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# A Cointegration Analysis of Broad Money Demand in Cameroon

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# A Cointegration Analysis of Broad Money Demand in Cameroon

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**Abstract**



This paper applies cointegration analysis and error-correction modeling to investigate the behavior of broad money demand in Cameroon over 1963/64-1993/94. The cointegrated VAR analysis first describes an open-economy model of money, prices, income, and a vector of rates of return, within which three steady state relations are identified: a stable money demand function, an excess aggregate demand relationship, and the uncovered interest rate relation under fixed exchange rates and perfect capital mobility. Empirical support is thereafter provided for both PPP and the international Fisher parity between Cameroon and France, and the stability of the short-run dynamics of the broad money demand function is confirmed.

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## I. Introduction

1. Finding a stable money demand function is generally considered essential for the formulation and conduct of efficient monetary policy. Hence, considerable effort has been made in the empirical literature—for both industrialized and developing countries—to determine the factors that affect the long-run demand for money and assess the stability of the relationship between these factors and various monetary aggregates.[2] In the case of Cameroon, a limited number of studies (Ntang, 1990 and Fielding, 1994) have attempted to identify the key macroeconomic variables determining the demand for money, with almost none—to my knowledge—focusing on the stability of the estimated coefficients. Furthermore, these studies have ignored the impact of foreign opportunity cost variables on money balances, as well as (except for Fielding's study) the problem of apparent but spurious regression that arises when statistical inferences are drawn from non-stationary time-series data.

2. This study applies system cointegration analysis and derives an error-correction model to examine the behavior of the demand for broad money in Cameroon for the period 1963/64-1993/94 (July-June).[3] The hypothesis is that there exists a stable relationship among broad money, income, and a vector of rates of return over this sample period. Information about the stability of the money demand function in Cameroon is crucial to the effectiveness of monetary policy conducted at the regional level by the Banque Centrale des Etats de l'Afrique Centrale (BEAC), as an accurate calibration of both long-run and dynamic effects of various rates of return on the demand for money would allow inferences about the macroeconomic implications of financial liberalization and the adoption of indirect monetary policy instruments by the BEAC.

3. There have been a number of studies of money demand in other sub-Saharan African countries, but most of them have either used traditional estimating methods —by applying the partial adjustment model as Goldfeld (1973 and 1976) did when analyzing U.S. money demand—or, in the very recent history, applied cointegration techniques to non-CFA sub-Saharan African countries.[4] Moreover, almost all published studies on African countries have failed to account for the effects of the own rate of return on money holdings, an omission that tends to bias the estimates of income elasticity. They have also failed to account for the alternative measures of foreign opportunity costs on money balances, an

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[2]See Goldfeld and Sichel (1990) and Laidler (1993) for an extensive theoretical and empirical review of money demand models. See Boughton (1991a) for a review of empirical models for industrialized countries. See Deadman (1995) for a review of empirical studies for developing countries. See Ericsson (1998) for a recent review of the main methodological issues.

[3]Although this study is based on the data covering the period from 1963/64 to 1993/94, the extension of the sample to more recent data does not significantly change the conclusions reported in this paper. The econometric results can be obtained from the author upon request.

[4]See Adam, Ndulu, and Sowa (1996); Adam (1992 and 1995).

omission that may bias the elasticity of inflation.[5] Each of these shortcomings is addressed in this paper.

4. The next section discusses the course of monetary policy and monetary aggregates from the early 1960s to 1994. Section III briefly explores the theoretical considerations, while Section IV details the empirical methodology. Section V discusses time-series properties and cointegration results. Section VI derives an error-correction model of broad money demand and evaluates the stability of the short-run money demand function. The last section of the paper summarizes the major findings and their policy implications.

## II. Monetary Regime and the Behavior of Monetary Aggregates

5. Cameroon's monetary regime is affected by two factors: (1) its membership in the African Financial Community (CFA) franc zone and (2) the constraints imposed by the pegging of the CFA franc to the French franc. The CFA franc zone comprises 14 countries belonging to two separate monetary unions: the West African Economic and Monetary Union (WAEMU) and the Central African Monetary and Economic Community (CAEMC).[6] Both the WAEMU and the CAEMC have their own supranational central bank (the Banque Centrale des Etats de l'Afrique de l'Ouest— BCEAO— and the Banque Centrale des Etats d'Afrique Centrale— BEAC) and issue their own CFA franc.[7] Beginning with the establishment of the CFA franc zone at the end of 1945 and for a period of 50 years, the currency for each of the two unions was pegged to the French franc at a parity of 50 CFAF per French franc; on January 12 1994, the member states authorized a realignment to 100 CFAF per French franc (i.e., a devaluation of 50 percent in foreign currency terms). Each of the two currency unions contains two relatively large countries with more developed economies: Senegal and Côte d'Ivoire in the WAEMU; and Cameroon and Gabon in the CAEMC.[8]

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[5]A few recent studies of African economies have found changes in foreign opportunity costs to be significant in explaining domestic money demand (see Adam (1992 and 1995), Darrat (1985), Domowitz and Elbadawi (1987), and Simmons (1992)).

[6]See, for instance, Nsouli (1994), Boughton (1991b), and Sacerdoti (1991) for a discussion of the institutional arrangements, monetary operations, and the origins of the CFA franc zone.

[7]The franc de la Communauté Financière Africaine and the franc de la Communauté Financière en Afrique Centrale, respectively. The WAEMU is composed of Benin, Burkina Faso, Côte d'Ivoire, Mali, Niger, Senegal, and Togo. The CAEMC comprises Cameroon, the Central African Republic, Chad, the Republic of Congo, Equatorial Guinea, and Gabon. See Hernández-Catá, François, and others (1998) for a recent review of the WAEMU.

[8]With 42 percent of WAEMU GDP and 45 percent of CAEMC GDP over the period 1980-94, Côte d'Ivoire and Cameroon are, respectively, the largest economies of their respective currency unions.

6. The CFA franc is fully convertible into the French franc and, with a few exchange restrictions, into other currencies. The French government guarantees the CFA franc external convertibility through a formal agreement with member countries, and, in return, international reserves of the member countries are pooled together in an "operations account" at the French Treasury. The exchange rate peg to the French franc is thus the main nominal anchor for macroeconomic and financial policies.[9] The inability to use the exchange rate as a policy instrument and the constraint imposed on monetary policy by the need to maintain the foreign assets position at a sustainable level have two major policy implications: (1) fiscal as well as credit policies remain the main adjustment tools, and (2) these tools have been used extensively with a view to promoting economic growth and development.

7. As a member of a currency zone, Cameroon's monetary policy is implemented at the regional level by the BEAC. The BEAC's monetary policy objectives are (1) to maintain the exchange rate peg to the French franc and (2) to achieve a regional target level of net foreign assets position consistent with the peg. Throughout its history, the main monetary policy instruments consisted of direct credit ceilings, interest rate controls, and limits on central bank refinancing. From the 1960s through the early 1980s, the BEAC conducted monetary policy with a view to speeding up economic development through credits to specific "priority" sectors and the maintenance of interest rates at a low level. Little regard was then accorded to the promotion of domestic savings in individual member states and the preservation of the CAEMC's net foreign assets position.[10] Over the period 1963-85, the BEAC adjusted its intervention rate (discount rate) only five times, and the interest rate differential between the CAEMC and France remained largely negative; see Table 1 and Figure 2. This period was characterized in Cameroon by a sustained economic development—with GDP growth averaging more than 6 percent annually— and a process of financial deepening—with the ratio of broad money to GDP (M2/GDP) increasing from 15 percent in 1963/64 to over 20 percent in 1984/85. Figure 2 illustrates this remarkable increase in financial intermediation as the share of currency in broad money declined from 50 percent to less than 20 percent over this period.

8. Following the deterioration in the economic and financial situation in the CFA franc zone after 1986 and with the necessity of maintaining a positive net foreign assets position,

[9]Each regional central bank —the BCEAO and the BEAC— maintains at least 65 percent of its international reserves in French francs in the operations account.

[10]The prevailing—Keynesian— view at the time was that domestic savings follow economic growth through higher income. In addition, almost all CFA franc governments were able to finance their fiscal deficits by borrowing heavily from the international private capital markets, as well as multilateral institutions. The Bretton Woods agreement and the ensuing low level of interest rates and relative exchange rate stability in major industrial countries (including France) remained the decisive factor in maintaining the low level of interest rates in the CAEMC zone, especially during the 1960s and early 1970s (see Figure 2).

the BEAC adopted a more active interest rate policy, such that the interest rate differential with France became positive or null—at the minimum— thereafter. During the period 1989-93 the BEAC shifted from direct to indirect instruments of monetary policy; interest rates were liberalized and credit controls lifted. Currently, the BEAC relies primarily on open market operations; reserve requirements are also available but have not been activated. With a pegged currency and free capital mobility with France, interest rates in the CAEMC are tied more than ever to those in the French money market.[11] The period 1986-94 was characterized in Cameroon by a severe economic and financial crisis, with real GDP growth averaging minus 4 percent annually and the ratio of broad money over GDP declining from 24 percent in 1991/92 to less than 17 percent in 1993/94. Thus, broad money velocity, which had been on a downward trend since the 1960s —and with the exception of the late 1970s and early 1980s, when it somewhat temporarily stabilized —experienced a structural break in 1992 (see Figure 2). Owing to significant banking sector problems and devaluation expectations, the steady decline observed since the early 1960s in the share of currency in broad money came to a halt with the ratio stabilizing around 21 percent over 1986-94.

## III. Some Theoretical Considerations

9. The theoretical underpinnings of the demand for money function have been well established in the economic literature, with widespread agreement that the demand for money is primarily demand for real cash balances. In the absence of money illusion, an increase in the general level of prices will induce a proportionate increase in the nominal demand for money, leaving the level of real balances unchanged. Keynes postulated three motives for holding real money balances: transactions, precautionary, and speculative. Following the liquidity preference theory, several authors have questioned Keynes's rationale for a speculative demand for money and have contributed to the theoretical literature by distinguishing broadly between the transactions demand (Baumol, 1952; and Tobin, 1956) and the asset motive (Tobin, 1958; and Friedman, 1956). Hence, empirical studies of money demand should converge to a specification where real money balances are a function of a scale variable (as measured by income, wealth, or expenditure), the own rate of return on money, and the opportunity cost of holding money, notably the domestic interest rate and/or the expected rate of inflation. The domestic interest rate and expected rate of inflation are proxies for the rates of return on alternative financial and physical assets, respectively.

10. The inclusion of the expected rate of inflation has been emphasized in the case of developing countries where, given the existence of underdeveloped monetary and financial systems and non-market-determined interest rates, physical assets represent one of the major hedges against inflation and an alternative asset in the portfolio of the non-bank public.[12]

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[11]See Mehran and others (1998).

[12]The conventional idea is that in developing countries, where interest rates ceilings and capital controls prevail, asset substitution is likely to be between money and physical assets rather than between money and financial assets.

Moreover, with increasing financial globalization and the empirical evidence on portfolio balance models in open economies, the expected rate of return on foreign securities has been often added as an explanatory variable. This is done either by adjusting the foreign interest rate by exchange rate movements or by introducing a measure of expected exchange rate depreciation separately in the money demand function.[13] Alternatively, assuming perfect asset substitutability, the differential between the domestic and foreign interest rates is included.

## IV. EMPIRICAL METHODOLOGY

11. The basic model underpinning the preceding discussion can be summarized as follows:[14]

$$(M^d / P) = f\,(Y, \mathbf{R}), \qquad (1)$$

where

$M^d$ = demand for nominal money balances;
$P$ = the price level;
$Y$ = scale variable (income, wealth, or expenditure, in real terms); and
$\mathbf{R}$ = vector of expected rates of return (within and outside broad money).

This specification represents the "desired" or long-run real money demand function and assumes a long-run unitary elasticity of the nominal cash balances with respect to the price level. This assumption of price homogeneity can be tested empirically. The function f is assumed increasing in $Y$, decreasing in those elements of $\mathbf{R}$ representing rates of return on alternative assets, and increasing in rates of return associated with assets included in $M$.[15]

12. For the purpose of our study, the assets considered are CFA franc broad money, as measured by M2, domestic goods, holdings of U.S. dollar cash, and French bonds. The corresponding expected rates of return for the four assets are proxied by the deposit rate (*DEPO*), the rate of inflation ($\Delta p$) as measured by the consumer price index, the depreciation

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[13]See Arango and Nadiri (1981) for an early treatment of the issues. In a recent study, Agénor and Khan (1996) find, for a group of ten developing countries, that the foreign interest rate and the expected depreciation of the parallel exchange rate are important factors in determining the choice between holding domestic currency and holding foreign currency deposits abroad.

[14]See Ericsson (1998).

[15]$M$ stands for the nominal money supply. It is assumed that in the long run, the money market is in equilibrium: the money supply ($M$) deflated by the price level ($P$) is equal to the real demand for money ($M^d / P$).

rate of the CFA franc per U.S. dollar exchange rate ($\Delta e$), and the French money market rate (*FMMR*), respectively. The scale variable $Y$ is proxied by GDP at market price in constant 1980 prices. Further details on data choice, construction, and sources are provided in Appendix I.

13. Following the traditional approach, equation (1) is specified in a log-linear form, with the exception of interest rates *DEPO* and *FMMR*:

$$(m^d - p)_t = a_0 + a_1 y_t + a_2 \Delta p_t + a_3 \Delta e_t + a_4 FMMR_t + a_5 DEPO_t + \varepsilon_t \quad (2)$$

where variables in lower case denote natural logarithms and $\varepsilon_t$ is the error term. The anticipated signs for the $a_i$'s are: $a_1 > 0$ (more specifically, $a_1$=1 for the quantity theory or $a_1$ = 0.5 for the Baumol-Tobin model of economies of scale), $a_2 < 0$, $a_3 < 0$, $a_4 < 0$, and $a_5 > 0$.

14. Equation (2) assumes, however, an instantaneous adjustment of the actual stock of real money balances to its desired level, that is, an equilibrium state between real money supply and the real demand for money. This is unlikely, given the existence of transaction costs and uncertainty. In addition, the desired level of real money balances is unobservable. A distinction is therefore generally made between the long- and short-run behavior in the money market by specifying an error-correction mechanism of actual real cash balances toward their desired (long-run) level. Furthermore, the time-series properties of the data have to be investigated to avoid the spurious regression problem that arises when statistical inferences are drawn from non-stationary time-series. Unit root tests and cointegration techniques have been developed to deal with the spurious regression problem. The current study applies the Johansen (1988) and Johansen and Juselius (1990) multivariate maximum likelihood procedure to determine empirically the number of cointegrating vectors and the adjustment parameters.

## V. Time-Series Properties and Cointegration Results

15. Annual data for the period 1963/64-93/94 are used. All the variables are expressed in logarithmic terms with the exception of the interest rates. Figures 1 to 3 plot the individual time-series. The empirical investigation commences with an analysis of the time-series properties of the variables of interest for the money demand function (see Table 2). The augmented Dickey-Fuller (ADF) test is used to determine the order of integration of data compiled for each variable. The results indicate that the variables in levels have unit roots. While expressed in first differences, all the variables except real GDP turn out to be stationary using the ADF test. It is well known that the ADF test has a very low power in the presence of a structural break, as under such circumstances it is biased toward the non-rejection of a unit root (i.e., of non-stationarity). It can therefore be hypothesized that the failure to reject the null hypothesis of non-stationarity for the real GDP growth series stems from the structural change occurring in that series around 1986/87 with the beginning of the

economic and financial crisis (see Figure 3).[16] Real income is therefore treated as an I(1) variable; this hypothesis is confirmed below through cointegration analysis.

16. After determining the order (1) of integration of the variables of interest, the Johansen procedure is applied to a first-order vector autoregression (VAR) version of equation (2) to test for cointegration among real broad money, real GDP, inflation, the depreciation rate of the exchange rate, the deposit rate, and the French money market rate.[17] A trend and three dummies (*DUM*8694, *DUMBW*, and *DUM*94) are also included.[18] *DUMBW* and *DUM*8694 are two dummies introduced to capture the Bretton Woods era—a period characterized by a fixed exchange rate regime among major industrialized countries—and the structural change occurring in Cameroon's economy during the crisis period, respectively. *DUM*94 is a dummy introduced to capture the effect of the January 1994 devaluation. The maximal and trace eigenvalue statistics ($\lambda_{max}$ and $\lambda_{trace}$) strongly reject the null hypothesis of both no and at most one cointegrating vector in favor of at least two cointegrating vectors at the 1 percent level. Some evidence exists—at the 10 percent level—for at most three cointegrating vectors (see Table 3). The first of the three possible cointegrating vectors can be interpreted as defining the long-run demand for broad money function in Cameroon:

$$m - p = a_0 + 1.1\,y - 1.5\,\Delta p - 0.8\,\Delta e - 1.2\,FMMR + 7.7\,DEPO \qquad (3a)$$

where $a_0$ is an estimated constant and a random error term is omitted for brevity. A look at the adjustment coefficients in Table 3 confirms that the first cointegrating vector goes into the money equation with a feedback parameter of -0.37, that is, real money balances are error correcting. As will be shown, after imposing identifying restrictions, the second cointegrating vector represents an excess aggregate demand relationship, while the third resembles a central bank interest-rate policy rule under a fixed exchange rate system and perfect capital mobility.

17. Various mis-specification tests of the unrestricted VAR(1) are reported in Table 6. These include single-equation mis-specification tests (AR, normality, ARCH, and $X_i^2$) and vector tests (AR and normality).[19] Neither the single-equation nor the vector mis-

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[16]Real GDP growth indeed became negative in 1986/87.

[17]Owing to the short length of the available time-series, I began with a general two-order VAR and found on the basis of the Schwarz-Bayesian criterion, as well as from tests for mis-specification, that one lag was appropriate. This makes sense intuitively, given that the study deals with annual data and a relatively short sample is available for VAR analysis.

[18]All estimation is carried out using PcGive and PcFiml within PcGive version 9.0. See Doornik and Hendry (1997), and Hendry and Doornik (1997).

[19]AR denotes the results of LM (Lagrange multiplier) tests for the second-order autocorrelated residuals of each single-equation [F(2,18)], and of the system [F(72, 22)].

(continued...)

specification tests reveal a serious problem, except the rejection of normality at the 5 percent and 1 percent critical values for the income equation and the system, respectively. As demonstrated by Gonzalo (1994), however, the Johansen procedure is robust under non-normal errors; see, for instance, Hubrich (1999) for a similar argument. The validity of the system can therefore be taken with confidence.

18. This subsection continues with likelihood ratio tests that are based first on the assumption of one cointegrating vector for the analysis of the money demand function.[20] Later on, the full system is identified by assuming three cointegrating vectors and imposing specific restrictions on the beta coefficients. All the coefficients in the money demand equation (3a) have the expected sign. The demand for broad money in Cameroon is positively elastic with respect to income and the deposit rate and negatively related to the rate of inflation, the currency's depreciation rate, and the French money market rate. The income elasticity of broad money demand is positive and close to unity (1.1), which is consonant with the quantity theory hypothesis. A test imposing a unitary income elasticity was not rejected: $\chi^2(1)$=1.4[0.24].[21] The finding of a unitary income elasticity suggests that over the sample period changes in real income have been inducing on average a proportionate increase in the demand for real broad money. This does not necessarily imply that broad money velocity is stationary, as our specification is also a function of rates of return. In fact, it is shown in Figure 2 that velocity has been non-constant owing to financial deepening.

19. The order of magnitude of the semi-elasticity with respect to inflation (1.5) is lower than in other studies on sub-Saharan African economies.[22] The inflation coefficient is significantly different from zero: $\chi^2(1)$=6.3[0.01]; see Table 3. The long-run inflation elasticity is equal to 0.10. This is computed by taking the product of the coefficient on inflation (1.5) and the sample mean of the inflation rate (0.067) (see Table 4). High inflation elasticities are generally expected in developing countries as the range of financial instruments outside money is very limited in these countries and real assets represent a substantial part of the public's portfolio. The explanation for this low elasticity has to be

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Normality denotes the results of the Doornik-Hansen test for each variable [$\chi^2(2)$] and for the system as a whole [$\chi^2(12)$]. For the system, the vector error autocorrelation test and the vector normality test are described in Doornik and Hendry (1997). ARCH and $X_i^2$ are single-equation tests for the first-order autoregressive conditional heteroskedasticity and White heteroskedasticity, respectively.

[20]This is motivated by the lack of sufficient degrees of freedom given our relatively short sample.

[21]Throughout this paper, asymptotic *p*-values are presented in square brackets following the observed chi-square statistics.

[22]For example, Adam (1992 and 1995) obtains higher values for Kenya and Zambia.

found in the membership of Cameroon in the CFA franc zone, where the peg to the French franc provides an anchor for price stability.[23] The correlation coefficient between Cameroon's inflation rate and the French inflation rate over the sample period is 0.69 (see Table 5 and Figure 3). A formal Johansen test is reported below, confirming that the two rates of inflation are indeed cointegrated.

20. The demand for broad money is also negatively and significantly affected by the currency's depreciation rate, with the estimated coefficient significantly different from zero: $\chi^2(1)$=5.10[0.02]. Based on the elasticities of the inflation and depreciation rates (0.10 and 0.015, respectively), one may conclude that, in the long term, there is a higher degree of substitution between money and physical assets than between money and holdings of U.S. dollar cash. The semi-elasticity of the own rate of return is positive and opposite in sign to the French money market rate. Further, it is approximately seven times the semi-elasticity of the French money market rate. These are, however, semi-elasticities. The implied long-term elasticities for *DEPO* and *FMMR* are 0.4 (0.052*7.7) and 0.1 (0.085*1.2), respectively. A test imposing an equal semi-elasticity (in absolute value) is statistically rejected. The effect of each interest rate is found to be statistically not different from zero: $\chi^2(1)$=2.6[0.1054] and $\chi^2(1)$=1.27[0.26] for *DEPO* and *FMMR*, respectively. This result is surprising, as the estimated semi-elasticity of the inclusion of the own rate is quite high. One explanation for this result is the collinearity between these two interest rates: the correlation coefficient between the two interest rates is 0.65 (see Table 5). Furthermore, the correlation coefficient between the own rate and income is even higher (0.96). Hence, when the income elasticity is constrained to unity, the coefficient of the own rate is statistically different from zero: $\chi^2(1)$=16.7[0.0002] (see Table 7). This result implies that the own rate of return is crucial for the broad money velocity to cointegrate with the other rates of return (*FMMR*, $\Delta p$, and $\Delta e$). In addition, the analysis explains the bias for a long-run income elasticity greater than one that is often found in money demand studies for developing countries that omit the inclusion of the own rate.[24]

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[23]A few studies have shown that inflation in the CFA zone is mostly imported from France. See, for example, Honohan (1992) and Nuven (1994). In a study comprising 32 sub-Saharan African countries and covering the period 1980-91, Odedokun (1997) uses a framework predicting that monetary growth, inflationary expectations, rates of depreciation of domestic currency in both the official and black markets, and foreign inflation should have a positive impact on domestic inflation. He finds that in contrast to non-CFA franc countries only foreign inflation (mostly imported from France) has a significant and strong positive effect on inflation in the CFA countries.

[24]Indeed, omitting the own rate or restricting its coefficient to zero will tend to bias upward the income elasticity. A better test of significance of rates of return would be conducted under the assumption—if empirically confirmed—of unitary income elasticity.

21. The Johansen approach provides an alternative means or, more precisely, a systems approach of testing for the existence of unit roots in each variable when the null hypothesis is that of stationarity, rather than non-stationarity. The statistics in Table 3 confirm that all the variables considered here are non-stationary. Owing to the short sample and insufficient degrees of freedom—after identification of the full system—weak exogeneity tests on the individual variables are also conducted under the assumption of one cointegrating vector and are presented in Table 3. They reveal that broad money, the currency's depreciation rate, and the French money market rate are not weakly exogenous; however, weak exogeneity cannot be rejected for income, the own rate, and the inflation rate. In any case, Cameroon's economy is too small to have any impact on the French money market rate or the depreciation rate of the CFA franc per U.S. dollar exchange rate.[25]

22. The full system is identified by assuming three cointegrating vectors and imposing specific restrictions on the beta coefficients. The second and third cointegrating vectors correspond to the excess aggregate demand/inflation relationship and the BEAC/Banque de France policy reaction function, respectively (see Table 8). The second cointegrating vector can be written as

$$y = c_0 + 8.5\,\Delta p + 0.07\,trend, \qquad (4)$$

where $c_0$ is an estimated constant and a random error term is omitted for brevity. Equation (4) implies that trend-adjusted real income is cointegrated with the inflation rate. See Juselius (1996, 1998a, and 1998b) for similar results in the case of Germany, Italy, and Denmark. Hence, trend-adjusted real income is an I(1) variable, confirming the previous conjecture. Equation (4) expresses the long-run inflationary impact of **excess aggregate demand.** Normalizing equation (4) on the inflation rate gives: $\Delta p = 0.12\ (y\text{-}y^*)$, where the expression $y^* = 0.07\ trend$ is the potential output. Thus, a one percent deviation of actual output from potential output induces, on average, a 0.12 percent increase in the rate of inflation. This low coefficient suggests that inflation in Cameroon has mostly foreign as opposed to domestic causes. This conjecture will be confirmed by showing that inflation in Cameroon is mostly imported from France.

23. The third cointegrating vector is the confirmation of the textbook relation of the **uncovered interest rate parity** under a fixed exchange rate and perfect capital mobility:

$$DEPO - FMMR = d_0 + \eta_t, \qquad (5)$$

[25]Cameroon is part of the CFA franc zone, which had basically fixed its common currency to the French franc for most of the period of the analysis until the January 1994 devaluation. The French franc is therefore the anchor of the zone, with monetary developments in France having an impact on the exchange rate of the French franc—and, hence, the CFA franc—vis-à-vis the U.S. dollar.

where $d_0$ and $\eta_t$ are the estimated constant and random error term, respectively. The finding that the interest rate differential between Cameroon and France is stationary provides empirical evidence for the inability of the BEAC to conduct a monetary policy independent of France in the long term. More specifically, this result provides empirical evidence that: (1) the CFA franc has been more or less credibly fixed to the French franc over the sample period, and (2) capital does flow freely between France and the BEAC zone. Lastly, it is interesting to note the increase in the semi-elasticity of the own rate of return in the broad money demand function after identification of the full system:

$$m - p = b_0 + y - 1.3\,\Delta p - 0.9\,\Delta e - 1.2\,FMMR + 10.4\,DEPO. \tag{3b}$$

This increase may be explained by the ability of the Johansen cointegration technique to derive more accurate estimates after identification of the full system.[26] More specifically, the collinearity between *DEPO* and *FMMR* is accounted for in the full system through the third cointegrating vector, thereby improving the accuracy of the parameters in the first cointegrating vector.[27] Figure 4 displays the three identified cointegrating relations.

24. Before closing the analysis of the long-run structure of the model, I employ a formal Johansen test to confirm that the rates of inflation in Cameroon and France are indeed cointegrated (see Table 9):

$$\Delta p = e_0 + 1.5\,\Delta p^* + \gamma_1, \tag{6a}$$

where $\Delta p^*$, $e_0$ and $\gamma_1$ are the French rate of inflation, the estimated constant and the stationary random error term, respectively. The analysis confirms the existence of one cointegrating vector, with inflation in Cameroon being error correcting to any disequilibrium with respect to the French rate of inflation (see the adjustment coefficient of -0.69). Moreover, $\Delta p^*$ is found to be weakly exogenous while a similar test is strongly rejected for $\Delta p$ thus reinforcing previous studies' claims that inflation causality runs from France toward Cameroon. However, a likelihood ratio test imposing the French rate of inflation coefficient to be equal to unity—the proportionality condition—is rejected: $\chi^2(1) = 5.04[0.0248]$. This result may suggest that weak-form relative **purchasing power parity** (PPP) holds between the two countries.[28] Various mis-specification tests of the two-order unrestricted structural VAR in Table 10 do not reveal any problems.

[26] The new semi-elasticity of the own rate of return (10.4) implies a long-run elasticity of 0.5 (instead of the 0.4 estimated previously).

[27] See Podivinsky (1998).

[28] Strong-form relative PPP requires that $\gamma_1$ is stationary and the proportionality condition holds.

25. Following Juselius (1995) a test for strong-form relative PPP taking into account the interaction between the goods and the financial markets is conducted. A two-order structural VAR comprising four variables (*FMMR*, *DEPO*, $\Delta p$, and $\Delta p^*$) is estimated using the Johansen procedure. The cointegration test reveals the existence of at most two cointegrating vectors and, after specific identifying restrictions, confirms that both the uncovered interest parity and the strong-form PPP hold (see Table 11). Equation (6a) could therefore be rewritten in terms of the inflation differential between Cameroon and France as predicted by strict relative PPP:

$$\Delta p - \Delta p^* = \gamma_2 , \qquad (6b)$$

where $\gamma_2$ is a stationary error term and the estimated constant term is omitted for brevity. The combination of equations (5) and (6b) implies that the **international Fisher parity** holds over the long-run horizon between Cameroon and France:

$$(DEPO - FMMR) - (\Delta p - \Delta p^*) = \psi_t , \qquad (7)$$

or, equivalently, that the uncovered real interest rate parity holds.[29] Nevertheless, this result does not imply that the Fisher relation holds at the national level in both countries; that is, that both national real interest rates are stationary. A Johansen cointegration test rejects the assumption of stationarity for each of the two real interest rates: $\chi^2(3) = 9.564[0.0227]$. The finding that the real interest rate is not stationary in Cameroon suggests the existence of nominal rigidities in the regional financial market despite the strong evidence of financial integration with France.[30]

## VI. Short-Run Error-Correction Model

26. The starting point is to model changes in real broad money balances as a response to departures from one, two, or all three stationary linear combinations of the I(1) variables, augmented by short-term dynamics from the current and lagged first differences of the variables included in the cointegrating vector. The error-correction model of the broad money demand function in Cameroon is derived from the following general equation:[31]

$$\Delta(m-p)_t = b_0 + \Sigma(b_{1i}\,\Delta y_{t-i} + b_{2i}\,\Delta^2 p_{t-i} + b_{3i}\,\Delta^2 e_{t-i} + b_{4i}\,\Delta DEPO_{t-i} + b_{5i}\,\Delta FMMR_{t-i})$$

$$+ \Sigma\, b_{6j}\,\Delta(m - p)_{t-j} + b_7\, ECM_{t-1} + b_8\,(DEPO - FMMR)_{t-1} + u_t , \qquad (8)$$

[29]As a linear combination of two stationary variables, $\psi_t$ is unambiguously stationary.

[30]The rejection of the Fisher principle may be due to the use of actual (instead of expected) rates of inflation.

[31]Lower-case letters denote natural logarithms; *i* and *j* denote lags ($i$=0, . . . 4; $j$=1, . . . 4).

where a change in real money balances in the current period is a function of the current and/or lagged changes in real income, expected rate of inflation, expected domestic interest rates, expected foreign interest rate, and lagged changes in real money balances, augmented by lagged changes to departures from the first ($ECM_{t-1}$ ) and third (( $DEPO - FMMR)_{t-1}$) cointegrating vectors. Use of the general-to-specific methodology and elimination of insignificant lags give a parsimonious model, with most of the variables found to be significant and of the expected sign for the short-term dynamics of money demand (see Specification 1 in Table 12):[32]

$$\Delta(m\text{-}p)_t = \underset{(-2.9)}{-1.4} + \underset{(2.0)}{0.7}\,\Delta y_{t-1} - \underset{(-1.7)}{0.6}\,\Delta^2 p_{t-1} - \underset{(-1.4)}{0.5}\Delta^2 p_{t-2} - \underset{(-3.9)}{0.5}\,\Delta^2 e_t + \underset{(1.3)}{0.9}\,\Delta DEPO_{t-2}$$

$$- \underset{(-2.0)}{1.3}\,\Delta FMMR_{t-1} - \underset{(-2.1)}{0.3}\,\Delta(m-p)_{t-2} - \underset{(-3.2)}{0.6}\,ECM_{t-1} - \underset{(-2.3)}{2.4}\,(DEPO\text{-}FMMR)_{t-1} \qquad (9)$$

$T = 30$ [1964/65-1993/94]
$R^2 = 0.90$
$F(12,17) = 12.1$
S.E. = 0.04
DW = 2.11
AR 1-2: $F(2,15) = 0.068$,
ARCH(1): $F(1,15) = 0.36[0.556]$
ARCH(2): $F(2,15) = 0.068[0.9345]$
Normality: $\chi^2(2) = 2.7979$ [0.2469]
RESET(1) : $F(1, 16) = 1.80[0.1979]$ ,

where $T$ is the number of observations; $R^2$ is the squared multiple correlation coefficient; and S.E. is the standard deviation of the residuals. The definitions of the remaining statistics are provided below.

27. This empirical model performs well both in terms of economic theory and on purely statistical grounds. The change in real broad money demand is positively related to both real income growth and changes in the deposit rate with one lag and two lags, respectively. Both the short-run income elasticity and the interest rate sensitivity of financial savings are weaker than those found in the long-run model.[33] Real money balances are negatively affected by the acceleration of both currency depreciation and inflationary expectations, albeit with some lags in the latter case. Also, the short-term semi-elasticity of currency depreciation is weaker than its long-run value. In contrast to the long-run analysis, *FMMR* affects significantly the demand for real broad money. In addition, the error-correction term from the long-run broad

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[32] $t$ values are in parentheses.

[33] Ericsson (1998) argues that finding short-run elasticities that are weaker than their unit long-run elasticities is consistent with Ss-type inventory models.

money demand function is significant and negatively affects the short-run dynamics. Clearly, there is a tendency for real broad money balances to restore equilibrium in the money market. Stability of the demand for money is also reinforced by the inclusion of the lagged interest rate differential, whose estimated coefficient is negative and significant. The economic interpretation would be that the interest rate differential offers a proxy of devaluation expectations of the CFA franc vis-à-vis the French franc, and, hence, an increase in devaluation expectations in the previous year does reduce money demand in the current year. This interpretation may suggest that agents form their expectations adaptively in Cameroon. The adaptive expectations' hypothesis is reinforced by the observation that only lagged changes in rates of inflation (up to two years) have any impact on current money demand.

28. The model also performs well on statistical grounds, as suggested by the diagnostic tests. The diagnostic statistics test against several alternative hypotheses—residual autocorrelation (DW—Durbin Watson— and AR), skewness and excess kurtosis (normality), autoregressive conditional heteroskedasticity (ARCH), and heteroskedasticity (RESET). None of the diagnostic statistics of our error-correction model reveal a problem. Model stability and parameter constancy of the retained Specification 1 are also good over the sample period. As Figure 5 shows, recursive estimates for all the variables are stable and increasing in efficiency over the sample period. In particular, the error-correction term in the broad money demand function exhibits strong stability. The recursive residuals of Specification 1 and the three Chow tests indicate a similar degree of stability (see Figure 6). Thus the steady recursive estimation performance of the model lends support to the initial implicit assumption that, over the sample period, the current dated variables of the model (including *FMMR* and $\Delta e$) are weakly exogenous for the parameters of the demand for real broad money. In addition, the relative constancy of the estimated parameters suggests that our model is immune to the Lucas critique.

## VII. Conclusions

29. The analysis reported in this paper provides new insight into the determination of money, prices, income, and interest rates in Cameroon, a small open economy operating under a fixed exchange rate and a high degree of international capital mobility (with France). First, the estimated system supports three cointegrating vectors: a long-run broad money demand function, an excess aggregate demand/inflation relationship, and the BEAC/Banque de France monetary policy reaction function. The estimated long-run broad money demand function has both unitary income elasticity and a strong own-rate-of-return effect, and is relatively sensitive to opportunity costs. The empirical analysis also supports both relative purchasing power parity and the international Fisher parity between Cameroon and France. Second, the parsimonious dynamic model for broad money demand has good statistical properties. Although the estimated short-run elasticities (and semi-elasticities) are generally weaker than the elasticities estimated for the long-run system, foreign opportunity costs turn out to be much stronger explanatory variables than the own rate of return. In addition, the dynamic model has highly stable parameters. Thus, the finding of a sufficiently stable money demand function in Cameroon provides a useful guide for the conduct of monetary policy by the BEAC. With both inflation and interest rates imported from France, the

targeted level of regional international reserves can be achieved by appropriately controlling BEAC's domestic credit.

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## DEFINITIONS AND SOURCES OF VARIABLES[34]

Unless otherwise indicated, the data series are mainly from the IMF *International Financial Statistics* (*IFS*) and World Economic Outlook (WEO) database, and Ghura (1997). *IFS* quarterly data have been converted to fiscal year (July-June) figures. With the exception of interest rates and dummies, all the series are in natural logarithms.

***p*** : consumer price index (line 64 in *IFS*; 1979/80=100). Following Ghura (1997) the series is spliced using the French CPI for the period before 1968. Hence, $\Delta p$ is the rate of inflation.

***m*** : broad money, in nominal terms (period average; sum of *IFS* lines 34 and 35). Hence, ***m-p*** is a measure of real broad money balances.

***cu*** : currency outside deposit money banks (*IFS* line 14a ). Hence, ***cu-p*** is real currency.
***p**** : French consumer price index (*IFS* line 64). Hence, $\Delta p^*$ measures the French rate of inflation.

***y*** : real GDP, 1979/80 prices. Source: Ghura (1997).

***e*** : CFA franc per U.S. dollar exchange rate (period average; *IFS* line rf). Hence, $\Delta e$ is the depreciation rate.

***DISR*** : discount rate (*IFS* line 60). This is the basic rediscount rate offered by the BEAC.

***DEPO***: deposit rate (*IFS* line 60l). This series is available from the *IFS* database only from 1980 onward and corresponds to the rate offered by commercial banks on passbook savings. Beginning October 1990, it is the minimum rate offered by deposit money banks on savings accounts. For the period before 1980, the series was spliced using the BEAC discount rate.

***FMMR*** : French overnight money market rate (*IFS* line 60b).

***DUM*8694**: crisis dummy taking value of one from 1985/86 through 1993/94 and zero elsewhere.

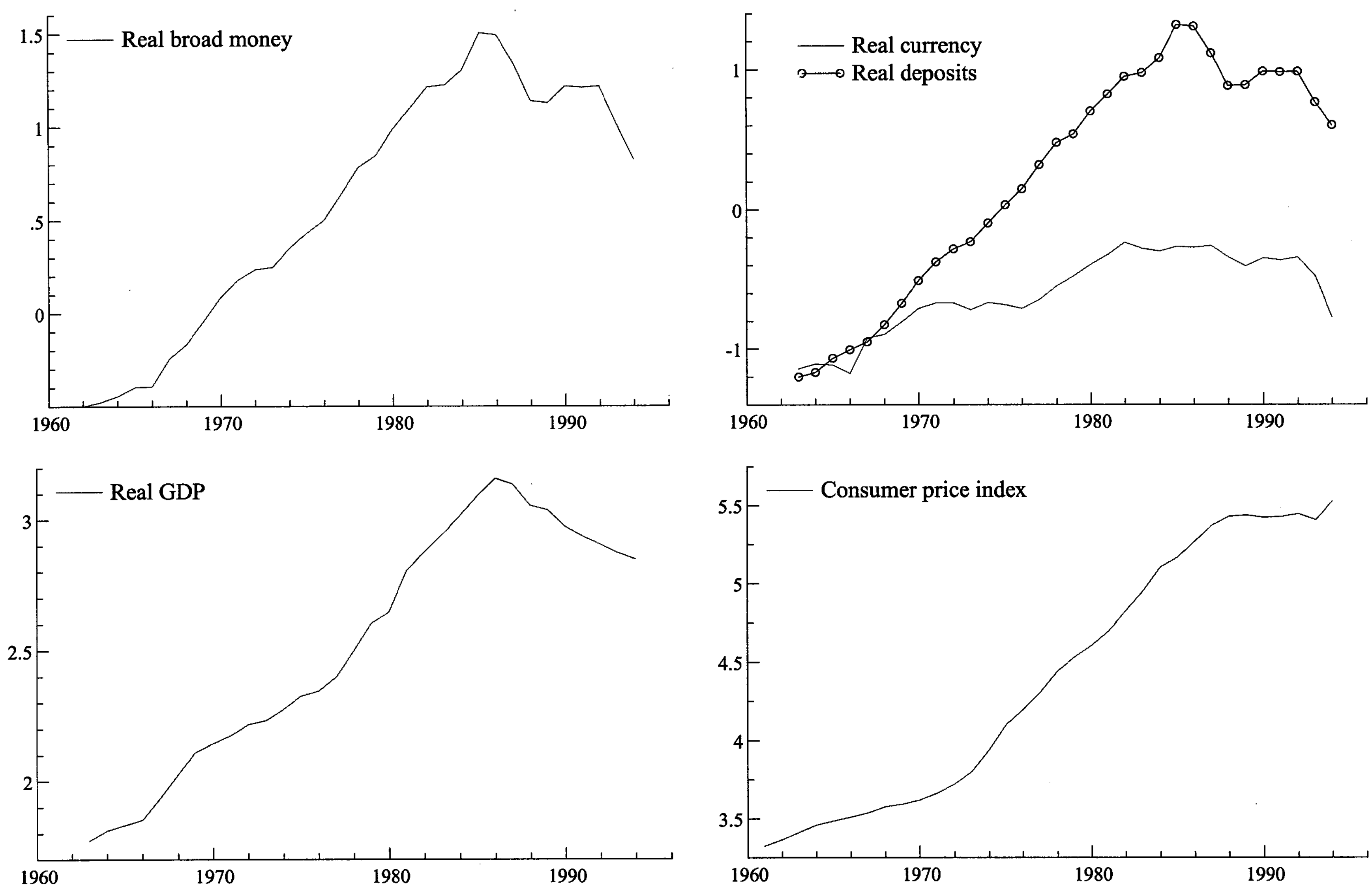
***DUMBW***: Bretton Woods dummy taking value of one from beginning of sample through 1972/73 and zero elsewhere.

***DUM*94**: devaluation dummy taking value of one in 1993/94 and zero elsewhere.

***DUM*92**: dummy variable taking value of one in 1991/92 and zero elsewhere.

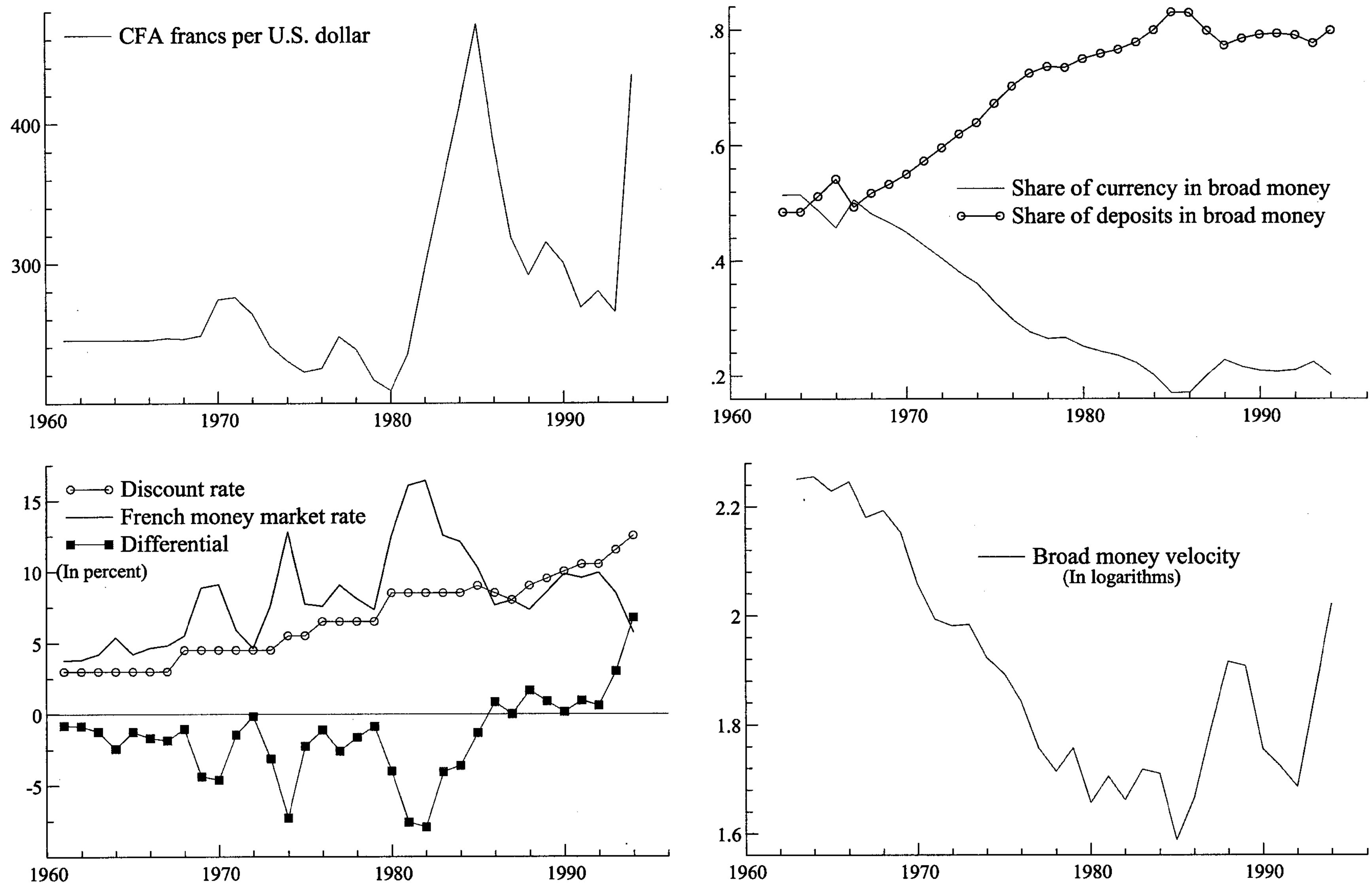
[34] All data are measured on a fiscal year (July-June) basis.

Figure 1. Cameroon: Money, Output, and Prices (in natural logarithms)



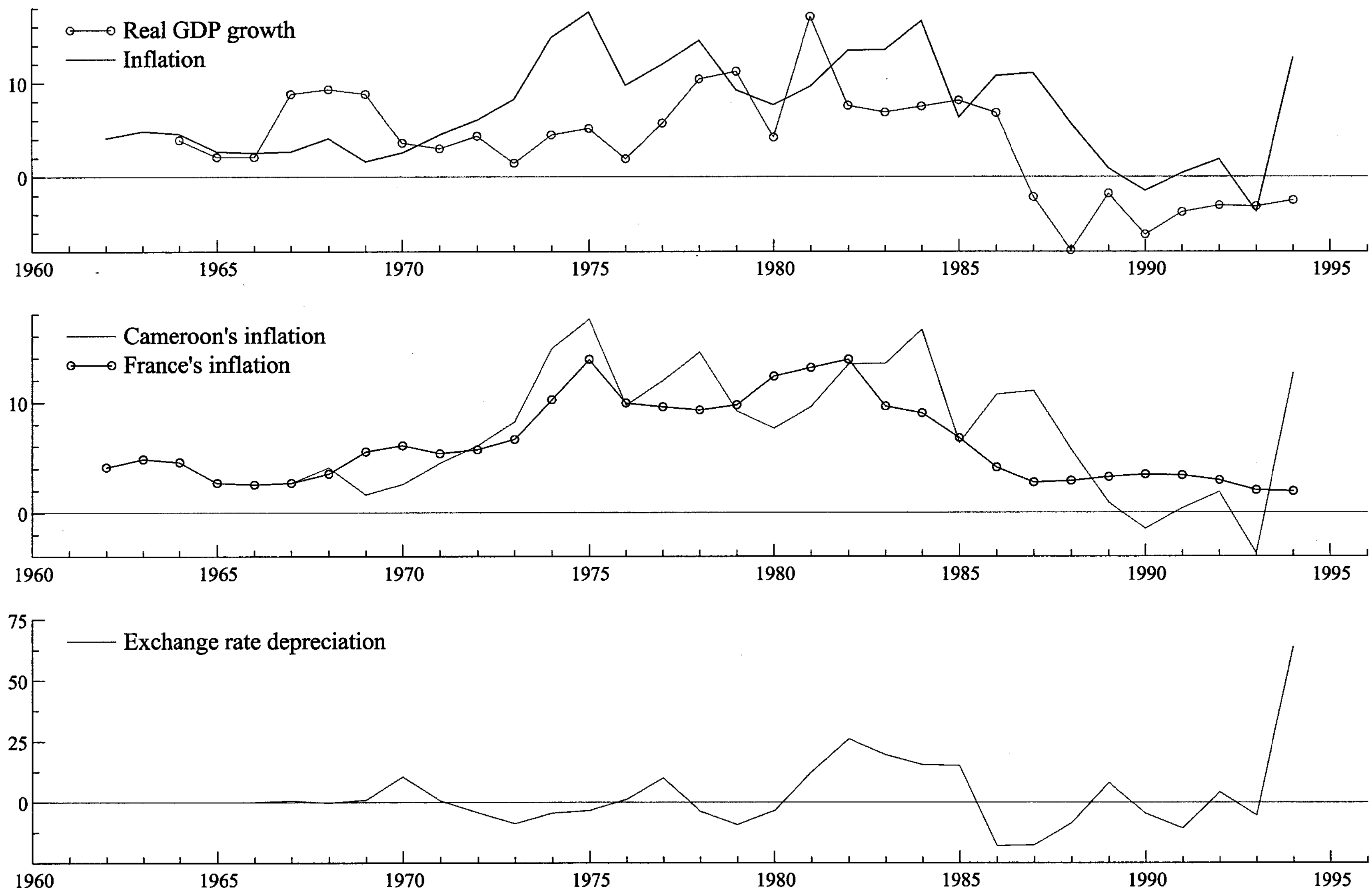

Sources: see Appendix I.

Figure 2. Cameroon: Exchange Rates, Interest Rates, and Velocity



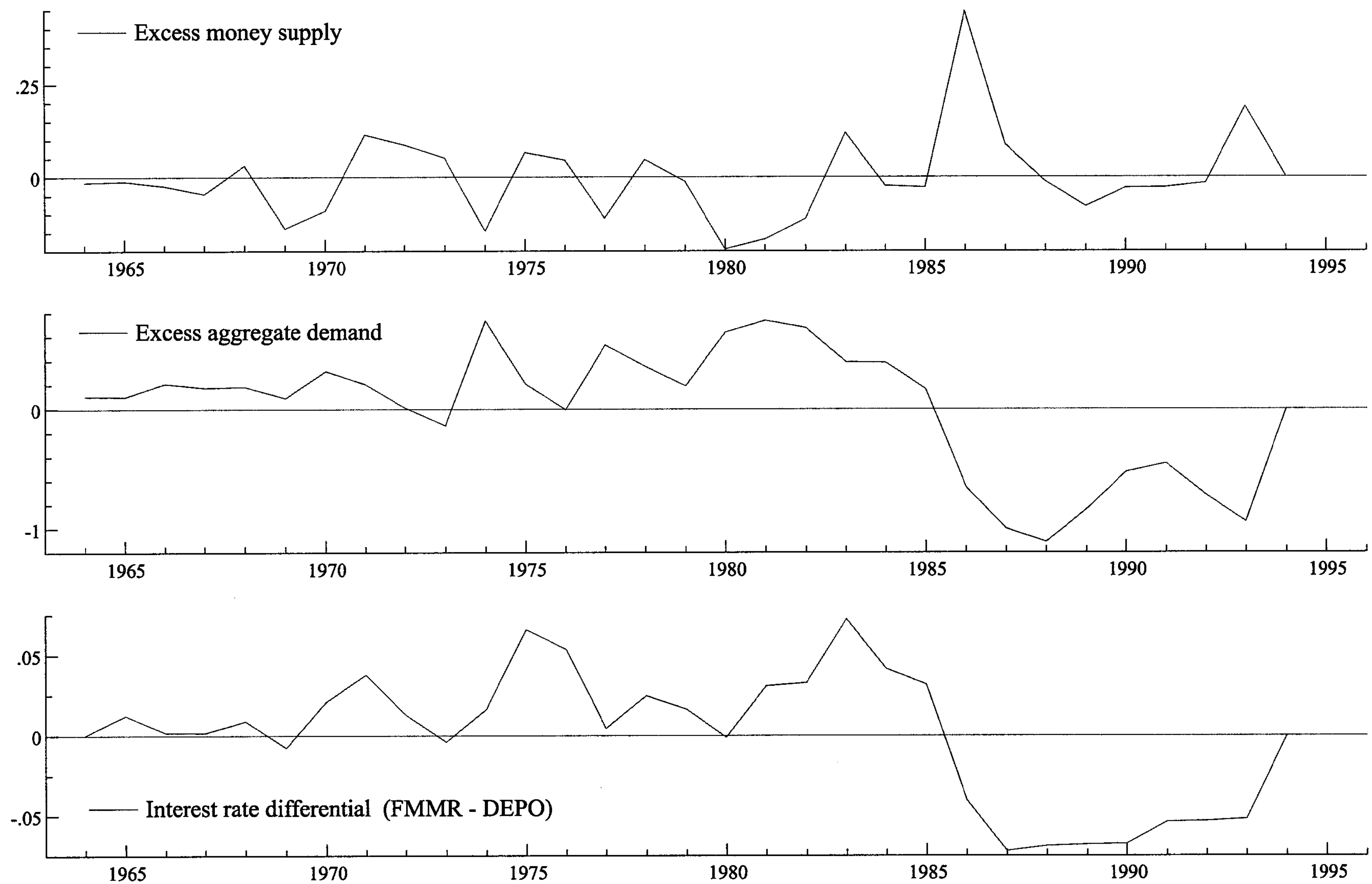

Sources: see Appendix I.

Figure 3. Cameroon: Inflation, Real GDP Growth, and Currency Depreciation




Sources: see Appendix I.

Figure 4. Cameroon: Identification of Three Cointegrating Vectors



# Figure 5. Cameroon: Recursive Estimates of Error-Correction Model

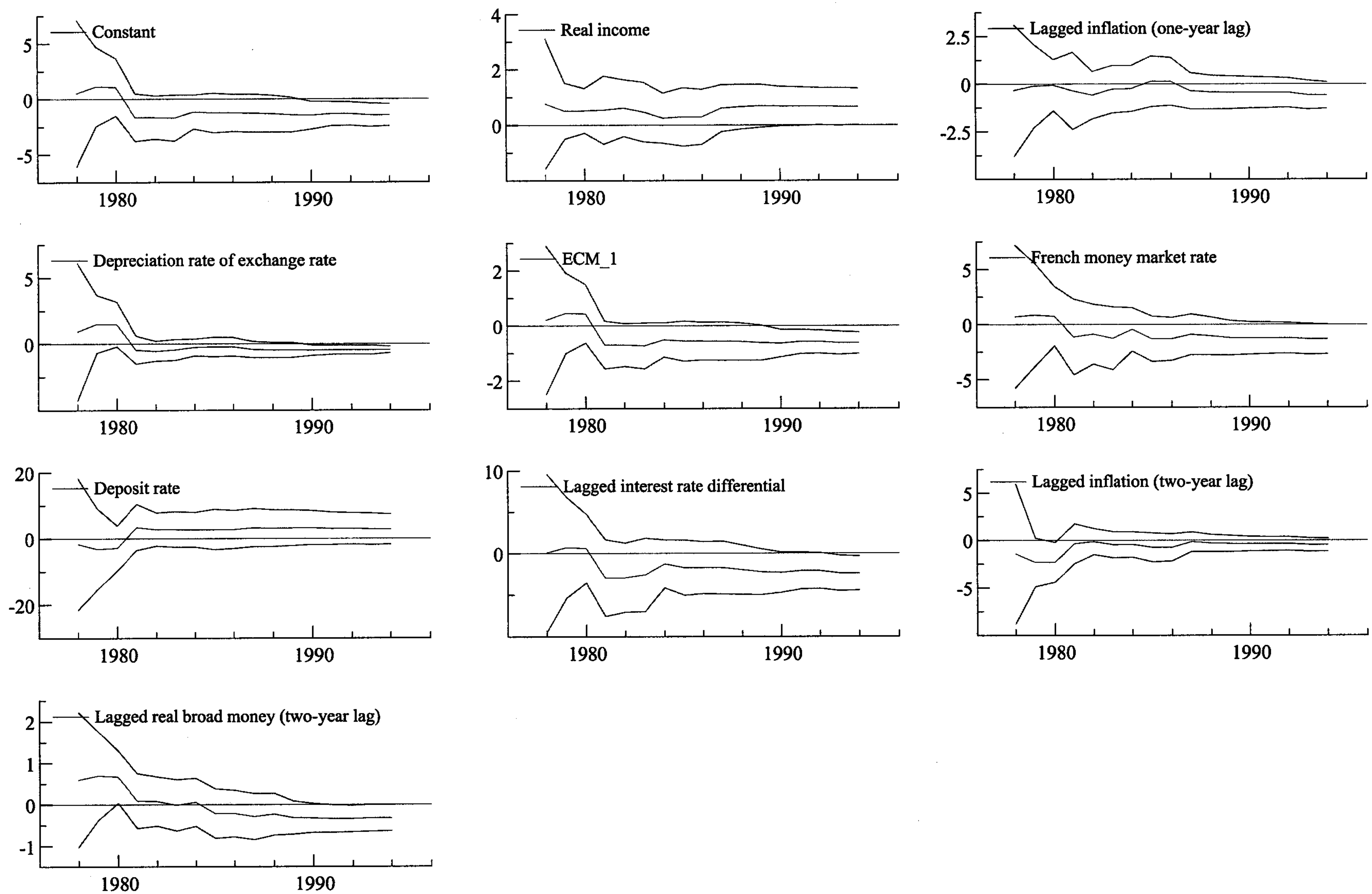


Figure 6. Cameroon: One-Step Residual and Chow Tests for Error-Correction Model

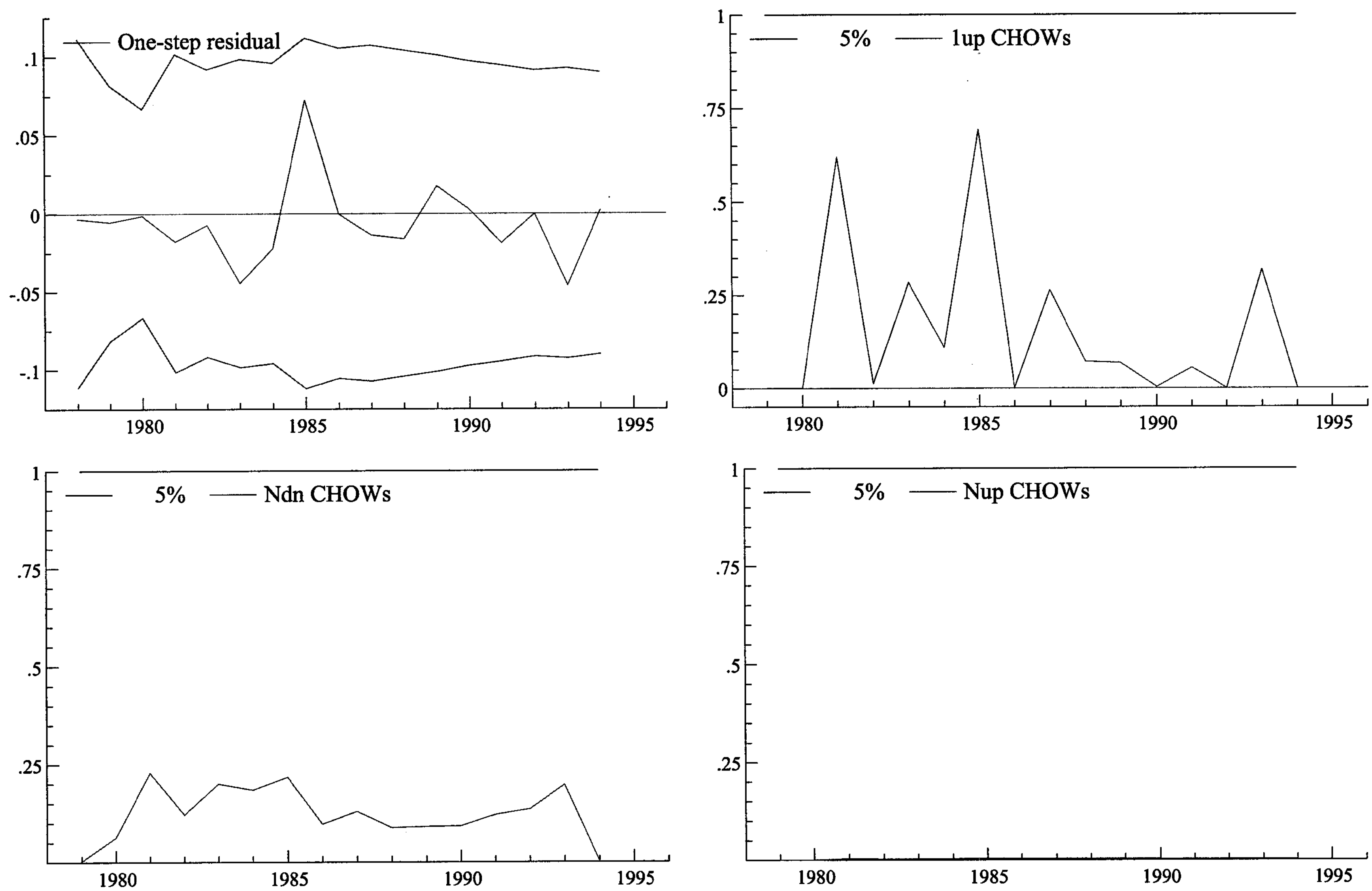


Table 1. Selected Financial and Economic Indicators

| Fiscal year | *M2/CPI* | *M2/GDP* | *CU/GDP* | *RDIFF* | $\Delta CPI$ | *RDISR* | $\Delta e$ | $\Delta y$ |
|---|---|---|---|---|---|---|---|---|
| 1960/61 | | | | -0.8 | | | | |
| 1961/62 | 60.7 | | | -0.8 | 4.1 | -1.1 | 0.0 | |
| 1962/63 | 62.0 | 14.9 | 7.7 | -1.2 | 4.9 | -1.9 | 0.0 | |
| 1963/64 | 64.1 | 14.9 | 7.7 | -2.4 | 4.6 | -1.6 | 0.0 | 3.9 |
| 1964/65 | 67.2 | 15.0 | 7.3 | -1.2 | 2.7 | 0.3 | 0.0 | 2.1 |
| 1965/66 | 67.5 | 14.7 | 6.7 | -1.7 | 2.5 | 0.5 | 0.0 | 2.1 |
| 1966/67 | 78.4 | 15.8 | 8.0 | -1.8 | 2.7 | 0.3 | 0.6 | 8.8 |
| 1967/68 | 84.6 | 15.7 | 7.6 | -1.0 | 4.1 | 0.4 | -0.2 | 9.3 |
| 1968/69 | 95.9 | 15.9 | 7.4 | -4.4 | 1.6 | 2.9 | 0.9 | 8.8 |
| 1969/70 | 109.3 | 13.6 | 6.1 | -4.6 | 2.6 | 1.9 | 10.5 | 3.6 |
| 1970/71 | 119.9 | 14.5 | 6.2 | -1.4 | 4.5 | 0.0 | 0.6 | 3.0 |
| 1971/72 | 126.7 | 14.7 | 5.9 | -0.1 | 6.1 | -1.6 | -4.3 | 4.3 |
| 1972/73 | 128.2 | 14.3 | 5.4 | -3.1 | 8.2 | -3.7 | -8.8 | 1.5 |
| 1973/74 | 142.2 | 14.8 | 5.4 | -7.3 | 14.9 | -9.4 | -4.5 | 4.5 |
| 1974/75 | 154.0 | 16.0 | 5.3 | -2.2 | 17.6 | -12.1 | -3.4 | 5.1 |
| 1975/76 | 165.1 | 16.7 | 5.0 | -1.1 | 9.8 | -3.3 | 1.2 | 1.9 |
| 1976/77 | 190.1 | 17.9 | 4.9 | -2.6 | 12.0 | -5.5 | 10.1 | 5.7 |
| 1977/78 | 219.1 | 19.3 | 5.1 | -1.6 | 14.6 | -8.1 | -3.7 | 10.4 |
| 1978/79 | 233.4 | 18.9 | 5.0 | -0.8 | 9.2 | -2.7 | -9.2 | 11.2 |
| 1979/80 | 268.9 | 19.1 | 4.8 | -4.0 | 7.7 | 0.8 | -3.4 | 4.2 |
| 1980/81 | 300.0 | 18.3 | 4.4 | -7.6 | 9.6 | -1.1 | 12.4 | 17.1 |
| 1981/82 | 336.9 | 19.3 | 4.5 | -7.9 | 13.4 | -4.9 | 26.1 | 7.6 |
| 1982/83 | 340.5 | 18.4 | 4.1 | -4.0 | 13.5 | -5.0 | 19.5 | 6.8 |
| 1983/84 | 368.6 | 19.0 | 3.8 | -3.6 | 16.6 | -8.1 | 15.5 | 7.5 |
| 1984/85 | 450.3 | 20.5 | 3.5 | -1.3 | 6.3 | 2.7 | 15.0 | 8.1 |
| 1985/86 | 445.4 | 21.0 | 3.6 | 0.9 | 10.7 | -2.2 | -17.9 | 6.8 |
| 1986/87 | 381.7 | 20.9 | 4.2 | 0.0 | 11.0 | -3.0 | -17.5 | -2.2 |
| 1987/88 | 312.5 | 19.5 | 4.4 | 1.7 | 5.7 | 3.3 | -8.5 | -7.9 |
| 1988/89 | 309.3 | 20.2 | 4.4 | 0.9 | 0.9 | 8.6 | 8.1 | -1.8 |
| 1989/90 | 338.1 | 22.8 | 4.8 | 0.2 | -1.5 | 11.5 | -4.7 | -6.2 |
| 1990/91 | 335.7 | 22.8 | 4.7 | 1.0 | 0.4 | 10.1 | -10.7 | -3.8 |
| 1991/92 | 338.0 | 24.5 | 5.1 | 0.6 | 1.9 | 8.6 | 4.4 | -3.1 |
| 1992/93 | 276.5 | 19.5 | 4.4 | 3.0 | -3.7 | 15.2 | -5.4 | -3.2 |
| 1993/94 | 228.5 | 16.8 | 3.4 | 6.8 | 12.7 | -0.2 | 63.7 | -2.5 |

Notes: Fiscal year beginning in July. *M2/CPI* is real broad money balances (broad money deflated by consumer price index). *M2/GDP* is ratio of broad money to GDP (in percent). *CU/GDP* is ratio of currency to GDP (in percent). *RDIFF* is interest rate differential (BEAC's discount rate minus French money market rate). $\Delta CPI$ is inflation as measured by annual percentage change in consumer price index. *RDISR* is real BEAC's discount rate. $\Delta e$ is depreciation rate of CFA franc per U.S. dollar exchange rate. $\Delta y$ is real GDP growth rate. See Appendix I for definitions, construction, and sources of variables.

Table 2. ADF (2) Statistics for Testing for a Unit Root

| Variables | t-ADF | Lag |
|---|---|---|
| In levels | | |
| $m - p$ | 0.4 | 1 |
| $y$ | -0.56 | 1 |
| $\Delta p$ | -1.95 | 1 |
| $\Delta e$ | -2.89 | 2 |
| *FMMR* | -2.34 | 1 |
| *DEPO* | -1.8 | 1 |
| In first differences | | |
| $m - p$ | -3.65* | 1 |
| $y$ | -2.26 | 1 |
| $\Delta p$ | -5.29** | 0 |
| $\Delta e$ | -4.3* | 0 |
| *FMMR* | -5.3** | 0 |
| *DEPO* | -4.4** | 0 |

Notes: The estimation period is 1965/66-1993/94 (July - June) for variables expressed in levels and 1966/67-1993/94 for variables expressed in first differences. See Appendix I for definitions, construction, and sources of variables. For each variable, values in the second column represent the t-value of the augmented Dickey-Fuller (ADF) statistics, with critical values based on the response surface in MacKinnon (1991). Lag denotes its lag order. For each variable expressed in level (first difference), the ADF(2) statistics is testing a null hypothesis of a unit root in that variable expressed in level (first difference) against an alternative of a stationary root. Each regression contains both a constant and a trend variable. * and ** denote rejection at the 5 percent and 1 percent critical values, respectively.

Table 3. Cointegration Analysis of Broad Money Demand 1/

| | | | | | | |
|---|---|---|---|---|---|---|
| Eigenvalues | 0.868 | 0.841 | 0.651 | 0.535 | 0.349 | 0.216 |
| Hypotheses | $r = 0$ | $r <= 1$ | $r <= 2$ | $r <= 3$ | $r <= 4$ | $r <= 5$ |
| Lambda max 2/ | 50.7 ** | 46.0 ** | 26.4 | 23.8 | 13.3 | 7.6 |
| 95% critical value | 44.0 | 37.5 | 31.5 | 25.5 | 19.0 | 12.3 |
| Lambda trace 2/ | 159.2** | 108.4** | 62.4 | 36.0 | 16.8 | 6.1 |
| 95% critical value | 114.9 | 87.3 | 63.0 | 42.4 | 25.3 | 12.3 |
| | | | Standardized eigenvectors | | | |
| | *m - p* | *y* | $\Delta p$ | $\Delta e$ | *FMMR* | *DEPO* |
| | 1 | -1.1 | 1.5 | 0.8 | 1.2 | -7.7 |
| | -2.7 | 1 | 9.7 | -2.4 | 6.3 | 27.4 |
| | -0.1 | -0.2 | 1 | -0.2 | 1.3 | 6.6 |
| | -0.3 | -0.1 | 2.4 | 1 | -5.3 | 7.6 |
| | -0.3 | 0.4 | 0.2 | 0.2 | 1 | -5.9 |
| | -0.1 | 0.1 | -0.2 | 0.0 | 0.3 | 1 |
| | | | Standardized adjustment coefficients | | | |
| *m - p* | -0.37 | -0.14 | 0.38 | 0.13 | 0.59 | 0.58 |
| *y* | -0.05 | -0.09 | 0.56 | 0.04 | -0.03 | -0.38 |
| $\Delta p$ | 0.01 | -0.05 | -0.11 | -0.16 | -0.13 | 0.43 |
| $\Delta e$ | -0.63 | 0.09 | 0.39 | -0.27 | -0.12 | -0.33 |
| *FMMR* | -0.12 | -0.01 | -0.18 | 0.01 | -0.13 | -0.02 |
| *DEPO* | -0.01 | 0.00 | -0.02 | -0.01 | 0.03 | -0.11 |
| | | | Weak exogeneity test statistics 3/ | | | |
| | *m - p* | *y* | $\Delta p$ | $\Delta e$ | *FMMR* | *DEPO* |
| Chi-square (1) | 5.4* | 0.7 | 0.0 | 9.9** | 14.3** | 2.4 |
| | | | Statistics for testing the significance of a given variable 3/ | | | |
| | *m - p* | *y* | $\Delta p$ | $\Delta e$ | *FMMR* | *DEPO* |
| Chi-square (1) | 10.1** | 13.6** | 6.3* | 5.1* | 1.3 | 2.6 |
| | | | Multivariate statistics for testing stationarity 3/ | | | |
| | *m - p* | *y* | $\Delta p$ | $\Delta e$ | *FMMR* | *DEPO* |
| Chi-square (5) | 26.4** | 26.4** | 19.6** | 25.5** | 26.5** | 24.9** |

1. The estimation period is 1963/64-1993/94 (July-June). See Appendix I for definitions, construction, and sources of variables. The VAR includes one lag on each variable, a constant term, a trend term, the devaluation dummy *DUM*94, the Bretton Woods dummy *DUMBW*, and the crisis dummy *DUM*8694. The deterministic trend and the crisis and Bretton Woods dummies are entered restricted so that they lie in the cointegration space. * and ** denote rejection at the 5 percent and 1 percent critical values, respectively.
2. Johansen's maximal and trace eigenvalue statistics for testing cointegration are adjusted for degrees of freedom.
3. Conducted under the assumption of one cointegrating vector.

Table 4. Mean and Standard Deviation of Each Variable 1/

| | $m - p$ | $cu - p$ | $y$ | $\Delta p$ | $\Delta e$ | *FMMR* | *DEPO* | *RDIFF* 2/ | $\Delta p^*$ 2/ |
|---|---|---|---|---|---|---|---|---|---|
| Mean | 0.627 | -0.594 | 2.527 | 0.067 | 0.018 | 0.085 | 0.052 | -0.033 | 0.061 |
| Standard deviation | 0.636 | 0.288 | 0.454 | 0.051 | 0.130 | 0.029 | 0.024 | 0.023 | 0.035 |

1/ Calculated over 1962/63-1993/94 period (July-June). See Appendix I for definitions, construction, and sources of variables.

2/ *RDIFF* and $\Delta p^*$ denote the interest rate differential between Cameroon and France (*DEPO* - *FMMR*) and the French inflation rate (first difference of the natural logarithm of the French consumer price index), respectively.

Table 5. Correlation Matrix 1/

| | $m - p$ | $cu - p$ | $y$ | $\Delta p$ | $\Delta e$ | *FMMR* | *DEPO* | *RDIFF* 2/ | $\Delta p^*$ 2/ |
|---|---|---|---|---|---|---|---|---|---|
| $m - p$ | 1.00 | | | | | | | | |
| $cu - p$ | 0.96 | 1.00 | | | | | | | |
| $y$ | 0.98 | 0.93 | 1.00 | | | | | | |
| $\Delta p$ | 0.24 | 0.23 | 0.17 | 1.00 | | | | | |
| $\Delta e$ | 0.07 | -0.02 | 0.09 | 0.24 | 1.00 | | | | |
| *FMMR* | 0.68 | 0.73 | 0.60 | 0.40 | 0.30 | 1.00 | | | |
| *DEPO* | 0.96 | 0.89 | 0.96 | 0.17 | 0.22 | 0.65 | 1.00 | | |
| *RDIFF* 2/ | 0.15 | -0.01 | 0.24 | -0.33 | -0.15 | -0.60 | 0.22 | 1.00 | |
| $\Delta p^*$ 2/ | 0.19 | 0.28 | 0.05 | 0.69 | 0.15 | 0.65 | 0.12 | -0.70 | 1.00 |

1/ Calculated over 1962/63-1993/94 period (July-June). See Appendix I for definitions, construction, and sources of variables.
2/ *RDIFF* and $\Delta p^*$ denote the interest rate differential between Cameroon and France (*DEPO* - *FMMR*) and the French inflation rate (first difference of the natural logarithm of the French consumer price index), respectively.

Table 6. Properties of VAR(1) Residuals

| | $m - p$ | $y$ | $\Delta p$ | $\Delta e$ | *DEPO* | *FMMR* | Vector |
|---|---|---|---|---|---|---|---|
| AR | 0.67 | 0.40 | 1.13 | 5.60* | 2.19 | 0.51 | 1.51 |
| Normality | 2.21 | 11.14* | 0.25 | 1.79 | 9.11 | 4.71 | 27.78** |
| ARCH | 0.05 | 2.34 | 1.70 | 3.16 | 0.09 | 0.71 | ... |
| $X_i^2$ | 0.35 | 0.31 | 0.53 | 0.23 | 0.33 | 0.31 | ... |

Notes: Calculated over 1963/64-1993/94 (July-June). See Appendix I for definitions, construction, and sources of variables. See footnote 19 for explanation of tests. * and ** denote rejection at the 5 percent and 1 percent critical values, respectively.

Table 7. Long - Run Broad Money Demand, Income Homogeneity, and Rates of Return

| | | | | | |
|---|---|---|---|---|---|
| | | Standardized eigenvectors | | | |
| $m - p$ | $y$ | $\Delta p$ | $\Delta e$ | *FMMR* | *DEPO* |
| 1.0 | -1.0 | 1.2 | 0.9 | 0.9 | -11.4 |
| | | Standardized adjustment coefficients | | | |
| $m - p$ | $y$ | $\Delta p$ | $\Delta e$ | *FMMR* | *DEPO* |
| -0.4 | -0.1 | 0.0 | -0.6 | -0.1 | -0.01 |
| | | Statistics for testing the significance of a given rate of return | | | |
| | | $\Delta p$ | $\Delta e$ | *FMMR* | *DEPO* |
| Chi-square(2) | | 8.2* | 9.1* | 1.9 | 16.7** |

Notes: The estimation period is 1963/64-1993/94 (July-June). See Appendix I for definitions, construction, and sources of variables. * and ** denote rejection at the 5 percent and 1 percent critical values, respectively. Analysis conducted under the assumption of one cointegrating vector and the restriction of a unitary income elasticity.

Table 8. Identification of the Three Cointegrating Vectors

| | Standardized eigenvectors | | | | | | |
|---|---|---|---|---|---|---|---|
| | $m - p$ | $y$ | $\Delta p$ | $\Delta e$ | *FMMR* | *DEPO* | *Trend* |
| Broad money demand function | 1.0 | -1.0 | 1.3 | 0.9 | 1.2 | -10.4 | 0.00 |
| Excess aggregate demand | 0.0 | 1.0 | -8.5 | 0.0 | 0.0 | 0.0 | -0.07 |
| Central bank policy rule | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 | -1.0 | 0.00 |

Notes: The estimation period is 1963/64-1993/94 (July-June). See appendix for definitions, construction, and sources of variables. The restrictions are imposed under the assumption of three cointegrating vectors, and were not rejected: chi-square(5)=11.2 [0.08].

Table 9. Cointegration Analysis of Cameroon's and France's Rates of Inflation

| | | |
|---|---|---|
| Eigenvalues | 0.430 | 0.055 |
| Hypotheses | $r = 0$ | $r <= 1$ |
| | | |
| Lambda max 2/ | 15.20* | 1.55 |
| 95% critical value | 14.10 | 3.80 |
| | | |
| Lambda trace 2/ | 16.70* | 1.55 |
| 95% critical value | 15.40 | 3.80 |
| | | |
| | Unrestricted standardized eigenvectors | |
| | $\Delta p$ | $\Delta p^*$ |
| | 1.0 | -1.5 |
| | 1.6 | 1.0 |
| | | |
| | Unrestricted standardised adjustment coefficients | |
| $\Delta p$ | -0.69 | -0.03 |
| $\Delta p^*$ | 0.01 | -0.14 |
| | | |
| | Weak exogeneity test statistics | |
| | $\Delta p$ | $\Delta p^*$ |
| Chi-square (1) | 9.8** | 0.5 |

Notes : The sample period is 1963/64-1993/94 (July-June). See Appendix I for definitions, construction, and sources of variables. The VAR includes two lags on each variable, a constant term, and the devaluation dummy. The devaluation dummy is entered unrestricted. Johansen's maximal and trace eigenvalue statistics for testing cointegration are adjusted for degrees of freedom. * and ** denote rejection at the 5 percent and 1 percent critical values, respectively.

Table 10. Properties of VAR(2) Residuals

| | $\Delta p$ | $\Delta p^*$ | Vector |
|---|---|---|---|
| AR 1-2 | 0.42 | 0.16 | 0.20 |
| Normality | 5.91 | 2.16 | 5.4 |
| ARCH | 1.58 | 1.81 | ... |
| $X_i^2$ | 0.87 | 2.48 | 1.47 |

Notes: Calculated over 1963/64-1993/94 period (July-June). See Appendix I for definitions, construction, and sources of variables. See footnote 19 for explanation of tests.

Table 11. Uncovered Interest Rate Parity and Strong-Form Relative PPP

| | $\Delta p$ | $\Delta p^*$ | *FMMR* | *DEPO* |
|---|---|---|---|---|
| Central bank policy rule | 0 | 0 | 1 | -1 |
| Relative purchasing power parity (PPP) | -1 | 1 | 0 | 0 |

Notes: The sample period is 1963/64-1993/94 (July-June). See Appendix I for definitions, construction, and sources of variables. The restrictions are imposed under the assumption of two cointegrating vectors and were not rejected: chi-square(4)=9.2 [0.0565].

## Table 12. Short-Run Error-Correction Model

| $\Delta(m - p)$ | Constant | Lagged Dependent Variable | Real Income | Inflation | | Nominal Exchange Rate | French Market Market Rate | Deposit Rate | Error Correction Term | Lagged Interest Rates Differential | Dummies | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $C$ | $\Delta(m - p)_{t-2}$ | $\Delta y$ | $\Delta^2 p_{t-1}$ | $\Delta^2 p_{t-2}$ | $\Delta^2 e$ | $\Delta FMMR_{t-1}$ | $\Delta DEPO_{t-2}$ | $ECM_{t-1}$ | $(DEPO\text{-}FMMR)_{t-1}$ | $DUMBW$ | $DUM8694$ | $DUM92$ |
| **Specification 1** | -1.4 | -0.3 | 0.7 | -0.6 | -0.5 | -0.5 | -1.3 | 0.9 | -0.6 | -2.4 | -0.1 | -0.4 | 0.2 |
| | (-2.9) | (2.1) | (2.0) | (-1.7) | (-1.4) | (-3.9) | (-2.0) | (1.3) | (-3.2) | (-2.3) | (-2.9) | (-3.6) | (2.9) |
| $R^2$=0.90 F(12,17)=12.1 | DW=2.11 | | | | | | | | | | | | |
| **Specification 2** | -1.7 | -0.4 | 1.0 | .... | .... | -0.5 | -1.5 | 4.3 | -0.7 | -2.4 | -0.2 | -0.3 | 0.1 |
| | (-3.5) | (-2.5) | (3.5) | .... | .... | (-4.4) | (-2.4) | (1.9) | (-3.9) | (-2.3) | (-3.7) | (-6.2) | (2.6) |
| $R^2$=0.87 F(10,19)=13 | DW=2.19 | | | | | | | | | | | | |
| **Specification 3** | -1.4 | -0.3 | 0.6 | -0.7 | -0.6 | -0.4 | -1.1 | .... | -0.6 | -2.3 | -0.1 | -0.4 | 0.2 |
| | (-2.8) | (-1.7) | (1.7) | (-2.2) | (-1.7) | (-3.8) | (-1.6) | .... | (-3.1) | (-2.2) | (-3.7) | (-7.0) | (3.1) |
| $R^2$=0.89 F(11,18)=12.7 | DW=2.11 | | | | | | | | | | | | |
| **Specification 4** | -1.0 | -0.2 | 0.4 | -0.8 | -0.6 | -0.4 | .... | 1.56 | -0.5 | -1.0 | -0.1 | -0.3 | 0.2 |
| | (-2.2) | (-1.3) | (1.2) | (-2.3) | (-1.1) | (-3.4) | .... | (0.7) | (-2.4) | (-1.3) | (-3.1) | (-6.1) | (3.0) |
| $R^2$=0.87 F(11,18)=11.1 | DW=2.06 | | | | | | | | | | | | |
| **Specification 5** | -0.5 | -0.3 | 0.4 | -0.7 | -0.4 | -0.4 | -0.3 | 2.4 | -0.3 | .... | -0.1 | -0.3 | 0.2 |
| | (-1.6) | (-1.9) | (1.2) | (-1.7) | (-1.2) | (-3.4) | (-2.0) | (0.9) | (-2.0) | .... | (-2.5) | (-5.6) | (2.9) |
| $R^2$=0.86 F(11,18)=10.2 | DW=1.84 | | | | | | | | | | | | |

Notes: See Appendix I for definitions, construction, and sources of variables. Ordinary least squares results over a sample of 30 observations.