

Monetary Policy Neutrality in WAEMU Countries: A SVAR Model

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Abstract

In an economic context characterized by significant fiscal imbalances and secular stagnation in WAEMU countries, some economists advocate using money to influence real economic activity. The aim of this paper is to analyze the neutrality of money in WAEMU countries. To address this issue, we set up a 2-lag SVAR dynamic model with short-term constraints to assess the responses of output growth rate, inflation rate and real interest rate to monetary shocks. The results of our estimations show that money is weakly active in the union countries, due to the long lags between monetary policy action and its impact on output. In addition, we find that inflation rates in WAEMU countries are highly sensitive to monetary shocks, which means that the effective growth resulting from the monetary shock cannot be sustained. The transmission of these shocks on the inflation rate and output growth rate is only partial, since the pass-through coefficients of the money supply are less than unity in all countries. This study suggests that the political and economic independence of the Central Bank should be strengthened, so that monetary policy is not used for opportunistic purposes.

Keywords

Economic Activity, Secular Stagnation, Inflation, Monetary Shocks

1. Introduction

In his 1970 monetary proposals, Friedman analyzed the economy's reactions to monetary shocks and argued:

- “There is a stable relationship between the rate of growth of the money supply and the rate of growth of nominal income;
- however, this relationship is not obvious because there is a time lag between money growth and nominal income growth;

- on average, however, the lag between money growth and nominal income growth can range from six to nine months;
- after a further lag of six to nine months, however, the effects of money growth are reflected in prices.”¹

Friedman’s proposals illustrate a weak dichotomy between the real and monetary sectors. Because of adaptive expectations and the fact that economic agents are victims of monetary illusion in the short term, but not in the long term, Friedman considers that variations in the money supply generate short-term variations in economic activity, and that the authorities must therefore inject increasing quantities of money to amplify the stimulus. Money is therefore active in the short term, but neutral in the long term.

However, another approach supports the thesis of the strong dichotomy between the real and monetary spheres, defended in the quantitative theory of money, from J. Bodin (1530 to 1596) in the 16th century to I. Fisher (1867-1947) in 1911. According to quantitative economists, money only affects absolute prices, i.e., the general price level, and not relative prices. Money is therefore neutral in relation to the real economy. From the point of view of economic policy, this conclusion means that it makes no sense to affect the functioning of the real economy by acting on money. Today, this thesis is defended by the New Classical School, which is attempting to revive the quantitative theory of money, admitting that money is neutral in both the short and long term. Any expansionary monetary policy would therefore be ineffective, due to the rational expectations of economic agents who anticipate inflationary effects. These conclusions justify the introduction of economic policy rules in many countries, which stabilize economic agents’ expectations and reduce uncertainty. For these economists, discretionary policies are therefore ineffective.

In developing countries, notably those of the WAEMU, monetary and budgetary rules have been adapted over the past few years by public authorities:

- In December 1999, WAEMU countries adopted the Convergence, Stability, Growth and Solidarity Pact, which requires countries to keep inflation below 3%, maintain a balanced budget, limit debt to 70% of GDP and keep the tax burden above 17%;
- As of January 2015, the modified convergence pact still keeps inflation below 3%, then sets the budget deficit at 3% of GDP and public debt at 70% of GDP.

Immediately after COVID, the States of the Union adopted economic recovery programs to boost economic activity and reduce youth unemployment. However, these stimulus programs have come up against a number of major stumbling blocks:

- the limits imposed by the WAEMU Convergence Pact have been exceeded in terms of inflation, prompting the Central Bank to implement strict monetary policies by raising key interest rates;

¹Friedman, M. (1970): *The Counter-Revolution in Monetary Theory*, Occasional Paper 33, London, Institute of Economic Affairs, for the Wincott Foundation.

- excessive levels of public debt and deficit are forcing governments to clean up their public finances, and they are attempting to contain the growth of their operating and public investment expenditure.

Today, in a context of fiscal adjustment and the reduction of macroeconomic imbalances, a real debate is taking place on the use of money to impact the real economy and escape from secular stagnation. Based on these developments, we address the following question: is money neutral in the WAEMU countries?

This article is of twofold interest: on the one hand, it enables us to assess the relevance of economic policy rules and, on the other hand, to study the need to strengthen the independence of the Central Bank in order to achieve a more rigorous monetary policy.

Using a dynamic SVAR model with 2 lags, this study aims to analyze the neutrality of money in the WAEMU countries. Three sections will be addressed in the remainder of this paper: the second section presents the empirical literature on currency neutrality; the third outlines the empirical methodology; and the fourth section analyzes the results and policy implications arising from our findings.

2. An Empirical Review of the Literature

The analysis of the effects of money on the economy differs according to whether money is considered exogenous or endogenous. Some economists, who consider money to be a privileged instrument of monetary policy, consider money to be exogenous. It is therefore a function of the central bank's money-supply behavior, and has its origins outside economic activity. This analysis was supported by quantitative economists (Bodin, Locke, Hume and the Currency school). Other economists saw money as endogenous, and the supply of money as dependent on the behavior of economic agents. Banking school economists agree that money should evolve according to the needs of the economy. And integrationist economists, who agree with this view, show that the dichotomy between the real and monetary spheres is completely irrelevant.

2.1. Money, a Neutral Instrument

Kydland and Prescott (1977) show that discretionary monetary policy leads to time inconsistency and inflationary bias. In the long term, it accentuates economic imbalances. These authors raise a number of points to explain the ineffectiveness of monetary policy:

- any increase in the money supply to stimulate output growth and combat unemployment in the short term would be meaningless, as economic agents will anticipate higher inflation in the future; this will prompt them to adjust their behavior to cope with the authorities' future actions;
- the more agents' expectations are fulfilled, the higher the inflation rate becomes, which means that actual growth cannot be sustained.

In their work, Barro and Gordon (1983) propose that central banks commit to an inflation target in order to reduce the inefficiency of monetary policy. Their

main idea is based on the notion of discretionary and reputational regimes in money management. In a discretionary regime, the central bank may be tempted to print more money and create inflation surprise. Monetary rules that fix the growth of money or target the rate of inflation would limit the discretionary capacity of monetary authorities. In this dynamic, Barro and Gordon have proposed a reputational equilibrium that leads monetary authorities to be cautious in their monetary policy so as not to weaken their scope.

Rogoff (1985) points out that in discretionary monetary regimes, the authorities are often tempted to use monetary policy for political ends, such as reducing unemployment; this encourages inflation. Discretionary policy leads to high and volatile inflation in the long term. To remove this ambiguity, he advocates the idea of a Central Bank totally independent of the government, which could encourage an inflationary monetary policy to reduce unemployment. This independence would keep inflation low, strengthen the Central Bank's reputation and align the behavior of economic agents with economic policy objectives.

Aguir (2013), on a study based on 54 developing countries classified by income level for the period 1991-2011, shows that inflation is a purely monetary phenomenon. He argues that central bank independence keeps inflation at an acceptable level, and that this independence does not affect output growth or unemployment. He considers money to be neutral in relation to real economic activity, and to reduce inflationary bias, it is necessary to strengthen the independence of the Central Bank and ensure better coordination between monetary policy and exchange rate policy.

In Bozkurt's (2018) work carried out in Türkiye and the Shanghai Cooperation Organization zone on panel data, the results present a dichotomy between the real and monetary sectors, since monetary shocks do not impact real output, real interest rates and real wages. Instead, they affect nominal variables, prices and nominal wages.

In his work, Kasiwa (2022) distinguishes currency neutrality from super-neutrality. In the first case, currency neutrality refers to the fact that changes in the currency have no impact on output, employment or the real interest rate. In the second, super-neutrality, the growth rate of the money supply has no effect on real variables. The results of his work, estimated on an ARIMA model, show that money has no impact on short- and long-term production in the Congo.

2.2. Money as an Active Instrument

De Grauwe (1999) considers that monetary policy suffers from problems of time inconsistency and credibility on the part of the monetary authorities. He believes that only a monetary policy that takes economic agents by surprise can have an impact on output growth and unemployment.

Using an impulse-response matching approach to estimate the parameters of their model, Christiano et al. (2001) find that monetary policy is not neutral in the economy, affecting both nominal and real variables in the short term. However,

these results are highly sensitive to economic conditions and the expectations of economic agents.

With the introduction of unconventional monetary policy instruments, [Nakamura et al. \(2013\)](#) show in their work the absence of currency neutrality with the US Federal Reserve's use of "forward guidance". They stipulate that money varies real and nominal interest rates and thus impacts output growth in the short term.

[Oloufade \(2015\)](#), using error-correction and panel VAR models, shows the positive effects of currency shocks on industrial output in the WAEMU, more specifically in Senegal in the short term and in Côte d'Ivoire in the long term.

[Pastén et al. \(2018\)](#) challenge the money neutrality thesis and emphasize the importance of monetary policy in economic stability and financial market regulation. For these authors, any increase in the money supply translates in the short term into higher financial asset prices during strong inflationary periods.

The work of [Brandao-Marques et al. \(2020\)](#) on a panel of 40 developing countries demonstrates the absence of monetary neutrality, and shows that positive monetary policy shocks have a negative influence on output growth and inflation. The extent to which monetary shocks are transmitted is strongly linked to the exchange rate in countries pegged to the dollar.

Using a staggered lag model and a Bayesian vector autoregression model, [Gbenou \(2021\)](#) estimates that upward variations in the money market interest rate lead to deflation and have a negative impact on effective growth in WAEMU countries.

Empirical literature remains mixed on the effects of monetary policy on short-term economic activity. Some studies have attempted to highlight the absence of monetary neutrality, and hence the strong dichotomy between the real and monetary sectors. Other works question this dichotomy and show the influence of money on short-term economic activity.

3. Empirical Methodology

3.1. Model Justification and Choice of Variables

In order to highlight the dynamic impact of monetary shocks on short-term fluctuations in economic activity, we will use structural VAR (SVAR) methodology with short-term constraints. The use of VAR models was introduced into economic analysis by Sims in 1980. The idea is based on the observation that macroeconomic models impose a priori assumptions without any statistical justification, and the exogeneity of certain postulated economic policy variables is not tested. According to [Clément and Germain \(1993\)](#), in a correctly specified general equilibrium model, each variable depends a priori on all the other variables in the system, notably through the formation of expectations. This general idea leads to the use of VAR models.

The monetary policy framework of the Banque Centrale des Etats de l'Afrique de l'Ouest (BCEAO) is the inflation targeting policy, which stipulates that the average annual inflation rate must be maintained at a maximum of 3% per year. This

policy requires the central bank to use its main monetary policy instrument, the interest rate, to achieve its inflation target. When the inflation rate exceeds its target level, the central bank activates a restrictive monetary policy, which translates into a rise in the interest rate, and vice versa. However, for this targeting policy to be possible, the currency must be neutral. Since currency neutrality means the absence of effects of monetary shocks on real economic variables such as output, employment and real interest rates, the model will be built using four economic variables: the money supply growth rate (tmm), the real interest rate (tint), the inflation rate (tinf) and the output growth rate (tcp); the study period running from the first quarter of 1990 to the last quarter of 2022.

In order for the model to be able to provide information on the lags in the absorption of monetary shocks, then assess the lags and prevent shocks from being permanent, the data must be stationary. In addition, the stationarity procedure remedies three pitfalls:

- the loss of information generated by the trend factor;
- the appearance of “spurious regressions” biasing the estimates;
- and the difficulty of assessing model lags.

The completion of the SVAR model presented for each WAEMU country should, however, lead us towards a methodological extension capable of identifying the difficulties linked to cyclical regulation by monetary policy in the States of the Union. Taking these dynamics into account is of paramount importance in defining the development strategies of the countries of the Union, as well as in the orientation of their economic policies.

3.2. Structural VAR Model Specification

After studying the stationarity of the series, it is possible to write the dynamic theoretical structural form of the model in the following form:

$$\mathbf{A}\mathbf{Y}_t = \mathbf{B}_1\mathbf{Y}_{t-1} + \mathbf{B}_2\mathbf{Y}_{t-2} + \mathbf{B}_3\mathbf{Y}_{t-3} + \dots + \mathbf{B}_p\mathbf{Y}_{t-p} + \mathbf{U}_t \quad (1)$$

where

\mathbf{A} is the (4×4) matrix of simultaneity relations between the variables of the economy; \mathbf{Y}_t is the vector of endogenous² variables composed of the money supply growth rate (tmm), the real interest rate (tint), the inflation rate (tinf) and the output growth rate (tcp); \mathbf{B}_i is the (4×4) matrix associated with the lag; \mathbf{U}_t is the vector of structural residuals of type iid $N(0, \pi)$ with π , a diagonal $(n \times n)$ matrix.

This assumption implies that the residuals of the model are independent of each other and can be considered as orthogonal structural shocks in pairs.

The reduced form of the above model is given by:

$$\begin{aligned} \mathbf{Y}_t &= \mathbf{A}^{-1}\mathbf{B}_1\mathbf{Y}_{t-1} + \mathbf{A}^{-1}\mathbf{B}_2\mathbf{Y}_{t-2} + \mathbf{A}^{-1}\mathbf{B}_3\mathbf{Y}_{t-3} + \dots + \mathbf{A}^{-1}\mathbf{B}_p\mathbf{Y}_{t-p} + \mathbf{A}^{-1}\mathbf{U}_t \\ \mathbf{Y}_t &= \mathbf{C}_1\mathbf{Y}_{t-1} + \mathbf{C}_2\mathbf{Y}_{t-2} + \mathbf{C}_3\mathbf{Y}_{t-3} + \dots + \mathbf{C}_p\mathbf{Y}_{t-p} + \mathbf{A}^{-1}\mathbf{U}_t \end{aligned} \quad (2)$$

This last writing of the structural form constitutes the structural VAR model in

²All the variables are stationary in first difference, the variables being in logarithmic form at the start of the study. They are therefore in growth rate in the VAR.

its general form. For its estimation, it is necessary to determine the optimal number of shifts, evaluate the parameters of the standard VAR, define the identifying constraints and then proceed with the Choleski decomposition of the variance-covariance matrix of the innovations of the estimated standard VAR.

a) Estimating delays using information criteria³

The number of variables in the economy is $n = 4$. To be able to estimate the SVAR, we therefore introduce $n(n - 1)/2$ constraints, i.e., $4(4 - 1)/2 = 6$ short-term constraints which are linked in particular to slow adjustment phenomena on certain economic variables. These adjustments concern the diffusion effects of certain measures relating to the growth rate of the money supply and the existence of lags in the reaction of output, inflation and interest rates following a variation in the growth rate of money. With regard to the arrangement of the variables, the classification is made taking into account the objectives of the study and the instruments used in the monetary policy framework. The money supply and the interest rate are the instruments of monetary policy; inflation growth and output growth are the objective variables of the model. Taking into account the lags in the reaction of certain variables on others, we can ask:

- shocks to the output growth rate do not have an instantaneous effect on the growth rate of the money supply, the interest rate and the inflation rate (3 constraints to be imposed on output growth rate shocks);
- shocks to the inflation rate do not instantaneously affect the growth rate of the money supply and the interest rate (2 constraints to be imposed on inflation rate shocks);
- interest rate shocks do not have an instantaneous impact on the growth rate of the money supply (1 constraint to be introduced on interest rate shocks).

We incorporate the constraints defined above in a triangular form, which justifies Choleski's methodology in order to be able to trace them back to the structural form. The matrix is given by:

$$\begin{bmatrix} tmm \\ tint \\ tinf \\ tcp \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ C21 & 1 & 0 & 0 \\ C31 & C32 & 1 & 0 \\ C41 & C42 & C43 & 1 \end{bmatrix} \times \begin{bmatrix} \mathcal{E}_{tmm} \\ \mathcal{E}_{tint} \\ \mathcal{E}_{tinf} \\ \mathcal{E}_{tcp} \end{bmatrix}$$

4. Presentation of Results and Analysis⁴

The model adopted is based on four variables: the growth rate of the money supply (tmm), the interest rate ($tint$), the inflation rate ($tinf$) and the growth rate of output (tcp).

³The lags are optimal when the residuals follow a white noise process. After ensuring that the residuals follow a white noise process, we can see that the 2-lag VAR captures the dynamics of the economy formed by the Y_t vector, which makes it possible to estimate the 2-lag SVAR.

⁴The confidence intervals in the analysis of the response functions were determined by the Monte Carlo method, since the residuals are normal and, moreover, not autocorrelated. Therefore, only the cumulative response functions will be commented on here, i.e., the cumulative multipliers or total effects.

4.1. Calculating the Matrix of Simultaneity Relations

After ensuring that the structural shocks are normal⁵ and uncorrelated⁶, it is possible to calculate the matrix of simultaneity relationships associated with the various shocks. Estimation of the instantaneous coefficients (see **Appendix 1**) gives the following results:

From these results, we can write the matrix of simultaneity relations as follows:

BENIN

$$\begin{bmatrix} tmm \\ tint \\ tint \\ tcp \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ -0.010 & 1 & 0 & 0 \\ +0.298 & -0.376 & 1 & 0 \\ -0.055 & +0.133 & -0.099 & 1 \end{bmatrix} \times \begin{bmatrix} \mathcal{E}_{tmm} \\ \mathcal{E}_{tint} \\ \mathcal{E}_{tinf} \\ \mathcal{E}_{tcp} \end{bmatrix}$$

BURKINA FASO

$$\begin{bmatrix} tmm \\ tint \\ tint \\ tcp \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ -0.012 & 1 & 0 & 0 \\ +0.097 & -0.613 & 1 & 0 \\ +0.055 & -0.083 & -0.117 & 1 \end{bmatrix} \times \begin{bmatrix} \mathcal{E}_{tmm} \\ \mathcal{E}_{tint} \\ \mathcal{E}_{tinf} \\ \mathcal{E}_{tcp} \end{bmatrix}$$

COTE D'IVOIRE

$$\begin{bmatrix} tmm \\ tint \\ tint \\ tcp \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ -0.023 & 1 & 0 & 0 \\ +0.096 & -0.196 & 1 & 0 \\ +0.027 & +0.793 & -0.182 & 1 \end{bmatrix} \times \begin{bmatrix} \mathcal{E}_{tmm} \\ \mathcal{E}_{tint} \\ \mathcal{E}_{tinf} \\ \mathcal{E}_{tcp} \end{bmatrix}$$

MALI

$$\begin{bmatrix} tmm \\ tint \\ tint \\ tcp \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ +0.011 & 1 & 0 & 0 \\ +0.101 & -0.841 & 1 & 0 \\ +0.091 & -0.457 & +0.148 & 1 \end{bmatrix} \times \begin{bmatrix} \mathcal{E}_{tmm} \\ \mathcal{E}_{tint} \\ \mathcal{E}_{tinf} \\ \mathcal{E}_{tcp} \end{bmatrix}$$

NIGER

$$\begin{bmatrix} tmm \\ tint \\ tint \\ tcp \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ -0.011 & 1 & 0 & 0 \\ -0.047 & -0.587 & 1 & 0 \\ +0.032 & -0.746 & +0.103 & 1 \end{bmatrix} \times \begin{bmatrix} \mathcal{E}_{tmm} \\ \mathcal{E}_{tint} \\ \mathcal{E}_{tinf} \\ \mathcal{E}_{tcp} \end{bmatrix}$$

SENEGAL

$$\begin{bmatrix} tmm \\ tint \\ tint \\ tcp \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ -0.019 & 1 & 0 & 0 \\ +0.475 & -0.506 & 1 & 0 \\ -0.052 & -0.104 & -0.201 & 1 \end{bmatrix} \times \begin{bmatrix} \mathcal{E}_{tmm} \\ \mathcal{E}_{tint} \\ \mathcal{E}_{tinf} \\ \mathcal{E}_{tcp} \end{bmatrix}$$

⁵Normality tests were performed using the Jarque-Bera method and the Box Jenkins method.

⁶The Box Jenkins method was used to test the non-autocorrelation of structural shock residuals.

The estimates show that monetary shocks have no instantaneous effect on real interest rates in WAEMU countries. We note that the instantaneous multipliers associated with interest rates are low and insignificant in the countries of the Union. This result is quite understandable, as when the Central Bank injects liquidity as part of its monetary policy, it takes time for real interest rates to be affected. When economic agents anticipate the effects of monetary shocks, their often rational behavior attenuates their impact.

The results also show that the rate of production growth reacts instantaneously and significantly to monetary shocks. However, the impact remains very weak, below 0.10 in all Union countries except Côte d'Ivoire, where the instantaneous effect is not significant. The other factor limiting the instantaneous impact of monetary shocks on production is price and wage rigidity. With fixed labor contracts and prices, it is difficult for production to adjust to changes in monetary policy.

4.2. Calculating Cumulative Multipliers or Total Effects of Monetary Shocks

The aim here is to analyze the reactions of output growth and inflation rates to monetary shocks. We thus present the cumulative multipliers (or total effects) following a shock to money supply growth (see [Appendix 2](#) and [Appendix 3](#)). The results are summarised in [Table 1](#) and [Table 2](#) below:

Table 1. Reactions of output growth rate to a monetary shock.

Quarters	Benin	Burkina	CI	Senegal	Mali	Niger
End of 4th quarter	-0.198	+0.156	+0.138	-0.082	+0.355	+0.235
End of 6th quarter	-0.147	+0.106	+0.234	+0.036	+0.429	+0.331
End of 9th quarter	+0.037	+0.046	+0.393	+0.27	+0.497	+0.465

Table 2. Inflation rate response to a monetary shock.

Quarters	Benin	Burkina	CI	Senegal	Mali	Niger
End of 4th quarter	+1.319	+0.434	+0.531	+1.394	+0.474	-0.219
End of 6th quarter	+1.446	+0.553	+0.827	+1.636	+0.635	-0.200
End of 9th quarter	+0.770	+0.440	+0.864	+1.019	+0.826	-0.098

Analysis of cumulative response functions following monetary shocks leads to the following comments:

- the total multiplier of a monetary shock on output growth at the end of Q4 shows a positive effect in Burkina Faso (0.156), Côte d'Ivoire (0.138), Mali (0.355) and Niger (0.235). However, there were negative effects in Benin (-0.198) and Senegal (-0.082). From the 5th quarter onwards, the total effect becomes positive in Senegal, but remains negative in Benin. The effects of cur-

rency shocks on output growth are highest in Mali and Niger until the end of Q9. The effects on output are felt most between the [6th and 9th] quarters, due to the time lag between the monetary policy measure and its impact on output. In the context of monetary policy, there are 4 types of delay:

- the time taken for the Central Bank to become aware of the economic problem;
 - time taken to decide on the monetary policy measure and communicate it;
 - the time taken to implement the monetary policy measure;
 - and the impact or effect period of the monetary policy measure.
- however, monetary shocks have a greater impact on the inflation rate than on output growth, especially in Benin and Senegal, where there has been a negative reaction to monetary shocks on output growth. Indeed, in these two countries, the total effect of monetary shocks on inflation was 1.319 for Benin and 1.394 for Senegal at the end of Q4. The effects increase until the 6th quarter, after which they start to move towards long-term equilibrium.

However, the response of economic activity to monetary shocks highlights the heterogeneous nature of the countries in the Union. Indeed, the WAEMU zone is made up of low-income and middle-income countries whose economic convergence is not yet perfect. Given the contrasting trends in national variables, it would be surprising if the conduct of centralised monetary policy were to suit all the member countries, which have different economic structures (differences in living standards, labour productivity and, above all, excessive budget imbalances).

4.3. Calculating Pass-Through Coefficients

In this subsection, we calculate the pass-through coefficients of monetary shocks on the interest rate, inflation rate and output growth rate. Pass-through coefficients are obtained from the ratio between the cumulative impulse response of the interest rate, inflation rate and output growth rate, after h years, and the cumulative response of the money supply growth rate following the initial shock to the money supply growth rate, after h years. In other words, for each of the prices considered, at forecast horizon h , the pass-through coefficient (PT) is calculated as follows:

$$PT = |O_{t,t+h}|/M_{t,t+h}$$

where $O_{t,t+h}$ is the cumulative change in the target variables and $M_{t,t+h}$ is the cumulative change in the growth rate of the money supply. The results of the calculations of the estimated Pass-Through coefficients are given in the following

Table 3:

Table 3. Pass-through coefficients for the growth rate of the currency.

Quarters (BENIN)	Interest rate	Inflation rate	Production growth rate
End of 4th quarter	0.012	0.2948	0.0445
End of 6th quarter	0.016	0.2983	0.0303
End of 9th quarter	0.029	0.316	0.0151

Continued

Quarters (BURKINA)	Interest rate	Inflation rate	Production growth rate
End of 4th quarter	0.0185	0.0973	0.0349
End of 6th quarter	0.0321	0.1014	0.0195
End of 9th quarter	0.0811	0.1218	0.0127
Quarters (Côte d'Ivoire)	Interest rate	Inflation rate	Production growth rate
End of 4th quarter	0.0248	0.1212	0.0315
End of 6th quarter	0.0357	0.1523	0.0431
End of 9th quarter	0.0855	0.2230	0.1015
Quarters (MALI)	Interest rate	Inflation rate	Production growth rate
End of 4th quarter	0.0278	0.1001	0.0750
End of 6th quarter	0.0396	0.1007	0.0680
End of 9th quarter	0.0579	0.1037	0.0624
Quarters (NIGER)	Interest rate	Inflation rate	Production growth rate
End of 4th quarter	0.0216	0.0315	0.0339
End of 6th quarter	0.0288	0.0216	0.0358
End of 9th quarter	0.0397	0.0083	0.0397
Quarters (SENEGAL)	Interest rate	Inflation rate	Production growth rate
End of 4th quarter	0.0250	0.4726	0.0279
End of 6th quarter	0.0411	0.4731	0.0104
End of 9th quarter	0.1068	0.4615	0.1226

Source: Authors' calculations using WINRATS software.

It follows from the estimates of the pass-through coefficients that the pass-through of monetary shocks to real interest rates, the inflation rate and the output growth rate is partial, insofar as all the estimated values are less than unity. However, it should be noted that the transmission of monetary shocks has a much greater impact on the inflation rate than on the output growth rate. These results are also confirmed by the analysis of the variance decomposition of the error on the inflation rate and output growth rate (see **Appendix 4**). Indeed, monetary shocks are transmitted:

- on production growth after one year: 4.45% in Benin, 3.49% in Burkina Faso, 3.15% in Côte d'Ivoire and 2.79% in Senegal. From the 5th quarter onwards, this transmission begins to decline towards its long-term equilibrium level. This low transmission can be explained by the time taken to implement monetary policy;
- on the inflation rate at 47.26% for Senegal and 29.48% for Benin, confirming the high sensitivity of the inflation rate to monetary shocks. Inflation transmission is 12% for Côte d'Ivoire and 9.73% for Burkina Faso after 4 quarters. The effects are more pronounced at the end of the 9th quarter for Côte d'Ivoire (22.30%) and Benin (31.60%).

To get a better idea of these effects, we can examine the reaction of key rates to monetary shocks. In most of the Union countries, interest rates vary negatively following monetary innovations, except in Mali, where positive effects are observed. Such negative interest rate behavior following monetary shocks in the Union countries favors increased demand for goods and services. If the supply of goods and services fails to keep pace with this demand, inflation ensues, weakening household purchasing power and thus reducing aggregate demand and economic growth. The real divergences following interest rate shocks can be explained by the fact that their effects occur at different stages of an economic cycle, often making policy pro-cyclical. With a single currency and a common monetary policy, there is only one interest rate, and consequently it cannot be used differently in different countries. For a monetary policy not to have asymmetrical effects, it is important that the countries have similar economic structures, which is not the case for the EU countries.

5. Conclusion

From these analyses, it should be noted that when monetary shocks are largely transmitted to inflation and weakly to output growth, monetary authorities should not use monetary policy for political purposes, such as fighting unemployment. By acting dynamically on inflation, monetary shocks reduce household purchasing power and weaken consumption. However, in developing countries such as those of the WAEMU, where effective economic growth is driven by consumption, weakening consumption is tantamount to reducing aggregate demand and further slowing production growth.

In an economic context characterized by high public deficits and excessive debt levels, the use of central bank monetary policy for political purposes, such as fighting against unemployment or overcoming secular stagnation, would only aggravate macroeconomic imbalances. Real inflation rates are highly sensitive to monetary shocks, which have little impact on output growth over 4 to 6 quarters. Under these conditions, using monetary policy to influence the real economy or to break out of secular stagnation would be a risky gamble for the Union countries, given the inflationary pressures it generates. High inflation discourages lenders and slows the supply of loans, thus reducing household purchasing power and business investment. For this reason, further strengthening the political and economic independence of the Central Bank is becoming a major imperative for the States of the Union:

- reduce the risk of opportunistic monetary policies;
- dissociate monetary policy from electoral cycles and short-term political pressures, since governments may be tempted to finance public spending by creating money in the run-up to elections, in order to win the confidence of potential voters;
- keep inflation low by basing its decisions on purely economic criteria;
- improve its responsiveness to crises by freely choosing the appropriate mone-

tary instruments without the approval of political decision-makers;

- and to align economic agents' expectations with monetary policy objectives by strengthening its credibility.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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Appendices

Appendix 1. Calculation of Simultaneity Coefficients

Case of Benin

Covariance Model-Concentrated Likelihood - Estimation by BFGS
 Convergence in 21 Iterations. Final criterion was 0.0000002 <= 0.0000100
 Observations 134
 Log Likelihood 152.9636
 Log Likelihood Unrestricted 152.9636

Variable	Coeff	Std Error	T-Stat	Signif
1. C21	-0.010024500	0.009991104	-1.00334	0.31569562
2. C31	0.298835444	0.028112544	10.62997	0.00000000
3. C32	-0.376672521	0.235961315	-1.59633	0.11041476
4. C41	-0.055804469	0.007491670	-7.44887	0.00000000
5. C42	0.133804536	0.061631679	2.17104	0.02992852
6. C43	-0.099619168	0.021142151	-4.71187	0.00000245

Case of Burkina Faso

Covariance Model-Concentrated Likelihood - Estimation by BFGS
 Convergence in 16 Iterations. Final criterion was 0.0000036 <= 0.0000100
 Observations 134
 Log Likelihood 7.1827
 Log Likelihood Unrestricted 7.1827

Variable	Coeff	Std Error	T-Stat	Signif
1. C21	-0.012381176	0.015358240	-0.80616	0.42015146
2. C31	0.097080033	0.032245881	3.01062	0.00260716
3. C32	-0.613460452	0.172503827	-3.55621	0.00037624
4. C41	0.055111591	0.017208559	3.20257	0.00136208
5. C42	-0.083628835	0.098859622	-0.84594	0.39758889
6. C43	-0.117044783	0.048445324	-2.41602	0.01569128

Case of Sénégal

Covariance Model-Concentrated Likelihood - Estimation by BFGS
 Convergence in 16 Iterations. Final criterion was 0.0000001 <= 0.0000100
 Observations 134
 Log Likelihood 218.3312
 Log Likelihood Unrestricted 218.3312

Variable	Coeff	Std Error	T-Stat	Signif
1. C21	-0.019005123	0.014718327	-1.29126	0.19661505
2. C31	0.475229675	0.031012746	15.32369	0.00000000
3. C32	-0.506193980	0.177545856	-2.85106	0.00435737
4. C41	-0.052159802	0.018686092	-2.79137	0.00524854
5. C42	-0.104745564	0.110597829	-0.94709	0.34359451
6. C43	-0.201259629	0.050695836	-3.96994	0.00007189

Case of Côte d'Ivoire

Covariance Model-Concentrated Likelihood - Estimation by BFGS
 Convergence in 18 Iterations. Final criterion was 0.0000001 <= 0.0000100
 Observations 134
 Log Likelihood 60.5516
 Log Likelihood Unrestricted 60.5516

Variable	Coeff	Std Error	T-Stat	Signif
1. C21	-0.023118211	0.010460579	-2.21003	0.02710296
2. C31	0.096281311	0.024414580	3.94360	0.00008027
3. C32	-0.196627544	0.195372537	-1.00642	0.31421182
4. C41	0.027762527	0.025048052	1.10837	0.26770174
5. C42	0.793959322	0.191745009	4.14070	0.00003462
6. C43	-0.182041092	0.083524267	-2.17950	0.02929459

Case of Mali

Covariance Model-Concentrated Likelihood - Estimation by BFGS
 Convergence in 16 Iterations. Final criterion was 0.0000025 <= 0.0000100
 Observations 135
 Log Likelihood -364.4392
 Log Likelihood Unrestricted -364.4392

Variable	Coeff	Std Error	T-Stat	Signif
1. C21	0.011666296	0.009531279	1.22400	0.22095183
2. C31	0.101400535	0.029885930	3.39292	0.00069152
3. C32	-0.841517384	0.278826673	-3.01807	0.00254393
4. C41	0.091312562	0.029989783	3.04479	0.00232844
5. C42	-0.457704391	0.267321993	-1.71218	0.08686280
6. C43	0.148428087	0.092591884	1.60304	0.10892679

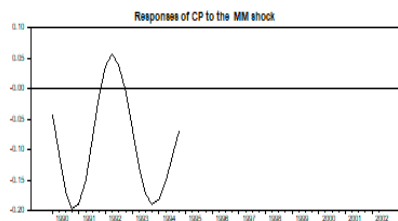
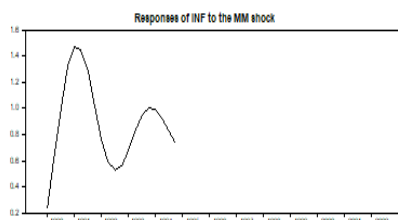
Case of Niger

Covariance Model-Concentrated Likelihood - Estimation by BFGS
 Convergence in 17 Iterations. Final criterion was 0.0000008 <= 0.0000100
 Observations 135
 Log Likelihood -437.6075
 Log Likelihood Unrestricted -437.6075

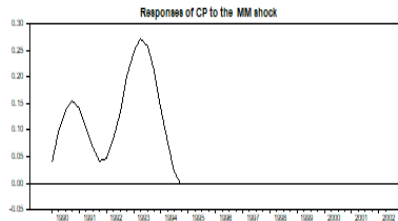
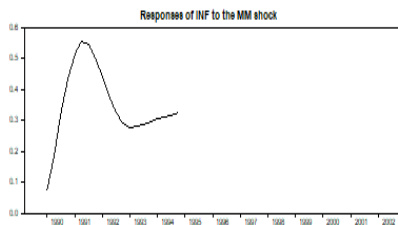
Variable	Coeff	Std Error	T-Stat	Signif
1. C21	-0.011104794	0.006029962	-1.84160	0.06553327
2. C31	-0.047671420	0.030128037	-1.58229	0.11358241
3. C32	-0.587686091	0.433496562	-1.35569	0.17519846
4. C41	0.032466147	0.016558913	1.96064	0.04992047
5. C42	-0.746400761	0.233772066	-3.19286	0.00140873
6. C43	0.103821061	0.046508540	2.23230	0.02559508

Appendix 2. Presentation of Cumulative Reaction Functions

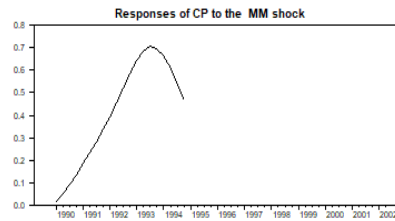
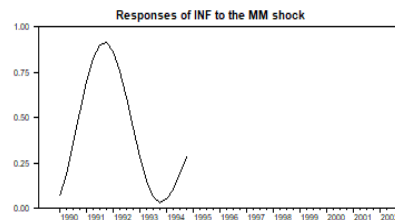
Case of Benin



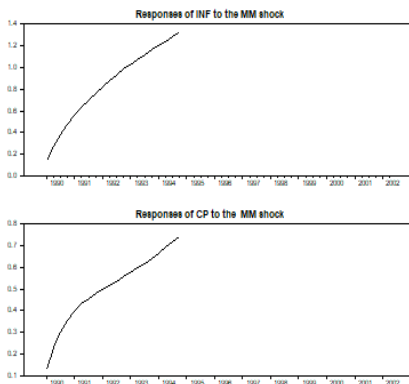
Case of Burkina Faso



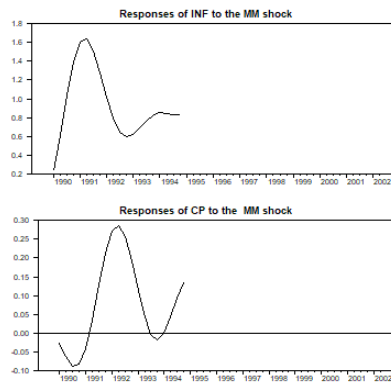
Case of Côte d'Ivoire



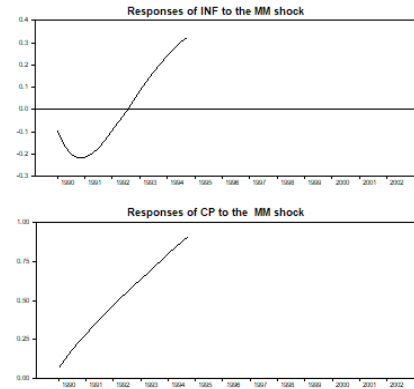
Case of Mali



Case of Senegal



Case of Niger



Appendix 3. Calculation of Cumulative Multipliers Following a Monetary Shock

Case of Benin

ENTRY	RCUMIMP (1, 1)	RCUMIMP (2, 1)	RCUMIMP (3, 1)	RCUMIMP (4, 1)
1	0.77544630557	-0.007773469547	0.231730834792	-0.043273370171
2	2.03558902059	-0.021515835952	0.606503167975	-0.107709204041
3	3.38436833475	-0.038384434731	1.006058909188	-0.166717251124
4	4.44336536905	-0.055177127413	1.319361874037	-0.198153854527
5	4.95649801615	-0.069018444693	1.472901974533	-0.190864572532
6	4.84857695441	-0.077895374849	1.446673846730	-0.147164706602
7	4.22610126745	-0.080940891348	1.273012303110	-0.080965913803
8	3.32647111778	-0.078437202129	1.020703673694	-0.012571867591
9	2.43854949803	-0.071581155472	0.770717879233	0.037965228867
10	1.80260115806	-0.062103640789	0.591547328338	0.056815022361
11	1.57147475912	-0.051853563177	0.521290595359	0.039973907071
12	1.75492501571	-0.042444955299	0.560815863342	-0.006320320928
13	2.24549464748	-0.035031152595	0.678616721996	-0.068174288616
14	2.86098521749	-0.030225662212	0.824511913240	-0.128584232916
15	3.40570478027	-0.028148942495	0.947110445582	-0.172439977330
16	3.72838661842	-0.028553838323	1.009466889506	-0.190509939994
17	3.76055048008	-0.030975293846	0.998532862964	-0.181375729722
18	3.52654963107	-0.034855801997	0.926335103249	-0.150980217249
19	3.12568229473	-0.039641451702	0.823473358936	-0.110170191673
20	2.69473262627	-0.044789916412	0.727720854543	-0.071145287721

Case of Burkina Faso

ENTRY	RCUMIMP (1, 1)	RCUMIMP (2, 1)	RCUMIMP (3, 1)	RCUMIMP (4, 1)
1	0.720429882774	-0.008919791827	0.069939401758	0.039704036076
2	1.922028281915	-0.025267020746	0.185682365866	0.094415102494
3	3.278702849494	-0.049842494251	0.316973735519	0.138854320748
4	4.464620648256	-0.083788280349	0.434705879596	0.156062591329
5	5.231352238241	-0.126681813320	0.517092968234	0.142312765657
6	5.457297795822	-0.175416196530	0.553421127809	0.106899192755
7	5.166092731890	-0.224240657579	0.544742275256	0.067457893944
8	4.477604270521	-0.265899820398	0.501695656722	0.042842368594
9	3.614775136332	-0.293448216523	0.440349134549	0.046156431064
10	2.792027084612	-0.302127676207	0.377367476513	0.080236056656
11	2.189472084614	-0.290715207806	0.325844696912	0.136870313584
12	1.911467407994	-0.261946699286	0.292803213712	0.199742279459
13	1.973478352571	-0.221918197041	0.278786751957	0.249892021477
14	2.311583408311	-0.178664009978	0.279338591749	0.271806146047
15	2.808967809312	-0.140323927995	0.287646994429	0.258189194139
16	3.330573409473	-0.113389849883	0.297389856520	0.212023965618
17	3.76535535332	-0.104459046673	0.304869049335	0.145456302247
18	4.006841073733	-0.104751213508	0.309850191602	0.076029746867
19	4.052954698697	-0.120428432149	0.314981372445	0.021544740431
20	3.915919074173	-0.143555258988	0.324146391289	-0.004874742217

Case of Sénégal

ENTRY	RCUMIMP (1, 1)	RCUMIMP (2, 1)	RCUMIMP (3, 1)	RCUMIMP (4, 1)
1	0.486089210052	-0.009238016178	0.23099742807	-0.02535846499
2	1.295854981818	-0.025129782868	0.614024317765	-0.061467836570
3	2.195397590023	-0.046770478086	1.038312406461	-0.086812616020
4	2.950982091968	-0.074039028619	1.394661343733	-0.092460055622
5	3.393764236596	-0.106470647432	1.604488287649	-0.039758369803
6	3.459173114258	-0.142401404578	1.636885491534	0.036289119848
7	3.192199476490	-0.178725450813	1.510320989450	0.128694710064
8	2.720814823942	-0.211345624598	1.280477490333	0.214225341902
9	2.208929783131	-0.236137942218	1.019542053452	0.270994765621
10	1.805046443805	-0.250074432279	0.794045757791	0.285294257382
11	1.602145129595	-0.252110475050	0.647822063937	0.255518928587
12	1.619163187540	-0.243531312769	0.594248966089	0.192150244583
13	1.806753428360	-0.227646551241	0.618614760509	0.114080796618
14	2.072447766551	-0.208928403795	0.688317956173	0.042679216239
15	2.315161087272	-0.191860725194	0.766584785208	-0.004432174594
16	2.457435895230	-0.179840221931	0.824952691568	-0.018000410542
17	2.465978530704	-0.174437218336	0.850831086379	0.001066325025
18	2.355781985268	-0.175199209815	0.848512048010	0.043004744090
19	2.170719531526	-0.180011239431	0.834292568745	0.092916010439
20	2.002128006161	-0.185867420975	0.828154305250	0.135565331307

Case of Côte d'Ivoire

ENTRY	RCUMIMP (1, 1)	RCUMIMP (2, 1)	RCUMIMP (3, 1)	RCUMIMP (4, 1)
1	0.702703448494	-0.016245246132	0.067657210119	0.019508825517
2	1.878363692110	-0.041929885087	0.192251016879	0.052184493625
3	3.211606388011	-0.073204684018	0.354924352847	0.093124251139
4	4.386789516267	-0.108873682217	0.531702224363	0.138550937765
5	5.164101307911	-0.149114786170	0.696968478291	0.185932833791
6	5.428257344669	-0.193887775308	0.827075186060	0.234235111204
7	5.200687490502	-0.241697379996	0.903698689516	0.283932985779
8	4.616447566834	-0.289165621991	0.916435886287	0.336548202347
9	3.75919887405	-0.331531386376	0.864406682877	0.393659522477
10	3.186572466537	-0.363856590776	0.756243365027	0.455756579297
11	2.710709467951	-0.382484293930	0.608692329427	0.521142464556
12	2.543635924756	-0.386228009163	0.443822982355	0.585491595752
13	2.643389485855	-0.376878778592	0.285360344585	0.642213581818
14	2.970120658477	-0.358850276908	0.154782180005	0.68366238168
15	3.387260796820	-0.338059803533	0.0679203087249	0.702935614798
16	3.769203525497	-0.320377877042	0.032567756077	0.695770710489
17	4.017988198196	-0.310102236528	0.047880804182	0.662020754106
18	4.085302932616	-0.308893688671	0.105047882785	0.606240873164
19	3.978620795180	-0.315465454744	0.189600275248	0.537168848087
20	3.750505754170	-0.326093441416	0.284486800391	0.466164598133

Case of Mali

ENTRY	RCUMIMP (1, 1)	RCUMIMP (2, 1)	RCUMIMP (3, 1)	RCUMIMP (4, 1)
1	1.42866402134	0.016667221180	0.144967310307	0.130454973320
2	2.68043283868	0.045361260787	0.269895742691	0.227964902580
3	3.77634670107	0.084541073952	0.378719147004	0.300763017445
4	4.73469760776	0.132708194658	0.474332810181	0.353412696133
5	5.57145461220	0.188429760952	0.559199471646	0.396780282734
6	6.30061448817	0.250354843236	0.635337976065	0.429020221769
7	6.9349143346	0.317225381526	0.704397458724	0.455082930310
8	7.4839569808	0.38788812772	0.767719462780	0.477253877697
9	7.95863292535	0.461271282158	0.826389978330	0.497230967859
10	8.36708915513	0.536438176267	0.881283055419	0.516246032666
11	8.71691894397	0.612532586014	0.933097364045	0.535163818492
12	9.01491935144	0.688002198797	0.982386843640	0.554562437675
13	9.26715796204	0.764589028944	1.029036393763	0.574798565677
14	9.47906296020	0.838324320115	1.075033999902	0.596060094202
15	9.65549462229	0.912522890492	1.1189895757540	0.618408479322
16	9.80080675912	0.983777139204	1.161636949173	0.641812634321
17	9.91889986495	1.052758888851	1.203128638994	0.666819595214
18	10.01326739705	1.119173202699	1.243561175133	0.691357320927
19	10.08703634102	1.182832285032	1.283002327083	0.711788370117
20	10.14300299776	1.243569548157	1.321494534088	0.743485814735

Case of Niger

ENTRY	RCUMIMP (1, 1)	RCUMIMP (2, 1)	RCUMIMP (3, 1)	RCUMIMP (4, 1)
1	2.09191787875	-0.023230320133	-0.099724686339	0.067916529318
2	3.92412461866	-0.057180949545	-0.165667884219	0.128722181534
3	5.52840391030	-0.100027898745	-0.203835259104	0.184245914187
4	6.93264725847	-0.150154446579	-0.219464505984	0.235903689420
5	8.16134141847	-0.206132291402	-0.217099861539	0.284785065827
6	9.23599241101	-0.266704114287	-0.200660801228	0.331693656040
7	10.17549470580	-0.330767463047	-0.173508667084	0.37722968120
8	10.99645296570	-0.397359873154	-0.138504662662	0.421789317091
9	11.71346271458	-0.465645147699	-0.098067708163	0.465670971390
10	12.33995540859	-0.534900723644	-0.05422213102	0.509386836372
11	12.88541263239	-0.604506055968	-0.008647697865	0.551980842048
12	13.36155349044	-0.673931955060	0.037200219346	0.594524068064
13	13.77649870433	-0.742730816128	0.082450955958	0.636649866856
14	14.13791444656	-0.810527682373	0.125804093271	0.678308841960
15	14.45253852851	-0.877012086515	0.167197967329	0.71942944802
16	14.76269120562	-0.941930617889	0.205581488916	0.75929756520
17	14.92878555767	-1.005080164812	0.240768959127	0.799721133747
18	15.17134813997	-1.066301784355	0.272517656104	0.838714893754
19	15.3122437524	-1.125475153976	0.300687957121	0.87682565592
20	15.50751496196	-1.182513561758	0.325225817300	0.913974191837

Appendix 4. Variance Decomposition of Inflation and Output Growth Rate Forecast Error

Case of Benin

Decomposition of Variance for Series TINFF						Decomposition of Variance for Series TCPF					
Step	Std Error	TMMF	TINTF	TINFF	TCPF	Step	Std Error	TMMF	TINTF	TINFF	TCPF
1	0.34311077	45.614	1.021	53.365	0.000	1	0.07995904	29.289	2.372	9.752	58.588
2	0.67129005	43.085	1.332	55.467	0.116	2	0.15418970	25.340	2.960	10.600	61.099
3	0.94953934	39.240	1.507	58.714	0.540	3	0.21568232	20.436	3.583	11.304	64.677
4	1.14399559	34.534	1.494	62.523	1.448	4	0.25842279	15.715	4.146	11.677	68.463
5	1.25861282	30.019	1.323	65.721	2.938	5	0.28483142	13.001	4.488	11.503	71.007
6	1.32242419	27.231	1.240	66.735	4.794	6	0.30134388	13.719	4.493	10.800	70.989
7	1.36786500	27.064	1.737	64.803	6.397	7	0.31313617	17.174	4.249	10.007	68.570
8	1.41239737	28.575	3.227	61.044	7.154	8	0.32180941	20.778	4.031	9.720	65.471
9	1.45691084	29.800	5.658	57.474	7.069	9	0.32737555	22.460	4.058	10.218	63.264
10	1.49749847	29.638	8.493	55.178	6.691	10	0.33117719	22.271	4.326	11.277	62.125
11	1.53423492	28.445	10.979	53.932	6.644	11	0.33602676	21.884	4.632	12.331	61.152
12	1.56955936	27.243	12.513	53.019	7.226	12	0.34367102	22.736	4.760	12.880	59.624
13	1.60277870	26.665	12.984	52.053	8.297	13	0.35292894	24.631	4.674	12.865	57.830
14	1.62944197	26.602	12.796	51.141	9.462	14	0.36089683	26.357	4.503	12.578	56.562
15	1.64625707	26.616	12.537	50.494	10.353	15	0.36569421	27.108	4.387	12.306	56.199
16	1.65534605	26.466	12.653	50.083	10.798	16	0.36784989	27.033	4.383	12.163	56.421

Case of Burkina Faso

Decomposition of Variance for Series TINFF						Decomposition of Variance for Series TCPF					
Step	Std Error	TMMF	TINTF	TINFF	TCPF	Step	Std Error	TMMF	TINTF	TINFF	TCPF
1	0.27415308	6.508	7.995	85.496	0.000	1	0.14963828	7.040	0.499	3.931	88.530
2	0.54044046	6.261	7.765	85.904	0.069	2	0.28163491	5.761	0.602	5.262	88.375
3	0.76962585	5.998	7.326	86.488	0.188	3	0.37952638	4.544	0.982	6.844	87.630
4	0.92779585	5.737	6.740	87.242	0.281	4	0.43291232	3.650	1.901	8.545	85.904
5	1.00891967	5.518	6.153	88.029	0.300	5	0.45306268	3.425	3.718	9.897	82.960
6	1.03307764	5.387	5.869	88.457	0.287	6	0.46283460	3.867	6.401	10.234	79.498
7	1.03707948	5.353	6.283	87.926	0.438	7	0.47923808	4.284	9.016	9.577	77.122
8	1.05522020	5.337	7.467	86.236	0.960	8	0.50231143	4.140	10.568	8.895	76.397
9	1.09868505	5.234	8.851	84.176	1.739	9	0.52260243	3.829	11.004	8.876	76.291
10	1.15365625	5.046	9.794	82.762	2.398	10	0.53463301	4.065	10.824	9.392	75.720
11	1.19935615	4.853	10.145	82.293	2.710	11	0.54084705	5.068	10.579	9.920	74.432
12	1.22479387	4.726	10.105	82.443	2.726	12	0.54671781	6.282	10.713	10.053	72.952
13	1.23303797	4.676	9.986	82.645	2.693	13	0.55478269	6.918	11.371	9.813	71.898
14	1.23574932	4.656	10.068	82.386	2.890	14	0.56361737	6.854	12.332	9.521	71.293
15	1.24376776	4.600	10.481	81.505	3.414	15	0.57109844	6.733	13.205	9.402	70.661
16	1.26010309	4.488	11.122	80.314	4.076	16	0.57695040	7.237	13.693	9.419	69.652

Case of Côte d'Ivoire

Decomposition of Variance for Series TINFF						Decomposition of Variance for Series TCPF					
Step	Std Error	TMMF	TINTF	TINFF	TCPF	Step	Std Error	TMMF	TINTF	TINFF	TCPF
1	0.20697926	10.685	0.678	88.637	0.000	1	0.20038394	0.948	11.799	3.134	84.119
2	0.41337543	11.763	0.635	87.529	0.073	2	0.39347516	0.935	12.590	2.980	83.494
3	0.60382791	12.771	0.473	86.516	0.240	3	0.56630282	0.974	12.519	2.626	83.880
4	0.75502104	13.650	0.310	85.575	0.465	4	0.69987603	1.059	11.667	2.160	85.113
5	0.85772747	14.289	0.329	84.692	0.690	5	0.79026298	1.190	10.313	1.740	86.757
6	0.91525142	14.570	0.764	83.822	0.843	6	0.84535839	1.367	9.062	1.571	88.000
7	0.94035733	14.467	1.801	82.853	0.879	7	0.87917400	1.583	8.755	1.798	87.864
8	0.95051602	14.177	3.385	81.576	0.862	8	0.90475133	1.833	9.979	2.355	85.833
9	0.96184118	14.138	5.081	79.757	1.024	9	0.92884406	2.117	12.537	2.951	82.395
10	0.98354302	14.730	6.282	77.324	1.664	10	0.95143610	2.444	15.530	3.302	78.724
11	1.01591717	15.916	6.682	74.498	2.904	11	0.96948979	2.809	18.014	3.351	75.826
12	1.05299191	17.266	6.473	71.676	4.584	12	0.98112198	3.172	19.497	3.275	74.055
13	1.08729662	18.318	6.083	69.223	6.376	13	0.98730431	3.463	20.018	3.333	73.187
14	1.11353523	18.840	5.856	67.355	7.949	14	0.99094394	3.613	19.975	3.685	72.727
15	1.13004112	18.885	5.928	66.119	9.068	15	0.99487431	3.622	19.851	4.289	72.239
16	1.13845617	18.703	6.240	65.409	9.648	16	1.00041680	3.587	19.952	4.930	71.531

Case of Mali

Decomposition of Variance for Series TINFF						Decomposition of Variance for Series TCPF					
Step	Std Error	TMMF	TINTF	TINFF	TCPF	Step	Std Error	TMMF	TINTF	TINFF	TCPF
1	0.50631438	8.187	6.846	84.968	0.000	1	0.51278700	6.472	1.974	1.825	89.728
2	0.68976262	7.697	6.508	85.755	0.041	2	0.66220137	6.049	1.671	1.873	90.407
3	0.81500569	7.296	6.193	86.388	0.123	3	0.74520004	5.731	1.431	1.904	90.935
4	0.90915215	6.969	5.903	86.893	0.235	4	0.79547253	5.500	1.264	1.918	91.318
5	0.98319860	6.704	5.637	87.290	0.369	5	0.82703251	5.340	1.176	1.919	91.565
6	1.04300338	6.490	5.396	87.597	0.517	6	0.84722733	5.233	1.168	1.911	91.689
7	1.09215743	6.319	5.177	87.830	0.674	7	0.86033243	5.166	1.234	1.896	91.704
8	1.13306066	6.183	4.981	87.999	0.837	8	0.86897334	5.129	1.366	1.878	91.626
9	1.16741367	6.077	4.805	88.117	1.001	9	0.87480825	5.113	1.553	1.860	91.473
10	1.19647298	5.996	4.649	88.191	1.164	10	0.87889740	5.113	1.785	1.844	91.259
11	1.22119626	5.936	4.510	88.229	1.325	11	0.88191941	5.124	2.046	1.832	90.998
12	1.24233092	5.893	4.388	88.237	1.482	12	0.88430493	5.144	2.327	1.824	90.705
13	1.26047093	5.865	4.280	88.221	1.634	13	0.88632212	5.173	2.616	1.820	90.391
14	1.27609522	5.849	4.186	88.185	1.779	14	0.88813273	5.209	2.904	1.822	90.065
15	1.28959435	5.843	4.105	88.133	1.919	15	0.88982930	5.252	3.184	1.828	89.736
16	1.30128974	5.846	4.034	88.069	2.051	16	0.89146017	5.302	3.450	1.838	89.410

Case of Niger

Decomposition of Variance for Series TINFF						Decomposition of Variance for Series TCPF					
Step	Std Error	TMMF	TINTF	TINFF	TCPF	Step	Std Error	TMMF	TINTF	TINFF	TCPF
1	0.74125273	1.810	1.338	96.852	0.000	1	0.42094556	2.603	6.695	3.237	87.465
2	0.99912290	1.432	1.180	97.164	0.224	2	0.55938951	2.656	7.267	3.618	86.459
3	1.16953446	1.151	1.039	97.121	0.689	3	0.64542101	2.735	7.836	3.994	85.435
4	1.29399186	0.955	0.917	96.791	1.337	4	0.70393116	2.838	8.395	4.361	84.406
5	1.38940641	0.829	0.817	96.240	2.115	5	0.74533705	2.961	8.938	4.712	83.389
6	1.46472353	0.758	0.738	95.530	2.973	6	0.77529192	3.103	9.458	5.041	82.397
7	1.52533720	0.731	0.681	94.716	3.872	7	0.79727578	3.260	9.952	5.346	81.442
8	1.57477219	0.735	0.644	93.845	4.776	8	0.81358900	3.431	10.415	5.622	80.532
9	1.61546413	0.761	0.626	92.954	5.658	9	0.82581877	3.612	10.843	5.869	79.676
10	1.64916927	0.801	0.625	92.073	6.500	10	0.83508912	3.802	11.234	6.084	78.879
11	1.67719844	0.848	0.639	91.225	7.287	11	0.84220841	3.998	11.589	6.269	78.144
12	1.70055883	0.898	0.667	90.426	8.009	12	0.84776266	4.198	11.905	6.424	77.473
13	1.72004365	0.947	0.705	89.685	8.662	13	0.85217789	4.399	12.185	6.551	76.864
14	1.73629080	0.992	0.753	89.010	9.245	14	0.85576346	4.599	12.431	6.653	76.317
15	1.74982215	1.032	0.808	88.403	9.757	15	0.85874303	4.797	12.643	6.732	75.829
16	1.76107059	1.067	0.868	87.863	10.203	16	0.86127727	4.989	12.825	6.791	75.395

Case of Senegal

Decomposition of Variance for Series TINFF						Decomposition of Variance for Series TCPF					
Step	Std Error	TMMF	TINTF	TINFF	TCPF	Step	Std Error	TMMF	TINTF	TINFF	TCPF
1	0.28944117	63.695	2.073	34.233	0.000	1	0.10824380	5.486	0.635	9.915	83.965
2	0.56567247	62.524	2.838	34.450	0.188	2	0.20339104	4.707	0.408	10.574	84.311
3	0.79785650	59.708	3.678	35.789	0.825	3	0.27787317	3.354	0.258	11.659	84.730
4	0.95636497	55.440	4.486	38.040	2.035	4	0.32647655	2.447	0.187	13.106	84.260
5	1.04390861	50.572	5.038	40.693	3.697	5	0.35546368	3.507	0.171	14.632	81.689
6	1.08557498	46.853	5.126	42.759	5.262	6	0.37490965	7.267	0.163	15.805	76.765
7	1.11173355	45.970	4.893	43.145	5.992	7	0.39070898	12.285	0.154	16.430	71.131
8	1.14218165	47.601	5.009	41.590	5.800	8	0.40270429	16.075	0.247	16.712	66.966
9	1.18170283	49.346	6.176	38.912	5.566	9	0.40943286	17.474	0.610	16.883	65.034
10	1.22662083	49.178	8.452	36.172	6.197	10	0.41266206	17.321	1.349	16.898	64.432
11	1.27165261	47.079	11.203	34.010	7.708	11	0.41682310	17.488	2.359	16.585	63.569
12	1.31168671	44.416	13.590	32.662	9.332	12	0.42483094	19.059	3.316	16.035	61.589
13	1.34206639	42.461	15.087	32.134	10.318	13	0.43550961	21.350	3.932	15.687	59.032
14	1.36067437	41.570	15.662	32.251	10.518	14	0.44546815	22.975	4.160	15.918	56.947
15	1.37012869	41.324	15.644	32.651	10.381	15	0.45260176	23.340	4.140	16.718	55.802
16	1.37682031	41.103	15.504	32.880	10.512	16	0.45735804	22.945	4.055	17.706	55.294