflecting difficulties in monetary control, the significant depreciation of the exchange rate during the preceding year, and expansionary fiscal policies during 1994. In 1995, GDP grew only by 1.4 percent (down from 4.5 percent in 1994), the budget deficit was reduced, and inflation fell somewhat to 54 percent. Of this increase, 42 percentage points were due to the rise in prices of foodstuffs. In 1996, a turnaround took place, with economic policy significantly tightened and the metical much more stable than in previous years, leading to an inflation rate of 17 percent despite floods in the first quarter of the year. Figure 1 shows that in mid 1995 both the exchange rate and broad money growth started a declining trend, whose effect on inflation

Figure 1. Mozambique: Monthly Growth Rates, 1991-1996

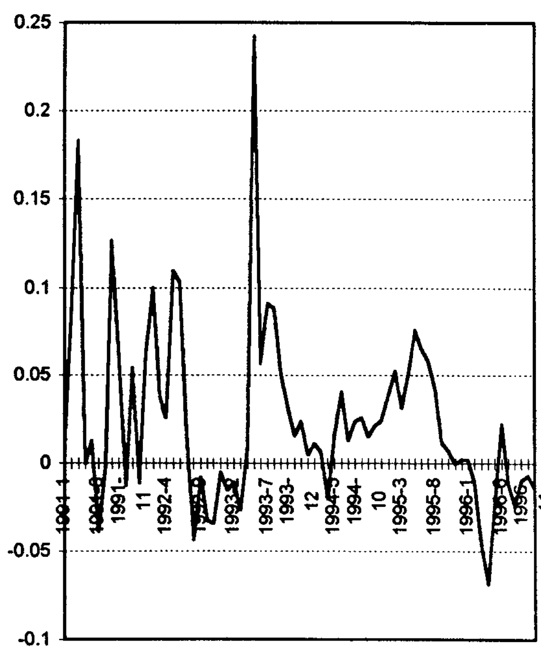
CPI



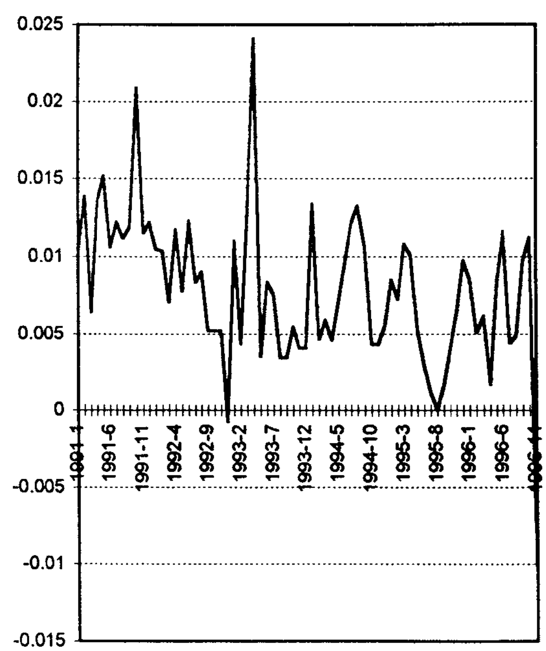
M2



Mt/Rand



CPISAF



was seen in 1996. These developments suggest an important, although lagged, effect of these two variables on inflation.

Table 2. Mozambique: Factors Influencing Inflation

	Inflation rate (end of period)	Budget deficit (% of GDP)	Exchange rate depreciation (%)	Real GDP growth (%)	Broad money growth	Weather or political
1990	47.1	12.3	26.42	0.9	37.32	
1991	35.2	5.5	78.21	4.9	35.61	
1992	54.5	5.4	48.51	-0.8	59.28	Drought
1993	43.6	5.1	91.03	18.8	78.76	Cyclone
1994	70.1	8.3	25.09	4.5	57.57	Elections
1995	54.1	5.0	64.46	1.4	54.68	
1996	16.6	5.2	4.82	6.4	15.04	Floods

IV. AN UNOBSERVED COMPONENTS INTERPRETATION: TREND, SEASONAL, AND IRREGULAR

The previous analysis of the possible causes of inflation during 1990-96 shows that the evolution of prices in Mozambique is likely to be a combination of the effect of food prices, with their marked seasonality, economic policies, and external factors affecting these two. A tentative interpretation of these factors could be that economic policies determine the evolution of "underlying inflation", which would be represented by the statistical trend of the series. Along this trend, the seasonal behavior would be determined by factors affecting agriculture, while exogenous events influence the series on an irregular basis. A way of exploring this interpretation is to perform a univariate decomposition of the series into these three elements, trend, seasonal, and irregular. This can be done in many ways, and there is no consensus in the literature about the superior performance of any particular model. We will follow a model-based approach, a procedure that is more cumbersome but probably more accurate than the use of ad-hoc filters.[4]

Hence, an ARIMA-model-based method was used to decompose the price series into its different unobserved components (see Appendix I for a brief description of the methodology). The computations were performed with SEATS, and the series were first filtered with TRAMO (see Maravall and Gomez, 1996) to remove outliers (the first observation of the sample, January 1990, was an outlier and was removed to avoid the effect

[4]See Maravall (1995) for a comparative analysis of the different approaches.

of initial conditions). For each series, an ARIMA model was fitted, and then the components were extracted. Well behaved residuals was a condition for the selection of the ARIMA model in each case. In all cases, the fitted model will be described as *(p,d,q)(bp,bd,bq)*, where *p* is the number of regular auto-regressive (AR) terms, *q* the number of moving average (MA) terms and *d* the number of regular differences. Likewise, *bp* is the number of seasonal AR terms, *bq* is the number of seasonal MA terms and *bd* the number of seasonal differences.

Following the conventional univariate analysis of inflation (see, e.g., Espasa and Cancelo (1993) for Spain) we have initially fitted an (0,0,1)(0,1,1) ARIMA model (Model 1) to the monthly inflation rate. Appendix Table 1 presents the original series and the performed decomposition. The trend component has decreased steadily over time, as a result of the stabilization policies implemented in the country. Inflation in Mozambique shows a very stable and sizable seasonal pattern, peaking in November-February and with a trough in May-June. This seasonal pattern resembles somehow the pattern we observe in agricultural production in Mozambique, although inverted. Figure 3 displays an index of agricultural production computed with information on agricultural output and prices.[5] We can see that agricultural production has a very marked seasonal pattern, with a peak in the winter months and a trough during the summer months.[6] This finding confirms the intuition that the marked seasonality of prices in Mozambique could be to a great extent the result of agricultural seasonality. We can see that the irregular component of inflation is important over the whole sample, and captures remarkably well the periods of droughts (early 92), cyclone Nadia (late 93 and early 94), elections (late 94), and floods (early 96).

However, there is a striking feature during 1996, which is that the irregular component of inflation is mainly negative during this year. This could imply the existence of a break in the trend of the series that the model is not able to capture, given the rigid structure that we have imposed. Therefore, we have tried overdifferencing the model and fitting a (0,1,2)(0,1,1) model (Model 2) to the series (see Figure 2 and Appendix Table 2). We are aware of the risks of overdifferencing, but in doing so we give more flexibility to the trend and, given that we suspect that the structural break may have happened in the last part of the sample, this model may be more suitable for understanding the recent behavior of inflation. The upper right panel of Figure 2 shows now an increasing trend component up to late 1994, a turnaround during 1995 and an acceleration of the decreasing trend in early 1996, reflecting the dramatic decrease in inflation during that year[7]. The seasonal component is basically the

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[5]This index was compiled by Marco Piñon-Farah, the Fund's resident representative in Maputo. A description of the methodology used is presented in Appendix II.

[6]Mozambique is located in the southern hemisphere. Therefore, its seasons are the reverse of those in the northern hemisphere.

[7]In order to check the robustness of our results, we have detrended the series with the Hodrick and Prescott filter. The trend component that we obtain is basically the same as in

(continued...)

Figure 2. Mozambique: Decomposition of Monthly Changes (Model 2), 1990-96
(in percent)

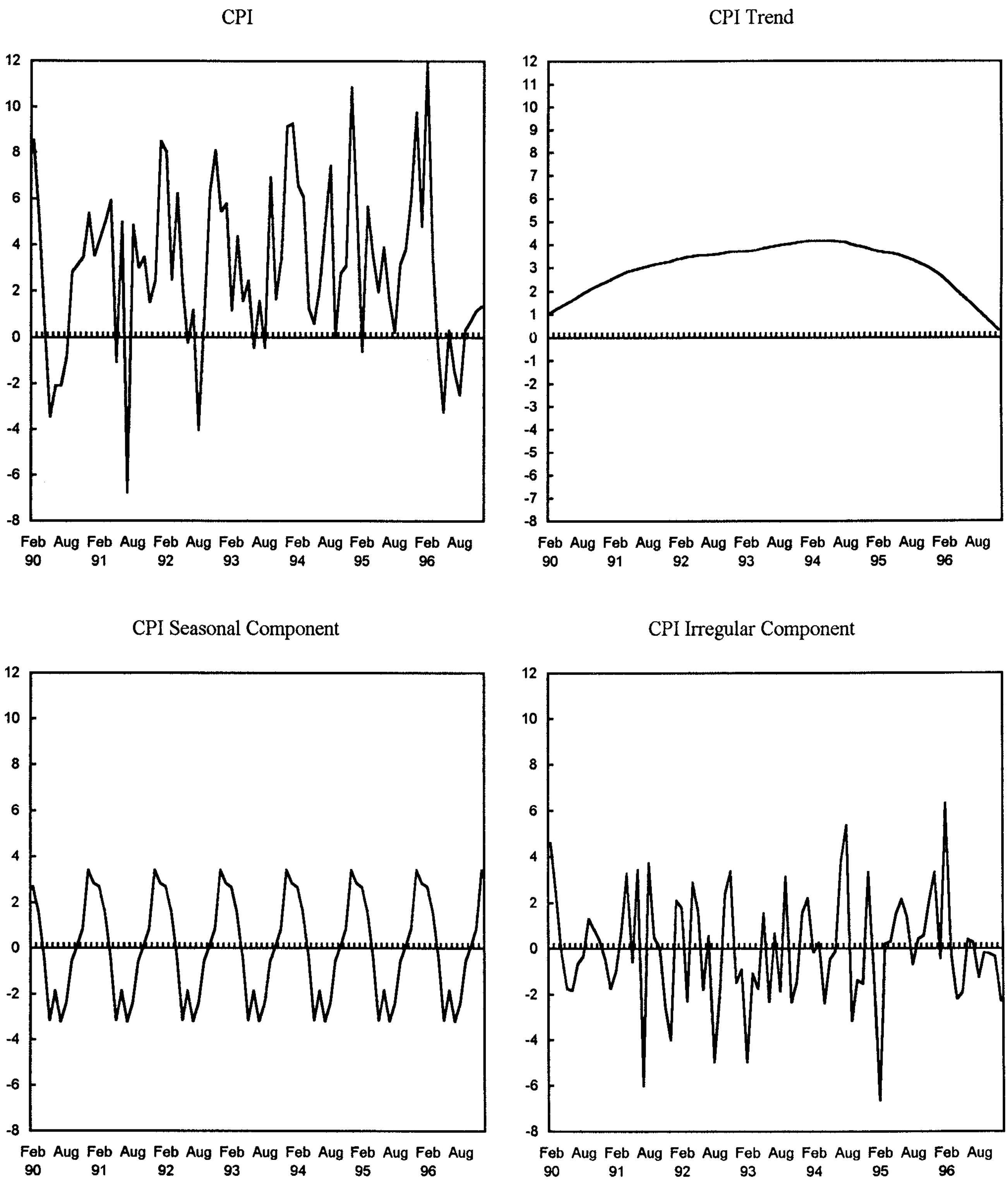
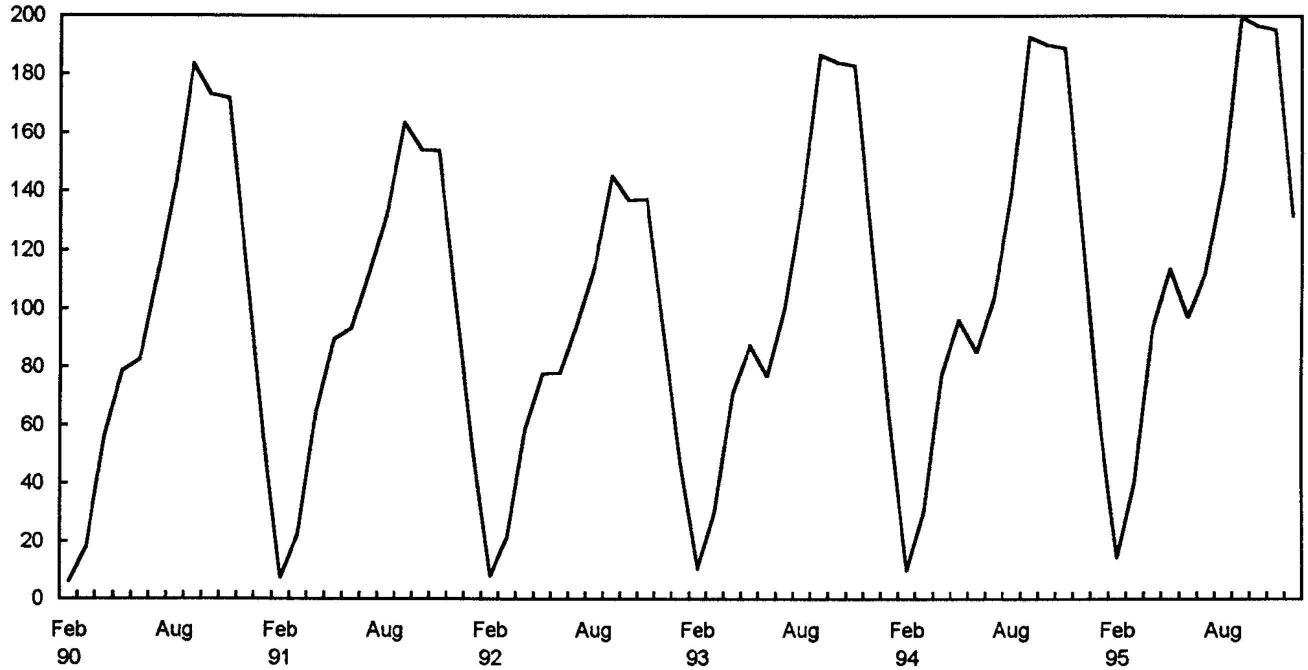
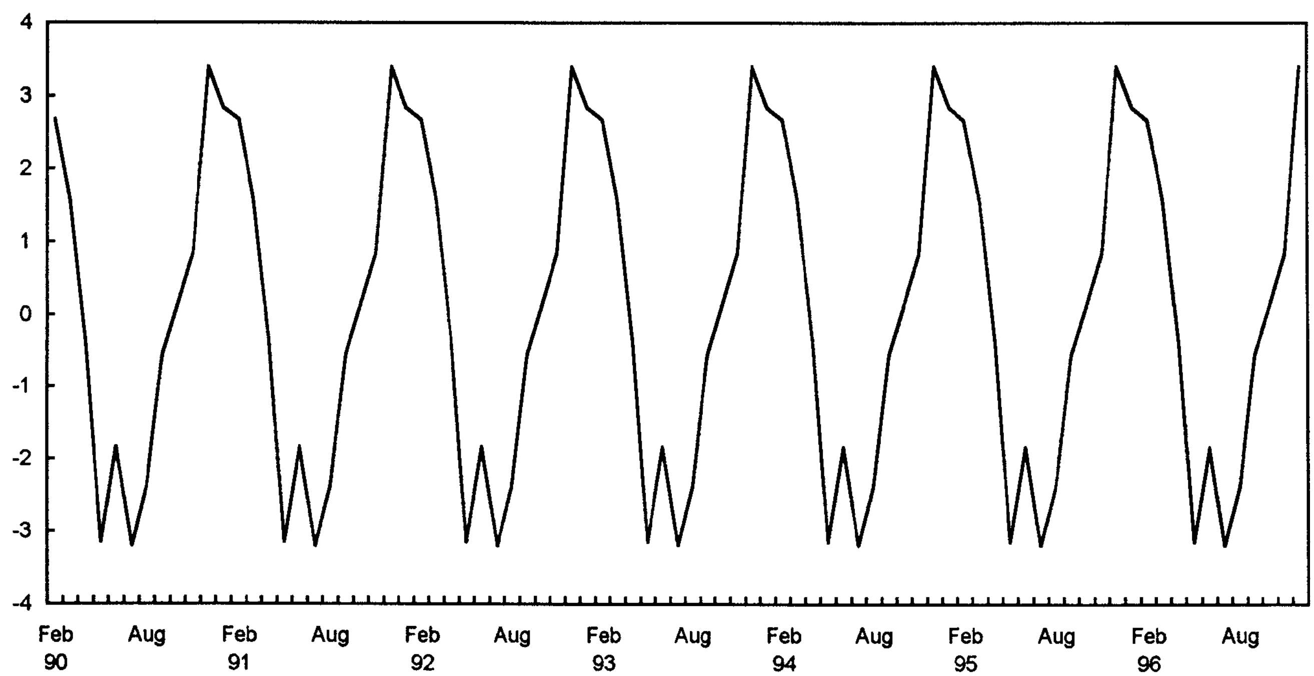


Figure 3. Mozambique: Agricultural Production, 1989-1996

Agricultural Production



CPI Seasonal Component



same as in Model 1, and so is the irregular, but now the behavior of the irregular component in 1996 is as expected, with both positive and negative values (compare the last row of Appendix Table 1 and 2).

In the previous section we have advanced money and exchange rates as possible factors affecting inflation. In order to better understand their behavior and the possible channels by which they may affect the different components of inflation, we have also decomposed these series into the same three components. For the analysis of monetary aggregates we have considered three definitions of money: currency in circulation (M0), narrow money (M1), and broad money (M2). In all cases an (0,1,1)(0,1,1) ARIMA model was fitted to the series. It is interesting to see how seasonality (Figure 4) is different for each of the series. In particular, it is remarkable how stable seasonality is for M0, whereas M1 and M2 seem to have an evolving seasonal component that smooths out and becomes more stable over time. Notice that in all cases peaks and troughs broadly correspond, although with some lag, to those of inflation, with peaks in the summer months and troughs in the winter months, although this pattern is less clear for M1 and M2. Notice also that M2 shows a small peak around July that smooths out over time, and in the last year this peak has almost disappeared. The explanation for this smoothing and for the reduced and more stable seasonality displayed in the last two years could be the improvement in monetary control on the part of the Bank of Mozambique.

Finally, the exchange rate also presents a stable seasonality (Figure 5). It shows a tendency to depreciate during the first part of the year and to appreciate during the second part. It is interesting to note how the model is able to identify the small seasonal peak in March/April, when the pilgrims buy foreign exchange for the pilgrimage to Mecca.

V. A SIMPLE THEORETICAL MODEL OF INFLATION DETERMINATION

Once we have analyzed the univariate properties of the series, the next step is to study them within a macroeconomic model. In order to provide a framework to analyze the impact of the different variables on inflation, a simple theoretical model of inflation determination in a developing country is presented below.

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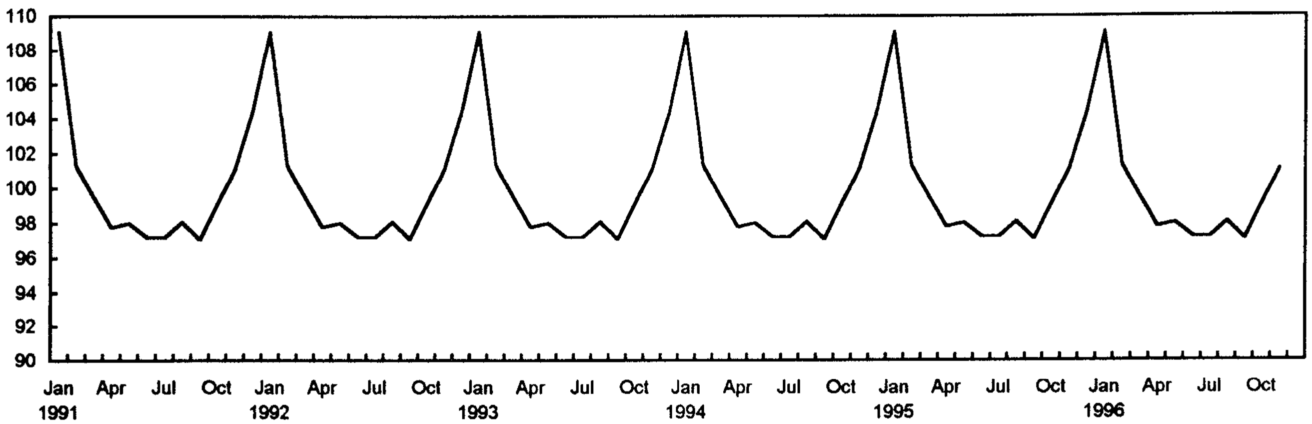
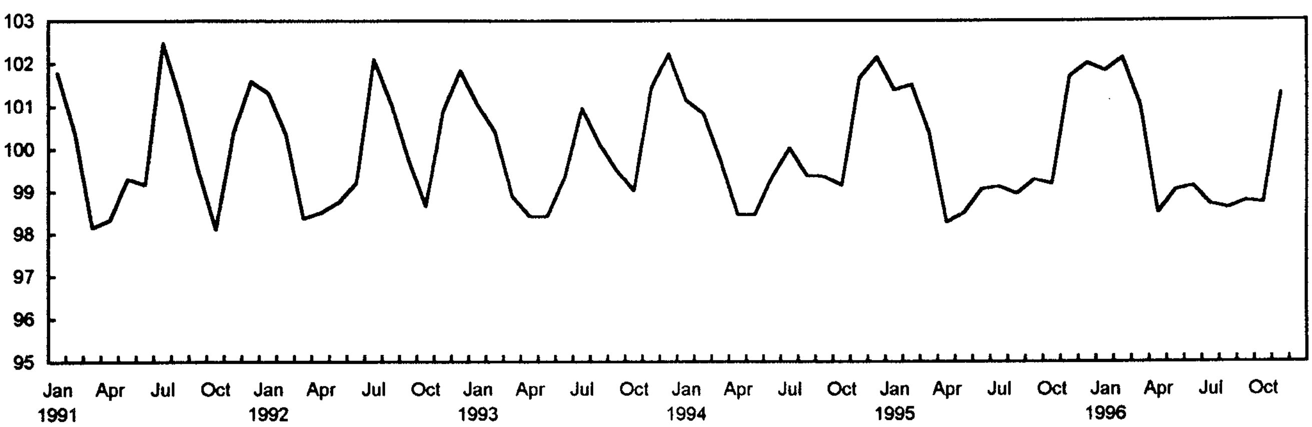
[7](...continued)
Model 2.

Figure 4. Mozambique: Monetary Seasonal Factors, 1991-1996

MO: Seasonal Component



M1: Seasonal Component



M2: Seasonal Component

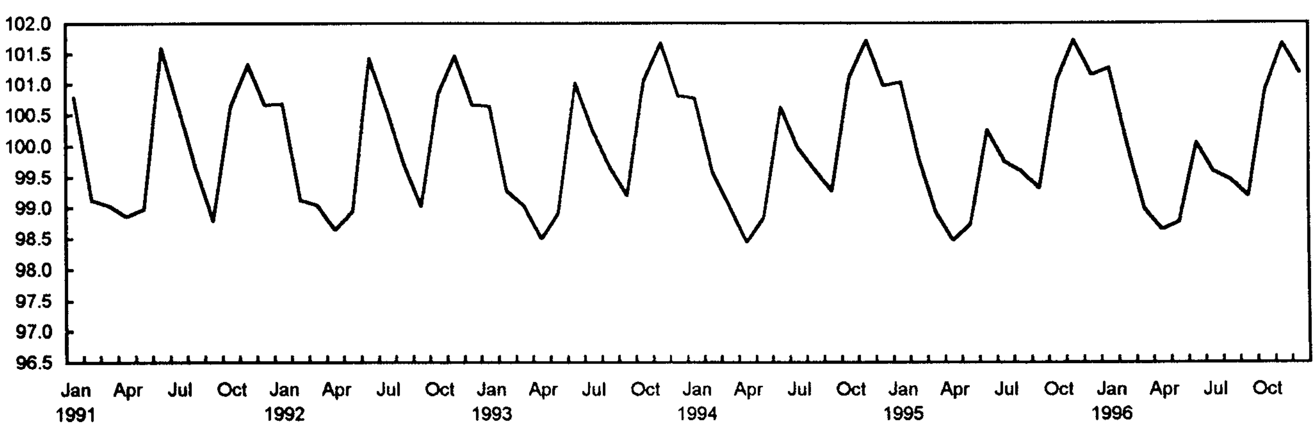
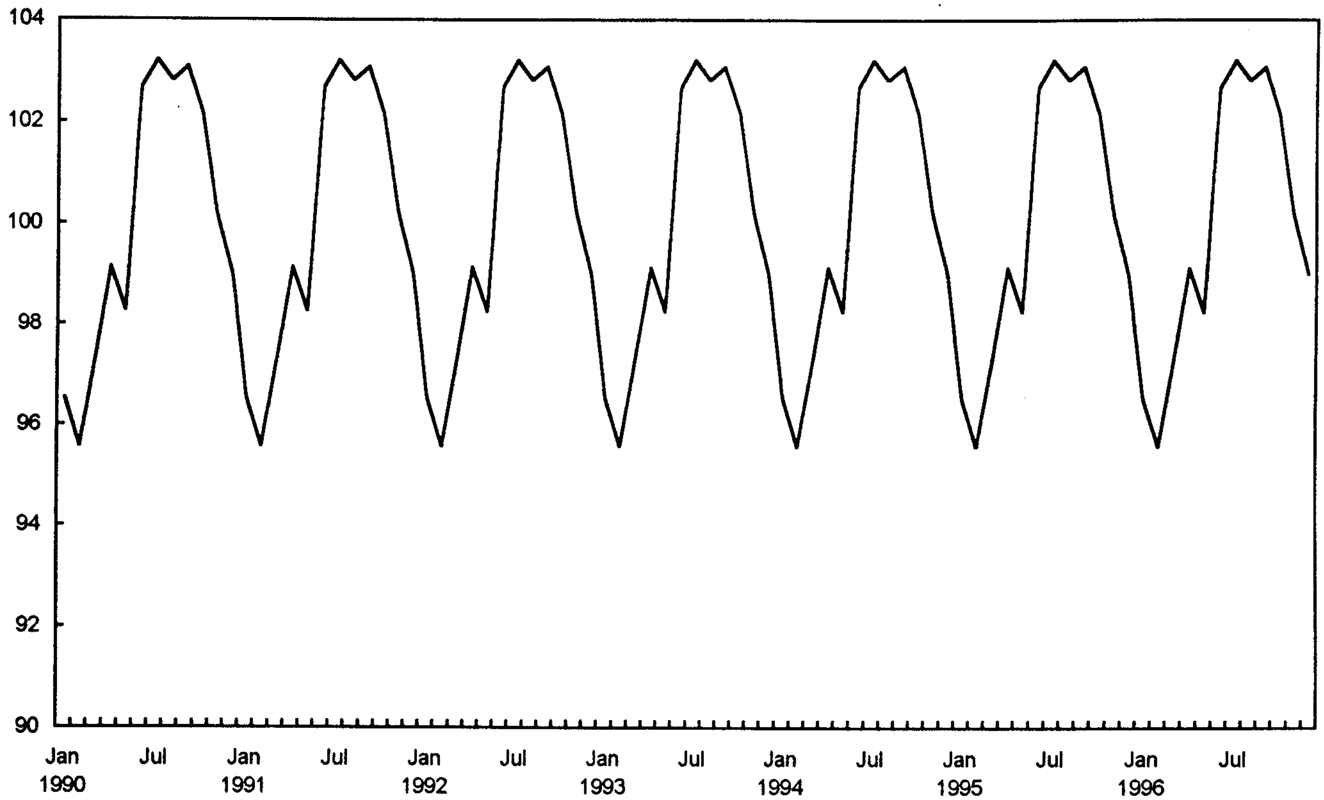


Figure 5. Mozambique: Exchange Rate Seasonal Factors, 1991-1996



We assume that the overall price level P is a weighted average of the price of tradable goods (P^T) and of nontradable goods (P^{NT}):

$$\log P_t = \alpha(\log P_t^T) + (1-\alpha)(\log P_t^{NT}) \tag{1}$$

where $0 < \alpha < 1$.

The price of tradable goods is determined in the world market and depends on foreign prices (P^f) and on the exchange rate (e), assuming that purchasing power parity holds

$$\log P^T = \log e_t + \log P_t^f \tag{2}$$

Hence a depreciation (appreciation) of the exchange rate or an increase (decrease) in foreign prices will increase (decrease) domestic prices.

The price of nontradable goods is set in the domestic money market, where demand for nontradable goods is assumed, for simplicity, to move in line with demand in the economy overall. As a result, the price of nontradable goods is determined by the money market equilibrium condition, where real money supply (M^s/P) equals real money demand (m^d):

$$\log P_t^{NT} = \beta(\log M_t^s - \log m_t^d) \tag{3}$$

where β is a scale factor representing the relationship between economy-wide demand and demand for nontradable goods. The demand for real money balances is assumed to depend on real income and inflationary expectations. A more conventional specification would include interest rates in addition to inflationary expectations. However, because of the lack of development of financial markets in Mozambique during the period under study, we consider that the relevant substitution is between goods and money, and not among different financial assets. Therefore, the opportunity cost of substitution between goods and money is the expected inflation rate.

$$m_t^d = f(y_t, E(\pi_t)) \tag{4}$$

Hence, an increase in real income will lead to an increase in money demand and an increase in expected inflation will lead to a decrease in money demand.

Another reason for including expected inflation in the model is the Lucas critique. As Lucas (1976) argued, rational agents will change their behavior with changes in the policy stance, and hence any inference that does not explicitly consider expectations is bound to make systematic predictive errors. Expected inflation can be modeled in different ways. A general formulation could be the following:

$$E(\pi_t)=d(L(\pi_t))+(1-d)\Delta\log P_{t-1} \qquad \textbf{(5)}$$

where $L(\pi)$ represents a distributed lag learning process for the agents of the country. If all the weights in $L(\pi)$ are equal, then we have adaptative expectations. If the weights decrease with time, we have a learning process. Therefore, people will form expectations on the basis of past inflation and past experience in forecasting inflation. To keep the procedure simple, we will assume that d=0.

Substituting and rearranging, we obtain an estimable equation of the type

$$\log P_t=c_1\log M_t+c_2\log y_t+c_3\Delta\log P_{t-1}+c_4\log e_t+c_5\log P_t^f \qquad \textbf{(6)}$$

where we expect that an increase in money supply, expected inflation, the exchange rate and foreign prices will push up prices, while an increase in real income will lead to a fall in the growth of prices. The effect of sluggish adjustment because of rigidities can be incorporated by adding the effect of lagged prices to the equation.

VI. Estimation of the Inflation Equation

A. Data Issues

The choice of the relevant variables is not straightforward. Given the lack of data on real income at a suitable frequency and for an adequate sample size, a possible proxy for real income would be consumption of electricity. However, given the lack of good data on electricity and the importance of agriculture (26 percent of gross output in 1995), especially of smallholder agriculture, an index of agricultural output would probably be a better indicator. Therefore, we use a monthly index of agricultural production constructed using information on agricultural prices (see Appendix II). For the same reason, a rainfall variable, measured in terms of millimeters of rainfall per month in Maputo, will be used in the estimation. The choice of the relevant partner country is also an important consideration. South Africa, which accounts for almost 30 percent of Mozambican trade seems the best choice, particularly when examining price developments in southern Mozambique. Likewise, the exchange rate variable is the metical/rand exchange rate. Agricultural and political events (such as floods or droughts and elections) will be modeled by including relevant dummies.

The main problem faced in the estimation process is the availability of data for a long sample. The longest sample available covering the main variables is monthly data from 1990 to 1996, but we have to deal with the delicate issue of seasonality. Because of the almost deterministic behavior of the seasonal component (see Section IV) and in order to avoid noninvertibility problems associated with the use of seasonality adjustment filters, such as X11, we chose to include seasonal dummies in our estimation.

A second issue is the unit root properties of the data. Taking into account the length of our sample, unit root testing with standard critical values could be misleading. However, based on visual inspection and the Augmented Dickey-Fuller (ADF) test, all the variables clearly reject the null of stationarity[8]. Hence, the possibility of cointegration should be taken into account to avoid spurious estimation results. We find weak evidence of cointegration, with a cointegrating vector that indicates that, in the long run, inflation in Mozambique is positively related to South African prices, money supply, and the metical/rand exchange rate (the cointegrating vector is [1.64 0.72 0.18]) . On the basis of the previous analysis we follow a general-to-specific modeling approach and estimate a general dynamic error-correction model. The general specification that we considered takes the form of an autoregressive distributed-lag model of the type

$$p_t=\alpha_0+ECM_{-1}+\sum_{j=0}^{n}(\alpha_{ij}x_{t-j})+\epsilon_t \tag{7}$$

where x_t is the vector of regressors, *ECM* is the error-correction component, and the lag length n is chosen on the basis of a priori information and/or data constraints. Different parameterizations and lag lengths were considered during the process, and model reduction with the final objective of a parsimonious and congruent model was the guideline used to reach the final specification.

B. Estimation Results

The empirical counterpart of our theoretically derived equation has been estimated with OLS estimation techniques with monthly data for the period 1989:1-1996:12. The general specification included all the variables in first differences with up to 12 lags, and its final specification appears in Table 3, Equation I. Two dummy variables were found to be significant, one in late 1994 accounting for the national elections and another in early 1996 accounting for the serious floods that affected the south of the country. Appendix Table 1 shows that the irregular component during these periods was very large, and, hence, the introduction of the dummy variables seems warranted. The agricultural index variable is a six-month moving average of the original series. Likewise, the rainfall variable is a three-month moving average of the original series. Several normality and heteroskedasticity tests were performed to ensure that the residuals were well behaved.

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[8]We are aware that the use of ADF and Phillips-Perron unit root tests on non-seasonally adjusted data may give inconsistent results. We checked the validity of our assumptions with the test proposed by Canova and Hansen (1992) for non-seasonally adjusted data, and the results were confirmed.

Table 3. Mozambique: Estimation Results

	Eq. I	Eq. II	Eq. III
Constant	0.008	0.008	0.01
	(0.008)	(0.007)	(0.008)
Δ Log *M2* (t-4)	0.46		
	(0.11)		
Δ Log *M1* (t-4)		0.41	
		(0.11)	
Δ Log *M0* (t)			0.19
			(0.09)
ECM (t-1)	-0.06	-0.06	-0.09
	(0.03)	(0.03)	(0.03)
Δ Log *Erate* (t)	0.16	0.17	0.14
	(0.06)	(0.07)	(0.07)
Δ Log *Erate* (t-5)	0.14	0.12	0.17
	(0.06)	(0.06)	(0.06)
ΔLog *Agr* (t-4)	-0.022	-0.023	-0.02
	(0.014)	(0.014)	(0.015)
Δlog *Rain*	-0.12	-0.12	-0.09
	(0.03)	(0.03)	(0.04)
Δlog *Rain* (t-2)	-0.057	-0.052	-0.043
	(0.02)	(0.02)	(0.02)
Δlog *Rain* (t-3)	-0.068	-0.063	-0.05
	(0.02)	(0.02)	(0.02)
R^2	0.81	0.80	0.74
DW	1.94	1.94	1.91
F-statistic	8.55	8.05	5.82

Note: Standard errors in parentheses. Seasonal dummies and two impulse dummies, 1994:8 and 1996:2, were included in the estimation. *ECM* is the error-correction term; *Erate* is the metical/rand exchange rate; *Agr* is a six-month moving average of the index of agricultural production; and *Rain* is a three-month moving average of monthly rainfall (in millimeters).

The results indicate that the metical/rand exchange rate has a significant short-run effect on inflation, both contemporaneous and lagged. Notice that the coefficient is positive as expected, reflecting the effect on inflation via trade in goods, mainly through imports in the informal sector.

As expected, money, represented by M2, has no contemporaneous effect on inflation, but it has an important effect with four lags. The short-run elasticity of money is 0.5. Interestingly, lagged inflation is not significant. These two facts would indicate that the adjustment process in Mozambique is very fast, and that changes in monetary policy are translated quickly into price changes. Finally, the coefficient of the error correction (ECM) term shows the rapid adjustment of inflation towards its equilibrium value, 6 percent per month.

The variable proxing for income, the monthly agricultural index, was found to be weakly significant and with a negative sign, as we have suggested. The variable rainfall is also significant with a negative sign, reflecting the positive effect of the rains on agricultural production and therefore on the evolution of prices in Mozambique.

Regarding the long run, our estimated long run equation shows a significant relationship between prices and both money and exchange rates, which appear with the expected sign (see previous subsection). Therefore, long-term projections of the inflation rate in Mozambique should take into account the scenarios considered for money and the exchange rate, and the stabilization of the value of the metical should help stabilize and reduce the rate of inflation in the long run. Notice also that the existence of a cointegration relationship including money may imply a failure of the purchasing power parity hypothesis to hold in the long run (we could not find a cointegration relationship when the money variable was dropped).

Simulations not reported here to save space show that, had the stance of monetary policy in 1996 been, ceteris paribus, that of 1995 (in terms of money growth), inflation in 1996 would have been 26 percent instead of the 17 percent actually recorded.[9] By the same token, had the exchange rate depreciated in 1996 as it did in 1995, inflation in 1996 would have been 36 percent. However, had agricultural output been in 1996 that of 1995, inflation in 1996 would have been 18 percent.

The model satisfies all the basic diagnostic tests, and we can see in Figure 6 that it is able to track all the main turning points of the inflation cycle, especially since mid–1995. The forecasting performance of the equation is also satisfactory. It seems from the evidence that the relationship has been more stable in the last two years, probably reflecting the

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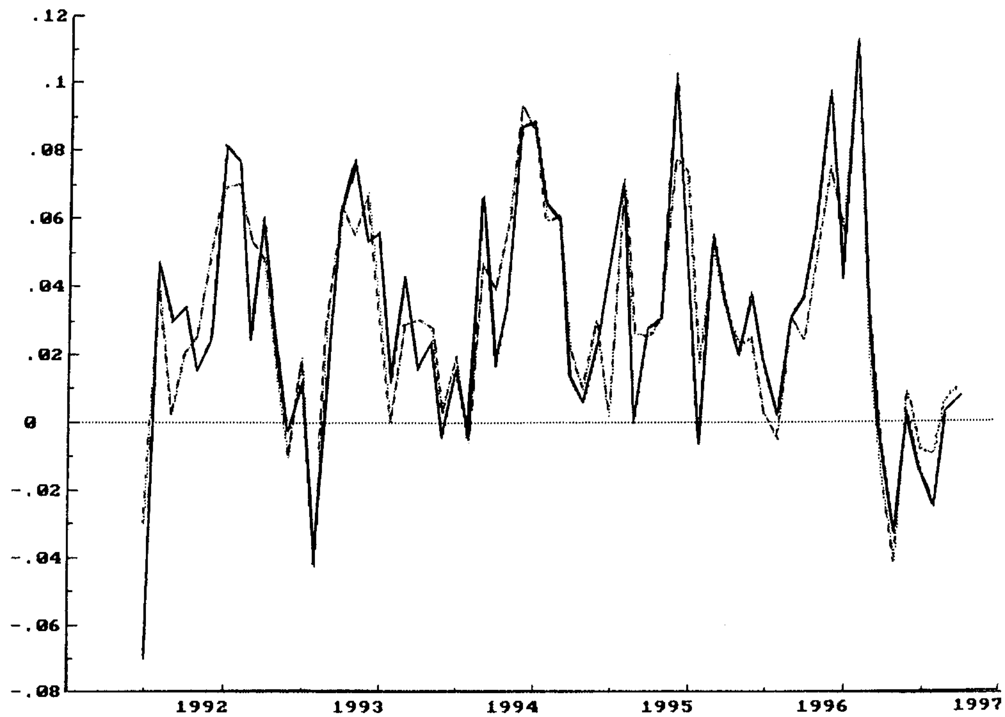
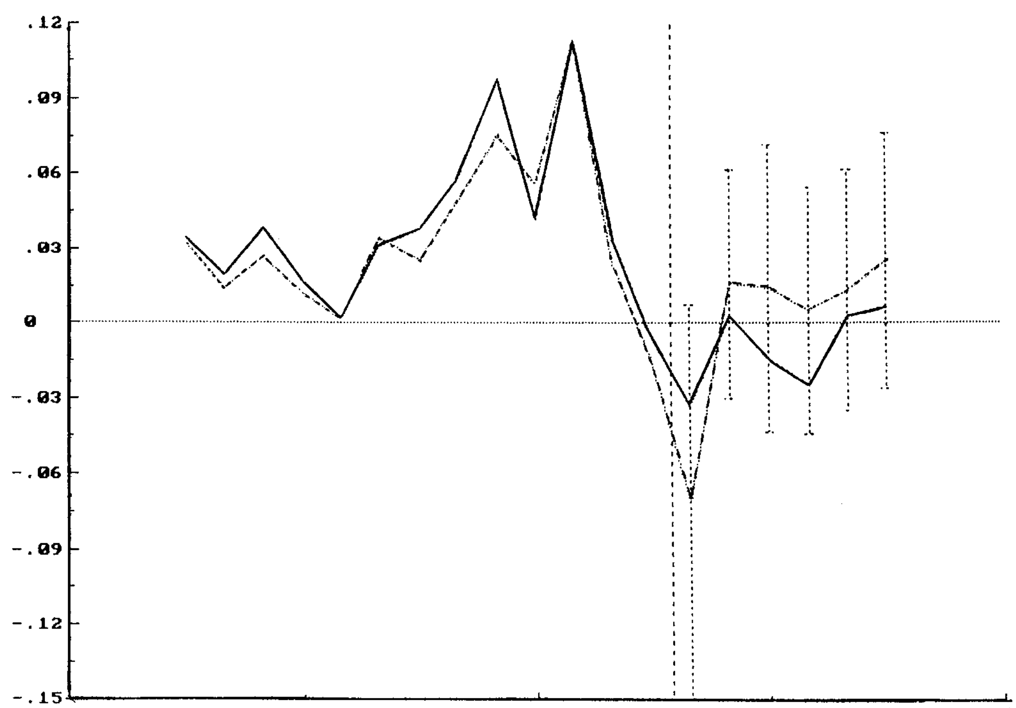
[9]Clearly, the ceteris paribus assumption is not consistent with the fact that money Granger-causes the exchange rate (see Table 5 below), but it is made for illustration only.

Figure 6. Mozambique: Actual, Fitted and Forecast Changes in the CPI, 1991-96

Actual (-) and Fitted (..)



Actual (-), Fitted (..) and Forecast



improvement in the conduct of monetary policy in Mozambique[10]. This confirms the results of Section 2, in which we have seen that the seasonal pattern of M2 has stabilized in the last two years.

As discussed before, the choice of the money supply variable was not clear a priori. In order to check the sensitivity of the results , we have estimated the equation using different measures of money, M1 and M0. The results appear in equations II and III in Table 3. Notice that M1 enters the equation with the same lag as M2, but that M0 enters the equation contemporaneously. In order to give a formal content to our selection and given the non-nested nature of our competing equations, we have performed encompassing tests (see Mizon and Richard (1986)) of each different equation against our preferred specification (equation I). These tests (Table 4) show that M2 is the most informative variable for understanding the behavior of inflation.

Table 4. Mozambique: Encompassing Tests

Eq. II v Eq. I	Form	Test	Form	Eq. I v Eq. II
-2.09754	N(0,1)	Cox	N(0,1)	0.8602833
1.64498	N(0,1)	Ericsson IV	N(0,1)	-0.7071149
2.48704	$Chi^2(1)$	Sargan	$Chi^2(1)$	0.5186022
2.58064	F(1,41)	Joint Model	F(1,41)	0.5125837
[0.1159]				[0.4781]
Eq. III v Eq. I	**Form**	**Test**	**Form**	**Eq. I v Eq. III**
-37.6504	N(0,1)	Cox	N(0,1)	-3.18692
25.5598	N(0,1)	Ericsson IV	N(0,1)	2.50694
12.133	$Chi^2(1)$	Sargan	$Chi^2(1)$	1.68694
16.6556	F(1,41)	Joint Model	F(1,41)	1.71234
[0.0002]				[0.1980]

VII. A DYNAMIC MULTIVARIATE ANALYSIS

The results from the inflation equation suggest the dynamic nature of the inflation transmission mechanism and the presence of feedback effects among prices, exchange rates,

[10]Since 1995 the conduct of monetary policy has improved considerably in Mozambique. The use of indirect instruments has increased, the real rediscount rate has been kept positive and the sale of the Banco Comercial de Moçambique allowed the Bank of Mozambique to exert a more strict control over the money supply, see Leite et al. (1996) for an extensive analysis.

and money. Hence, a dynamic multivariate analysis that encompasses the single equation methodology can give robustness to our analysis and shed some light on these dynamic transmission mechanisms, by allowing us to test for causality and to conduct impulse response and variance decomposition analyses. However, a word of caution about the results is needed. Multivariate analyses of this type, and in particular the critical values of the Granger causality test, are sensitive to short sample sizes. Hence, we will give a global view of the results based on the three tests.

In short, consider that the vector X_t containing the relevant series of interest can be represented as

$$\Delta X_t = C(L)\epsilon_t \qquad \textbf{(8)}$$

where ϵ_t is a white noise process with zero mean and variance Σ, and $C(L)$ is a matrix polynomial in the lag operator L, $C(L) = I - C_1L - C_2L^2 - \ldots$, satisfying standard regularity conditions. In this framework we will perform three different exercises. The first one is to compute the accumulated orthogonal impulse response function. In order to do that we first have to transform the VAR model such that the white noise process has a diagonal covariance matrix . This will be achieved by means of a Cholesky decomposition of the matrix Σ . Since Σ is a positive definite matrix, there is a nonsingular matrix P such that $P \Sigma P' = I$. This implies

$$\Delta X_t = C(L)\epsilon_t = C(L)P^{-1}P\epsilon_t = D(L)w_t \qquad \textbf{(9)}$$

Once we have the transformed system, the orthogonalized impulse response of variable k at time i to a unit shock to variable j is represented by the kjth element of the matrix $D(L)$.

The second step is to compute the forecast error variance decomposition. The forecast error covariance matrix of an h-step forecast is

$$\Sigma(h) = D(L)_0 D(L)_0' + D(L)_1 D(L)_1' + \ldots + D(L)_{h-1} D(L)_{h-1}' \qquad \textbf{(10)}$$

The contribution of innovations in the jth variable to this forecast error is given by

$$d^2_{mj,0} + d^2_{mj,1} + \ldots d^2_{mj,h-1} \qquad \textbf{(11)}$$

where $d_{mj,\,n}$ is the mjth element of $D(L)_n$.

The final step is to test for Granger causality within the VAR (see Granger (1969)). Broadly speaking, a variable x_{1t} is said to be *Granger caused* by a variable x_{2t} if the information in past and present x_{2t} helps to improve the forecast of x_{1t}. The AR representation of the VAR system in equation (8) is

$$X_t = \Theta(L)X_{t-1} + \epsilon_t \tag{12}$$

Then, it can be shown (see, e.g., Judge et al. (1985)) that variable x_i does not Granger-cause variable x_j if and only if

$$\theta_{ji,1} = \theta_{ji,2} = \ldots = \theta_{ji,p} = 0 \tag{13}$$

where θ are the elements of the matrix Θ and p is the length of the VAR. Hence, testing for Granger causality is equivalent to testing for zero constraints on the coefficients of the VAR.[11]

We have fitted a VAR to Mozambican prices, the metical/rand exchange rate, money and South African prices. The lag length of the VAR has been selected so as to minimize a multivariate version of the Hannan and Quinn (1979) criterion. We found evidence of cointegration among the variables and the system was estimated by maximum likelihood (see Johansen (1995)). The selected specification on the basis of this criterion is a VAR(6) and the residuals do not display any problem of serial correlation. Table 5 presents the Granger causality test and Table 6 the forecast error variance decomposition analysis.

Table 5. Mozambique: Granger Causality Test

	CPI	CPISAF	Erate	M2
CPI	0.00	4.20	24.97	11.09
CPISAF	3.63	0.00	1.01	5.23
Erate	13.99	9.70	0.00	12.11
M2	2.30	15.36	5.06	0.00

Note: Critical value: 9.48. Cell (i,j) is the test for variable *j* causing variable *i*. *CPI* and *CPISAF* are the consumer price indices for Mozambique and South Africa, respectively. *Erate* is the metical/rand exchange rate.

Accumulated orthogonal impulse responses are displayed in Figure 7. The results can be summarized as follows: Granger causality tests indicate that both money and the exchange rate Granger-cause inflation, in line with our previous analysis. Interestingly, the accumulated orthogonal impulse response of prices when money is shocked by one percent shows a peak after four to five months, stabilizing thereafter to a long run effect of 0.4 percent. A one

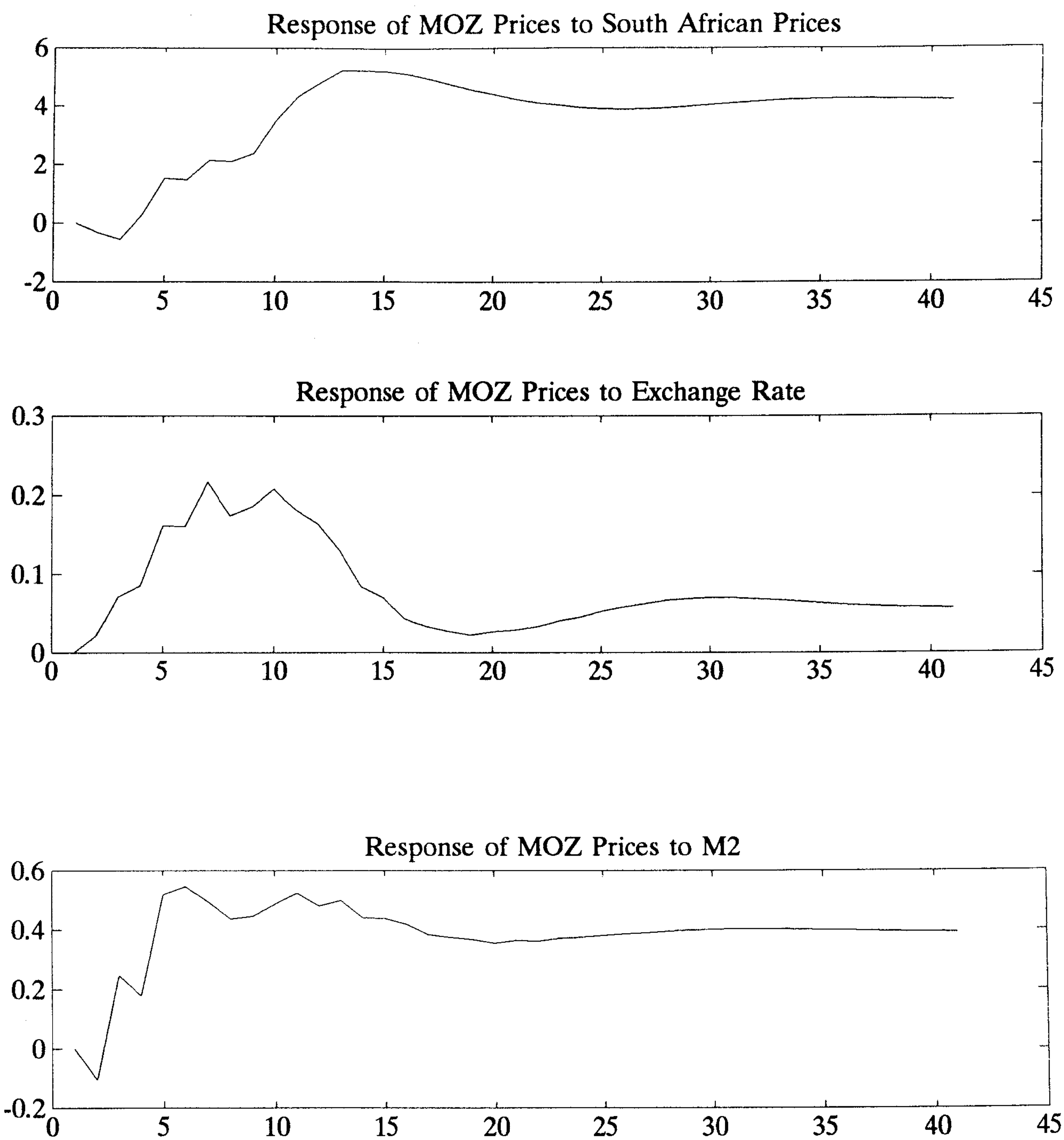
[11] See Judge et al. (1985) for the implications of cointegration for Granger causality testing.

Table 6. Mozambique: Forecast Error Variance Decomposition

Variable	Horizon	*CPI*	*CPISAF*	*Erate*	*M2*
CPI	1.0000	1.0000	0.0000	0.0000	0.0000
CPISAF	1.0000	0.0240	0.9760	0.0000	0.0000
Erate	1.0000	0.0179	0.1495	0.8326	0.0000
M2	1.0000	0.0000	0.0025	0.0096	0.9879
CPI	3.0000	0.9128	0.0016	0.0018	0.0838
CPISAF	3.0000	0.1141	0.8060	0.0766	0.0034
Erate	3.0000	0.0812	0.1667	0.7510	0.0010
M2	3.0000	0.0425	0.0792	0.0141	0.8642
CPI	5.0000	0.8324	0.0283	0.0106	0.1287
CPISAF	5.0000	0.1154	0.7628	0.0951	0.0266
Erate	5.0000	0.1163	0.2929	0.5271	0.0638
M2	5.0000	0.1237	0.1049	0.0453	0.7261
CPI	7.0000	0.8251	0.0296	0.0174	0.1279
CPISAF	7.0000	0.1372	0.7348	0.0985	0.0295
Erate	7.0000	0.1287	0.2855	0.5201	0.0658
M2	7.0000	0.1378	0.1160	0.0471	0.6991
CPI	10.0000	0.8134	0.0381	0.0241	0.1244
CPISAF	10.0000	0.1538	0.7131	0.0967	0.0364
Erate	10.0000	0.1291	0.2816	0.5220	0.0674
M2	10.0000	0.1493	0.1277	0.0497	0.6734

Note: For definitions of variables, see notes to Table 5.

Figure 7. Mozambique: Accumulated Orthogonal Impulse Response of Prices



percent depreciation of the metical induces a 0.2 percent increase in inflation that lasts about ten months and dies out after 20 months. Quantitatively speaking, the forecast error variance decomposition analysis shows that money explains eight percent of the variance of prices after three months and twelve percent after five months.

The metical/rand exchange rate is Granger caused by all the variables. The impulse responses show that a positive shock to Mozambican prices induces a depreciation of the exchange rate that lasts 3 months followed by an appreciation of approximatedly the same amount as the shock (Figure 8). A shock to South African prices creates an opposite and more intense effect, an initial appreciation followed by a return to the steady state. In quantitative terms, the variance decomposition shows that after three (five) periods Mozambican prices explain eight (eleven) percent of the forecast error variance of the exchange rate whereas South African prices explain sixteen (twenty-nine) percent. Hence, it seems that the exchange rate moves in the short run toward an equilibrium value, a value that is not necessarily the purchasing power parity.

Finally, money seems to be caused only by South African prices. The impulse responses show that an inflationary shock in Mozambique drives down money in the long run, and the same happens after an appreciation of the exchange rate; the opposite happens after an inflationary shock in South Africa (Figure 9). These results point to the importance of capital flows moving between Mozambique and South Africa in accordance with the economic conditions of each country.

VIII. CONCLUSIONS

The rate of inflation in Mozambique has been consistently high over the 1989-1994 period; after dropping in 1995 to 54 percent it plunged in 1996 to 17 percent from 70 percent in 1994. In this paper we use three alternative approaches to the empirical analysis of inflation and argue that monetary expansion, together with the depreciation of the exchange rate and unpredictable events in the agricultural sector, are responsible to a large extent for the inflationary process in Mozambique. The combined analysis of the three approaches suggests that the marked tightening of monetary policy in 1996 was the ultimate reason for the deceleration of the inflation rate in 1996. The control of monetary expansion had the multiplier effect of helping to stabilize the metical (recall that money Granger-causes the exchange rate), thus contributing twice to the contention of inflation. There are several reasons to believe that this success can be long lasting. First, this turnaround was obtained in a year that started with a major agricultural shock as a result of the serious floods in early 1996 that pushed accumulated inflation up to 10 percent in February, of which about 5 percent were due to the floods. Second, the unobserved components analysis shows a break in the trend in 1996, probably reflecting the changes in monetary control policies. This hypothesis is corroborated by the analysis of the seasonality of money supply, which shows a stabilization of the seasonal fluctuations in the last two years. Finally, the stability of the metical should also benefit from any improvement in the economic situation in South Africa and from the rand being more stable; this should help in turn to keep inflation under control. It

Figure 8. Mozambique: Accumulated Orthogonal Impulse Response of the Exchange Rate

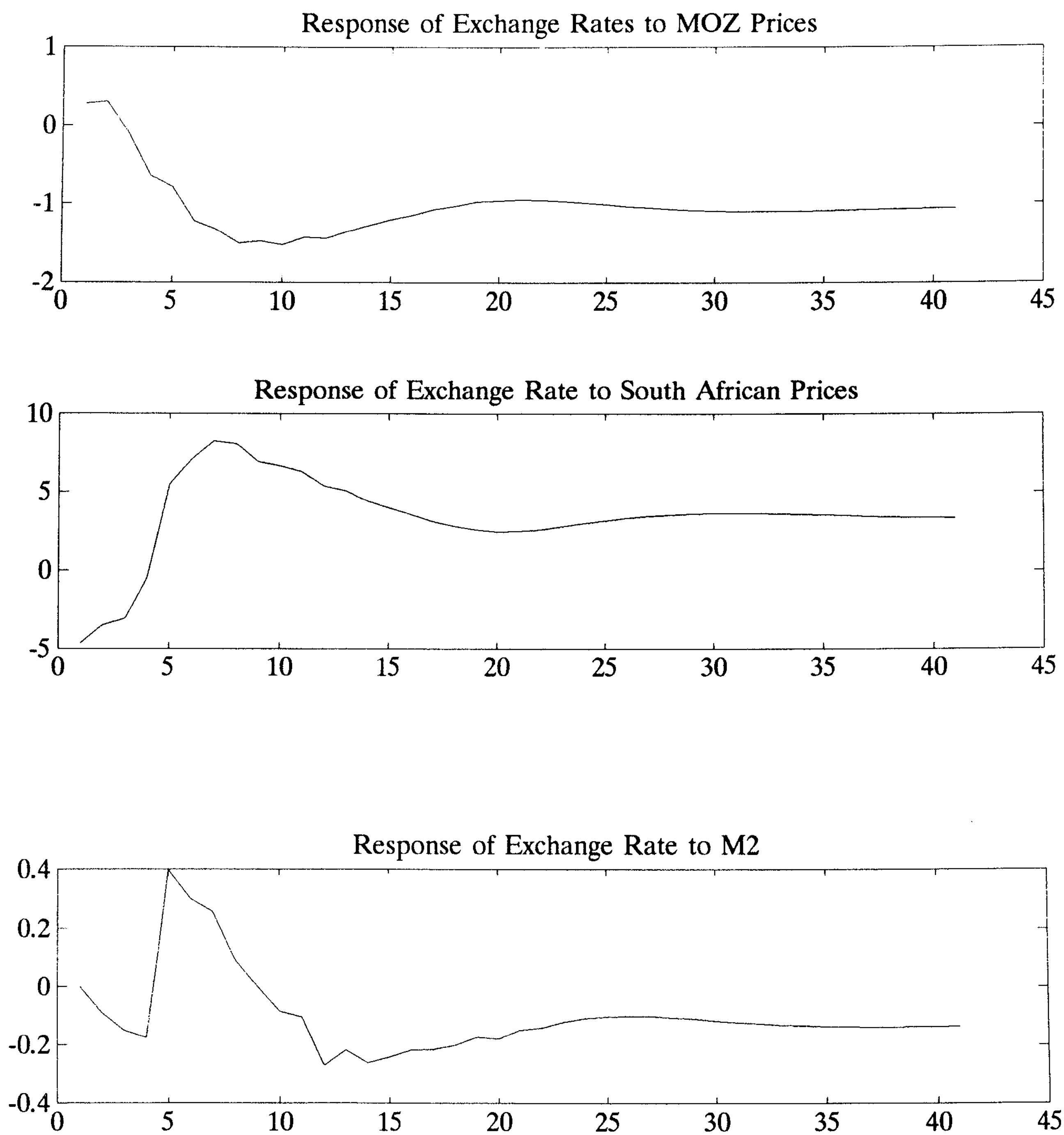
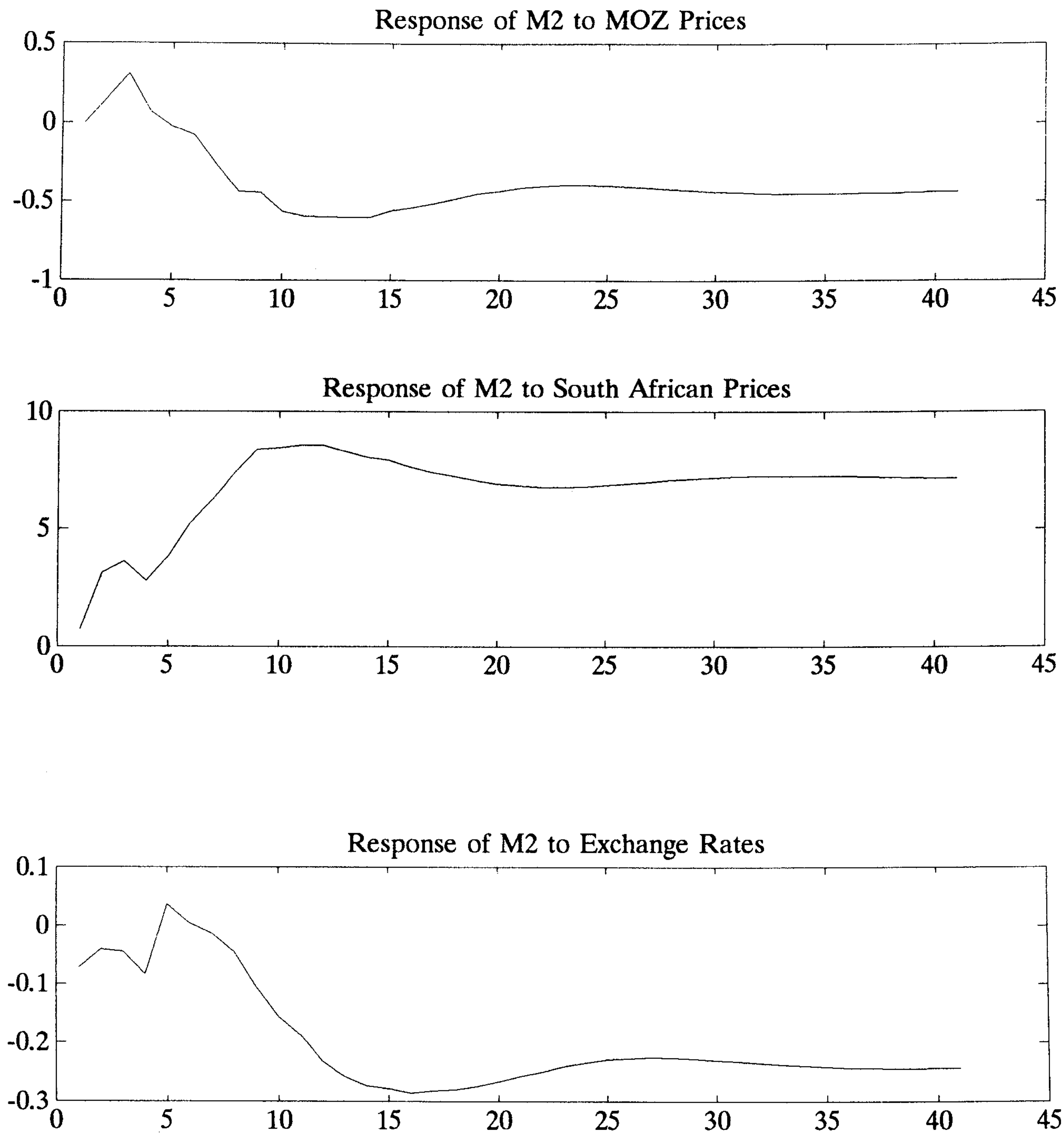


Figure 9. Mozambique: Accumulated Orthogonal Impulse Response of Money



is important to notice that money is Granger-caused by South African prices, reflecting the mounting inflows of capital from South Africa into Mozambique during the last year as a result of the decrease in the inflation differential between the countries. These inflows should be kept under control to avoid inflationary pressures and excessive exchange rate fluctuations. Inflation movements in 1997 seem to follow 1996, and inflation up to July is below 3 percent despite new floods during the first months of the year.

A MODEL-BASED UNOBSERVED COMPONENTS DECOMPOSITION

This appendix describes the methodology for decomposing a series into its unobserved components. Briefly, the procedure is as follows. Let x_t denote the original series, and let

$$z_t=\delta(B)x_t$$

represent the "differenced" series, where B stands for the lag operator, and $\delta(B)$ denotes the differences being taken on x_t in order to achieve stationarity. We will consider the case

$$\delta(B)=\Delta^d\Delta_s^D$$

where $\Delta^d = 1\text{-}B$ and $\Delta^D{}_s = (1\text{-}B^s)^D$ represents the seasonal differencing of period s. The model for the differenced series z_t can be expressed as

$$\phi(B)(z_t-\bar{z})=\theta(B)a_t$$

where z is the mean of z_t, a_t is a white noise series of innovations, $\phi(B)$ and $\theta(B)$ are autoregressive (AR) and moving average (MA) polynomials in B, respectively. This relationship can be expressed in a multiplicative form as the product of a regular polynomial in B and a seasonal polynomial in B^s, as in

$$\phi(B)=\phi_\tau(B)\phi_s(B^s)$$
$$\theta(B)=\theta_\tau(B)\theta_s(B^s)$$

Substituting and rearranging, the complete model can be written in a detailed form as

$$\phi_\tau(B)\phi_s(B^s)\Delta^d\Delta_s^Dx_t=\theta_\tau(B)\theta_s(B^s)a_t+c$$

and, in concise form, as

$$\Phi(B)x_t=\theta(B)a_t+c$$

where $\Phi(B) = \phi(B)\delta(B)$ represents the complete autoregressive polynomial, including all unit roots. Notice that if p denotes the order of $\phi(B)$ and q denotes the order of $\theta(B)$, then the order of $\Phi(B)$ is $P = p + q + D \times s$.

We will decompose this model into several components as follows

$$x_t = \sum_i x_{it}$$

where x_{it} are the different components we will consider, namely x_{pt} (trend), x_{st} (seasonal) and x_{ut} (irregular). Broadly, the trend represents the long-term evolution of the series and displays a spectral peak at zero frequency; the seasonal component, in turn, captures the spectral peaks at seasonal frequencies. The irregular component captures erratic, white-noise behavior and, hence, has a flat spectrum[12]. The decomposition assumes orthogonal components, and each of them will have in turn an ARIMA expression.

[12]Given the nature of the series, we do not consider a fourth component, the cyclical component, which we will include in a more general trend component.

Table 1: Mozambique. Components of Inflation - Model 1

	YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Original	1990		8.55	5.20	0.73	-3.46	-2.09	-2.06	-0.86	2.83	3.14	3.48	5.37
Trend			5.46	3.92	3.20	2.70	2.72	3.00	3.33	3.65	3.70	3.48	2.89
Seasonal			2.34	1.25	-0.64	-3.45	-2.10	-3.50	-2.60	-0.77	-0.09	0.61	4.00
Irregular			0.75	0.03	-1.83	-2.72	-2.71	-1.56	-1.59	-0.05	-0.48	-0.60	-1.51
Original	1991	3.54	4.27	5.04	5.94	-1.08	4.98	-6.76	4.85	3.01	3.46	1.52	2.47
Trend		2.50	3.02	3.95	4.18	4.09	3.61	3.02	3.81	4.11	3.44	2.69	2.40
Seasonal		4.92	2.33	1.25	-0.63	-3.43	-2.09	-3.49	-2.59	-0.77	-0.09	0.61	4.00
Irregular		-3.88	-1.09	-0.16	2.39	-1.73	3.45	-6.29	3.64	-0.33	0.11	-1.79	-3.93
Original	1992	8.50	8.02	2.49	6.24	2.09	-0.23	1.16	-4.02	1.04	6.31	8.09	5.46
Trend		3.41	3.82	3.58	4.17	4.07	3.48	3.17	2.51	2.94	4.28	4.32	3.19
Seasonal		4.88	2.32	1.25	-0.64	-3.42	-2.09	-3.46	-2.60	-0.77	-0.09	0.62	4.02
Irregular		0.20	1.87	-2.34	2.71	1.43	-1.63	1.45	-3.92	-1.13	2.12	3.15	-1.75
Original	1993	5.79	1.17	4.38	1.57	2.44	-0.45	1.58	-0.44	6.92	1.66	3.45	9.15
Trend		2.35	2.32	2.83	3.38	3.55	3.37	3.31	3.61	3.87	3.30	3.13	3.64
Seasonal		4.85	2.31	1.25	-0.66	-3.41	-2.09	-3.43	-2.60	-0.77	-0.11	0.61	4.05
Irregular		-1.40	-3.47	0.30	-1.15	2.30	-1.74	1.69	-1.46	3.83	-1.53	-0.29	1.46
Original	1994	9.29	6.61	6.09	1.28	0.60	2.14	4.81	7.43	0.02	2.80	3.10	10.86
Trend		3.67	3.62	3.44	3.10	3.22	3.76	4.74	4.61	3.15	2.66	3.25	3.50
Seasonal		4.82	2.31	1.25	-0.68	-3.41	-2.08	-3.40	-2.59	-0.79	-0.11	0.61	4.07
Irregular		0.80	0.68	1.39	-1.14	0.79	0.46	3.47	5.40	-2.35	0.25	-0.76	3.28
Original	1995	5.42	-0.62	5.67	3.54	1.97	3.91	1.65	0.21	3.15	3.80	5.98	9.75
Trend		2.32	1.70	2.81	3.51	3.69	3.84	3.49	3.06	3.07	3.28	3.62	3.21
Seasonal		4.80	2.31	1.26	-0.69	-3.41	-2.07	-3.40	-2.59	-0.79	-0.12	0.61	4.09
Irregular		-1.70	-4.63	1.60	0.71	1.70	2.14	1.56	-0.26	0.88	0.64	1.75	2.46
Original	1996	4.80	11.94	3.45	-0.51	-3.24	0.30	-1.45	-2.48	0.31	0.70	1.12	1.33
Trend		3.02	3.73	3.01	1.87	1.95	2.34	2.27	1.94	1.94	1.94	1.98	1.91
Seasonal		4.79	2.34	1.26	-0.69	-3.42	-2.06	-3.40	-2.60	-0.79	-0.12	0.61	4.08
Irregular		-3.00	5.87	-0.82	-1.69	-1.77	0.03	-0.32	-1.82	-0.84	-1.11	-1.47	-4.66

Table 2: Mozambique. Components of Inflation - Model 2

	YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Original	1990		8.55	5.20	0.73	-3.46	-2.09	-2.06	-0.86	2.83	3.14	3.48	5.37
Trend			7.03	5.39	3.93	2.88	2.31	2.14	2.15	2.28	2.29	2.22	2.14
Seasonal			1.97	1.02	-0.77	-3.43	-2.00	-3.27	-2.35	-0.46	0.27	1.03	3.60
Irregular			-0.45	-1.22	-2.44	-2.92	-2.41	-0.93	-0.67	1.02	0.58	0.24	-0.37
Original	1991	3.54	4.27	5.04	5.94	-1.08	4.98	-6.76	4.85	3.01	3.46	1.52	2.47
Trend		2.16	2.58	3.06	3.41	3.31	3.29	2.85	3.14	2.97	2.73	2.46	2.50
Seasonal		4.38	1.97	1.02	-0.77	-3.43	-1.99	-3.27	-2.35	-0.46	0.27	1.03	3.60
Irregular		-3.01	-0.29	0.95	3.30	-0.96	3.68	-6.34	4.05	0.51	0.46	-1.98	-3.62
Original	1992	8.50	8.02	2.49	6.24	2.09	-0.23	1.16	-4.02	1.04	6.31	8.09	5.46
Trend		3.00	3.42	3.51	3.78	3.63	3.23	2.99	2.65	2.87	3.26	3.31	2.87
Seasonal		4.38	1.97	1.02	-0.77	-3.43	-1.99	-3.27	-2.35	-0.46	0.27	1.03	3.60
Irregular		1.12	2.63	-2.05	3.23	1.88	-1.47	1.44	-4.32	-1.37	2.78	3.75	-1.01
Original	1993	5.79	1.17	4.38	1.57	2.44	-0.45	1.58	-0.44	6.92	1.66	3.45	9.15
Trend		2.53	2.38	2.68	2.93	3.27	3.29	3.51	3.57	3.82	3.67	3.80	4.10
Seasonal		4.37	1.97	1.02	-0.77	-3.43	-1.99	-3.26	-2.35	-0.46	0.27	1.03	3.60
Irregular		-1.12	-3.18	0.68	-0.59	2.60	-1.74	1.33	-1.67	3.57	-2.28	-1.37	1.45
Original	1994	9.29	6.61	6.09	1.28	0.60	2.14	4.81	7.43	0.02	2.80	3.10	10.86
Trend		4.24	4.28	4.27	4.18	4.38	4.65	4.93	4.78	4.00	3.63	3.41	3.37
Seasonal		4.37	1.97	1.03	-0.77	-3.43	-1.99	-3.26	-2.34	-0.46	0.27	1.03	3.60
Irregular		0.68	0.36	0.79	-2.13	-0.36	-0.52	3.14	4.99	-3.52	-1.10	-1.33	3.89
Original	1995	5.42	-0.62	5.67	3.54	1.97	3.91	1.65	0.21	3.15	3.80	5.98	9.75
Trend		2.93	2.77	3.30	3.72	4.08	4.22	4.12	3.93	3.90	3.94	4.02	3.99
Seasonal		4.37	1.97	1.03	-0.78	-3.43	-1.99	-3.26	-2.35	-0.46	0.27	1.03	3.60
Irregular		-1.89	-5.36	1.35	0.59	1.33	1.68	0.79	-1.37	-0.29	-0.40	0.93	2.16
Original	1996	4.80	11.94	3.45	-0.51	-3.24	0.30	-1.45	-2.48	0.31	0.70	1.12	1.33
Trend		3.68	3.68	2.93	2.22	1.76	1.52	1.23	0.89	0.68	0.48	0.32	0.24
Seasonal		4.37	1.97	1.03	-0.78	-3.43	-1.99	-3.26	-2.35	-0.46	0.27	1.03	3.60
Irregular		-3.25	6.29	-0.51	-1.96	-1.57	0.77	0.58	-1.02	0.09	-0.04	-0.23	-2.51

INDEX OF AGRICULTURAL PRODUCTION[13]

This appendix describes the methodology used to construct a monthly time series for agricultural production consistent with the annual national accounts as reported by the National Planning Directorate (DNP) of the Ministry of Planning and Finance. In order to explain this exercise, it is necessary to first highlight some of the key assumptions made by the DNP in constructing its data for the agricultural sector.

The monthly time series has as its starting point the available annual data on total agricultural production on a product by product basis (for a total of 29 products). These data have three main components: (i) production by the business sector, published by the Ministry of Agriculture, (ii) production commercialized by the family sector - as reported by the Ministry of Industry, Tourism and Commerce - and (iii) an estimate for subsistence production, that is, the portion of the production by the family sector that is consumed by the producer itself. Total production, including for subsistence, is estimated by dividing actual figures on commercialized production by average commercialization ratios (i.e. the percentage of the production that is commercialized), on a product by product basis. Production for subsistence, representing some 85 percent of total production, is calculated as the difference between total and commercialized production. The latter figures are subsequently adjusted to both incorporate information on the specific conditions of each crop year (i.e. deviations from the average percentage of commercialized production) and to reflect the expectation that commercialized production should exhibit more variability than the subsistence portion.

The calculation of total agricultural production on a monthly basis required that we first arrive at figures for each of the following components: production by the business sector, production commercialized by the family sector and subsistence production. The procedure starts with the calculation of a monthly distribution of the annual production for which there are actual data (production by the business sector and production commercialized by the family sector). First, data are compiled for the 1989-97 crop years on a product by product basis, both in terms of volumes (tons) and in terms of values (nominal meticais). Second, a notional monthly distribution of the crop year on a product by product basis is constructed; these "coefficients" were the result of numerous consultations with experts in the agricultural sector. Third, by applying this notional monthly distribution to the data on production the first calculation of monthly production both in nominal and real terms is obtained. Finally, using the average prices for each product in 1995, volumes are converted into constant meticais and the data are aggregated so as to obtain the level of total production in real terms.

A monthly time series for production for subsistence in the family sector was obtained by following the DNP methodology outlined above. Based on the calculated monthly series for commercialization by the family sector, on a product by product basis, and using the commercialization ratios by product, the initial estimates for subsistence production are obtained. These monthly figures are subsequently adjusted assuming that the "correction"

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factors used by the DNP for each year apply equally across the months of the year. To convert into constant meticais and aggregate production, 1995 prices for each product are used. Finally, the calculation for total monthly production is obtained by adding the three calculated components, that is, production by the business sector and commercialized and subsistence production by the family sector.

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