

IMF Working Paper

© 1998 International Monetary Fund

This is a *Working Paper* and the author(s) would welcome any comments on the present text. Citations should refer to a *Working Paper of the International Monetary Fund*. The views expressed are those of the author(s) and do not necessarily represent those of the Fund.

WP/98/57

INTERNATIONAL MONETARY FUND

African Department

**Money Demand and Regional Monetary Policy in the
West African Economic and Monetary Union**

Prepared by Philipp C. Rother*

Authorized for distribution by I. Diogo

April 1998

Abstract

Regional monetary integration, financial liberalization, and the adoption of indirect policy instruments have changed the conditions for monetary policy in the West African Economic and Monetary Union (WAEMU). The stability of money demand has become a crucial element for monetary policy. This paper presents empirical money demand estimations for regional monetary aggregates and analyzes their stability and forecast performance. The estimations result in a stable relationship for narrow money (*M1*). Consequently, the region's central bank, the BCEAO, can continue to conduct monetary policy in line with the fixed exchange rate system if it succeeds in maintaining financial stability.

JEL Classification Numbers: E41, E58

Keywords: regional money demand, CFA franc zone, WAEMU, BCEAO

Author's E-Mail Address: prother@imf.org

* The author would like to thank Geert Almekinders, the Banque Centrale des Etats de l'Afrique de l'Ouest, David T. Coe, Erik de Vrijer, Innocent Diogo, Christian François, Mark Henstridge, Ernesto Hernández-Catá, Ekué Kpodar, and Athanasios Vamvakidis for helpful comments and suggestions.

Contents	Page
I. Introduction	4
II. Institutional Background in the WAEMU	4
1. Money Demand and Fixed Exchange Rates	5
2. The Impact of Liberalization on Monetary Policy	6
III. Empirical Analysis	8
1. The Choice of Variables	8
2. The Data	10
3. Estimation Results	11
4. Stability of the Money Demand Function	14
a. Parameter stability	14
b. Forecast performance	17
c. The impact of the devaluation	18
5. Forecasting M2 for 1997	19
6. Summary of Empirical Findings	21
IV. Conclusions	22
Appendix	23
References	24
Tables	
1. Money Demand Equations, 1973-1996	12
2. Autoregressive Specifications, 1973-1996	18
3. Root Mean Squared Forecast Errors	18
4. Money Demand Equations, 1973-1993	19
Charts	
1. Graphs of Variables	11
2. Regression 1	15
3. Regression 2	16
4. M2 – Actual and Fitted Values	20

Summary

Regional monetary integration, financial liberalization, and the adoption of indirect policy instruments continue to change the conditions for monetary policy in the West African Economic and Monetary Union (WAEMU). Regional integration requires the monetary authorities to shift their focus from national to regional macroeconomic relationships, while financial liberalization and the adoption of indirect instruments introduce market forces to the regional financial markets and make the impact of changes in monetary policy more difficult to predict.

Given the specific monetary environment — a fixed exchange rate with France and a low degree of capital movements with countries outside the region — the BCEAO (Banque Centrale des Etats de l’Afrique de l’Ouest) requires accurate information on the effects of macroeconomic changes on the demand for money. This paper presents empirical money demand estimations for regional monetary aggregates including an analysis of their stability and forecast performance. A relationship between real narrow money ($M1$) and a number of explanatory variables remains stable over time and yields accurate forecasts. For the sum of fixed term and savings deposits (Mt) there is also a stable relationship, however, with inferior forecast properties. Estimates of the sum of these two variables, $M2$, on the other hand, do not result in statistically viable equations.

The conclusion is that, despite the change in the monetary environment, the BCEAO can maintain its ability to conduct monetary policy in line with the requirements of the fixed exchange rate system if it strengthens the effectiveness of its indirect instruments and succeeds in maintaining financial stability in the region.

I. Introduction

Regional monetary integration, financial liberalization, and the adoption of indirect policy instruments continue to change the conditions for monetary policy in the West African Economic and Monetary Union (WAEMU). Regional integration requires the monetary authorities to shift their focus from national to regional macroeconomic relationships, while financial liberalization and the adoption of indirect instruments introduce market forces to the regional financial markets and make the impact of changes in monetary policy more difficult to predict.

Having initiated these processes, the region's central bank, the BCEAO (Banque Centrale des Etats de l'Afrique de l'Ouest), now faces the question of how to adapt its monetary policy without destabilizing the existing fixed exchange rate system with the French franc. In particular, the BCEAO requires accurate information on the effects of macroeconomic changes on the demand for money. For this, the central bank needs to consider two major issues. First, as a consequence of regional monetary integration, it has to forecast a regional monetary aggregate, the behavior of which has not yet been analyzed. Second, as a result of the adoption of indirect monetary instruments and financial liberalization, the impact of changes in economic variables like income and interest rates on the decision to hold money will become stronger so that existing forecast procedures may fail in the future.

This paper presents empirical money demand estimations for regional monetary aggregates including an analysis of their stability and forecast performance. A relationship between real narrow money ($M1$) and a number of explanatory variables remains stable over time and yields accurate forecasts. For the sum of fixed term and savings deposits (Mf) there is also a stable relationship, however, with inferior forecast properties. Estimates of the sum of these two variables, $M2$, on the other hand, do not result in statistically viable equations. The conclusion is that, despite the change in the monetary environment, the BCEAO can maintain its ability to conduct monetary policy in line with the requirements of the fixed exchange rate system if it strengthens the effectiveness of its indirect instruments and succeeds in maintaining financial stability in the region.

The structure of the paper is as follows. The second section analyzes the institutional background in the WAEMU with a particular emphasis on the effects of financial liberalization. The third section contains the empirical results for the demand for money. In addition to presenting the estimated equations, there is a discussion of various stability and forecast tests which indicate the usefulness of a particular specification for monetary policy. The fourth section concludes with an assessment of the study's implications for the future monetary policy of the BCEAO.

II. Institutional Background in the WAEMU

In the following evaluation, some theoretical issues concerning the demand for money under fixed exchange rates are briefly reviewed. A discussion follows on the challenges for monetary policy in the WAEMU resulting from the introduction of indirect monetary instruments.

1. Money Demand and Fixed Exchange Rates

Two specific factors characterize monetary policy in the WAEMU and constrain the choice of policy variables by the central bank. First, the member countries form a monetary union with a common currency, the CFA franc, which is issued by the BCEAO. Second, the common currency is linked by a fixed peg to the French franc. For this reason, the BCEAO has to keep the region's net foreign assets at a sustainable level so as to maintain its ability to repurchase CFA francs at the given parity at any time.

The necessity of maintaining a sufficient level of net foreign assets determines the central bank's approach to monetary policy based on the relationship between net foreign assets (*NFA*), net domestic assets (*NDA*), and the volume of money (*M*) which is given by the definition:

$$NFA = M - NDA,$$

where *NDA* is the sum of domestic credit and other items (net). To target *NFA* at the regional level, the central bank has to predict or control possible changes on the right hand side of the equation — particularly in the demand for broad money (*M*) and the volume of domestic credit assuming that the other items (net) remain unchanged.

The feasibility of targeting *NFA* depends on the degree of direct interaction between *NFA* and *M*, i.e. the importance of capital flows for the *NFA*. With a completely closed capital account, the central bank achieves changes in net foreign assets by varying the interest rate which affects aggregate output and, resulting from this, the demand for imports. In this situation, the central bank can perform its monetary policy in two steps: first, it has to predict the demand for money and then to control domestic credit by using its monetary instruments.

With more liberal capital movements, on the other hand, interest rate changes directly affect net capital flows due to their impact on the relation between domestic and foreign asset returns. These changes in capital flows result in changes in the demand for the domestic money, leaving domestic credit unaffected. Consequently, with increased capital account movements the demand for money may become unstable in the short run. In fact, such short-term fluctuations may dominate the demand for money with a completely open capital account so that the central bank has to focus on return differences for targeting its net foreign asset position.

The degree of correlation between domestic credit and net foreign assets allows an empirical assessment of the importance of capital flows for the conduct of monetary policy. With a high negative correlation, the control of domestic credit assuming a stable demand for money allows, in principle, the central bank to influence the *NFA* position while a less negative (or even positive) correlation would necessitate the more direct control of net foreign assets. The analysis of monthly BCEAO data for the period December 1985 to December 1993 yields a correlation coefficient of around -0.8 between net foreign assets and domestic credit

indicating that even short term movements in the net foreign asset position do not dominate broad money growth and, therefore, endorsing the two step approach described above.

2. The Impact of Liberalization on Monetary Policy

The liberalization of monetary policy by the BCEAO implies increased uncertainty for the central bank since it has to rely on different transmission channels and the variables of interest, such as the demand for money, become more volatile. To offset the adverse effects of this heightened uncertainty, the central bank needs to acquire more information about the effects of monetary policy in general, on the demand for money, in particular.

The reform of monetary policy by the BCEAO included the implementation of indirect monetary instruments in recent years.¹ Before 1990, the central bank conducted its monetary policy by direct instruments. These consisted of binding interest rates limits for the banks' business with nonbanks as well as credit ceilings for the individual banks. For loans refinanced with the BCEAO, the banks had to request approval in advance from the central bank. In October 1989, the BCEAO started to shift its monetary policy toward more market oriented instruments. During the first years of the transition period, credit ceilings were lifted and eventually abolished and the influence of sectoral considerations on the allocation of credit decreased. Furthermore, interest rates on deposits and loans were progressively liberalized. In 1993, the second step towards the implementation of indirect instruments in monetary policy consisted of the introduction of minimum reserve requirements, auctions of central bank bills, and an interbank money market. Today, interest rate limitations exist only with regard to a minimum rate on small savings deposits and an upper limit for loans to prevent usury.

In principle, the system of direct monetary instruments gave the central bank the ability to target net foreign assets accurately for two reasons. First, under that system, interest rates were not market clearing and the diversity of financial instruments was low. As a result, projections of the volume of money were likely to be precise since, in the absence of alternatives for the allocation of wealth, the population kept money holdings in bank accounts at the prescribed interest rates. Low international capital mobility also meant that possible foreign determinants of the demand for money were not important. Second, the direct credit limits for individual banks allowed the central bank to maintain tight control over the domestic credit level. However, the system of direct monetary instruments imposed a high cost on the economy in terms of distortions of interest rates and inefficient allocation of resources and its abolition removed a barrier to long-term economic growth.

The switch to indirect instruments increases the uncertainty concerning the credit volume as well as the demand for money. Concerning the volume of credit, the functioning of indirect instruments relies on the uncertain relationships between various macroeconomic variables, in particular between the interest rates in the money market and in the credit market, as well as the link between the latter and the volume of credit. While the central bank can control the

¹ For more information, see J. Clément (1996) and P. Honohan (1996).

money market rate using indirect instruments, the volume of credit to the economy as well as the equilibrium interest rate, are influenced by variables such as inflation expectations, that are beyond the direct control of the central bank.

In addition, substantial excess liquidity in the banking system further complicates the use of indirect instruments. Excess liquidity may mask the relationship between the market for central bank money and the banks' activities in the retail market since the banks can always take recourse to their liquid resources to finance additional credit. Consequently, before the BCEAO's instruments can gain full impact on the money market, this excess liquidity has to be absorbed. The decision which measures to employ for this, e.g. the auctioning of government paper or of central bank deposits, needs to be based on the specific environment in the WAEMU.²

Forecasts of the demand for money may also become more difficult. As a result of liberalization, new financial instruments may develop widening the array of financial assets at the agents' disposal. In response, agents will be able to substitute money holdings for other financial assets and vice versa in response to changes in the economic environment so that the strong link between money and income under a regime of direct monetary policy instruments is replaced by a more complex relationship including additional determinants. At the same time, this more complex relationship may be more transparent as the decision to hold money depends increasingly on relative prices and less on non price factors such as centrally directed credit.

The stability of the demand for money will depend crucially on the public's confidence in the soundness of the financial sector. In the absence of this confidence, minor events may be perceived as indicators of an impending financial collapse and induce a cycle of self fulfilling prophecies ending in the actual failure of the financial system. Therefore, enforcing financial sector soundness is indispensable, in particular, when the central bank loosens direct control of the monetary sector by introducing indirect instruments.

Finally, external capital mobility in the WAEMU has been low although there were few explicit capital account restrictions. As indicated above, an increasing integration of the WAEMU in the international capital markets may add further to the uncertainty concerning the demand for money by inducing speculative capital movements.

Having argued that the demand for money function is becoming more complex at the same time as its importance for monetary policy increases, we proceed now to the empirical analysis of money demand relationships in the WAEMU.

² A detailed discussion of the issues involved in this decision can be found in International Monetary Fund (1996).

III. Empirical Analysis

An empirical analysis of the regional demand for money follows, which places emphasis on its stability and discusses the implications for the design of future monetary policy.

1. The Choice of Variables

In line with basic theoretical considerations, it is assumed that the demand for financial assets depends on income as well as the rates of return of the asset and of alternative assets. In the following discussion, the choice of the monetary assets is examined including the degree of regional aggregation as well as that of the asset return variables. Income is proxied by the gross domestic product.

The choice of the monetary aggregate is determined by the trade-off between gains from aggregation (e.g. due to canceling disturbances) and gains from disaggregation — due to higher information content of disaggregated variables.³ Theory indicates that the subaggregates of broad money — narrow money and the sum of fixed term and savings deposits — should have different functional specifications. For example, while narrow money is likely to fall with rising interest rates on term and savings deposits, the level of these deposits should increase. Similarly, expected exchange rate changes may influence fixed deposits more strongly owing to their function as a store of wealth while narrow money, held for transactions purposes, remains largely unaffected. Consequently, aggregation will result in a loss of information on the effects of interest rates and exchange rates on the demand for money. In view of this consideration, separate specifications for narrow money and the sum of fixed term and savings deposits are estimated.⁴ However, equations for a broader monetary aggregate are also presented to test the importance of the above considerations.

Concerning regional aggregation, the assessment of possible sources of bias results in choosing an aggregate money demand relationship for the WAEMU region due to financial and economic integration, as well as the specific data situation in the region. Because of the integration of financial markets and the convergence of national interest rates, income shocks in neighboring countries may increasingly affect national demand functions, in addition to national variables, while the aggregate demand function remains stable. Furthermore, economic integration will result in more homogenous national money demand functions so that gains from estimating national functions diminish. Finally, with virtually identical banknotes being issued in each of the participating countries while being accepted throughout

³ Pesaran, Pierse, and Kumar (1989) provide a theoretical basis for evaluating this trade-off between the specification bias and the aggregation bias.

⁴ The estimation of Divisia monetary indices provides a theoretically compelling solution to the question of functional aggregation. This, however, relies on the availability of a wide range of financial assets and therefore is not applicable in the present study.

the region, the amount of currency in any single country is difficult to determine.⁵ On the regional level, however, the outstanding supply of currency is relatively simple to determine.

Regarding the asset return variables, a differentiation is made between narrow money on the one hand and the sum of fixed term and savings deposits on the other, in line with the above argumentation. Narrow money is assumed to have no financial return, so that the return on alternative financial assets (term and savings deposits) is included in the specifications to proxy opportunity costs. Another consideration is that the expected inflation rate measures the cost of holding money in terms of real assets, and the current rate of inflation is used as an indicator for expected inflation. With regard to foreign alternatives, current changes in the exchange rate between the CFA franc and the U.S. dollar turned out to have a significantly negative impact on the demand for money. A possible explanation is that current exchange rate changes may serve as an indicator for expected exchange rate changes thus measuring the opportunity cost of holding the domestic currency as opposed to a foreign currency.

With regard to the modeling of fixed term and savings deposits, domestic financial alternatives for storing wealth did not exist during the sample period in the WAEMU. Consequently, only the French interest rate is used along with exchange rate changes vis-à-vis the U.S. dollar as well as the inflation rate to model opportunity costs while the domestic savings rate depicts the own return of this asset.

Two questions arise with regard to the choice of interest rate and exchange rate variables. First, due to the regulation of financial markets, the interest rate in the WAEMU was not market clearing for the greater part of the sample, rendering its information content in the estimation of an equilibrium relationship questionable. Therefore, also the interest rate on deposits in France is included, or alternatively the difference between the two variables in the estimations. The second question concerns the impact of expected exchange rate changes vis-à-vis the French franc which may be more important for the asset allocation decision than the price changes of other currencies like the U.S. dollar. However, for a currency with a fixed exchange rate as stable as the CFA franc, the inclusion of exchange rate expectations requires a degree of additional modeling which is beyond the scope of this paper, but may be of interest for further studies.⁶

⁵ In fact, because of technical problems at the national branches of the central bank in counting banknotes and verifying their origin, national data on money volumes are likely to be inaccurate. See Almekinders (1996).

⁶ For a study of expected exchange rate changes in the European Monetary System see Fratianni and von Hagen (1992).

2. The Data

For the estimation, we employ annual data from the International Financial Statistics (IFS) and the World Economic Outlook (WEO) data bases for the member countries of the WAEMU.⁷ The sample period is 1973 through 1996. Monetary volumes, interest rates, and exchange rates have been taken from the IFS.⁸ The interest rates used in the study are the rates for twelve months deposits in Côte d'Ivoire and the French pass book savings rate.⁹ After 1992, the minimum rate on savings under CFAF 5 million in the BCEAO area is employed as the domestic interest rate. The WEO data base is the source of income and consumer price data, since it provides complete time series for all countries over the full sample period. Real money and income variables for the area as a whole are simple sums of the national real data and are taken in logarithms. Regional inflation is the GDP-weighted sum of national inflation rates. Graphs of the variables are presented in Chart 1.

Prior to the choice of the econometric techniques, the time series properties of the variables concerned have to be established. If the variables are non-stationary of the same order, cointegration techniques may allow the estimation of long-run equilibrium relationships, as well as short run dynamic specifications. If the variables are stationary, however, the conventional Ordinary Least Squares (OLS) method may yield unbiased estimates. For the present study, the methodology presented by Dolado, Jenkinson, and Sosvilla-Rivero (1990) is employed to test for stationarity. This methodology pays particular attention to the specification of the Dickey Fuller test, thereby reducing the risk of distorted results due to the spurious inclusion of a constant or a trend in the test equation.

Stationarity tests were performed for all variables specified as in the estimations. The tests yielded clear-cut results pointing to stationarity for all variables except real income for which the results are inconclusive. While the trend and the constant in the test equation for real income turn out to be not significantly different from zero, the Dickey Fuller test without trend and constant yields a highly significant positive coefficient for the lagged variable, pointing to an exploding behavior of the income time series.¹⁰ Since the power of tests for non-stationarity is generally low and therefore the risk of incorrectly inferring that a stationary time series is non-stationary is relatively high, real income is treated as a stationary variable.

⁷ The countries included in this study are Bénin, Burkina Faso, Côte d'Ivoire, Mali, Niger, Senegal, and Togo.

⁸ The data for *MI* and *M2* for 1996 are not yet available in the IFS. Therefore, these data have been calculated by applying a GDP-weighted average of the unpublished estimated growth rates of the individual countries to the 1995 data.

⁹ The 12-month interest rates were equal in the WAEMU countries throughout the sample period.

¹⁰ Fielding (1997) finds a similar result for real income in Côte d'Ivoire.

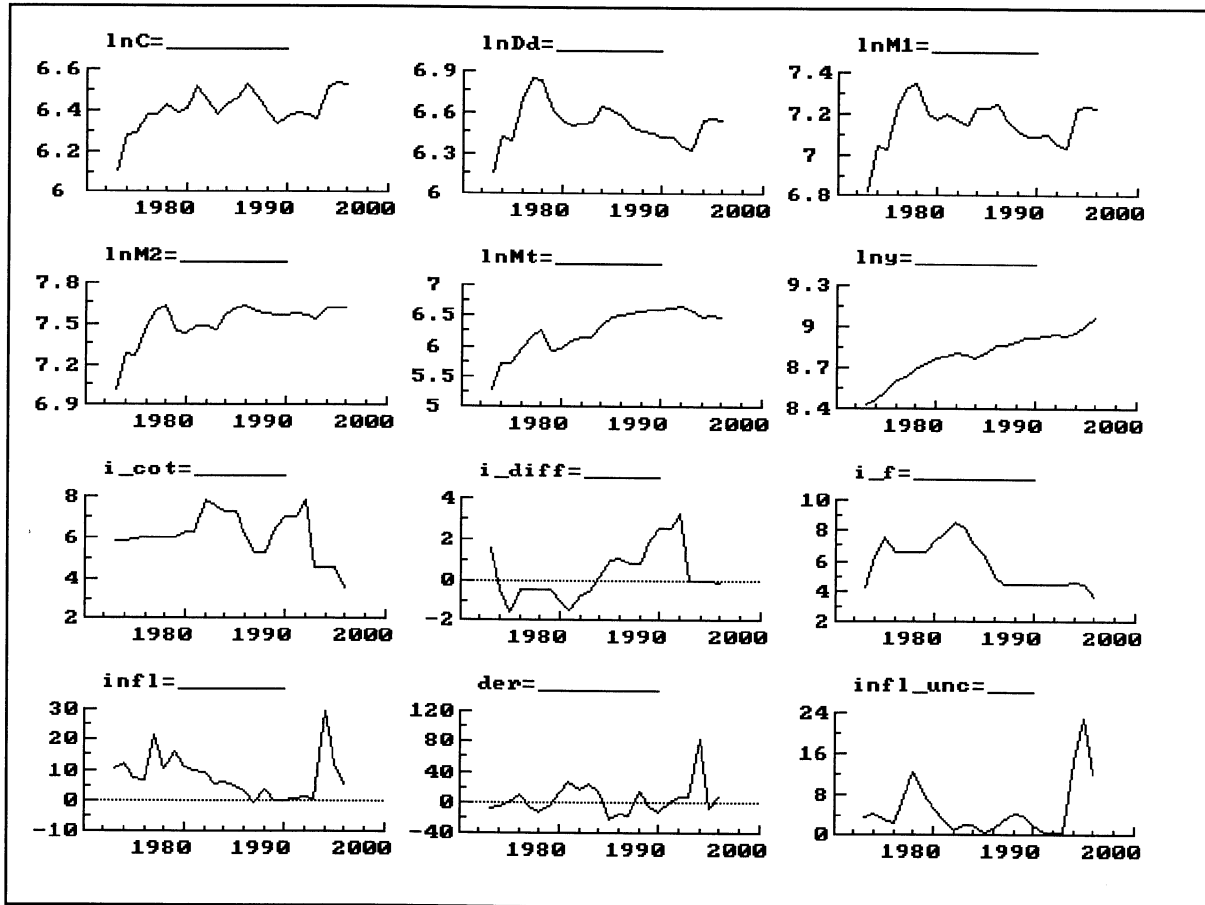


Chart 1: Graphs of variables

3. Estimation Results

In view of the results of the stationarity tests the demand for money is estimated using the OLS method. The general form of the regression equation is:

$$y_t = \beta_0 + \sum_{i=1}^n \beta_i x_i + \epsilon_t,$$

where y_t is the dependent variable in period t , the β are the regression coefficients, the x_i are the n explanatory variables, and ϵ_t is the error term.

Table 1 shows the preferred regression results with heteroskedasticity-consistent standard errors in brackets.¹¹ Money demand specifications result with significant parameter values for both monetary subaggregates of $M2$, $M1$, and Mt . For $M2$, only a specification with nearly significant parameters is found. The demand for real $M1$ depends positively on real income,

¹¹ Further estimation results are available from the author upon request.

Table 1: Money Demand Equations, 1973-1996

		const.	lny	i_cot.	i_diff.	infl.	der.	Han	R ²	Mis-specific
1.	lnM1	1.9394 (1.7205)	0.56203** (0.18581)	0.03650* (0.01719)	-0.05408** (0.01683)	0.00973** (0.00363)	-0.00281** (0.00111)	var*	0.58	RES*
2.	lnMt	-11.000** (2.1956)	1.9618** (0.24957)				-0.00252* (0.00123)		0.82	Norm**
3.	lnM2	0.17861 (1.8549)	0.81238** (0.20087)	0.02187 (0.01500)		0.00690 [†] (0.00400)	-0.00193 [†] (0.00113)	var*	0.66	RES**

Heteroskedasticity-consistent standard errors are presented in brackets. Significance levels of 10%, 5%, and 1% are marked by †, *, and **, respectively.

ln indicates a natural logarithm; *const.* is a constant term; *y* is real income; *i_cot.* is the interest rate on deposits in Côte d'Ivoire; *i_diff.* is the difference between the interest rate on deposits in Côte d'Ivoire and France; *der.* is the change in the end-of-period CFAF/USD exchange rate; *Han* is Hansen's test for variance instability (indicated by *var.*); *R²* is the coefficient of determination.

Mis-specific contains the results of specification tests when those tests indicate mis-specification. *RES* stands for Ramsey's Reset-test for heteroskedasticity and functional mis-specification. *Norm* stands for a test of normality of the residuals. Significant values of the Hansen tests and the tests for mis-specification point to instability and violation of the standard assumptions underlying OLS regression, respectively. Further details on the specification tests can be found in the PC-Give manual.

the interest rate in Côte d'Ivoire, and the inflation rate while it depends negatively on the difference between interest rates in Côte d'Ivoire and France as well as exchange rate changes. The income elasticity of *MI* is around 0.5. Compared to interest rate effects, the impact of inflation and exchange rate changes on the demand for money is relatively small. The coefficient of multiple determination is around 0.6.

Estimations for the subaggregates of *MI*, cash and demand deposits, result in basically very similar equations as for *MI* itself, as can be seen from equations 1c and 1e in Table A2 in the Appendix. Furthermore, these two specifications indicate that demand deposits are more strongly influenced by the return variables while the income elasticity is higher for the cash specification. These results justify the aggregated estimation of *MI* instead of its subaggregates.

While some of these results may seem surprising from an economic point of view, they may be explained by taking the specific nature of the economies into consideration. The positive own interest rate elasticity may result from the combination of a low degree of financial development and the widespread use of agricultural credit in the economies in the study.¹² In this environment, economic agents hold a relatively high share of their wealth in physical capital (e.g. livestock) while they use short-term agricultural credit for smoothing consumption over the agricultural cycle. Increasing interest rates may now induce the agents to shift wealth out of physical capital and into money to reduce expensive agricultural credit

¹² See for this explanation Fielding (1997) who also finds a positive interest elasticity for the money demand in Côte d'Ivoire.

which explains the above result. This interpretation is corroborated by the fact that the positive interest effect on demand deposits exceeds that on cash holdings.

The positive relationship between inflation and real money may reflect a decrease in uncertainty concerning the macroeconomic environment over the sample. Adverse economical as well as political conditions in the 1970s and 1980s resulted not only in high inflation rates but also in high uncertainty over the future development. This may have caused relatively high holdings of liquidity which then decreased as uncertainty (and inflation) diminished in the 1990s. An empirical assessment of this hypothesis does not, however, yield conclusive results, as Table A2 in the Appendix shows. Taking a moving two year average of absolute changes in inflation as an indicator for inflation uncertainty in the money demand regression results in a positive though insignificant coefficient on inflation uncertainty. However, the coefficient on inflation also stays positive. A possible explanation for this statistical result is the close relationship between the two variables (see also Graph 1) which may induce collinearity in the estimation.¹³

The interest rate difference between the WAEMU and France is an indicator of expected changes in the parity. While the difference should be zero with completely credibly fixed exchange rates it increases when agents expect a devaluation of the domestic currency to induce them to keep their financial assets in the domestic currency. A look at the development of the interest rate difference between the WAEMU and France shows that the difference increased substantially in the years before the devaluation in 1994. A regression of real money on the domestic and the foreign interest rate separately results in an insignificantly negative coefficient on the domestic interest rate as shown by equation (1a) in Table A1 in the Appendix. This is a consequence of mixing the positive domestic interest elasticity, explained above, with the negative effect of devaluation expectations.

Assuming a positive relationship between actual and expected exchange rate changes, the negative impact of exchange rate changes on the demand for money is in line with the basic economic consideration that the demand for a currency should decrease when its external value is expected to diminish.

The preferred specification for Mt reflects the impact of the external alternatives for storing wealth. The demand for savings and fixed term deposits increases with real income with an elasticity of about two and decreases with a devaluation vis-à-vis the U.S.-dollar. The coefficient of determination exceeds 0.8. As can be seen from Table A2 in the Appendix (equations 2a – 2f), including further explanatory variables individually or in groups in the equation results in parameter coefficients carrying the expected signs for all parameters in each of the specifications. Significance levels, however, are generally low. This indicates that

¹³ For a further investigation of the effects of inflation uncertainty it might be useful to treat the inflation in the aftermath of the devaluation in 1994 differently from the previous observations since expectations are likely to have been more precise in this environment.

all these variables do in fact have an impact on Mt and therefore supports the assumption that the behavior of this aggregate is already dominated by pure portfolio considerations.

The specification for $M2$ which comes closest to an economically viable relationship is presented as equation 3 in Table 1.¹⁴ Being the sum of the previous two subaggregates, $M2$ depends on broadly the same set of variables and the coefficients have the same signs. However, due to canceling effects the own interest elasticity is not significantly different from zero. Also, the impact of inflation and exchange rate changes is only significant at the 10 percent level. The coefficient of determination lies between those for the subaggregates. In view of these results the following discussion of the stability of the demand for money will be limited to the specifications for MI and Mt .

The last column in Table 1 contains the results of various tests for mis-specification if these tests turn out to be significant. Tests were performed for residual autocorrelation, autoregressive conditional heteroskedasticity, normality of the residuals, heteroskedasticity, functional form mis-specification, and a combination of heteroskedasticity and mis-specification. As can be seen from the table, only the combined test for heteroskedasticity and mis-specification (*RESET*) and the test for normality of the residuals (*Norm*) yield significant results. To account for possible heteroskedasticity as indicated by the *RESET* test, heteroskedasticity consistent standard errors are presented. Furthermore, with only 24 observations, possible mis-specification and non-normality of the residuals may to a large extent be explained by the scarcity of data. Consequently, future estimations with longer time series should find better test results in this respect.

4. Stability of the Money Demand Function

For monetary policy, the stability of the money demand function is critical. Stability of the money demand function refers to two characteristics. First, the stability of the parameters of the money demand function over time shows the historical behavior of the equation. Parameter stability ensures that repeated estimations of the money demand function over different subsamples yield the same results. Second, the accuracy of out of sample forecasts of the money demand function reflects its usefulness for predicting the demand for money which — as shown in chapter 2 — is a prerequisite for the monetary policy of the BCEAO. In addition to these three general issues this section also presents results for the impact of the devaluation of the CFA franc on the demand for money.

a. Parameter stability

The parameter stability of the money demand equations is examined using Hansen's (1992) techniques to investigate stability for individual parameters as well as for the parameter set as a whole and the variance of the residuals. Furthermore, the degree of parameter stability can be inferred from recursive regressions which show the behavior of the coefficients for

¹⁴ Further regression equation are presented in Table A2 in the Appendix, equation 3a – 3c.

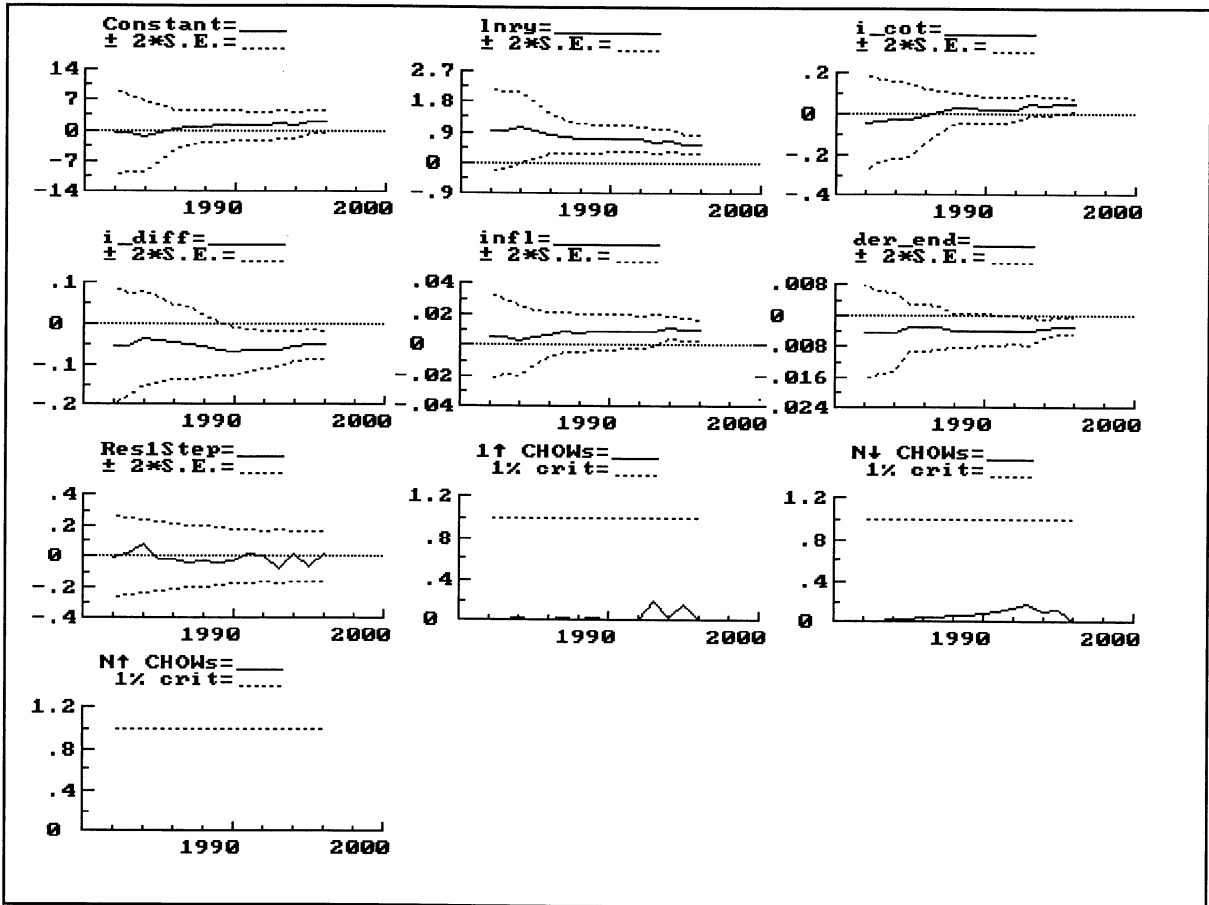


Chart 2: Regression 1

incrementally increased sample sizes.¹⁵ In addition, repeated break point and forecast Chow tests reveal structural breaks. Break point Chow tests indicate structural breaks for periods after the end of the respective subsample, while forecast Chow tests point to possible breaks before the respective subsample. By repeating the tests for various subsample lengths the complete time period is covered.

The tests regarding parameter stability point to a relatively high stability of the parameters in the two specifications for *MI* while there appears to be some fluctuation concerning the parameters for *Mt*. For *MI* the results of the Hansen tests point only to an instability of the variance at the 5 percent level which is another indication for the presence of heteroskedasticity while for *Mt* the tests do not detect instability. Charts 2 and 3 present the graphic results from recursive estimation. The first graphs contain the recursively estimated parameters, as well as the bands for two standard deviations.¹⁶ After these graphs the results

¹⁵ The recursive estimations start after the first nine initializing observations.

¹⁶ The standard deviations in the graphs are not based on heteroskedasticity consistent

(continued...)

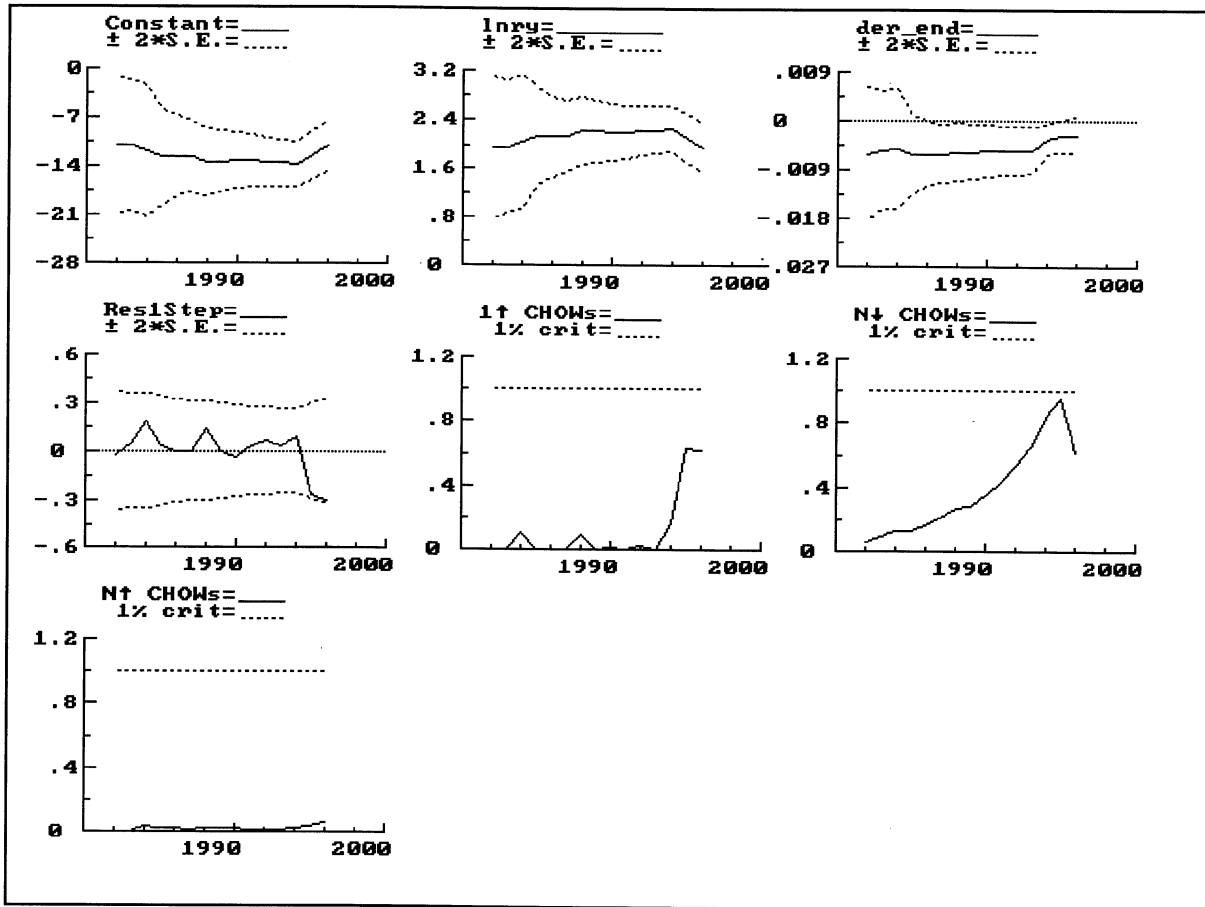


Chart 3: Regression 2

of forecast tests are presented, namely the recursive one-step-ahead residuals (titled Res1Step) and the one-step-ahead Chow test (titled 1↑Chow). These two graphs will be discussed further below. The final two graphs contain the results of the break point Chow test (N↓Chow) and the forecast Chow test (N↑Chow), respectively.

As can be seen from the first six graphs of Chart 2, the parameter estimates in equation 1 show a little variation especially before 1987 and remain remarkably stable afterwards. In no case lies the parameter estimate for a specific subsample outside the error band of the previous estimation. The error bands converge rapidly with increasing sample length, except for the interest rate coefficients which become significantly different from zero only relatively recently. The break-point Chow test (indicated by N↓) as well as the forecast Chow test (N↑) remain insignificant throughout the full sample.

With regard to equation 2, Chart 3 points to a somewhat higher instability of this specification. The repeated coefficient estimates show some variation, and particularly in 1994

¹⁶(...continued)

estimation and are therefore not directly comparable to the numbers in Table 1.

there may have occurred a structural shift. However, the coefficients remain within the error bands of the previous estimation throughout the sample. The hypothesis of a structural shift is supported by the outcome of the Chow test for structural breaks (N!) which is nearly significant in 1995.¹⁷

b. Forecast performance

For monetary policy, the forecast of the demand for money is the ultimate goal of money demand estimations. The forecast performance is evaluated using three different methods. First, employing the results from the recursive estimations, we compute one-step-ahead forecast errors for each subsample. These show if the prediction error for a particular period lies outside the confidence interval computed by the previous estimation thus indicating a significantly non-zero forecast error. Second, recursive one step Chow tests measure possible structural breaks between the estimation period and the forecast period which point to a fundamental shift in the estimated relationship.

Third, the behavior of the estimated equations is compared with that of pure time series models. To this end, autoregressive processes of the order one (AR(1)) are estimated for each of the independent variables.¹⁸ As a first measure, we compare the coefficients of determination (R^2) of the AR(1) processes with those of the structural relationships. A second step evaluates the forecast performance. For this, root mean squared forecast errors (RMSE) are computed from the recursive one-step-ahead forecasts for variable i

$$RMSE_i = \sqrt{\frac{\sum_{t=1}^n (y_{i,\tau+t} - \bar{y}_{i,\tau+t})^2}{n}},$$

where y is the actual outcome, \bar{y} is the predicted value, τ stands for the final estimation period, and n is the number of one step forecasts. The root mean squared forecast error of the AR(1) estimations are then compared with the equivalent number for the structural equations.

The first two methods of assessing the forecast performance, inspecting the one-step ahead forecast errors and the Chow test for structural break, yield the following results. The one-step-ahead forecast errors of MI (seventh graph in Chart 2) remain well within the two standard error bands throughout the sample and appear to be centered around zero. Also, the one step Chow test is insignificant. For Mt , the forecast standard error nearly exceeds the error bands in 1995 and the bands widen after 1994 indicating increased forecast uncertainty. The value for the one step Chow test is high, though still insignificant, in 1995 and 1996.

¹⁷ Estimations including a shift dummy for the period after the devaluation yield a significant coefficient for the dummy variable but overall unstable parameter values; the signs of the remaining coefficients are unchanged. The results are available from the author upon request.

¹⁸ Higher lags for the AR process were found to be insignificant.

Table 2: Autoregressive Specifications, 1973-1996

	const.	lag. end. v.	Han.	R ²	Mis-specific.
lnM1	2.5143* (1.08030)	0.65013** (0.15090)		0.59	
lnMt	1.5318** (0.26250)	0.76302** (0.04125)		0.91	Norm**

lag end. v. is the lagged endogenous variable.

Regarding the third method, Table 2 shows the AR(1) specifications for *MI* and *Mt*. The coefficients of determination for these specifications are slightly higher than for the structural specification in Table 1.

The root mean squared errors for 16 one-step-ahead forecasts were computed, allowing for nine initializing periods. The results are presented in Table 3. As can be seen from the table, the mean squared forecast errors for the AR specification of *MI* are higher than those of the structural equation. Concerning *Mt*, however, the result of the structural specification are inferior to that of the AR process. Computations for varying numbers of forecast periods yielded broadly similar results.

These results indicate that for *MI* the structural specification dominates the time series approach indicating that the economic explanation of *MI* is valid. For *Mt*, on the other hand, the preferred structural specification in Table 1 is still less useful for forecasting than the time series method.

c. The impact of the devaluation

A further area of interest to policy makers is to what extent the devaluation of CFA franc in 1994 affected the estimated money demand functions. In addition to interpreting the graphs presented above, the same regression equations are estimated over the shorter sample 1973 through 1993 to see if the equations remain structurally unchanged without the devaluation shock.

With regard to *MI*, Chart 2 indicates that equation this aggregate is not significantly affected by the devaluation in 1994. Furthermore, as shown in Table 4, the estimation of the same equation over the shorter period up to the devaluation yields the same signs for the coefficients as the original regression. However, the coefficient on the domestic interest rate

Table 3: Root mean squared forecast errors

	M1 (eq. 1)	M1 (AR)	Mt (eq. 2)	Mt (AR)
RMSE	0.039	0.053	0.121	0.080

RMSE is the root mean square error for 16 one step forecasts.

Table 4: Money Demand Equations, 1973-1993

		const.	lny	i_cot	i_diff.	infl.	der.	Han.	R ²	Mis-specific
1.	lnM1	1.3635 (2.0530)	0.62686** (0.22950)	0.03891 [†] (0.02250)	-0.06383** (0.02023)	0.00957 [†] (0.00539)	-0.00407** (0.00151)		0.59	
2.	lnMt	-13.419** (1.8246)	2.2403** (0.20610)				-0.00528** (0.00154)	var*	0.89	
3.	lnM2	-1.1286 (2.5267)	0.97335** (0.28397)	0.00310 (0.01441)		0.00989 (0.00616)	-0.00234 [†] (0.00132)	var*	0.67	RES**

and inflation are only significant at the 10 percent level. The Hansen and the misspecification test, on the other hand, are insignificant in the shorter sample pointing to a more stable relationship for *M1* before the devaluation.

As shown in Chart 3, the specification for *Mt* is strongly affected by the devaluation. In addition to the coefficient changes, the forecast error for 1994 lies only narrowly within the two standard error band and the bandwidth widens in response to the devaluation. Estimation over the shorter period (see Table 4) results in a more stable relationship with a higher significance level for the exchange rate change. The specification for *M2*, finally, is virtually unaffected by the changed sample period since the factors responsible for the shift in *Mt* have less impact on the broader aggregate.

These results induce the following conclusions. The devaluation appears not to have destabilized the demand for *M1* as coefficients remain basically unchanged. Regarding *Mt*, while the explanatory variables remain the same before and after the devaluation, the size of the coefficients, particularly for expected exchange rate changes, changes inducing some instability in the specification. The increased instability of the *Mt* specification after 1994 indicates that the equation does not capture some effects on *Mt* which occurred or became more forceful after the devaluation. An example for such a variable may be trust in the local financial system which may affect financial assets with a longer maturity more strongly than liquid assets. A reduction in confidence in the regional financial stability caused by the devaluation may be responsible for the shift in the demand equation for *Mt*. However, a longer period of financial stability after the devaluation should result in the return of a more stable demand for *Mt*.

5. Forecasting M2 for 1997

To assess the performance of the estimation equations with respect to the real development of *M2*, Chart 4 presents graphs of the actual and fitted values of *M2*, where the fitted values have been derived from the structural model for *M1* in combination with the time series model for *Mt*. The fitted values track actual *M2* quite closely.

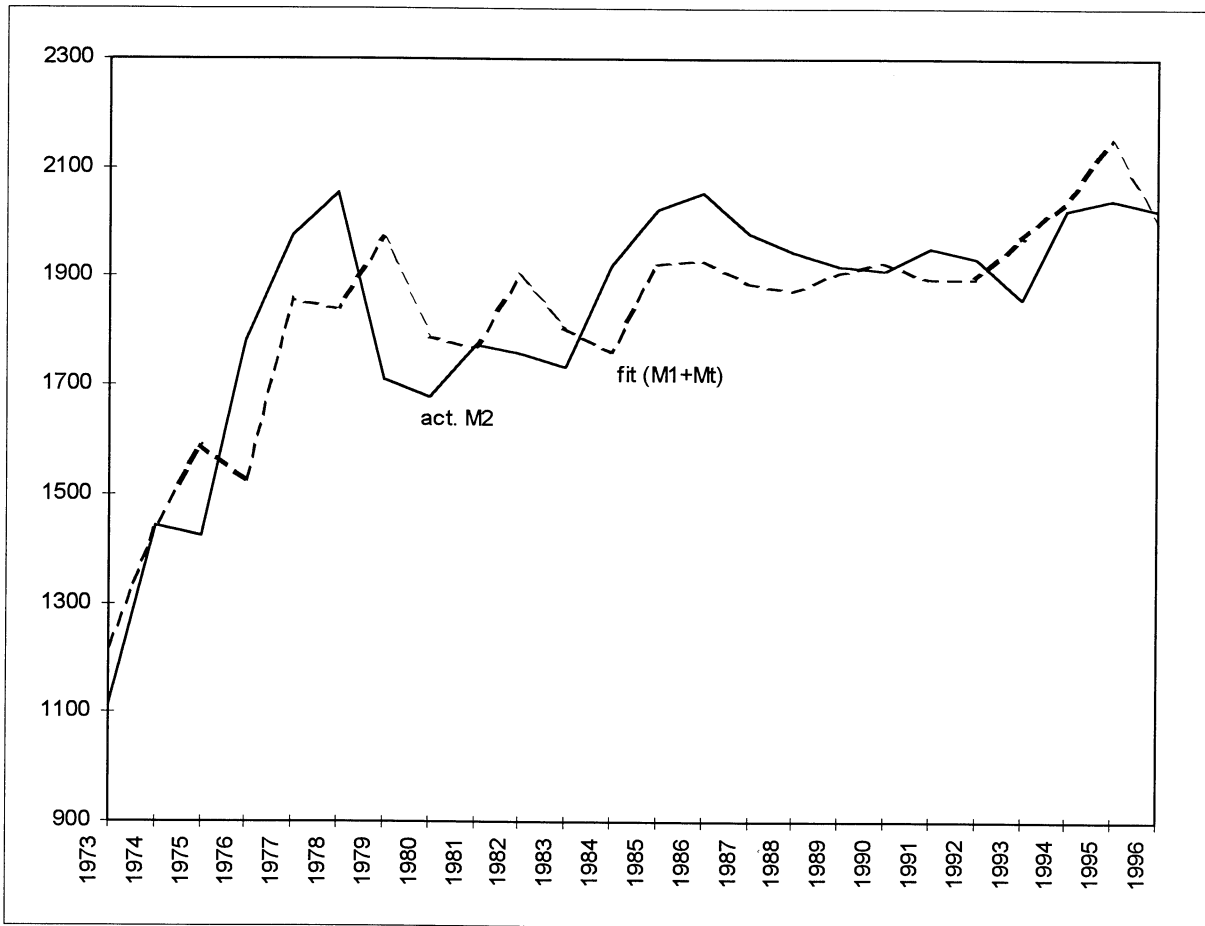


Chart 4: M2 – Actual and fitted values

Using the specification for $M1$ from Table 1, i.e.

$$\ln M1_t = 1.9394 + 0.27245 \ln y_t + 0.03650 i_{cot} - 0.05408 i_{diff} + 0.00973 infl - 0.00281 der$$

and from Table 2 for Mt

$$\ln Mt_t = 1.5318 + 0.76302 \ln Mt_{t-1} ,$$

and using projections for output and inflation from the WEO database, a decrease in the demand for real balances of about 2.5 percent in 1997 is projected — nominal balances will increase slightly but the increase will be overcompensated by the increase in the price level.¹⁹

¹⁹ Note that since the model is in logarithms the expected value of the levels is given by the moment generating function of the lognormal distribution as $E(g(y)) = \exp(\bar{y} + 1/2 \sigma_y^2)$, where $E(g(y))$ is the expected value of the level, \bar{y} is the estimate of the logarithm and σ_y^2 is

(continued...)

This is a result of decreasing inflation and high expected depreciation vis-à-vis the U.S. dollar which have a higher impact on the demand for money than the increase in real output.

6. Summary of Empirical Findings

Summarizing the main results of the empirical analysis, a stable relationship for $M1$ with a good forecast performance is found while the specification for Mt appears to be somewhat unstable, and its forecasts are dominated by a pure time series specification. For $M2$ there is no economically viable specification.

- A structural specification for $M1$ has been found with significantly positive parameters for income, the domestic interest rate, and inflation and negative parameters for the interest rate difference with France and exchange rate changes. Taking the economic environment in the WAEMU region into account, this behavior appears to be economically reasonable. Agents increase their money holdings with increasing interest rates for agricultural credit and augmented confidence in the stability of the financial sector. They decrease their holdings with increasing devaluation expectations: vis-à-vis the French franc as documented by the coefficient on the interest rate difference, as well as vis-à-vis the U.S. dollar as shown by the coefficient on exchange rate changes. The effects of inflation and the exchange rate vis-à-vis the U.S. dollar are smaller than those of the interest rates. The equation dominates a time series specification in terms of forecast performance and remained unaffected by the devaluation in 1994. This means that economic fluctuations during the devaluation period have been fully captured by the variables in the equation.
- The results for Mt point to a dominating influence of exchange rate considerations vis-à-vis the U.S. dollar in addition to real income. However, the parameters of this specification turn out to be somewhat unstable and a structural shift may have occurred with the devaluation of the CFA franc in 1994. In addition, the forecast performance of the structural specification is inferior to that of a pure time series approach. A continued stabilization of the economic environment should result in a closer relationship between the demand for fixed term and savings deposits and further macroeconomic variables in the future.
- The absence of a reasonable economic relationship between $M2$ and further variables complies with our expectations from economic theory. Opposing effects of economic variables on the subaggregates of $M2$ cancel out when the behavior of the sum of these subaggregates is analyzed.

The results with respect to the devaluation of the CFA franc in 1994 show that the basic monetary relationships remained unchanged pointing to a considerable degree of stability in the underlying behavioral patterns.

Concerning forecasts for $M2$, a combination of structural predictions for $M1$ and time series predictions for Mt provides accurate results which will be useful for the design of monetary

¹⁹(...continued)
the conditional variance.

policy. For 1997, nominal money demand is expected to remain unchanged relative to last year.

IV. Conclusions

Regional integration, financial liberalization, and the introduction of indirect monetary instruments induce increased uncertainty in the design of monetary policy in the WAEMU. Under these conditions, several empirical and structural requirements must be fulfilled if monetary policy is to succeed in maintaining the fixed exchange rate system. The present paper shows that the demand for money in the WAEMU is sufficiently stable to allow accurate projections. Consequently, the success of future monetary policy depends on the central bank's ability to ensure implementation of the additional structural conditions.

The success of monetary policy in the WAEMU hinges on the implementation of two fundamental structural conditions. First, for the indirect instruments to work in both (i.e. the contractionary and the expansionary) directions, excess liquidity in the money market needs to be eliminated. Otherwise, a tightening of the monetary policy which may be necessary to maintain the exchange rate peg, will be impossible. Second, the stability of the demand for money will only continue as long as the economic agents have confidence in the stability of the financial system. Therefore, maintaining financial sector soundness becomes an indispensable task for the central bank — in particular if the WAEMU is integrated more closely in the international capital markets.

If the BCEAO can ensure the soundness of the financial sector in the WAEMU and succeeds in absorbing the excess liquidity it can exploit the stability of the demand for money for a successful monetary policy in the future.

Appendix

Table A1: Including Inflation Uncertainty, 1973-96

		const.	lny	i_cot.	i_diff.	infl.	infl_unc.	der.	R ²
1aa	lnM1	1.9677 (2.0784)	0.55852* (0.23244)	0.03688 † (0.02100)	-0.05401** (0.01732)	0.00960† (0.00551)	0.00023 (0.00759)	-0.00279* (0.00125)	0.58

infl_unc. is inflation uncertainty as measured by the average absolute change in the inflation rate over the past two years.

Table A2: Further Specifications, 1973-96

		const.	lny	i_cot.	i_f	i_diff.	infl.	der.	R ²
1a.	lnM1	1.9394 (1.7205)	0.56203** (0.18581)	-0.01758 (0.01521)	0.05408** (0.01683)		0.00973** (0.00363)	-0.00281** (0.00111)	0.58
1b.	lnM1	1.8691 (1.7366)	0.56228** (0.18784)		0.04583** (0.01590)		0.01090** (0.00302)	-0.00281** (0.00106)	0.56
1c.	lnC	0.91520 (0.72752)	0.60911** (0.07790)	0.01834† (0.01069)		-0.04116** (0.00951)	0.00403† (0.00219)	-0.00116† (0.00066)	0.75
1d.	lnC	0.91520 (0.72752)	0.60911** (0.07790)	-0.02282* (0.01103)	0.04116** (0.00951)		0.00403† (0.00219)	-0.00116† (0.00066)	0.75
1e.	lnDd	1.5664 (2.5946)	0.51784† (0.28064)	0.05223* (0.02499)		-0.06540** (0.02527)	0.01424** (0.00561)	-0.00414** (0.00171)	0.49
1f.	lnDd	1.5664 (2.5946)	0.51784† (0.28064)	-0.01317 (0.02194)	0.06540** (0.02527)		0.01424** (0.00561)	-0.00414** (0.00171)	0.49
1g.	lnDd	1.5138 (2.5644)	0.51804† (0.27777)		0.05922** (0.02280)		0.01512** (0.00490)	-0.00413** (0.00164)	0.49
2a.	lnMt	-11.170** (1.8196)	1.9507** (0.20319)	0.04227 (0.03023)					0.81
2b.	lnMt	-9.6883** (3.1483)	1.8236** (0.34115)		-0.01868 (0.03350)				0.80
2c.	lnMt	-9.0573** (3.1348)	1.7378** (0.35566)			0.05579† (0.03220)			0.83
2d.	lnMt	-9.6337** (2.1486)	1.8119** (0.2431)				-0.00775** (0.00045)		0.82
2e.	lnMt	-9.6119** (3.4973)	1.7860** (0.38005)	0.07002** (0.02653)	-0.04817 (0.03988)				0.84
2f.	lnMt	-10.045** (3.8796)	1.8376** (0.42260)	0.05763 (0.03601)	-0.03610 (0.04484)		-0.00130 (0.00739)	-0.00130 (0.00222)	0.84
3a.	lnM2	0.90237 (1.9372)	0.73813 ** (0.20886)	-0.00045 (0.01236)	0.01900 (0.02244)				0.62
3b.	lnM2	-0.47402 (2.1794)	0.88335** (0.23609)	0.00684 (0.01493)	0.02201 (0.02379)		0.00610 (0.00412)	-0.00224† (0.00131)	0.69
3c.	lnM2	-0.47402 (2.1794)	0.88335** (0.23609)	0.02885 (0.02091)		-0.02201 (0.02379)	0.00610 (0.00412)	-0.00224† (0.00131)	0.69

i_f is the French interest rate; *C* is cash in circulation; *Dd* is demand deposits.

References

- Adam, Christopher, 1994: "On the Dynamic Specification of Money Demand in Kenya," *Journal of African Economics*, 1, 2, 233-270.
- Alexander, William E., Tomás J. T. Baliño, and Charles Enoch, 1995: "*The Adoption of Indirect Instruments in Monetary Policy*," (Washington: International Monetary Fund) Occasional Paper No. 126.
- Almekinders, Geert, 1996: "Paper on the Demand for Money in Mali, Niger, and Senegal," (Washington: International Monetary Fund) mimeo.
- Boughton, James M., 1991: "The CFA Franc Zone: Currency Union and Monetary Standard," (Washington: International Monetary Fund) Working Paper WP/91/133.
- Clément, Jean A. P., 1996: "*Aftermath of the CFA Franc Devaluation*," (Washington: International Monetary Fund) Occasional Paper No. 138.
- Dolado, Juan, Tim Jenkinson, and Simon Sosvilla-Rivero, 1990: "Cointegration and Unit Roots", *Journal of Economic Surveys*, 4, 249-273.
- Fielding, David, 1994: "Money Demand in Four African Countries," *Journal of Economic Studies*, 21, 2, 3-37.
- Fielding, David, 1997: "Money Demand in Côte d'Ivoire," mimeo, University of Nottingham.
- Fратиanni, Michele, Jürgen von Hagen, 1992: "*The European Monetary System and European Monetary Union*," (Boulder, San Francisco, Oxford: Westview Press).
- Hansen, B. E., 1992: "Testing for Parameter Instability in Linear Models," *Journal of Policy Modeling*, 14, 517-533.
- Honohan, Patrick, 1996: "Monetary Policy in the CFA Franc Zone: Incentives and Operating Performance," mimeo.
- Honohan, Patrick, Stephen A. O'Connell, 1997: "Contrasting Monetary Regimes in Africa," (Washington: International Monetary Fund Working Paper) WP/97/64.
- International Monetary Fund, 1996: "Monetary Policy Through Primary Market Issues: Government Securities or Central Bank Securities?," MAE Operational Paper, MAE OP/96/5
- Moser, Gary, Scott Roger, and Reinold van Til, 1997: "Nigeria, Experience with Structural Adjustment," (Washington: International Monetary Fund) Occasional Paper No. 148.

Pesaran, M. H., R. G. Pierse, M. S. Kumar, 1989: "Econometric Analysis of Aggregation in the Context of Linear Prediction Models," *Econometrica*, 57, 4, 861-888.

Van Riet, A. G., 1993: "Studies of EC Money Demand: Survey and Assessment," De Nederlandsche Bank, *Quarterly Bulletin*, 63-74.