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Financial Liberalization, Money Demand, and Inflation in Uganda

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Abstract

This paper uses cointegration analysis to investigate the empirical relationship among money, prices, income, and a vector of interest rates in Uganda from 1982 to 1998. Despite the substantial financial market liberalization in the early 1990s, quarterly time-series data confirm that a stable relationship prevailed among real broad money, income, and domestic and foreign interest rates. The empirical results indicate income homogeneity, a strong own-rate-of-return effect, a high degree of international capital mobility, and asset substitutability, and they demonstrate that both domestic and foreign factors are important determinants of inflation in Uganda.

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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 Uganda, a limited number of studies (Atingi-Ego and Matthews, 1996; Henstridge, 1999; and Katarikawa and Sebudde, 1999) have attempted to identify the key macroeconomic variables determining the demand for money, with almost none focusing on a broader monetary aggregate (such as M2) and the stability of the estimated coefficients. Furthermore, these studies have ignored the impact of foreign interest rates on money balances, and also the extent to which domestic financial market changes have affected the demand for money in Uganda.

2. This study applies systems cointegration analysis and error-correction modeling to examine the behavior of broad money in Uganda for the period 1982–98. The hypothesis is that there exists a stable relationship among broad money, income, and various rates of return over the sample period. Information about the stability of the money demand function in Uganda is crucial to the effectiveness of the monetary policy implemented by the Bank of Uganda; an accurate calibration of both long-run and dynamic effects of rates of return on the demand for money is important for the design and assessment of the macroeconomic implications of financial liberalization and for the adoption of indirect monetary policy instruments. This paper also investigates the long-run determinants of inflation in Uganda by testing two macroeconomic theories: (1) monetarist theories emphasizing the effect of excess money supply; and (2) external theories emphasizing the working of the foreign transmission mechanism in a small, open economy (Juselius, 1992).

3. This study covers two periods: a period when monetary policy was conducted in an environment of underdeveloped and repressed financial markets, with negative real interest rates, low output growth, high inflation, a fixed exchange rate, and demonetization; and a subsequent period, following a regime change, in which disinflation and financial liberalization resulted in positive real interest rates, exchange rate flexibility, financial deepening, and sustained high output growth. The demand for broad money in Uganda is found to be stable despite the substantial financial liberalization accomplished in the early 1990s. The analysis also suggests that, in the long run, Ugandan inflation is influenced by both monetary and external factors. It is shown, however, that certain domestic policy variables, such as positive real interest rates, strict money growth, and exchange rate stability, can be effective in controlling inflation in the short run.

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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 Ericsson (1998) for a recent review of the main methodological issues.

4. Uganda entered the 1980s in the grip of an economic crisis, with distortions evident in most sectors of the economy. GDP growth was negative, and quarterly inflation reached double digits (Table 1 and Figures 1 to 3).[3] High inflation was a consequence of fiscal deficits financed by seigniorage (Sharer and others, 1995; and Brownbridge, 1998). Since the exchange rate was fixed and most interest rates controlled, the currency soon became overvalued, and real interest rates turned negative. This situation aggravated Uganda's balance of payments difficulties and triggered a process of financial disintermediation. In June 1981, the government signed a Stand-By Arrangement with the IMF aimed at restoring macroeconomic stability and eliminating the distortions in the key markets. This program included exchange rate flexibility, as well as quantitative targets for the overall budget deficit, net credit to the government, and money growth. Despite a recovery of real GDP growth in 1981/82-1983/84 (July-June), political uncertainty and the intensification of the civil war caused the stabilization program to collapse in early 1984. Inflation skyrocketed to over 50 percent in the first quarter of 1985 and remained high until 1988.[4]

5. A year after an entirely new government took power in 1986, Uganda sought a structural adjustment program with IMF/World Bank support. The program, approved in June 1987, succeeded in restoring fiscal and monetary discipline, while simultaneously removing domestic price distortions and promoting the liberalization of trade, payments, and the exchange rate. During the late 1980s and early 1990s, inflation was reduced dramatically and brought under control.[5] As a result, real interest rates increased sharply and turned positive (Figure 2). Between October 1989 and July 1990, a crawling peg system was introduced, reorienting the exchange rate policy toward external competitiveness. The authorities legalized the parallel market in foreign exchange in July 1990 by approving foreign exchange bureaus, and the creation of an interbank market in November 1993 completed the unification of the foreign exchange market.

6. Real money balances began to increase at a steady pace following the disinflation and its impact on the level of real interest rates, which became positive in 1989 (Figure 2). In addition to the impact of disinflation on the level of real interest rates, the remarkable increase in real money balances during the 1990s was due to sustained output growth, a stable (though flexible) exchange rate, declining international interest rates, and the gradual liberalization of domestic nominal interest rates begun in April 1992 (resulting in strongly positive real interest rates in 1993 and a continuously widening differential between the deposit rate and the treasury bill rate; see Figures 1 to 3). Prior to April 1992, the level and structure of all formal financial sector interest rates (including the treasury bill rate) were determined by the Bank of Uganda (BOU)

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[3]Between 1970 and 1986, per capita real GDP fell by more than 30 percent.

[4]On an annual basis, inflation averaged 179.5 percent over 1985-88, against 41.5 percent over 1982-84.

[5]Annual inflation averaged 45.3 percent and 8 percent during 1988-92 and 1993-97, respectively. In 1998, the inflation rate was barely zero percent.

after approval by the Ministry of Finance and Economic Planning (MOFEP).[6] Thus, during the 1970s and the 1980s, the main instruments of monetary policy consisted of reserve requirements, direct credit controls, and treasury bill auctions.[7] The liberalization of interest rates was completed in June 1994, with most rates determined by the market. Other financial sector reforms were undertaken to increase the efficiency of the banking system and promote financial market development.[8] In addition, the responsibility for the formulation and implementation of monetary policy was fully transferred from the MOFEP to the BOU. Nowadays, the BOU manages interest rates by means of indirect monetary policy instruments. Open market operations, carried out through weekly auctions, have become the main instrument of monetary control, with the 91-day treasury bill rate—a risk-free rate—serving as anchor. Other instruments of monetary policy include the setting of reserve requirements and the operation of two BOU lending facilities (a rediscount facility and a lender-of-last-resort facility).[9]

7. Section II explores the theoretical considerations and the empirical methodology connected with the estimation of the money demand and the inflation equations in Uganda. Section III discusses the econometric results. Finally, Section IV summarizes the major findings and their policy implications.

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[6]Throughout the 1970s and most of the 1980s, nominal interest rates were kept well below the level of inflation, as the BOU conducted monetary policy with a view to speeding up economic development through credits to specific "priority" sectors.

[7]Prior to Uganda's liberalization of interest rates in April 1992, treasury bill auctions were used as a means to finance fiscal operations through the nonbank public (Sharer and others, 1995).

[8]These included the generation of updated and accurate balance sheets of financial institutions; removal of restrictions imposed on commercial banks' operations and asset holdings (such as foreign transactions and treasury bills); strict compliance with statutory reserve requirements by commercial banks; elimination of preferential rates and directed credits to priority sectors (mainly agriculture, manufacturing, trade, and commerce); restructuring of the Uganda Commercial Bank; higher capital requirements; and elimination of entry barriers into the banking industry. See Kasekende and Atingi-Ego (1999) and Brownbridge (1998).

[9]Until 1993, the cash reserve requirement was set at 10 percent of deposit liabilities (Brownbridge, 1998). However, this instrument was ineffective for monetary control because banks had automatic access to the BOU lending facilities whenever they faced liquidity constraints. In 1998, Uganda had a reserve requirement of 9 percent of demand deposits, 8 percent of time and savings deposits, and 20 percent of foreign currency deposits. However, banks are allowed to average reserves over a two-week maintenance period, and penalties are imposed for noncompliance (Mehran and others, 1998).

II. Theory and Empirical Methodology

8. 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 a 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 converge to a specification in which 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.

9. 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 nonbank public.[10] 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 often been 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.[11] Alternatively, assuming perfect asset substitutability, the differential between the domestic and foreign interest rates is included.

10. The basic model underpinning the preceding discussion can be summarized as follows (Ericsson, 1998):

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

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

[10] 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. This assumption does not hold in Uganda over the sample period covered, as a statistically significant role is found for the treasury bill rate in the long-run analysis, while inflation affects only the short-run dynamics.

[11] See Arango and Nadiri (1981).

return (within and outside 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 to be 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.[12]

11. For the purpose of this study, the assets considered are Uganda shilling broad money as measured by M2 (money plus quasi money), domestic goods, holdings of U.S. dollar cash, and domestic and foreign bonds. The corresponding expected rates of return for the five assets are proxied by the annual interest rate offered on time deposits (*DEPO*), the rate of inflation (Δp) as measured by the consumer price index, the depreciation rate of the Uganda shilling per U.S. dollar exchange rate (Δe), the 91-day treasury bill rate (*TBILL*), and the annualized three-month London interbank offered rate (*LIBOR*), respectively. The scale variable Y is proxied by monetary gross domestic income (GDI) at market price in constant 1987 prices (rebased to 1991). With the exception of real income, all the series are quarterly and taken from the *International Financial Statistics* database. The real income series is from the Henstridge (1999) database.[13]

12. Following the traditional approach, equation (1) is specified in a log-linear form, with the exception of the three interest rates:

$$(m-p)_t = a_0 + a_1\, y_t + a_2\, \Delta p_t + a_3\, DEPO_t + a_4\, TBILL_t + a_5\, LIBOR_t + a_6\, \Delta e_t + \varepsilon_t\,, \qquad \text{(2a)}$$

where variables in lower case denote natural logarithms and ε_t is the error term. The anticipated signs for the a_i's are the following: $a_1 > 0$ (more specifically, $a_1=1$ for the quantity theory or $a_1 = 0.5$ for the Baumol-Tobin model of economies of scale), $a_2 < 0$, $a_3 > 0$, $a_4 < 0$, $a_5 < 0$, and $a_6 < 0$. Assuming for now an equal semielasticity (in absolute value) for *DEPO* and *TBILL*, equation (2a) can be rewritten with a spread, as follows:

$$(m-p)_t = d_0 + d_1\, y_t + d_2\, \Delta p_t + d_3\, (DEPO - TBILL)_t + d_4\, LIBOR_t + d_5\, \Delta e_t + \varpi_t\,, \qquad \text{(2b)}$$

where (*DEPO-TBILL*) represents the return on domestic monetary assets relative to domestic non-monetary financial assets (or, equivalently, the incremental opportunity cost of holding

[12] 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).

[13] GDI is GDP with the impact of changes in terms of trade on net export receipts added. See Henstridge (1999, p. 354 and pp. 376-77) for the construction and primary source of this series.

domestic nonmonetary financial assets relative to domestic interest bearing bank deposits) and the sign of d_3 is positive.[14]

13. Equations (2a) and (2b) assume, 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 behaviors 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 nonstationary time series. Unit root tests and cointegration techniques have been developed to deal with the spurious regression problem. The current study applies Johansen (1988) and Johansen and Juselius (1990) procedures to determine empirically the number of cointegrating vectors and the adjustment parameters.

14. If a stable demand for money can be established, broad money can be used as a monetary target in seeking price stability, assuming that inflation is, in the long run, a monetary phenomenon, determined by conditions in the domestic money market. It is the monetarist thesis that inflation results from excessive growth in the money supply. But in small, open economies the level of domestic prices is also affected by external factors, namely, the nominal exchange rate and foreign prices, as predicted by purchasing power parity (PPP) theory. Following Juselius (1992), these two theories (the monetarist and the PPP theories) are tested by estimating a dynamic model of inflation in which inflation is postulated to be generated by deviations from the long-run equilibrium in the money market and the foreign sector.[15] The long-run equilibrium in the monetary sector is spelled out in equation (2). To fully capture the inflationary impact of the external sector, Juselius (1992, p. 175) argues that one has to account for the fact that the exchange rate is simultaneously determined in both the goods and the asset markets. Thus, the long-run equilibrium in the foreign sector can be summarized through the PPP and the uncovered interest rate parity (UIP) relations, as follows:

$$ner_t = c_1 (p - p^*)_t \text{ , and} \tag{3}$$

$$(DEPO - LIBOR)_t = c_2 \Delta ey_{t+1} , \tag{4}$$

[14]Working with equation (2b) instead of (2a) offers the empirical advantage of reducing the number of parameters to be estimated and thus provides a gain in terms of degree of freedom. The assumption of an equal semielasticity (in absolute value) for *DEPO* and *TBILL* is tested for and confirmed in the next section. It is also shown later that the holding of this assumption does not necessarily imply that domestic bank deposits and treasury bills are perfect substitutes.

[15]Other authors have referred to these two theories as the "fiscal-monetarist view" and the "balance-of-payments school." See, for instance, Montiel (1989).

where *ner* and p^* are the natural logarithms of the nominal effective exchange rate (defined as the number of domestic currency units per unit of foreign currency) and the foreign effective price index, respectively, and Δey_{t+1} is the expected annual currency depreciation rate. The constants and error terms are omitted for brevity. The anticipated signs of the c_i's is positive: $c_1 = 1$ under strong-form absolute PPP, and $c_2 = 1$ under perfect capital mobility. Assuming the left- and right-hand variables of equations (3) and (4) are nonstationary, weak-form absolute PPP and capital mobility would require only that there exists positive values of c_1 and c_2 such that both equations are cointegrating relationships. Let us note that equation (4) includes no explicit foreign exchange risk premium, the implicit assumption being that foreign interest rate shocks and other noise in the foreign exchange market (including shocks to the exchange rate premium) are stationary.

15. If equations (2) through (4) are cointegrating relationships and assuming the domestic price level is I(1) (or, equivalently, inflation is stationary), the following error-correction model for inflation can be estimated through an ordinary least squares regression:[16]

$$\Delta p_t = b_0 + b_1\, ecm_{t-1} + b_2\, ecp_{t-1} + b_3\, ecuip_{t-1} + \sum^{n}_{j=1} b_{4j}\, \Delta p_{t-j} + u_t \,, \tag{5}$$

where *ecm* is the error-correction term from the money demand equation (2), *ecp* is the error-correction term capturing the disequilibrium in the tradable goods market as measured by deviations from PPP, and *ecuip* is the error-correction term capturing the disequilibrium in the asset market as measured by deviations from UIP. Various stationary variables (in levels or first differences) that are short-term determinants of (or policy variables affecting) inflation will be added to relation (5). The anticipated signs for the b_i's are $b_1 > 0$, $b_2 > 0$, and $b_3 < 0$; the signs of the lagged dependent variables may be positive or negative. A positive *ecm* means that, at the current level of domestic prices, there is an excess nominal (and real) money supply: this situation leads to an increase in the next period's rate of inflation. Assuming PPP holds in the long run, a positive deviation ($ecp > 0$) from equation (3) corresponds to a real currency depreciation and this tends to increase domestic inflationary pressures through two—direct and indirect—channels (Dornbusch and Kuenzler, 1988). First, a depreciation of the real effective exchange rate brought about by a nominal currency depreciation will increase domestic inflation because the depreciation is passed directly into the price of imported goods—converted in the home currency. Second, a real currency depreciation brought about by a rise in competitors' prices allows domestic firms to increase their profit margins through higher prices without losing market shares. By the same arguments, an overvalued currency is expected to lead to a fall in the inflation rate.

16. A positive deviation from UIP ($ecuip > 0$) means that the expected return on domestic financial assets is greater than the return on foreign bonds: this situation leads to capital inflows, and the ensuing appreciation (or revaluation) of the domestic currency in the foreign

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[16] j denotes lag. If the consumer price index is I(2), then the dependent variable is specified in terms of acceleration of inflation (second difference of the logarithm of the consumer price index).

exchange market leads to a fall in the rate of inflation.[17] In contrast, a negative deviation from UIP leads to capital outflows and currency depreciation (or devaluation), which, in turn, results in increased inflationary pressures. Lastly, positive and significant coefficients of the lagged dependent variables would point to the existence of inertial forces in the inflation process in Uganda. Inertial forces play a major role in the inflation process in countries where formal and informal indexation mechanisms of nominal contracts are widespread. Anecdotal evidence suggests this is not the case in Uganda, and we thus do not expect—a priori— inertial inflation to play a significant role in Uganda's inflation process.[18]

17. Previous studies on money demand in Uganda have successfully controlled for the effects of the own rate of return on money holdings and have generally found a near unit income elasticity. However, they have all ignored the impact of foreign interest rates on money balances, an omission that may bias the elasticity of the domestic opportunity cost of holding money (inflation and/or the interest rate). Furthermore, these studies have failed to account for the extent to which domestic financial market changes have affected the demand for broad money and the inflation process in Uganda. Atingi-Ego and Matthews (1996) estimate the demand for both narrow and broad money using annual data over 1970-93; they conclude that the demand for M2 is unstable, and, hence, only M1 can be used for monetary targeting in Uganda. In contrast, Katarikawe and Sebudde (1999) find a stable demand for M2 using monthly data over 1990-96. Henstridge (1999) estimates separately the demand for currency, demand deposits, and time and saving deposits—rather than aggregated into M1 and M2—using quarterly data over 1968:Q2-1998:Q2, and finds stable functions in particular over the sub-sample 1982:Q2-1998:Q2. Studies by Atingi-Ego and Matthews (1996) and Henstridge (1999) omit both the treasury bill and the foreign interest rates.[19] Katarikawe and Sebudde (1999) include the treasury bill rate but omit the foreign interest rate. Each of these shortcomings is addressed in this paper.

18. This paper estimates a parsimonious broad money demand function and finds strong evidence that it remained stable before, throughout, and after the financial liberalization process. Cointegration analysis indicates a strong relationship among real broad money, real income, and domestic and foreign interest rates. The dynamic models for both broad money velocity and inflation exhibit significant parameter constancy even after financial liberalization as indicated by a number of statistical tests.

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[17] This channel depends crucially on finding a money demand function that is sensitive to rates of return on both domestic and foreign financial assets. This is shown to be the case in Uganda over the sample period covered.

[18] Durevall and Ndung'u (1999) apply the Juselius (1992) framework to Kenya.

[19] The definition of M2 adopted in this paper is the IMF *International Financial Statistics* one, that is, money plus quasi money. It differs from the M2 aggregate used in Atingi-Ego and Matthews (1996) and Katarikawe and Sebudde (1999) as it includes foreign currency deposits.

III. Integration and Cointegration

A. Time-Series Properties

19. Quarterly data for the period 1982:Q4–98:Q4 are used. All the variables are expressed in logarithm terms with the exception of the interest rates. Figures 1 to 3 plot the individual time series in levels, while Table 8 gives their respective means and standard deviations. The empirical investigation commences with an analysis of the time-series properties of the variables of interest for the money demand function (Table 2). The augmented Dickey-Fuller (ADF) test is used to determine the order of integration of data compiled for each variable. With the exception of inflation, currency depreciation, and the annualized real deposit rate (*RDEPO*), the results indicate that the variables in levels have unit roots. While expressed in first differences, all the variables are stationary using the ADF test. These results are in line with Henstridge (1999). The stationarity of currency depreciation and inflation implies that the two series can be excluded from the cointegration analysis (without loss of generality) and later on included in the error-correction model capturing the short-run dynamics.

20. After determining the order of the integration of the variables of interest, the Johansen procedure is first applied to a seventh-order vector autoregression (VAR) simplified version of equation (2b) to test for cointegration among real broad money, real GDP, the domestic spread (*DEPO-TBILL*), and the LIBOR rate.[20] The maximal and the trace eigenvalue statistics reject the null hypothesis of no cointegrating vector in favor of a single cointegrating vector at the 1 and 5 percent levels, respectively; see Table 3.

B. The Long-Run Demand for Broad Money

21. The single cointegrating relationship found corresponds to the long-run open economy demand function for broad money in Uganda and can be written as

$$m - p = 1.23\,y + 11.14\,(DEPO - TBILL) - 8.15\,LIBOR + 0.013\,trend\,, \tag{6}$$

where the estimated constant and random error term are omitted for brevity. Various misspecification tests of the unrestricted VAR(7) underlying equation (6) are reported in Table 7a. These include single-equation tests (normality, AR, ARCH, and portmanteau) and vector tests (normality, AR, and portmanteau). Neither the single-equation nor the vector misspecification tests reveal a serious problem, except for the rejection at 5 percent critical value of normality for (*DEPO - TBILL*).[21]

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[20]Throughout this paper the optimal lag length of the VAR is chosen on the basis of the Schwarz-Bayesian criterion, as well as on the residuals' being white noise. Also, unless otherwise indicated, all models tested for cointegration contain seasonal dummies and a trend. The seasonal dummies are entered unrestricted while the trend is entered restricted.

[21]Most important, the vector test does not reject the null hypothesis of normality.

22. All the coefficients have the expected signs. The demand for broad money in Uganda is positively related to income and the relative own rate of return, and negatively to the LIBOR rate. The income elasticity of M2 is close to unity (1.23) and significantly different from zero: $\chi^2_{(1)}$= 11.6[0.0].[22] A test imposing a unitary income elasticity was not rejected: $\chi^2_{(1)}$= 0.53 [0.47]. This is consistent with the quantity theory hypothesis. 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, Figure 3 shows that broad money velocity has been declining since the late 1980s, owing to financial deepening. The ADF test statistics reported in Table 2 confirm that we cannot reject the presence of a unit root in the data generating process of broad money velocity.

23. The demand for M2 is negatively affected by the LIBOR rate, with the estimated coefficient statistically different from zero: $\chi^2_{(1)}$= 22.1[0.0]. The semielasticity of the relative own rate of return is positive and statistically different from zero: $\chi^2_{(1)}$= 39.3[0.0]. Thus, for an unchanged *LIBOR*, policies affecting the differential between *DEPO* and *TBILL* can be effective in increasing financial savings through money holdings. Furthermore, for a given (*DEPO-TBILL*), an increase in the LIBOR rate triggers capital outflows. Lastly, for given *LIBOR* and *DEPO*, an increase in *TBILL* induces portfolio changes from bank deposits into government treasury bills. The positive coefficient of the trend is statistically different from zero: $\chi^2_{(1)}$= 5.9[0.02]. A test imposing perfect asset substitutability (hereafter "PAS")—an equal interest rate semielasticity (in absolute value)—for (*DEPO-TBILL*) and *LIBOR* is not statistically rejected: $\chi^2_{(1)}$= 2.02[0.15]. The restricted cointegrating vector—under equal interest rate semielasticity and income homogeneity—has the following parameters:

$$m - p = y + 10.85\,(DEPO - TBILL) - 10.85\,LIBOR + 0.013\,trend\,. \tag{7}$$

24. The Johansen approach provides a systems approach of testing the existence of unit roots in each variable, when the null hypothesis is that of stationarity, rather than nonstationarity. The various chi-square statistics reported in Table 3 confirm that all the variables considered here are indeed nonstationary. In addition, weak exogeneity tests conducted under the assumption of income homogeneity reveal that although broad money and (*DEPO-TBILL*) are not weakly exogenous, weak exogeneity cannot be rejected for either real income or *LIBOR*. Nonetheless, a look at the adjustment coefficients in Table 3 confirms that real broad money is more likely to be endogenously determined than (*DEPO-TBILL*); compare the feedback parameter of -0.62 for $m - p$ with 0.03 for (*DEPO-BILL*). Interestingly, joint weak exogeneity for both y and (*DEPO-TBILL*) under the assumptions of income homogeneity and PAS could not be rejected: $\chi^2_{(4)}$=8.4[0.08].

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

25. With income homogeneity assumed, the analysis is further simplified by testing cointegration among (inverse) broad money velocity, (*DEPO-TBILL*), and *LIBOR*. A VAR(8) is run with the result that the null hypothesis of no cointegration is rejected in favor of a single cointegrating vector at the 1 percent level (see Table 4). In addition, PAS—an equal interest-rate semielasticity (in absolute value)—for (*DEPO-TBILL*) and *LIBOR* is tested and is not rejected: $\chi^2_{(1)}$=2.9[0.1]. Thus, the model can be reduced to the following equation:

$$m - p - y \;=\; 11.15\,(DEPO - TBILL) - 11.15\;LIBOR \;+\; 0.014\;trend. \qquad (8)$$

Likelihood ratio tests confirm that (*DEPO-TBILL*) and *LIBOR* are weakly exogenous, in contrast to broad money velocity (p+y-m) which is endogenous: $\chi^2_{(2)}$=10.03[0.01], $\chi^2_{(1)}$=1.7[0.04], and $\chi^2_{(2)}$=17.9[0.0], respectively.[23] The coefficient of the trend is significantly different from zero: $\chi^2_{(1)}$=18.0[0.0]. Table 7b reveals that the vector of the unrestricted VAR(8) underlying equation (8) violates the assumption of normality. Gonzalo (1994) shows, however, that the Johansen procedure is robust under nonnormal errors.

26. Thus far, the vector of rates of return has been specified in terms of the domestic spread (*DEPO–TBILL*) and *LIBOR*, a choice that was primarily motivated by a gain in terms of degree of freedom for the estimation of the semilog linear model. Given this, the economic interpretation and policy implications of PAS—defined in terms of equal interest rate semielasticities—deserve further clarification. To this end, a cointegration analysis where *LIBOR*, *DEPO*, and *TBILL* enter separately into the money demand function is conducted, and the implied long-run interest rate full elasticities are computed. A VAR(7) modified version of equation (8) is run to test cointegration among (inverse) broad money velocity, *LIBOR*, *DEPO*, and *TBILL*, with the result that the null hypothesis of no cointegration is strongly rejected in favor of the following single cointegrating vector at the 1 percent level (see Table 5):

$$m - p - y \;=\; 10.45\;DEPO - \;10.97\;TBILL \;-\; 8.81\;LIBOR \;+\; 0.016\;trend\,, \qquad (9)$$

where the estimated constant and random error term are omitted for brevity. Equation (9) is our preferred specification. The various misspecification tests of the unrestricted VAR(7) underlying equation (9) are reported in Table 7c and do not reveal any problem. The estimated semielasticities of interest rates are significantly different from zero (see Table 5), while the trend coefficient is also statistically significant: $\chi^2_{(1)}$=13.6[0.0]. Weak exogeneity was established for *DEPO* and *TBILL*, strongly rejected for the inverse velocity, and slightly rejected for *LIBOR*. Nevertheless, values of the adjustment coefficients in the α matrix confirm that broad money velocity is likely to be more endogenous than *LIBOR*, given the feedback parameter of -0.67 for $m - p - y$ against 0.02 for *LIBOR*. PAS is tested and confirmed for *DEPO* and *TBILL* ($\chi^2_{(1)}$=1.3[0.26]), for *DEPO* and *LIBOR* ($\chi^2_{(1)}$=0.30[0.58]); and for *TBILL* and *LIBOR*: $\chi^2_{(1)}$=0.47[0.49]. Logically, PAS is demonstrated for the three

[23]Under the assumption of PAS, however, weak exogeneity is rejected for *LIBOR*.

interest rates considered simultaneously ($\chi^2_{(2)}$=1.32[0.52]), resulting in the following parsimonious inverse broad money velocity equation:

$$m - p - y \;=\; 11.21\,DEPO \;-\; 11.21\,TBILL \;-\; 11.21\,LIBOR \;+\; 0.014\;trend\,. \qquad (10)$$

27. Because of the use of the semilog linear money demand specification, the various PAS tests conducted have been specified in terms of equal semielasticities and not equal full elasticities. To get quarterly average full elasticities for *DEPO*, *TBILL*, and *LIBOR*, the estimated semielasticities are multiplied by their respective means over the sample period (Table 8) and divided by four. In the case of equation (9), such a computation gives average full elasticities of 0.50 for *DEPO*, 0.63 for *TBILL*, and 0.22 for *LIBOR*; see Table 9. Thus, a 1 percent increase in the quarterly deposit rate induces on average a ½ of 1 percent increase in the demand for real broad money, while a 1 percent increase in *LIBOR* induces a 0.2 percent fall in real broad money balances. Likewise, a 1 percent increase in the quarterly *TBILL* rate induces, on average, a 0.6 percent fall in the demand for real broad money. Thus, the holding of PAS in semilog linear models (hereafter "semi-PAS") does not necessarily imply PAS will hold in terms of equal full elasticities (hereafter "full-PAS"), as the sample means of the interest rates may be statistically different from one another. Indeed, the key in determining whether full-PAS holds (following the holding of semi-PAS) is whether the means of the considered interest rates are statistically not different.[24]

28. Likelihood ratio tests for equal full elasticities are rejected for *DEPO* and *LIBOR*, *TBILL* and *LIBOR*, and *DEPO* and *TBILL*: $\chi^2_{(1)}$=5.8[0.0], $\chi^2_{(1)}$=8.5[0.0], and $\chi^2_{(1)}$=16.2[0.0], respectively. Thus, although broad money demand is sensitive to foreign interest rates, the substitution between foreign and domestic assets in Uganda is an imperfect one. Moreover, even though long-run interest rate elasticities for *DEPO* and *TBILL* are numerically close, imperfect asset substitutability prevails between treasury bills and domestic bank deposits.

29. These results are in line with two recent money demand studies on sub-Saharan African economies applying the Johansen multivariate cointegration framework. Nachega (2001) estimates a broad money demand function for Cameroon using annual data over 1963/64-1993/94. He finds, among other results, a unitary income elasticity, a strong own-rate-of-return effect—a positive deposit rate (*DEPO*) elasticity of 0.5— and a negative foreign interest rate (French money market rate) elasticity of -0.1. Although rightly signed, the estimated French money market rate (*FMMR*) elasticity is not significant, however, owing to cointegration (and, hence, strong collinearity) between *DEPO* and *FMMR*.[25] The

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[24]For instance, the likelihood ratio test for full-PAS evaluates whether (0.25*a_3* 0.19) is, in absolute value, statistically not different from (0.25*a_4* 0.23). Given that semi-PAS already holds, we are in fact testing whether the mean of *DEPO* (0.19) is statistically not different from the mean of *TBILL* (0.23).

[25]Although individually I(1), the differential between *DEPO* and *FMMR* is found to be stationary, or, equivalently, the two interest rates are cointegrated with a coefficient that is not significantly different from unity. Nachega (2001) shows, however, that lagged changes

(continued...)

assumption of semi-PAS is also rejected by the data. Nachega (2000) estimates a broad money demand function for Rwanda using quarterly data over 1982-1998 and establishes income homogeneity, a positive and significant (0.2) deposit rate elasticity, and a strong negative correlation between broad money velocity and (*DEPO-LIBOR*).[26]

C. The Long-Run Demand for Quasi Money and Financial Deepening

30. Using a similar "general to specific" modeling strategy, the long-run demand for quasi money was estimated, resulting in the following parsimonious cointegrating (inverse) velocity equation:

$$qm - p - y = 9.03\, DEPO - 8.75\, TBILL - 10.21\, LIBOR\,, \tag{11}$$

where *qm* stands for nominal quasi money; see Table 6. The estimated semielasticities of the three interest rates support semi-PAS and are significantly different from zero.[27] The trend coefficient is not statistically significant and is therefore constrained to zero. This is in contrast with the result obtained when estimating M2. It can thus be hypothesized that, when estimating M2, the trend is capturing some form of monetization of the economy beyond what can be explained by interest rate developments alone. However, given the finding that the vector of rates of return is sufficient to explain the actual behavior of quasi money velocity, this monetization may have resulted from increased demand for narrow money (M1) during the 1990s.[28] Equation (11) implies long-run full elasticities of 0.43 for *DEPO*, 0.50 for *TBILL*, and 0.26 for *LIBOR*. Likelihood ratio tests for equal full elasticities are conducted for *DEPO* and *LIBOR*, for *TBILL* and *LIBOR*, and for *DEPO* and *TBILL*. Full PAS is rejected for *TBILL* and *DEPO* ($\chi^2_{(1)}$=6.8[0.01]) and for *TBILL* and *LIBOR* ($\chi^2_{(1)}$=4.5[0.03]). Interestingly, full-PAS is not rejected for *DEPO* and *LIBOR* ($\chi^2_{(1)}$=3.52[0.06]). The holding of full-PAS between quasi-monetary assets and foreign bank deposits, in contrast with its rejection in the case of broad money, makes sense intuitively as

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in *FMMR* affect significantly (at the 10 percent level) the short-run dynamics of broad money demand.

[26]The cointegration tests reveal the existence of two vectors: a money demand function and an IS curve. For the purpose of systems identification, *LIBOR* is excluded from the monetary sector, but enters the IS relation. *DEPO* and *LIBOR* are found to enter the latter equation with an equal semielasticity in absolute terms.

[27]The semi-PAS restriction yields: $qm - p - y = 8.72\, DEPO - 8.72\, TBILL - 8.72\, LIBOR$.

[28]Developments exogenous to the financial sector, such as security problems (during the civil war), unattractive producer prices, and a very inefficient payments system, may have contributed to a fall in the demand for M1 during the 1980s. Public confidence was further undermined by the 1987 currency exchange, which imposed a tax of 30 percent on holdings of currency and bank deposits. See Henstridge (1999), Brownbridge (1998), and Sharer and others (1995).

the M1 component of broad money is held mainly for transaction purposes, unlike quasi-monetary assets which are held primarily for store of wealth—or saving—considerations. Weak exogeneity is demonstrated for the three interest rates considered individually, but rejected when these are considered jointly. Quasi-money velocity is found to be endogenous: should there be an exogenous shock that pushes quasi-money velocity off its long-run path, 39 percent of the actual disequilibrium will be corrected in the next quarter. Various misspecification tests of the seven-order unrestricted structural VAR in Table 7 do not reveal any problems.

31. One indicator of financial depth used in the literature is the ratio of quasi money over broad money (hereafter "FD"). Figure 5 plots the behavior of FD. The FD ratio declined from 24 percent in 1980 to less than 8 percent in 1988, but increased considerably since 1989 to peak at more than 34 percent in 1998. On average, the FD ratio declined by 2.4 percent per quarter between 1982 and 1988 and increased by an average of 4.2 percent per quarter from 1989 to 1998. Figure 5 shows that, in the long run, these trends are explained by domestic and international interest rate developments, especially in the period when financial liberalization was under way. Low inflation and a stable currency are important for facilitating positive domestic real rates of return and a small differential between foreign and domestic interest rates, and for strengthening confidence in the domestic banking system.[29] It will be shown later, in the error-correction model, that inflation and exchange rate depreciation have significant negative effects on the short-run dynamics of broad money demand.

32. In sum, the cointegration analysis discussed in this section confirms that the liberalization of domestic interest rates has led to increased financial savings in the form of money holdings in the domestic banking system. In addition, the empirical evidence suggests a relatively high degree of integration between the Ugandan and the international financial markets. Figure 3 confirms that developments in domestic and international nominal interest rates were important determinants of the long-run behavior of broad money and quasi-money velocities from the early 1980s through the late 1990s.

D. The Short-Run Dynamics of Broad Money Velocity

33. Having established the existence of cointegration and in accordance with the Granger representation theorem, I now model changes in broad money velocity as a response to departures from the stationary linear combination of the I(1) variables, augmented by short-run dynamics from the current and lagged first differences of the variables included in the cointegrating vector, as well as by any other stationary variables, such as inflation and currency depreciation. Using the general-to-specific methodology and eliminating insignificant lags yields a parsimonious model, with most of the variables found to be

[29] Another indicator of financial depth is the ratio of currency to broad money. This ratio averaged 30.4 percent over 1992-98 compared with 39.5 percent over 1980-86.

significant and of the expected sign for the short-run dynamics of the inverse broad money velocity:[30]

$$\underset{}{\Delta(m-p-y)_t} = \underset{(4.3)}{2.5} + \underset{(3.7)}{3.7}\,\Delta(DEPO\text{-}TBILL)_t \; - \underset{(-7.7)}{1.2}\,\Delta p_t - \underset{(-4.9)}{0.4}\,\Delta e_t - \underset{(-5.2)}{0.3}\, ecm_{t-1}$$

$$- \underset{(-4.7)}{4.3}\,\Delta(DEPO\text{-}TBILL)_{t-1} + \underset{(3.5)}{5.6}\,\Delta LIBOR_{t-4} + \underset{(5.0)}{7.9}\,\Delta LIBOR_{t-6}$$

$$+ \underset{(2.6)}{0.2}\,\Delta(m-p-y)_{t-4} + \underset{(2.0)}{0.1}\,\Delta(m-p-y)_{t-6} \qquad (12)$$

T = 63[1983/2-98/4]
R^2 = 0.81
$F(13, 49)$ = 16.6
SE = 0.11
DW = 1.73
AR 1-4: $F(4, 45)$ = 1.11[0.361]
ARCH(4): $F(4, 41)$ = 1.59[0.196]
Normality: $\chi^2(2)$ = 0.23[0.89]
RESET(1) : $F(1, 48)$ = 0.62[0.43] ,

where T is the number of observations; R^2 is the squared multiple correlation coefficient; and SE is the standard deviation of the residuals.[31] The definitions of the remaining statistics are provided below.

34. The empirical model performs well, both in terms of economic theory and on purely statistical grounds. The change in broad money demand is negatively and highly significantly related to inflation and currency depreciation. The short-run semielasticity of currency depreciation is weaker than that of inflation. A positive change in the differential between *DEPO* and *TBILL* slows velocity. The short-run sensitivity of financial savings is weaker than that found in the long-run model. In this specification including inflation and currency depreciation, current changes in *LIBOR* do not significantly affect the demand for real broad money. The error-correction term from the long-run broad money demand function is significant and negatively affects the short-run dynamics. Clearly, real broad money balances have a tendency to restore equilibrium in the money market: should there be an exogenous shock that pushes broad money velocity off its long-run path, 30 percent of the actual disequilibrium will be corrected in the next quarter.

35. Lagged changes in (*DEPO-TBILL*) and *LIBOR* have signs that are not easily interpretable. Economic agents may be overreacting to actual changes in rates of return,

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[30] *t*-values are in parentheses and "Δ" stands for the first difference of a specific variable.

[31] $ecm = m - p - y - 11.15\, DEPO + 11.15\, TBILL + 11.15\, LIBOR$.

implying that they will reevaluate their portfolio adjustments later on. Such behavior is consistent with the "overshooting" hypothesis (Dornbusch, 1976). For consistency, one has to show that current values of $\Delta LIBOR$ ($\Delta DEPO$-$\Delta TBILL$) affects positively (negatively) the dynamics of broad money velocity. This is indeed the case in specifications where currency depreciation and inflation are excluded from the short-run dynamics. See Figure 9 for the recursive estimates of one such specification, in which the (alternative) model excludes inflation and currency depreciation and $\Delta LIBOR$ ($\Delta DEPO$-$\Delta TBILL$) affects positively (negatively) broad money velocity.

36. The model also performs well on statistical grounds, as suggested by the diagnostic tests. The diagnostic statistics test against several alternative hypotheses—residual autocorrelation (Durbin Watson and AR), skewness and excess kurtosis (normality), autoregressive conditional heteroscedasticity (ARCH), and heteroscedasticity (RESET). None of the diagnostic statistics of our error-correction model reveals a problem. Model stability and parameter constancy are also good over the sample period. Figure 8 shows that 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 the parsimonious specification and the three Chow tests indicate a similar degree of stability. Thus the steady recursive estimation performance of the model lends support to the initial implicit assumption that, over the sample period, all the current dated variables of the model are weakly exogenous for the parameters of (inverse) broad money velocity. In addition, the relative constancy of the estimated parameters suggests that our model is immune to the Lucas critique.

E. Is Inflation a Long-Run Monetary Phenomenon in Uganda?

37. After analyzing the monetary sector, I now turn to the estimation of equilibrium relations in the foreign sector, with a view to capturing the foreign sector long-run transmission mechanisms of the inflation process in Uganda. Estimation of equations (3) and (4) through Johansen cointegration analysis resulted in the following long-run-equilibrium relations:[32]

$$ecp = ner + 1.3\,(p^* - p)\text{, and} \tag{13}$$

$$ecuip = DEPO - (LIBOR + \Delta ey)\text{,} \tag{14}$$

where Δey is the four-quarter (annual) actual currency depreciation rate and the estimated constant is omitted for brevity. Relation (13) holds over the period 1984:Q2-1998:Q4 and implies that only weak-form absolute PPP holds over this period—the coefficient 1.3 is

[32]Due to space considerations, the cointegration results underlying these two relations are not reported in this paper. The reader can rely on Figure 4 and Figure 6 to see why PPP and UIP hold. Nevertheless, the econometric results can be obtained by sending an e-mail to the author.

statistically different from 1. However, over 1981:Q2-1998:Q4 the real effective exchange rate is trend stationary in Uganda, using both the Johansen and the ADF tests, implying that strict absolute PPP holds over this extended period.[33] The α matrix also reveals that the exchange rate is weakly exogeneous with respect to prices during 1981:Q2-1998:Q4, while it is endogeneously determined over 1984:Q2-1998:Q4. In other words, over the extended period characterized by a less rigidly fixed exchange rate, *ner* adjusts much faster than domestic prices to restore equilibrium in the PPP relation. Relation (14) implies that deviations from UIP are stationary over the sample period. The α matrix also reveals that the exchange rate adjusts much faster than domestic interest rates to restore equilibrium in the financial markets. Figure 4 displays the three cointegrating vectors of the monetary, tradable goods, and asset markets. Interestingly, the period marked by financial liberalization is characterized, on average, by a positive interest rate differential (in favor of Uganda), even after being adjusted for currency depreciation. Thus, with the estimation of error-correction terms (*ecm*, *ecuip*, and *ecp*) that capture the inflationary effect of deviations from the long-term steady state relations in the three markets, equation (5) can now be estimated. Various stationary variables in levels or first differences are added to capture the short-term effect, with a view to investigating the short-term policy implications of financial liberalization and macroeconomic stability for inflation control in Uganda.

38. The econometric results of the inflation equation are reported in Table 10. All the variables have the expected sign. Specification 5 is the preferred one. The error-correction term from the monetary sector enters positively and substantially, suggesting that in the long run inflation is a monetary phenomenon. However, *ecp (-1)* and *ecuip (-1)* are also significant, implying that the foreign sector also plays a significant role in the determination of inflation in Uganda. More specifically, a real depreciation (appreciation) of the exchange rate increases (decreases) inflation in the long run, while a positive (negative) deviation from UIP causes inflation to fall (rise). While some of the stationary variables are not significant, all those capturing the short-term effect on inflation also have the expected sign. A policy of high real deposit rates (*RDEPO*) has a quite substantial negative effect on inflation. In the short run, the greatest positive inflationary effect is produced by increases in the return on foreign securities (as measured by $\Delta LIBOR$ and/or Δe). Foreign inflation (Δp^*) is only marginally significant. Broad money growth (Δm) has a short-run positive inflationary effect with one lag. In Specifications 1 to 3 changes in financial depth (ΔLFD) and in real income (Δy) have the expected negative sign but are only marginally significant, while in Specifications 1 to 4 changes in *TBILL* have the expected positive sign and are highly significant.[34] Lagged domestic

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[33] A 914 percent devaluation of the shilling (in nominal effective terms) in June 1981 may have affected the result of test in favor of strict PPP. The results of misspecification tests for this extended period—where strict PPP holds—are however problematic. This explains why the cointegrating vector derived from the restricted sample—where only weak-form PPP holds—are instead preferred.

[34] *LFD* stands for natural logarithm of the financial deepening ratio.

rates of inflation were not found to be significant and thus were removed from all the specifications.

IV. Conclusions and Policy Implications

39. This paper provides new insights into the relation among money, prices, income, and interest rates in Uganda—a developing country that adopted interest rate liberalization as part of an adjustment program—over the period 1982-98. The empirical results indicate a stable money demand function and a predictable relationship between inflation and monetary and external variables. The estimated long-run broad money demand function indicates a unitary income elasticity and is highly sensitive to domestic and foreign interest rates. In particular, the analysis suggests that a monetary policy aimed at an own rate of return on money that sufficiently exceeds both domestic and foreign opportunity costs can be an effective means of boosting domestic financial savings. Indeed, the empirical evidence supports a high degree of international capital mobility and asset substitutability. With regard to the short-run dynamics, the analysis suggests that the adjustment to shocks in the money market is fairly fast, and that the overshooting hypothesis may come into play when domestic and foreign interest rates change.

40. In the 1980s, Uganda experienced a severe financial disintermediation crisis, as real money balances declined in response to rising inflationary and devaluation pressures, and to a declining domestic spread between deposit rates and treasury bill rates. This development was reversed in the late 1980s and early 1990s, as the reorientation of macroeconomic and financial policies, a fall in inflation, and sustained growth led to a marked rise in money demand. It is shown that the financial deepening process and the decline in broad money velocity experienced by Uganda in the 1990s were due mainly to the liberalization of domestic interest rates and the decline in foreign interest rates in an environment of low inflation and exchange rate stability.

41. One of the policy implications of finding a sensible and stable broad money demand function is that it would enable the broad money aggregate to be used in the process of monetary targeting for inflation control in Uganda. The analysis suggests that, in the long run, Ugandan inflation is influenced by both monetary and external factors. Disequilibriums in the monetary and financial sectors, as well as in the tradable sector, have a lasting inflationary impact in Uganda. Changes in the return of foreign securities, in the exchange rate, and in import prices are found to have a positive inflationary effect in the short run. At the same time, it is shown that certain policy variables, such as positive real interest rates, strict money growth, and exchange rate stability, can be effective in controlling inflation in the short run.

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Definitions and Sources of Variables

Unless otherwise indicated, the data series are from the IMF *International Financial Statistics* (*IFS*) and Information Notice System (INS) databases, and Henstridge (1999). With the exception of interest rates, all the series are in natural logarithms.

p : consumer price index (line 64 in *IFS*). Hence, Δp is the rate of inflation.

m : nominal broad money (sum of *IFS* lines 34 and 35). Hence, ***m-p*** is real broad money, and Δm is broad money growth.

qm : quasi money in nominal terms (*IFS* line 35). Hence, ***qm-p*** is real quasi money.

p* : foreign effective price index (1995=100). Hence, Δp^* measures the foreign rate of inflation. Hence, $p - p^*$ is the ratio of domestic to foreign prices. Source: INS.

y : real monetary gross domestic income (1987 prices). Source: Henstridge (1999).

e : Uganda shillings per U.S. dollar exchange rate (period average; *IFS* line rf). Hence, Δe is the depreciation rate, and Δey is the annualized (four-quarter) depreciation rate.

ner : nominal effective exchange rate index (1995=100). Source: INS.

TBILL : 91-day treasury bill rate (*IFS* line 60c). This is the rate on 91-day treasury bills auctioned every two weeks.

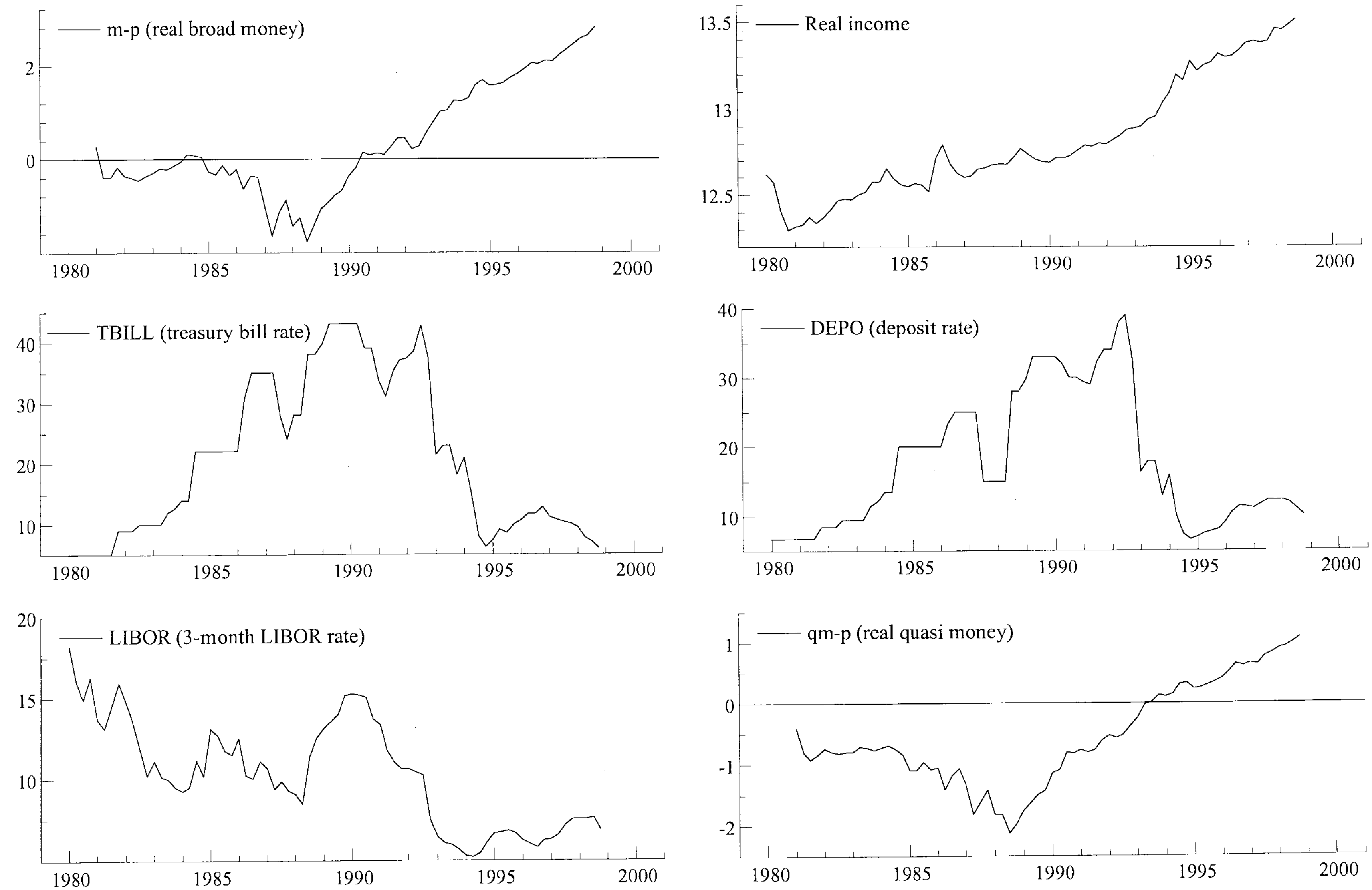
DEPO: deposit rate (*IFS* line 60l). This is the rate offered by commercial banks on time deposits of less than 12 months. ***RDEPO*** is the real interest rate (*DEPO* adjusted by annual inflation). Formally, *RDEPO* = [(1 + *DEPO*)/(1 + annual inflation)]-1.

LIBOR : London interbank offered rate (on three-month U.S. dollar-denominated deposits in London).

LR: lending rate (*IFS* line 60p). This is the rate offered by commercial banks on credit to finance exports and manufacturing production.

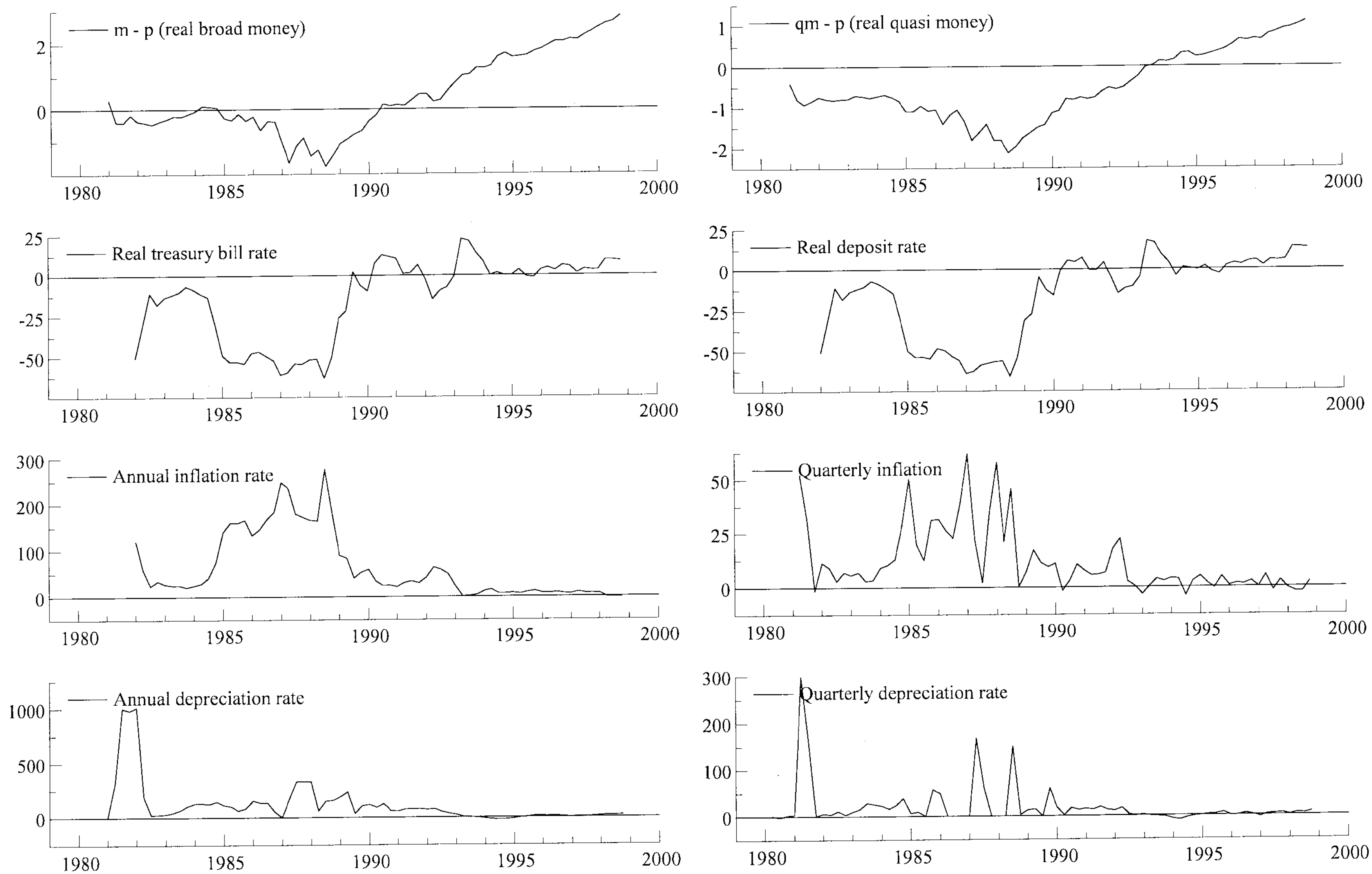
D85Q1: dummy variable taking value of one in 1985:Q1 and zero elsewhere.

Figure 1. Uganda: Money, Income, and Interest Rates, 1980-98



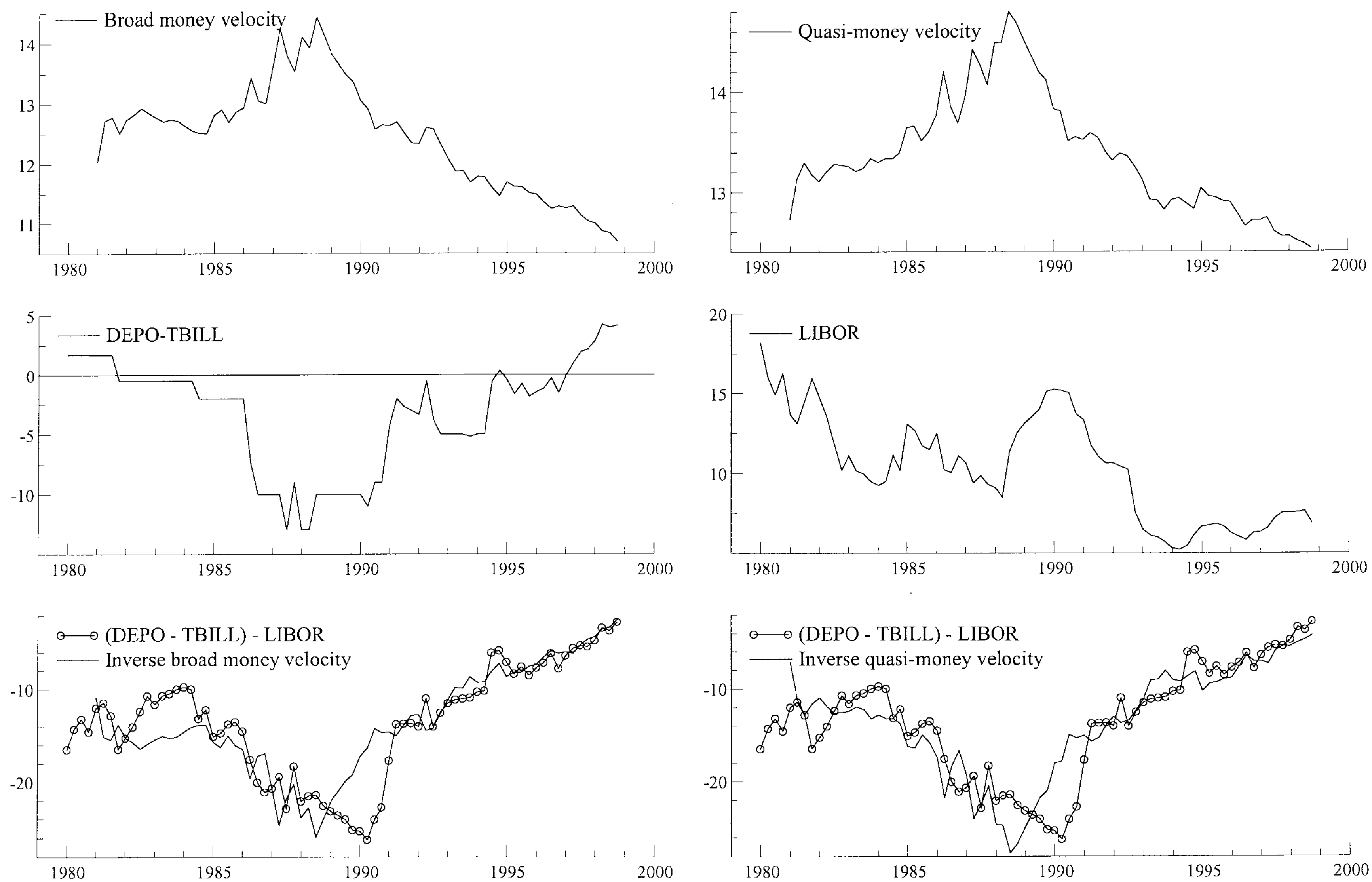
Sources: See Appendix.

Figure 2. Uganda: Inflation, Currency Depreciation, and Interest Rates, 1981-98



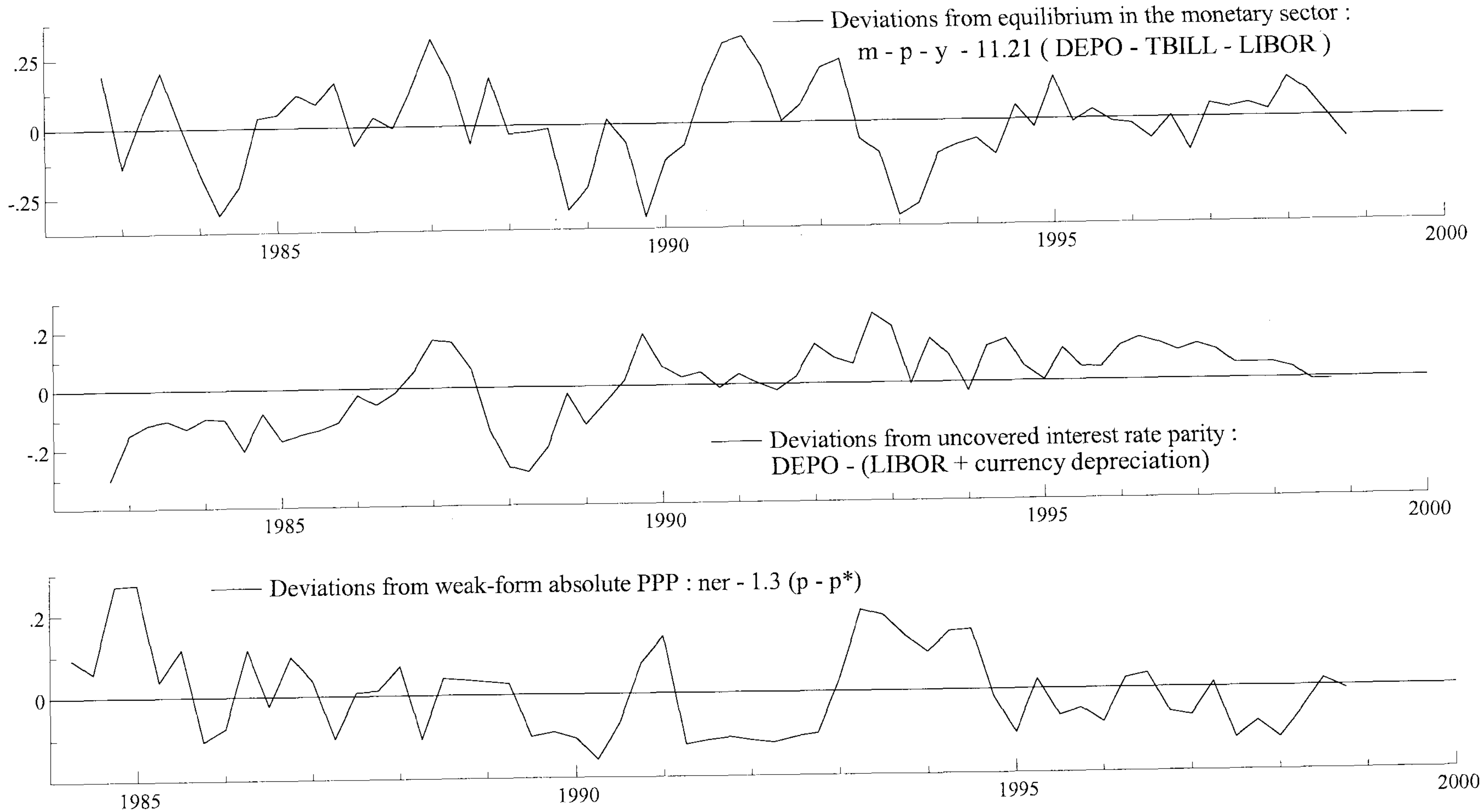
Sources: See Appendix.

Figure 3. Uganda: Velocity and Interest Rates, 1980-98



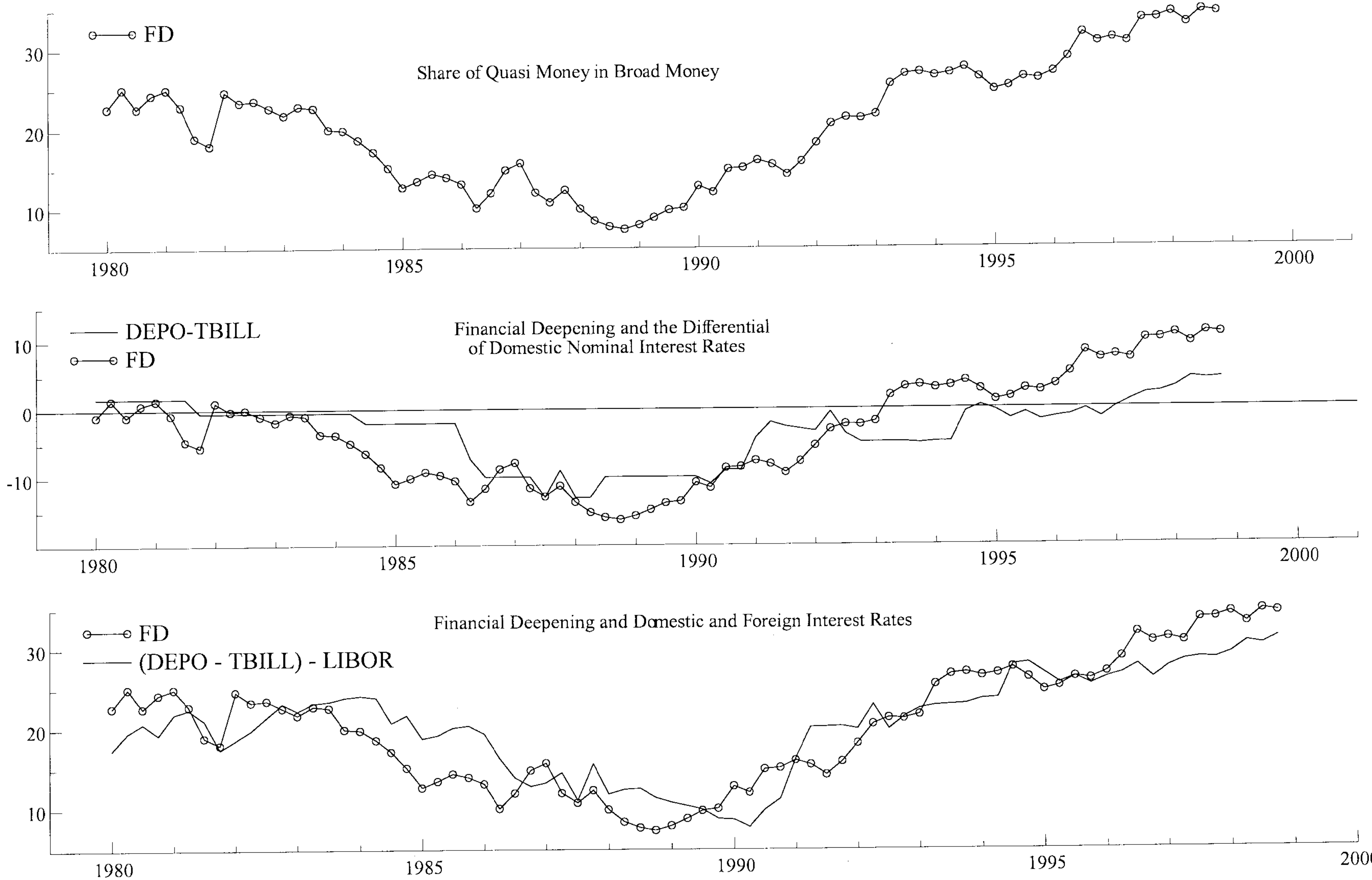
Sources: See Appendix.

Figure 4. Uganda: Cointegrating Relationships of the Monetary, Financial, and Foreign Sectors



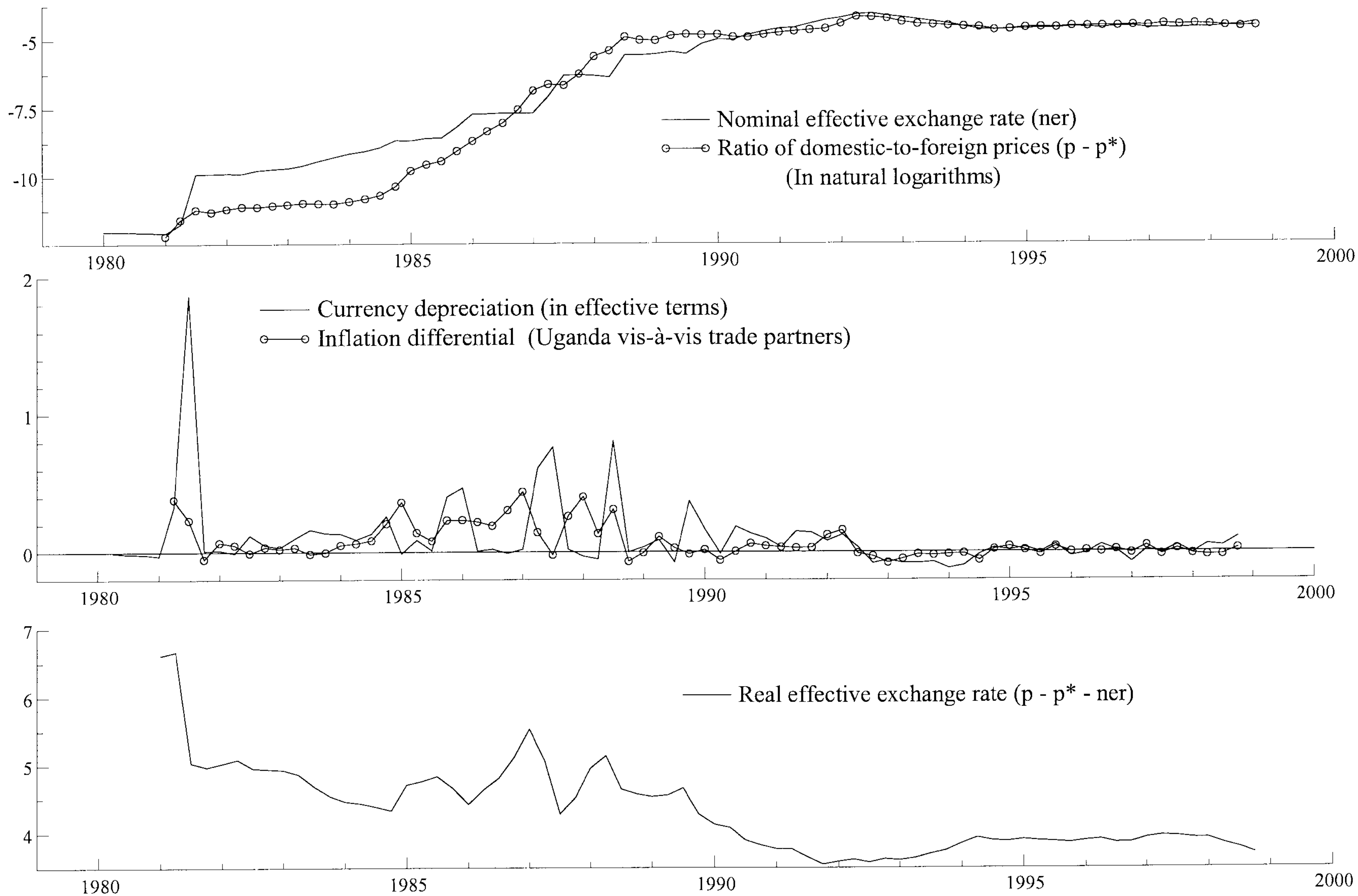
Sources: See Appendix.

Figure 5. Uganda: Financial Deepening and Interest Rates, 1980-98



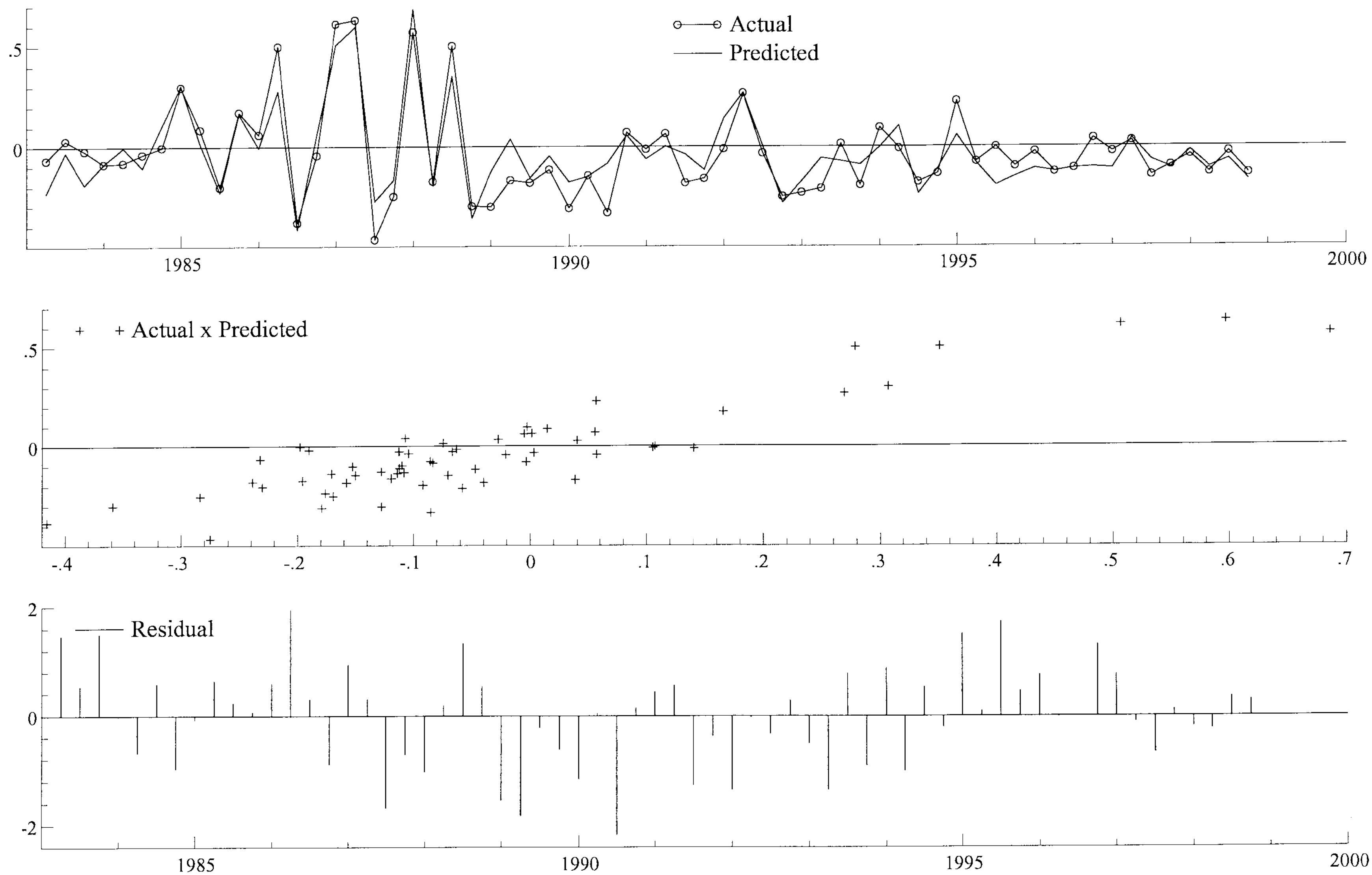
Sources: See Appendix.

Figure 6. Uganda: Effective Exchange Rates and Prices, 1980-98



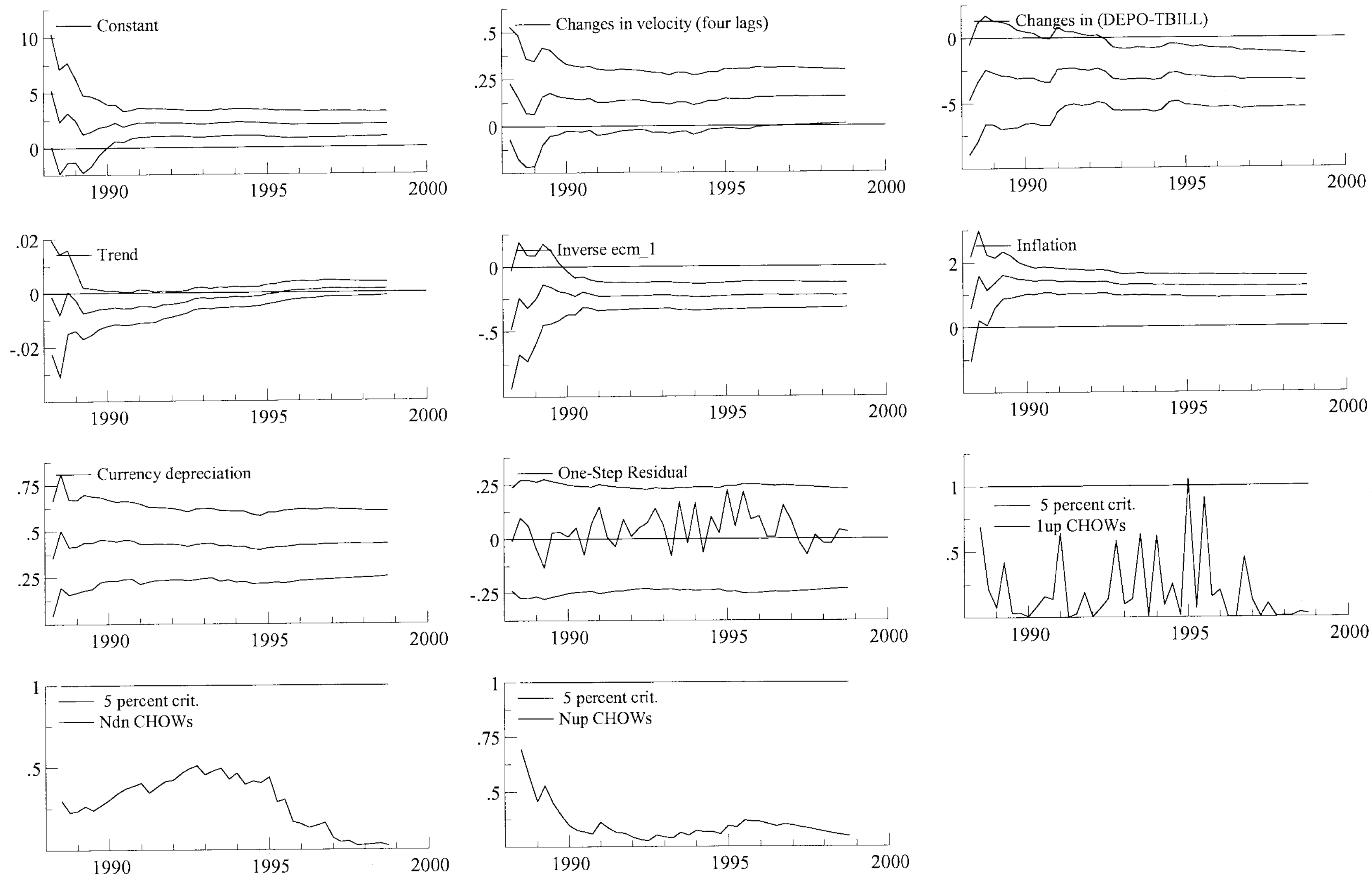
Sources: See Appendix.

Figure 7. Uganda: Changes in Broad Money Velocity : Actual and Predicted, 1983-98



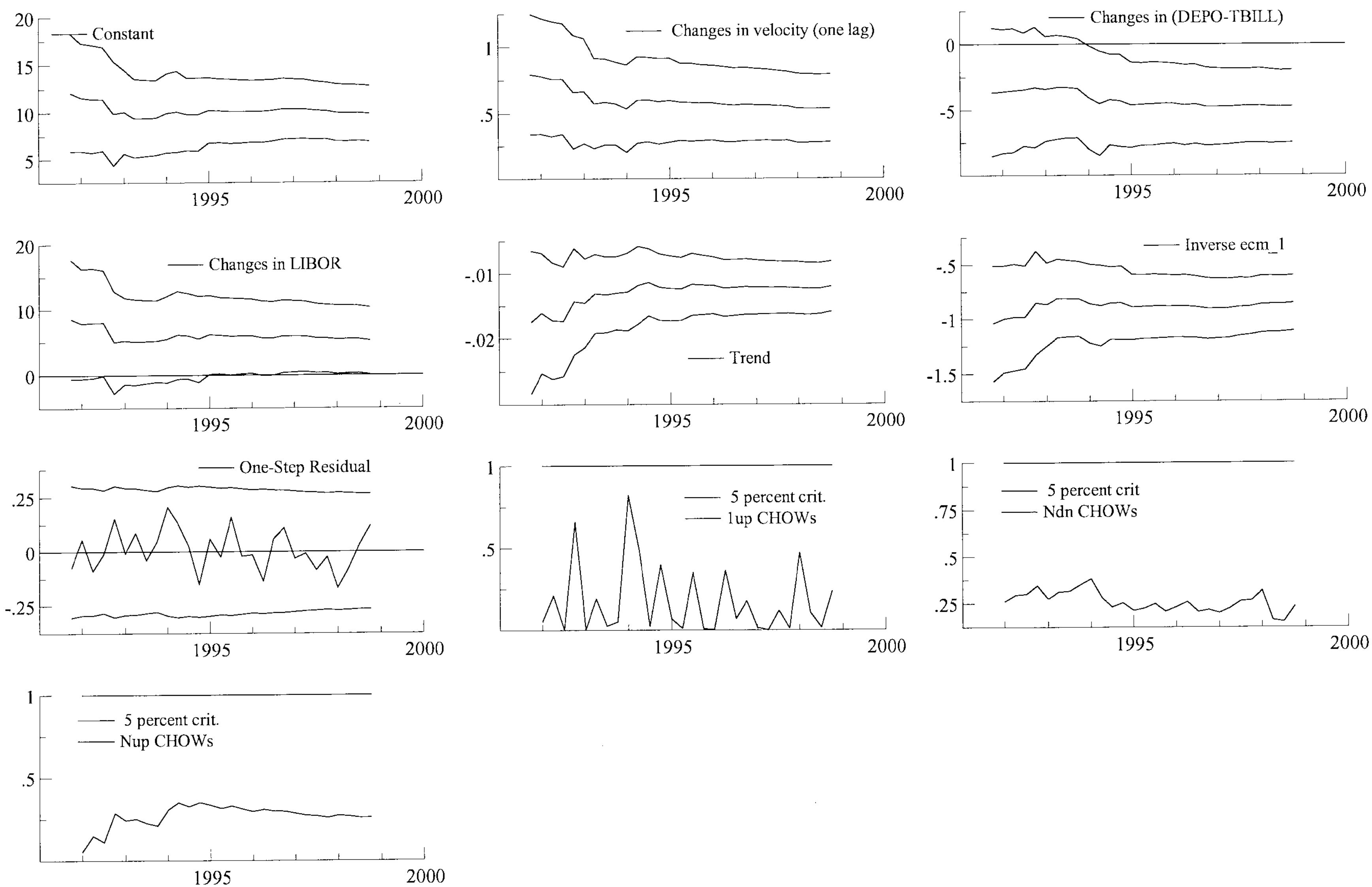
Sources: See Appendix.

Figure 8. Uganda: ECM for Broad Money Velocity I: Recursive Estimates and Stability Tests, 1988-98



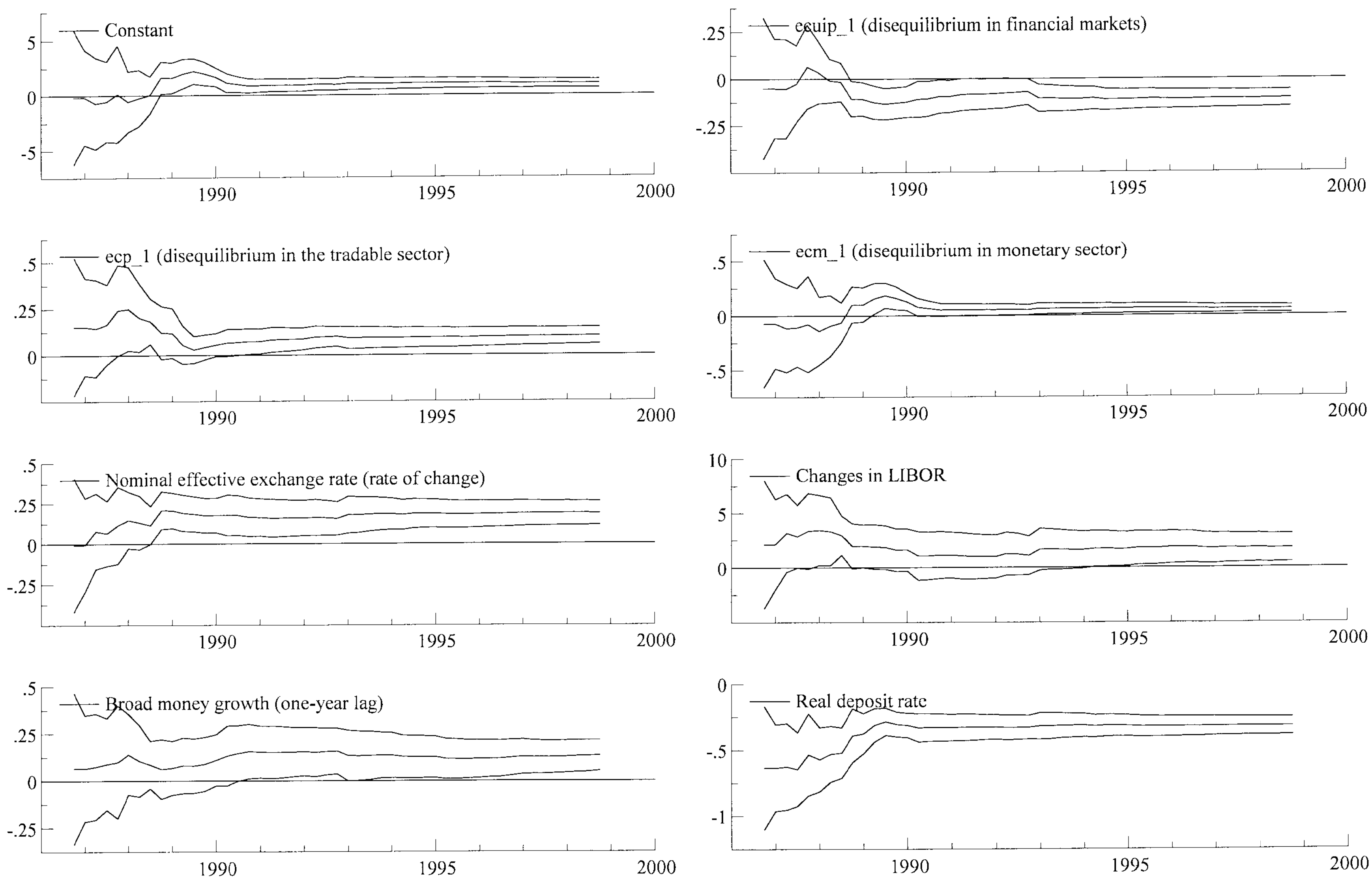
Sources: See Appendix.

Figure 9. Uganda: ECM for Broad Money Velocity II: Recursive Estimates and Stability Tests, 1992-98



Sources: See Appendix.

Figure 10. Uganda: ECM for Inflation: Recursive Estimates, 1987-98



Sources: See Appendix.

Figure 11. Uganda: ECM for Inflation: One-Step Residual and Chow Stability Tests, 1987-98

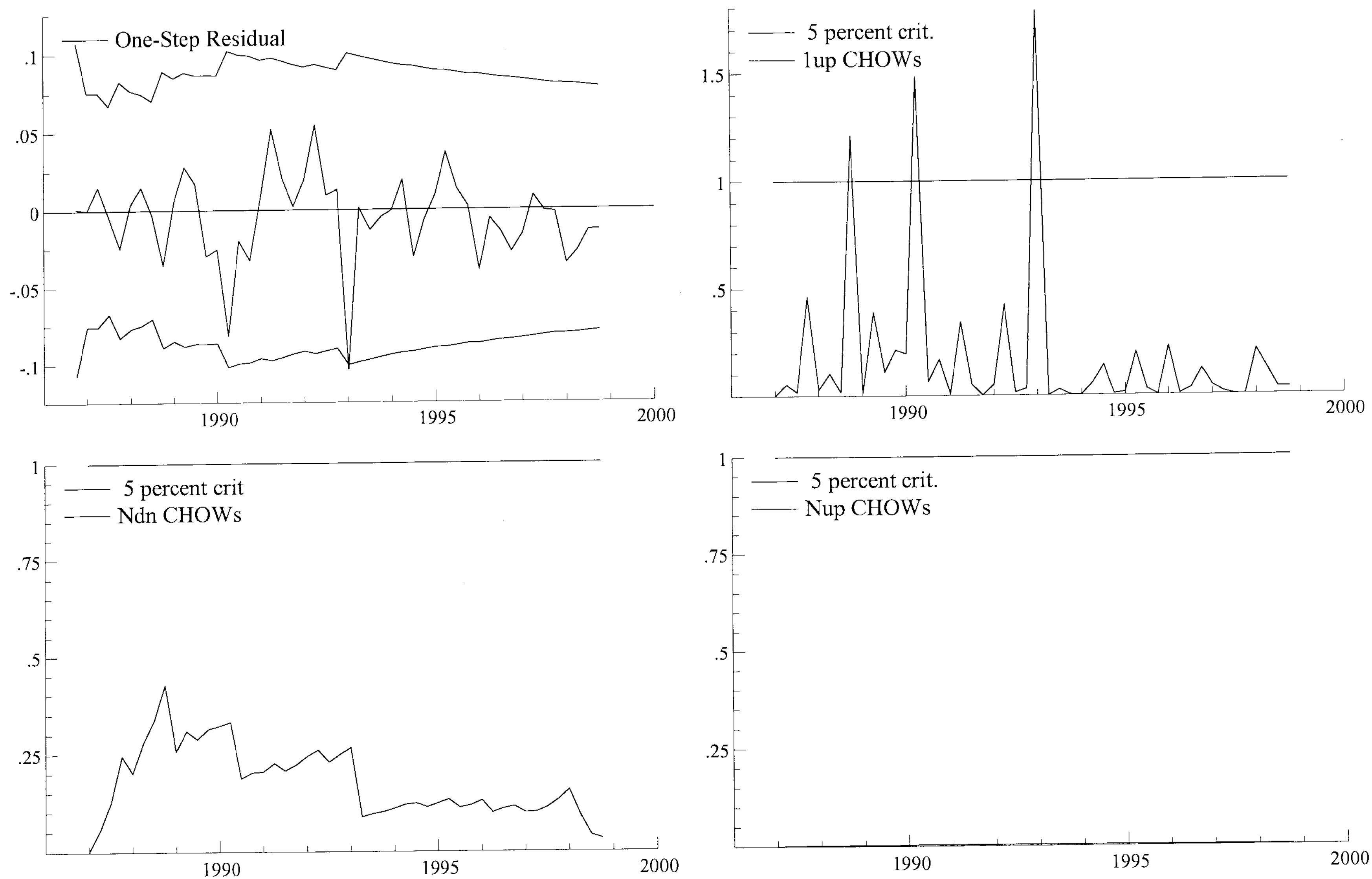
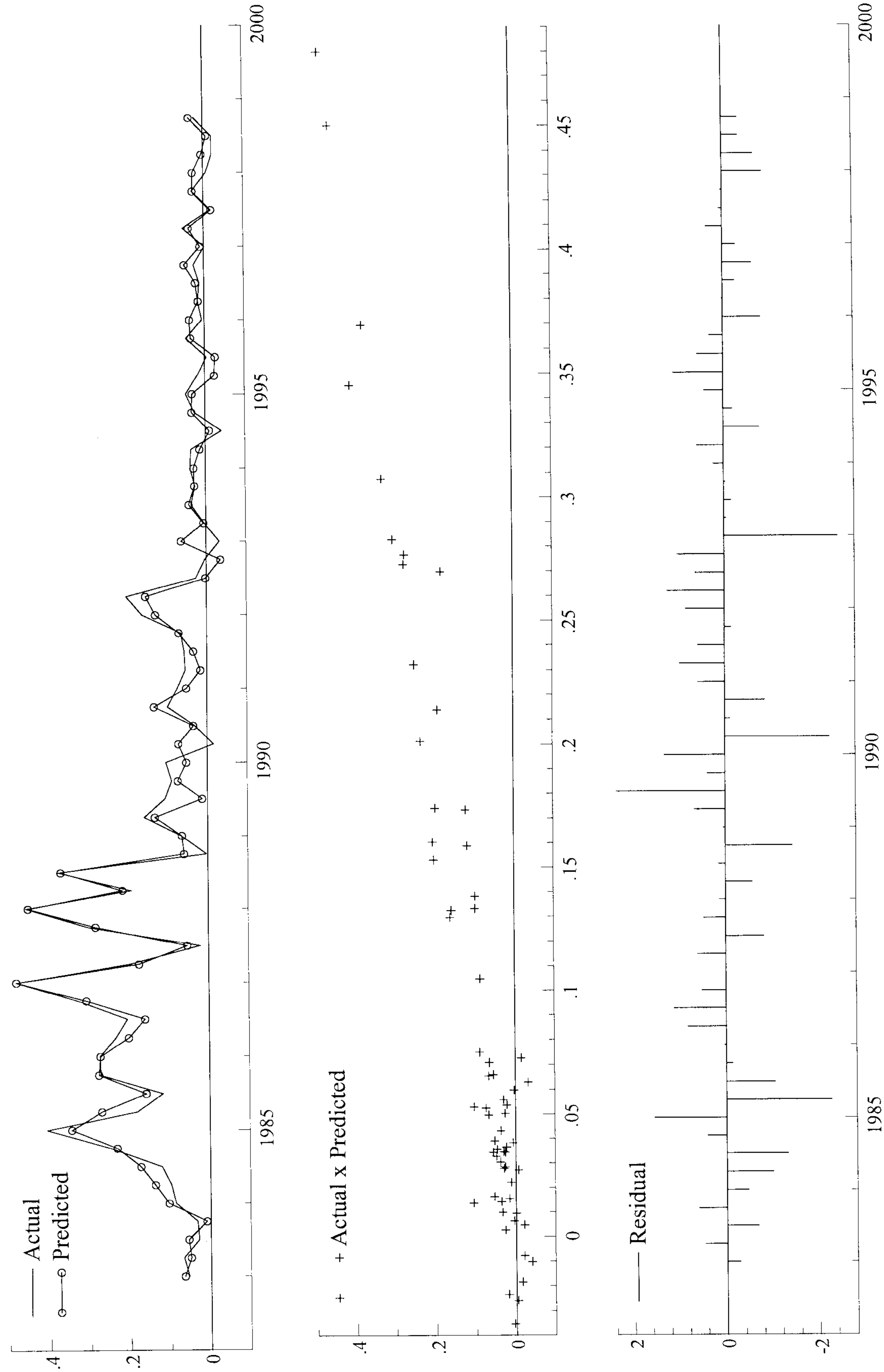


Figure 12. Uganda: Inflation: Actual, Predicted, and Residual, 1983-98



Sources: See Appendix.

Table 1. Selected Financial and Economic Indicators, 1965-98

	LR	*DEPO*	*IM*	*INF*	*GR*	*PCGR*	*LIBOR*	*TBILL*	ΔNER	*QM/M2*	*M2/GDP*	*CU/M2*
1965-69		...	...	...	5.3	2.6	...	...	...	...	14.4	...
1970	...	...	...	...	1.5	-1.2	...	...	...	...	13.9	...
1980	...	6.8	...	...	-3.4	-6.0	16	5		23.7	9.7	39.7
1981	12.5	6.8	5.7	106	3.9	1.3	14	5	442	21.3	9.5	33.4
1982-84	17.5	12.1	5.4	42	3.4	0.8	11	13	153	21.1	8.6	37.5
1985-88	31.8	21.2	10.5	180	2.6	0.1	11	29	132	11.8	9.9	45.6
1988-92	37.1	30.4	6.8	45	5.2	2.5	12	38	80	19.7	7.6	37.3
1993-97	19.1	11.3	7.8	8	7.5	4.4	6	13	-8	27.9	11.5	30.1
1998	20.9	11.4	9.5	0	5.5	2.6	7	8	10	34.1	14.4	25.4

Sources: IMF, *International Financial Statistics*, and *World Economic Outlook*.

Notes: *LR* is the lending rate, *DEPO* is the deposit rate, *IM* is the financial intermediation margin (*LR-DEPO*), *INF* is the inflation rate, *GR* is the real *GDP* growth rate, *PCGR* is the per capita GDP growth rate, *LIBOR* is the LIBOR rate on three-month U.S. dollar-denominated deposits in London, *TBILL* is the 91-day treasury bill rate, ΔNER is the nominal effective exchange rate depreciation (national currency per foreign currency), *QM/M2* is ratio of quasi money over broad money (in percent); *M2/GDP* is the ratio of broad money to GDP (in percent), and *CU/M2* is the ratio of currency to broad money (in percent).

Table 2. ADF Statistics for Testing for a Unit Root

Variables	t-ADF	Lag
In levels		
m - p	-1.52	5
qm-p	-1.97	5
m - p - y	-2.38	5
qm - p - y	-2.76	5
y	-1.61	0
Δp	-4.92**	1
Δe	-7.47**	2
DEPO-TBILL	-1.59	0
LIBOR	-2.83	4
DEPO	-2.11	3
TBILL	-1.69	1
RDEPO	-3.82*	6
RTBILL	-3.43	6
In first differences		
m - p	-8.24**	0
qm-p	-8.01**	0
m - p - y	-9.16**	0
qm - p - y	-8.33**	0
y	-8.42**	0
DEPO-TBILL	-8.65**	0
LIBOR	-7.46**	0
DEPO	-7.14**	0
TBILL	-6.99**	0
RDEPO	-6.54**	0
RTBILL	-6.56**	0

Notes: The estimation period is 1982:Q4-1998:Q4 for variables expressed in levels and 1983:Q1-1998:Q4 for variables expressed in first differences. See Appendix for definitions 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. The ADF statistics are testing a null hypothesis of a unit root in each variable 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

Eigenvalues	0.71	0.33	0.16	0.07
Hypotheses	$r = 0$	$r <= 1$	$r <= 2$	$r <= 3$
Lambda max	44.1**	14.4	6.4	2.7
95 percent critical value	31.5	25.5	19.0	12.3
Lambda trace	67.8*	23.6	9.1	2.7
95 percent critical value	63.0	42.4	25.3	12.3
	Standardized eigenvectors			
	m - p	*y*	*DEPO-TBILL*	*LIBOR*
	1.00	-1.23	-11.14	8.16
	Standardized adjustment coefficients			
	m - p	*y*	*DEPO-TBILL*	*LIBOR*
	-0.62	-0.01	0.03	-0.01
	Weak exogeneity test statistics			
	m - p	*y*	*DEPO-TBILL*	*LIBOR*
$\chi^2(2)$	28.2**	0.7	7.1*	4.2
	Statistics for testing the significance of a given variable			
	m - p	*y*	*DEPO-TBILL*	*LIBOR*
$\chi^2(1)$	51.3**	11.6**	39.3**	22.1**
	Multivariate statistics for testing stationarity			
	m - p	*y*	*DEPO-TBILL*	*LIBOR*
$\chi^2(3)$	64.3**	71.5**	70.2**	60.6**

Notes: The estimation period is 1983:Q2-1998:Q4. See Appendix for definitions, construction, and sources of variables. The VAR includes seven lags on each variable, a constant term, a trend term, and seasonal dummies.

Johansen's maximal and trace eigenvalue statistics for testing cointegration are adjusted for degrees of freedom.

The system-based test statistics for weak exogeneity, significance, and stationarity are evaluated under the assumption that $r=1$ and hence are asymptotically distributed as $\chi^2(2)$, $\chi^2(1)$, or $\chi^2(3)$ if weak exogeneity, significance, or stationarity of the specified variable is valid. Weak exogeneity tests are conducted under the assumption of income homogeneity.

Table 4. Cointegration Analysis of Broad Money Velocity I

Eigenvalues	0.52	0.25	0.10
Hypotheses	$r = 0$	$r <= 1$	$r <= 2$
Lambda max	28.3**	11.1	4.1
95 percent critical value	25.5	19.0	12.3
Lambda trace	43.5**	15.2	4.1
95 percent critical value	42.4	25.3	12.3
		Standardized eigenvectors	
	p + y - m	*DEPO-TBILL*	*LIBOR*
	1.00	11.92	-8.56
		Standardized adjustment coefficients	
	p + y - m	*DEPO-TBILL*	*LIBOR*
	-0.98	-0.03	0.02
		Weak exogeneity test statistics	
	p + y - m	*DEPO-TBILL*	*LIBOR*
$\chi^2(1)$	17.7**	1.7	1.9
		Statistics for testing the significance of a given variable	
	p + y - m	*DEPO-TBILL*	*LIBOR*
$\chi^2(1)$	26.7**	24.6**	19.9**
		Multivariate statistics for testing stationarity	
	p + y - m	*DEPO-TBILL*	*LIBOR*
$\chi^2(2)$	37.4**	38.6**	31.7**

Notes: The estimation period is 1983:Q2-1998:Q4. See Appendix for definitions and sources of variables. The VAR includes eight lags on each variable, a constant term, a trend term, and seasonal dummies.

Johansen's maximal and trace eigenvalue statistics for testing cointegration are adjusted for degrees of freedom.

The system-based test statistics for weak exogeneity, significance, and stationarity are evaluated under the assumption that r=1 and hence are asymptotically distributed as $\chi^2(2)$, $\chi^2(1)$, or $\chi^2(2)$ if weak exogeneity, no long-run presence, or stationarity of the specified variable is valid.

Table 5. Cointegration Analysis of Broad Money Velocity II

Eigenvalues	0.68	0.29	0.26	0.16
Hypotheses	$r = 0$	$r <= 1$	$r <= 2$	$r <= 3$
Lambda max	42.0**	12.8	11.3	6.3
95 percent critical value	31.5	25.5	19.0	12.3
Lambda trace	72.4**	30.4	17.6	6.3
95 percent critical value	63.0	42.4	25.3	12.3
	Standardized eigenvectors			
	m - p - y	*DEPO*	*TBILL*	*LIBOR*
	1.00	-10.45	10.97	8.81
	Standardized adjustment coefficients			
	m - p - y	*DEPO*	*TBILL*	*LIBOR*
	-0.67	0.04	0.00	-0.02
	Weak exogeneity test statistics			
	m - p - y	*DEPO*	*TBILL*	*LIBOR*
$\chi^2(1)$	28.9**	3.8	0.2	5.9*
	Statistics for testing the significance of a given variable			
	m - p - y	*DEPO*	*TBILL*	*LIBOR*
$\chi^2(1)$	37.2**	22.9**	24.7**	17.1**
	Multivariate statistics for testing stationarity			
	m - p - y	*DEPO*	*TBILL*	*LIBOR*
$\chi^2(3)$	59.7**	60.1**	59.5**	59.4**

Notes: The estimation period is 1982:Q4 -1998:Q4. See Appendix for definitions, construction, and sources of variables. The VAR includes seven lags on each variable, a constant term, a trend term, and seasonal dummies.

Johansen's maximal and trace eigenvalue statistics for testing cointegration are adjusted for degrees of freedom.

The system-based test statistics for weak exogeneity, significance, and stationarity are evaluated under the assumption that r=1 and hence are asymptotically distributed as $\chi^2(1)$, $\chi^2(1)$, or $\chi^2(3)$ if weak exogeneity, no long-run presence, or stationarity of the specified variable is valid.

Table 6. Cointegration Analysis of Quasi-Money Velocity

Eigenvalues	0.66	0.36	0.26	0.12
Hypotheses	$r = 0$	$r <= 1$	$r <= 2$	$r <= 3$
Lambda max	37.9**	15.8	10.5	4.4
95 percent critical value	31.5	25.5	19.0	12.3
Lambda trace	68.6*	30.7	14.9	4.4
95 percent critical value	63.0	42.4	25.3	12.3
	Standardized eigenvectors			
	qm - p - y	*DEPO*	*TBILL*	*LIBOR*
	1.00	-9.03	8.75	10.21
	Standardized adjustment coefficients			
	qm - p - y	*DEPO*	*TBILL*	*LIBOR*
	-0.39	-0.07	0.01	0.02
	Weak exogeneity test statistics			
	qm - p - y	*DEPO*	*TBILL*	*LIBOR*
$\chi^2(1)$	28.9**	3.5	0.0	3.1
	Statistics for testing the significance of a given variable			
	qm - p - y	*DEPO*	*TBILL*	*LIBOR*
$\chi^2(1)$	24.3**	20.8**	18.5**	29.5**
	Multivariate statistics for testing stationarity			
	qm - p - y	*DEPO*	*TBILL*	*LIBOR*
$\chi^2(3)$	55.6**	55.5**	55.7**	56.7**

Notes: The estimation period is 1983:Q2 -1998:Q4. See Appendix for definitions, construction, and sources of variables. The VAR includes seven lags on each variable, a constant term, a trend term, and seasonal dummies.
Johansen's maximal and trace eigenvalue statistics for testing cointegration are adjusted for degrees of freedom.
The system-based test statistics for weak exogeneity, significance, and stationarity are evaluated under the assumption that r=1 and hence are asymptotically distributed as $\chi^2(1)$, $\chi^2(1)$, or $\chi^2(3)$ if weak exogeneity, no long-run presence, or stationarity of the specified variable is valid.

Table 7. Properties of VAR Residuals

Table 7a. Properties of VAR(7) Residuals: Broad Money Demand

	m - p	*y*	*DEPO-TBILL*	*LIBOR*	*Vector*
AR 1-4	1.09	1.87	3.14*	1.16	1.21
Normality	0.10	4.03	1.79	1.47	7.11
ARCH 4	0.36	0.90	0.31	0.58	...
Portmanteau	4.96	6.26	6.07	6.73	77.14

Table 7b. Properties of VAR(8) Residuals: Broad Money Velocity I

	p + y - m	*DEPO-TBILL*	*LIBOR*	*Vector*
AR 1-4	0.65	0.69	0.33	1.19
Normality	3.26	6.08*	5.50	12.98*
ARCH 4	0.45	0.13	0.13	...
Portmanteau	7.32	1.9	4.68	45.5

Table 7c. Properties of VAR(7) Residuals: Broad Money Velocity II

	p + y - m	*DEPO*	*TBILL*	*LIBOR*	*Vector*
AR 1-5	2.08	1.62	0.82	0.91	1.41
Normality	1.63	3.98*	3.62*	0.18	4.38
ARCH 4	0.48	0.38	0.20	0.51	...
Portmanteau	8.81	8.65	9.10	5.53	115.39

Table 7d. Properties of VAR(7) Residuals: Quasi-Money Velocity

	p + y - qm	*DEPO*	*TBILL*	*LIBOR*	*Vector*
AR 1-4	1.43	0.96	0.82	0.07	1.14
Normality	2.52	8.14	6.73	1.17	4.15
ARCH 4	0.45	0.12	0.20	0.26	...
Portmanteau	4.80	7.84	3.04	3.50	92.10

Notes: see Appendix for definitions and sources of variables. AR denotes the results of LM (Lagrange multiplier) tests for residual autocorrelation of each single equation and of the system. Normality denotes the results of the Doornik-Hansen test for each variable and for the system as a whole. It checks whether the residuals are normally distributed. ARCH (autoregressive conditional heteroscedasticity) denotes the results of the LM tests for autocorrelated squared residuals. The portmanteau statistic is a degrees-of-freedom corrected version of the Box and Pierce statistic for each variable and for the system as a whole. See Doornik and Hendry (1997) for details.

Table 8. Mean and Standard Deviation of Variables

	$m - p$	$qm - p$	$m - p - y$	$qm - p - y$	y	Δp	Δe	*DEPO*	*TBILL*	*LIBOR*	*RDEPO*	*RTBILL*
Mean	0.42	-0.52	-12.46	-13.40	12.87	0.10	0.11	0.19	0.23	0.10	-15.97	-13.91
Standard deviation	1.20	0.85	0.93	0.60	0.31	0.12	0.19	0.10	0.12	0.03	24.93	24.51

Notes: See Appendix for definitions and sources of variables.

Table 9. Long-Run Interest Rate Elasticities

	Broad Money			Quasi Money		
	DEPO	*TBILL*	*LIBOR*	*DEPO*	*TBILL*	*LIBOR*
Annual semielasticity	10.45	10.97	8.81	9.03	8.75	10.21
Quarterly elasticity	0.50	0.63	0.21	0.43	0.50	0.25

Notes: The quarterly interest rate elasticities are computed as 0.25 * interest rate annual semielasticity * mean of the interest rate. See Appendix for definitions and sources of variables.

Table 10. Determinants of Inflation

	Specification 1	Specification 2	Specification 3	Specification 4	Specification 5
Constant	1.6	1.7	1.5	1.2	1.1
	(6.1)	(6.1)	(6.0)	(7.0)	(5.2)
ecm(-1)	0.11	0.12	0.10	0.07	0.06
	(5.0)	(5.1)	(4.6)	(4.2)	(3.3)
ecp(-1)	0.08	0.09	0.10	0.15	0.11
	(2.8)	(2.9)	(3.6)	(6.4)	(4.6)
ecuip(-1)	...	...	...	-0.12	-0.11
				(-5.6)	(-4.7)
RDEPO	-0.3	-0.3	-0.3	-0.3	-0.3
	(-7.7)	(-7.8)	(-8.3)	(-10.9)	(-8.8)
Δm	0.12	0.10	0.16	...	...
	(2.0)	(1.8)	(2.9)		
$\Delta m(-1)$	...	...	...	...	0.12
					(2.5)
Δy	-0.36	-0.34	-0.24	...	...
	(-2.1)	(-1.9)	(-1.5)		
Δp^*	0.66	0.62	0.60	0.61	0.31
	(1.6)	(1.5)	(1.5)	(2.1)	(1.0)
Δe	0.03	0.02	...	...	0.18
	(0.7)	(0.5)			(5.0)
Δ *TBILL*	0.91	0.85	0.86	0.44	...
	(4.5)	(4.1)	(4.5)	(2.7)	
Δ *LFD*	-0.15	-0.14	-0.14	...	...
	(-1.6)	(-1.5)	(-1.6)		
$\Delta(LIBOR + \Delta e)$	...	...	0.09	0.16	...
			(2.9)	(5.9)	
Δ *LIBOR*	...	0.9	...	1.9	1.7
		(1.0)		(3.0)	(2.7)
D85Q1	...	...	...	0.25	0.14
				(5.0)	(2.9)
Trend	-0.001	-0.001	-0.001	...	...
	(-1.6)	(-1.8)	(-1.4)		
R^2	0.84	0.85	0.86	0.91	0.92
F*(a,b)*	21.0	19.6	25.0	42.2	37.8
SE	0.05	0.05	0.05	0.04	0.04
DW	1.71	1.64	1.73	1.64	1.86
AR	2.12	1.92	1.5	1.5	1.31
Normality	3.1	6.4*	6.5*	4.1	5.5
ARCH	1.03	1.12	0.64	0.91	0.95
Xi^2	1.3	1.2	1.9	1.1	0.6
RESET	34.6**	27**	24.4**	21.6**	2.6

Notes: The dependent variable is Δp . The estimation period is 1983:Q1 - 1998:Q4; t-statistics are in parentheses. See Appendix for definitions and sources of variables.