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MONETARY POLICY IN THE END-GAME TO EXCHANGE-RATE BASED STABILIZATIONS: THE CASE OF MEXICO

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Abstract

Exchange-rate based stabilizations, while useful in accelerating the disinflation process, typically lead to overvalued exchange rates and large current account deficits. These factors, in turn, make it difficult to sustain exchange rate pegs, placing heavy demands upon monetary policy to sustain exchange-rate based programs in their later phases, This paper evaluates the extent to which Mexican monetary policy in 1994 may have loosened, or not tightened sufficiently, in the lead up to the devaluation of the peso that December. Using econometric models of the demand for money, we find evidence that the high growth of the monetary base in 1994 reflected strong positive shocks to the demand for money, not to its supply. Next, we estimate a monetary policy reaction function for Mexico. Basedon this estimate, we argue that interest rates rose only moderately less in 1994, in response to downward pressure on the peso and on international reserves, than was predicted by the authorities' reaction function. This result is qualified somewhat by our finding that if interest rates are modeled as reacting to reserves net of Tesobonos, rather than gross reserves, the measured deviation of actual from predicted interest rates would have been much greater. However, the relative complacency with which both the authorities and the market viewed the build-up in Tesobonos, at least until late in 1994, suggests that the reaction function based on net reserves probably does not capture "normal" monetary policy behavior. Our findings suggests that in order to have maintained the peg, the authorities would have needed to intensify their response to exchange market developments--that is, to alter their reaction function--at a time when concerns over the health of the banking sector, and of the economy more generally, would have pointed to a relaxation of monetary policy. Insofar as such tightening of monetary reaction functions are difficult to achieve, Mexico's experience suggests that policymakers relying on the exchange rate as a nominal anchor probably should be prepared either to abandon that anchor or tighten monetary policy well before speculative pressures intensify.

Monetary Policy in the End-Game to Exchange-Rate Based Stabilizations: The Case of Mexico

Steven B. Kamin and John H. Rogers[1]

I. Introduction and Summary

As considerable research has documented, reliance on the exchange rate as a nominal anchor, while useful in helping to bring inflation down quickly, leads to a host of developments that may threaten the continued process of disinflation and stabilization.[2] For reasons that continue to be debated, exchange-rate based stabilization nearly invariably leads to an appreciation of the real exchange rate and an expansion of the current account deficit. These developments, in turn, undermine the viability of the exchange-rate peg underlying the stabilization program, even if fiscal and structural policies have been appropriate.

The breakdowns of the so-called "tablita" experiments in the early 1980s, as well as of the "heterodox shock" programs in Argentina and Brazil in the later 1980s, in most cases stemmed primarily from failures to correct the underlying cause of inflation, the fiscal deficit. However, the withdrawal of various European countries from the ERM in 1992 and 1993 usually was not associated with significant fiscal deficit problems (Rose and Svensson (1994)). Similarly, Mexican fiscal policy in 1994, while somewhat looser than it had been in the immediately preceding years, was still much tighter than it had been in the 1980s. Even so, Mexico was forced to devalue the peso in December

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[2]See, among others, Kiguel and Liviatan (1992), Vegh (1992), Rebelo and Vegh (1995), and Uribe (1995).

1994. precipitating the most profound financial crisis since the onset of the debt crisis in 1982.

Hence, it appears that the most recent failures to maintain pegged exchange rates do not reflect the resumption of profligate macroeconomic policies. Rather, it seems that the breakdowns of exchange-rate pegs were induced by developments--real appreciation and current account deficits--endemic to exchange-rate based stabilizations themselves. These developments made the stabilization programs increasingly reliant upon a tightening of monetary policy to maintain the exchange-rate peg in the face of mounting reserve losses and speculative attacks. Mexico and various EMS participants failed to tighten monetary policy adequately in response to these developments, and as a result were forced to give up their pegs.

Under these circumstances, it is fair to ask whether monetary policy ever can be sufficiently prescient and determined to maintain a peg in the late stages of an exchange-rate based disinflation program. The case of Mexico may be especially illustrative. Through a combination of fiscal tightening, exchange-rate management, and a social pact between government, business, and labor, Mexico reduced its rate of inflation from 159 percent in 1987 to 7 percent by 1994. This reduction was supported by prudent monetary policy. Between the end of 1988 and the end of 1993, its international reserves rose by nearly $20 billion; these increases were largely sterilized by the Bank of Mexico, so that, even in the face of accelerating investor interest in Mexico, real interest rates averaged 30 percent during the 1988-89 period and a still sizeable 6 percent in 1990-1993. But notwithstanding this record of prudent management and pronounced reduction of inflation, some analysts have criticized Mexican monetary policy for failing to respond forcefully enough to the decline in reserves and pressure on the peso occasioned by various economic and political shocks.[3]

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[3]Observers have pointed to a long 1 ist of factors contributing to downward pressure on reserves and the peso in 1994, including (1) the armed rebellion in Chiapas in January; (2) the rise in U.S. interest rates; (3) the assassination of PRI presidential candidate Luis Donaldo Colosio in March; (4) rising concern that the peso was over-valued; (5) a resurgence of the current account deficit from $23 billion in 1993 to $29 billion in 1994; (6) concerns about the creditworthiness of the public and

The relevance of the Mexican experience to other countries implementing exchange-rate based stabilizations--particularly emerging-market economies-- in part depends upon whether actual policy mistakes in 1994 can be identified. If it can be ascertained that monetary policy loosened significantly in 1994, or that it responded less forcefully than usual to exchange market shocks, then there is hope that authorities in other countries might avoid those mistakes and sustain their exchange-rate based stabilization programs. Conversely, it may be the case that no obvious loosening of Mexican monetary policy, nor any obvious deviation of its pattern of response to events in the exchange market, took place in 1994. Under these circumstances, a tightening of monetary policy sufficient to have forestalled devaluation would have required an active shift in the behavior of monetary policy, that is, in the monetary authorities' reaction function.

For reasons of both politics and administrative inertia, such shifts are difficult to achieve. Moreover, the longer a disinflation program lasts, the dimmer will be memories of the cost of high inflation, while economic activity is likely to be weaker as a result of the real appreciation of the exchange rate. These factors will likely pose additional barriers to a tightening of monetary policy beyond already established norms in order to maintain a peg. Therefore, to the extent that protecting the exchange rate requires a shifting of the monetary reaction function in the later stages of an exchange-rate based stabilization program, this lowers the chances that such a program can be sustained.

This paper evaluates the extent to which Mexican monetary policy may have loosened in 1994,

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private sectors; (7) a loosening of fiscal policy; (8) uncertainties associated with the presidential election in August and presidential transition in December; (9) the assassination of PRI Secretary-General Ruiz Massieu in September; and (10) the resurgence of rebel activity in Chiapas in December. Mexico's exchange rate strategy led directly to some of these factors--particularly exchange rate overvaluation and rising current account deficits--and most likely increased its vulnerability to other, more exogenous shocks. In this paper, as noted below, we focus on the conduct of monetary policy in the lead-up to devaluation, and leave to others (see Atkeson and Rios-Rull (1995), Lustig (1995), Sachs et.al. (1995)) the heroic task of assigning degrees of importance to the factors listed above.

either in an absolute sense or relative to what might have been predicted on the basis of past policy behavior. In Section H, headdress one factor cited as indicative of loosening monetary policy, the sharp pick-up in the growth rate of the monetary base during 1994. Usingan econometric model of the demand for currency, which comprises nearly all of the monetary base in Mexico, we evaluate whether the high growth of the monetary base in 1994 reflected a loosening of monetary policy or, instead, strong positive shocks to the demand for money. In Section III, we estimate a monetary policy reaction function for Mexico, explaining movements in interest rates through variations in inflation, exchange rates, and international reserves. Based on this estimate, we determine whether interest rates rose by less in 1994, in response to downward pressure on the peso and on international reserves, than was predicted by the authorities' reaction function. Our conclusions are detailed in Section IV.

II. Evidence on the Demand for Money

The growth of Mexico's monetary aggregates during 1994 represents part of the basis for arguments that excessively loose monetary policy was an important factor in the devaluation of the peso. Nominal currency growth (December over December) rose from 7.3 percent in 1993 to 20.6 percent in 1994, while M2 growth rose from 14.4 percent to 22.7 percent over the same period. The top panel of Chart 1 depicts the growth rates of the monetary aggregates. Based on this evidence, some observers have argued that expansionary monetary policy, perhaps motivated by a desire to jumpstart Mexico's recovery from flagging economic activity in 1993, led to the capital outflows that eventually forced the December devaluation. Even those subscribing to a more conventional view--that Mexico's authorities failed to tighten sufficiently in the face of declining reserves and downward pressure on the peso--point to the high growth of the monetary aggregates as evidence of the excessive looseness of monetary policy in 1994.

However, there are a number of special factors, as cited by the Bank of Mexico, that may have boosted the demand for currency in 1994.[4] (The argument focuses primarily upon the demand for currency, because since 1988, there have been no reserve requirements on bank deposits. Therefore, currency comprises nearly all of the monetary base, and it is the monetary base, rather than a wider aggregate, that is under the direct control of the Mexican **authorities**.[5]) First, commercial banks increased charges for checking accounts, causing a **shift** in transactions balances toward currency. Second, interest rates on checking accounts were not moved proportionally to other interest rates **after** February, thereby reducing the opportunity costs of holding currency relative to checking accounts. Third, banks imposed tighter restrictions on credit card issuance, constraining another substitute for currency. As a result, the growth of Ml slowed to only 3.8 percent in 1994, and the deposit component of Ml declined, even as currency growth picked up substantially. As acknowledged by the Bank of Mexico, its policy during 1994 was to accommodate the demand for currency at appropriate interest rates. Therefore, high currency growth during 1994 reflected positive shocks to the demand for money, not to its supply, and hence did not indicate a loosening of monetary policy.

11.1 Estimation of a Model of Currencv Demand

To evaluate whether high monetary growth was indicative of loose monetary policy in 1994, we estimate an econometric model of the demand for currency. We follow in the approach of recent

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‘See Bank of Mexico (1995a, 1995 b), as well as Mancera (1995).

‘As noted above, we have focused our analysis on the monetary base because it is the aggregate most closely controlled by the Bank of Mexico, and hence has been closest to the center of the debate over Mexican monetary policy in 1994. It is by no means certain that the monetary base is the best indicator of the stance of monetary policy. Conceivably, some broader aggregate might be better correlated with prices, exchange rates, or economic activity, However, given the importance of currency as a transactions medium in Mexico, it is likely to be better correlated with economic outcomes than in more industrialized economies. Additionally, as indicated below, we found our equation for currency demand to be quite stable over most of the estimation period. Finally, we analyzed the behavior of M2 in 1994, in addition to the monetary base, and got broadly similar results. Nevertheless, a study that determined which monetary aggregate in Mexico was most closely linked to prices and activity would be a useful contribution to the literature and to monetary policymaking.

analyses of money demand which posit a cointegrating vector between real money, interest rates, and output, and estimate an error-correction equation to capture the dynamic interactions between these variables. (See, for example, Hendry and Ericsson (1991)).

Charts 1 and 2 display the basic data used in the analysis. In the top panel of Chart 1 are plots of the growth rate of currency and, for purposes of comparison, of M2 as well. The lower panel plots consumer price inflation along with the 28-day Cetes auction interest rate. After falling steadily for most of the 1990s, interest rates rose in 1994 while inflation stayed flat. The top panel of Chart 2 depicts the nominal interest rate with the velocity of currency, where velocity is the ratio of real GDP to the CPI-deflated value of currency, indexed to 100 in the first quarter of 1983. The bottom panel of Chart 2 depicts M2 velocity and the interest rate. Despite large and persistent movements in each of the series individually, there appears to be a stationary long-run relationship between velocity and the interest rate. This suggests that there may be a cointegrating relationship between real money balances and the traditional determinants of money demand, and foreshadows the econometric estimates.

Unit Roots and Cointegration

Augmented Dickey-Fuller tests for unit roots indicate that, over the period 1982Q4 to 1994Q4, each of the individual series is integrated of order one [1(1)]. For example, the test that real currency balances, real M2, the interest rate, and GDP, is 1(1) produces a test statistic of -0.30, -0.50, -0.78, and 0.23, respectively, implying a failure to reject the unit root null. The analogous test that these series are individually I(2) is easily rejected, with test statistics of -22.1, -7.80, -5.32, and -28.7.[6]

Based on the univariate statistical properties of the data, we test for cointegration among real money, the interest rate, and GDP in a fourth-order vector autoregression. In the system with currency, Johansen's (1991) maximal eigenvalue test rejects the null of no cointegration in favor of one

[6]Based on tests with four lagged differences.

cointegration relationship at 1 percent, while the trace test rejects at 5 percent. The test statistics for the null hypotheses of zero, one, and two cointegrating vectors are (25.7, 6.81, and 0.004) compared to 5 percent critical values of (21 .0. 14.1. and 3.8) for the maximal eigenvalue test, and (32.6, 6.81, and 0.004) compared to 5 percent critical values of (29.7, 15.4, and 3.8) for the trace test. In the system with M2, the maximal eigenvalue test produces test statistics of (22.2, 6.66, and 0.09), while the trace test produces statistics of (28.9, 6.75, and 0.09). Thus, the maximal eigenvalue test rejects the null of no cointegration at 5 percent, while the trace test rejects at 10 percent.

An Error-Correction Model of Money Demand

In light of the cointegration test results, this section develops a parsimonious single-equation model of money demand. Paralleling the vector autoregression used in the Johansen procedure, we begin with a fourth-order autoregressive distributed lag (ADL) in money, prices, interest rates, and GDP. Dummy variables designed to capture the strong seasonal component to the money data (see Chart 2) are also included.

The estimated equations, displayed in Table 1 for real currency demand, relate the growth rate of the CPI-deflated monetary aggregate to the current level of the interest rate, lagged velocity, and seasonal dummies. The model is a restricted version of an error-correction model of money demand. In unrestricted form, the error-correction model relates changes in real balances to changes in lagged real balances, contemporaneous and lagged changes in interest rates and GDP, seasonal dummies, and the “error-correction term” -- the deviation of actual real balances from their long-run value. Error correction models generalize the traditional partial adjustment model by permitting actual money demand to react with different speeds to changes in the different determinants of equilibrium money demand, while at the same time imposing a long-run stationary relationship between money and its traditional arguments. The final, parsimonious specification displayed in Table 1 reflects the (many) restrictions we imposed on the general model based upon Statistical testing.[7] Several other variables, including Mexican inflation, the differential between the CETES rate and interest rates on checking accounts, U.S. interest rates, and peso depreciation rates were found to have little explanatory power.

Table 1: Estimation Results for currency Demand Function

Dependent Variable: Δ Log Real Currency

	OLS	Instrumental Variables
Constant	-4.58 (-6.08)	-3.86 (-3.43)
Interest Rate	-0.15 (-7.15)	-0.13 (-4.38)
Log (Real Currency/GDP) (-1)	-0.31 (-6.48)	-0.27 (-3.69)
Seasonal Q1	-0.38 (-22.71)	-0.39 (-19.88)
Seasonal Q2	-0.26 (-19,63)	-0.26 (-18.1 1)
Seasonal Q3	-0.33 (-24.90)	-0.34 (-23.41)
Adjusted R-squared	.97	--
Regression Standard Error	.032	.033
Durbin-Watson Statistic	2.20	2.17
AR	F(4, 38): 0.50	--
ARCH	F(4,34): 1.79	F(3, 29): 0.93
Normality	chi-square(2): 1.97	chi-square(2): 2.70
Heteroscedasticity	F(7, 34): 1.55	F(7, 27): 2.81
RESET	F(1, 41): 0.003	--

T-statistics are in parentheses. (--) indicates the statistic is not applicable,

[7]For example, both the contemporaneous change and the lagged level of the interest rate are significant, but with equal coefficients, so only the contemporaneous level of the interest rate appears in the model. Appendix C details the specification search used to derive the currency demand model.

The models are estimated using quarterly data over the period 1983 to 1994. The coefficients are all of the expected signs and are statistically significant. According to the OLS estimate, the long-run interest rate elasticity is -0.48. Additionally, a long-run unit income elasticity cannot be rejected, leading us to impose that restriction in the final version of the model.[8]

The residuals from each model satisfy a battery of diagnostic tests designed to detect model misspecification, including tests for residual autocorrelation (AR and Durbin-Watson), skewness and excess kurtosis (Normality), autoregressive conditional heteroscedasticity (ARCH), as well as RESET (another test for a specific functional form of heteroscedasticity) and heteroscedasticity. Moreover, despite the large changes that occurred in the Mexican economy over the sample period, the coefficient estimates are found to be constant over several sub-samples. This is illustrated in Chart 3, showing estimated coefficients derived from the OLS models when estimated over sample periods with progressively later endings dates, starting in 1986 Q3. Note that the estimated coefficients remain essentially unchanged through 1994, notwithstanding the marked pickup in monetary growth and other shocks that occurred in that year. Additionally, as seen in the final column of Table 1, estimation with instrumental variables, using lags of velocity, interest rates, inflation, and U.S. interest rates as instruments for contemporaneous interest rates, resulted in little change to estimated coefficients or their statistical significance.

II.2 The Behavior of Currency Demand in *1994*

The model can be used as a reference point for interpreting the strong upswing in money growth in 1994, particularly in light of its constancy over much of the sample period. Chart 4

[8]We discovered few other recent analyses of Mexican currency demand in the literature. One exception, Aboumrad (1995), estimates a monthly error-correction model of money demand that is very similar to our own. It regresses the log-change in real currency balances on the 28-day Cetes rate, the difference between the logs of real currency and industrial production, and various dummy variables for the Mexican political cycle. The estimated long run elasticity of money demand with respect to the interest rate in Aboumrad's model is about -0.5, virtually identical to our own estimate.

compares the actual and fitted values from the equation for log-changes in real currency demand, and plots the residuals. It indicates that in 1994 the demand for currency grew faster than what would have been predicted based on the model, with the residuals being especially large in the first and third quarters. Indeed, the first quarter of 1994 represents the only observation in the sample for which the estimated residual is more than twice the standard error, and a simple decomposition of actual 1994 currency growth indicates that 85 percent of this growth is unaccounted for by the explanatory variables in the model.

While the excess of actual over predicted currency growth might be interpreted as the result of money supply creation relative to money demand, at least two factors suggest that the greater-than-predicted currency growth more likely reflected a positive shock to the demand for money, which the Mexican authorities were merely accommodating. First, if a loosening of monetary policy were the cause of high monetary growth, then interest rates should have fallen in 1994. The fact that interest rates--nominal and real--rose in 1994, as indicated on Chart 1, suggests that the demand for money rose even more quickly than its supply in that year.

Second, if a money demand equation is well-specified, particularly in terms of capturing the dynamic responses of money demand to shocks in the short-term, shifts in monetary policy should not by themselves induce large forecast errors. The relative stability of our currency demand model over a period of sharp shifts in monetary policy regime suggests that the model is well specified, and hence that it most likely could have tracked currency demand in 1994, had shocks been attributable to money supply rather than money demand. Put another way, given that the model's residuals were unexceptional during 1987 and 1988, when Mexico's monetary policy shifted dramatically as part of an exchange-rate based stabilization, it is hard to believe that the much larger residuals in 1994 were induced by expansionary monetary policy alone.

We have focused on currency because it is the aggregate directly controlled by the monetary authority. However, the criticism leveled against Mexican monetary policy in 1994 has focused on the rapid growth not only of currency but also of M2. Insofar as monitoring larger aggregates also is part of prudent monetary policy, it is instructive to look at a model of the demand for M2 as well, even though changes in the money multiplier are largely outside of the central bank's control.

Following the procedures outlined above, we estimated an econometric model for M2 similar to that of currency. The final, parsimonious model, displayed in Appendix Table A-1, is quite similar in form to that of real currency demand. The estimated long-run interest elasticity is about twice as large for M2 than currency, and a long-run unit income elasticity once again could not be rejected. As displayed in Appendix Chart A-1, actual M2 growth last year also was greater than predicted by the model, although the residuals from the M2 model are not unusually large. Unlike in the case of the demand for currency, there are no obvious explanations for the positive shocks to the demand for M2; in its recent publications, the Bank of Mexico presents no explanations for the strong pick-up in M2 growth during 1994.[9]

To sum up, both the facts that the bulge in currency growth is not explained by a stable money demand model, and that interest rates rose rather than fell over the period, represent indirect evidence that Mexican monetary policy was not actively expansionary in the lead-up to December's devaluation crisis.[10] On the other hand, the evidence on money demand does not address the issue of whether or not the authorities tightened Mexican monetary policy adequately in the face of severe reserve pressures. In Section III below, we address the posture of Mexican monetary policy in a more direct fashion.

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[9] Calvo and Mendoza (1995) focus on the behavior of real M2 in their assessment of the role of Mexican monetary policy in the crisis.

[10] As noted above, the fact that Ml was so weak in 1994, due to the weakness of its non-currency component, also lends support to the view that a shill in demand from deposits to currency was taking place.

II.3 The Behavior of Currency Demand in 1995

The large, consistently positive residuals evidenced by our currency demand equation in 1994 raise concerns that Mexico's demand for currency, even if moderately stable over most of the estimation period, has now shifted to the point that our estimated equation no longer can track it. To address this issue, we estimated the model through 1995 Q3, the latest available date for GDP; the fitted values and residuals are indicated in Appendix Chart 2.

The model accurately predicted the very sharp decline in real currency balances in the first quarter of 1995, even though, as evident from the chart, this decline was of nearly unprecedented magnitude. In the second quarter, real balances rebounded much more slowly than predicted by the model. While it might have been desirable if the model could have more accurately tracked currency behavior in Q2, it should be noted that the large negative residual in part offsets the large positive residuals during 1994. That is, considering 1994 and 1995 together, it is not obvious that the model's predictions have become biased in any single direction. This suggests that the large positive residuals in 1994, as well as the large negative residual in 1995, were temporary shocks to currency demand rather than permanent shifts in the parameters of the currency demand function. That interpretation is further supported by the model's accurate prediction of currency behavior in 1995 Q3.

III. Evidence from a Monetary Policy Reaction Function

It is true, tautologically, that Mexican monetary policy in 1994 was not sufficiently tight to prevent a devaluation. It is less clear whether or not the authorities tightened monetary policy adequately in the face of declining reserves, measured against the benchmark either of what might have been considered appropriate policy at the time, or of how the authorities had reacted to similar episodes of reserve loss and exchange rate pressure in the past. In this section, we attempt to gauge the stance of Mexican monetary policy in 1994 by comparing the path of interest rates in that year with those predicted by a reaction function for the monetary authorities, estimated over the period since 1984.

III.1 Estimation of a Model of Monetary Policy

During the last decade, the monetary authorities (both the Ministry of Finance and the Bank of Mexico)" are presumed to have determined monetary policy so as to have achieved various, usually (but not always) complementary, goals, including: (1) stabilization of output, (2) reduction of inflation, (3) maintenance of international reserves (during periods when the exchange rate was pegged), and *(4)* maintenance of the foreign exchange value of the peso (during periods when the exchange rate had some latitude to move). Using quarterly data over the 1982 Q4 to 1994 Q4 period,[12] we estimated an error-correction model relating the quarterly change in the 28-day Cetes interest rate to the lagged level of the interest rate and to changes and lagged levels of real GDP, the quarterly change in consumer prices (at an annual rate), gross reserves less gold, and the Mexican-U.S. CPI-adjusted exchange rate (pesos per dollar). In order to focus on monetary policy in the period leading up to the devaluation of the peso, we excluded observations after December 19, 1994 from our data on interest rates, exchange rates, and international reserves, since these variables exhibited substantial changes following the devaluation.[13] After eliminating lags, according to Hendry's general-to-specific methodology, and imposing certain restrictions on some variables, the specification detailed in Table 2

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[11]In April 1994, implementing legislation became effective making the Bank of Mexico fully autonomous, allowing it to determine monetary policy freely.

[12]This date range excludes the period immediately following the 1982 devaluation, which was subject to severe macroeconomic dislocations.

'quarterly data on interest rates, exchange rates, and prices represent averages over the last month of each quarter, while data on reserves are end-of-quarter and data on GDP represent quarterly averages. For the 1994 Q4 observation, we used the average of the first two weekly auction rates in December for the interest rate, the average peso value of the dollar through December 19 for the exchange rate, and the December 19 level of international reserves for the reserves variable. We examine the robustness of our results to this choice of excluding observations in a later section.

was estimated.

Table 2: Estimation Results for Monetary Policy Reaction Function

Dependent Variable: Δ Interest Rate

	OLS	Instrumental Variables
Constant	0.69 (2.63) [3.52]	1.09 (2.1 1)
Real Interest Rate (-l)	-0.46 (-4.47) [-4.20]	-0.50 (-2.59)
Δ CPI Inflation	0.68 (8.67) [5.00]	0.71 (5.92)
Δ Log Real Exchange Rate (pesos/dollar)	0.79 (3.49) [2.35]	0.72 (1.05)
Log Real Exchange Rate (-l) (pesos/dollar)	0.14 (2.44) [3.33]	0.23 (2.03)
Δ Log International Reserves	-0.15 (-3.39) [-3.91]	-0.45 (-2.48)
Adjusted R-squared	.72	--
RegressionStandard Error	.066	.098
Durbin-Watson Statistic	2.18	1.70
AR	F(4, 37): 0.58	--
ARCH	F(4,33) 0.69	F(4, 30): 0.11
Normality	chi-square(2): 5.40	chi-square(2): 0.60
Heteroscedasticity	F(10,3O): 2.40*	F(10,27): 5.34*
RESET	F(1, 40): 13.1 **	--

T-statistics in parentheses; White (1980) heteroscedasticity consistent t-statistics in brackets.
(--) indicates the statistic is nonapplicable.
* (**) indicates significant at 5% (lo/o), [Applies to statistics below the double line only.]

Anumber ofpoints should be made conceding the specification of the reaction function and the estimation results. First, neither the level nor the change in real GDP were found to enter the regression with the appropriate sign (positive) and in a statistically significant manner. In some specifications, real GDP was found to affect interest rates negatively, implying that increases in output or output growth impelled the Bank of Mexico to lower interest rates, which would have been a destabilizing response. This finding probably was spurious, reflecting the fact that over the past decade, declines in output have been associated with negative terms-of-trade shocks, devaluation crises, and other factors that simultaneously have tended to raise interest rates. As a result, it has been difficult to identify the separate influence of variations in output growth on central bank policy. It may also be true that over the past decade, the authorities--and particularly the Bank of Mexico--have been preoccupied with stabilizing prices and the exchange rate, and have not focused monetary policy on smoothing variations in output.

Second, the coefficients on the lagged levels of the interest rate and the inflation rate were found to be statistically significant and of approximately equal magnitudes and opposite signs (the coefficient on the lagged interest rate being negative, on the lagged inflation rate being positive). To reduce multicollinearity, and because we could not reject that the coefficients were equal in absolute value, an approximation to the real interest rate, the interest rate minus inflation, was substituted for the two variables. Thus, a feature of our specification is that increases in the rate of inflation lead to one-for-one increases in interest rates in the long run, leaving the real interest rate unchanged. Considering that a genuinely anti-inflationary monetary policy would entail increasing the real interest rate in response to increases in inflation, this result suggests that, on average over the past decade, Mexican monetary policy was not oriented exclusively toward reducing inflation.

Third, the coefficients on the external balance variables--reserves and the real exchange rate--are statistically significant and of the expected sign. A weakening of the real value of the peso--an increase in the real exchange rate, measured as pesos per dollar--leads to a rise in interest rates, while a rise in international reserve holdings causes interest rates to decline.

Fourth, the diagnostic tests indicate that there is some evidence of heteroscedasticity. Hence, we include next to the OLS t-statistics White's (1980) heteroscedasticity consistent t-statistics in square brackets [ ]. According to the robust t-statistics, three of which are larger than the OLS t-statistics and three of which are smaller, ail coefficients remain statistically significant.

Because, depending upon the exchange regime, either the exchange rate, the reserves level, or both are endogenous with respect to the interest rate, the coefficient estimates are subject to simultaneity bias. To gauge the extent of this bias, the reaction function was re-estimated using instrumental variables, with four lags of reserves and exchange rate changes being used as instruments, in addition to the other exogenous and predetermined variables in the model.[14] As indicated in the table above, the IV estimates for the coefficients on the lagged real interest rate, the change in inflation, and the change in the real exchange rate are largely unchanged. However, the absolute magnitude of the coefficient on the change in reserves rises substantially. In addition, the coefficient on the lagged level of the real exchange rate rises from 0.14 to 0.23, a change of less than two standard errors (though nonetheless sizable). This is consistent with our view that once feedback effects from the interest rate to exchange rates and reserves are controlled for, the exchange rate and reserve variables should have an even greater effect on the determination of interest rates. On the other hand, the standard error of the IV-estimated regression is higher, probably reflecting the low explanatory power of the first-stage regressions in the IV estimation. Therefore, we will continue to use the OLS estimates as our primary estimate of the Bank of Mexico's reaction function.

As a final test of the reliability of our estimated reaction function, Chart 5 indicates the coefficient estimates resulting from recursive estimation of our OLS equation when the date range is extended progressively from 1986 Q4 through 1994 Q4. After some initial shifting of coefficient

[14] In principle, the contemporaneous change in the inflation rate might also be considered endogenous. We considered it unlikely, however, that the interest rate would be able to affect the inflation rate without any lags.

estimates in 1987 and 1988, when inflation reached record levels and then was reduced, the parameters of the reaction function show remarkable constancy from 1989 through 1994. This constancy is further confirmed by Chart 6, which indicates the Chow test statistic for model stability as the sample size is adjusted progressively through time (the so-called "N-step down" Chow test). The test statistic for any quarter gauges whether the model estimated through that quarter differs from the model estimated through the entire sample. At no point does the Chow test statistic rise above its critical value at the 5 percent level of significance, and usually it is well below that level. This provides comfort that the estimated reaction function is a reasonable benchmark against which to examine Mexican monetary policy in 1994.

III.2 A Model-Based Evaluation of Monetary Policy in 1994

The top panel of Chart 7 compares the actual path of quarterly changes in the 28-days Cetes interest rate with the fitted values associated with the estimated OLS reaction function; the bottom panel plots the associated residuals.[15] The results show that in each quarter of 1994, the authorities raised interest rates by less than predicted by the model. However, as highlighted by the bottom panel, the deviations of changes in interest rates from the changes predicted by the reaction function were small compared with past deviations, being less than the standard error of the regression in each case. Moreover, as shown in Chart 6, which was discussed above, the Chow test statistic for the comparison of the model's parameters estimated through 1993 Q4 with those estimated through 1994 Q4 was well below its critical level, indicating that no significant shift in the parameters of the monetary policy reaction function occurred in 1994. As a check on the robustness of these results, Chart 8 presents the fitted values and residuals from the IV-estimated reaction function, indicating much the same story.

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[15]The units are changes in interest rates, with a 10 percentage point increase in the interest rate shown as 0.1.

Both the parameter constancy tests shown on Chart 5 and the recursive Chow tests shown on Chart 6 suggest that the parameters of the reaction function, while quite stable during 1989-1994, experienced a considerable shift in the years immediately prior to that period. This is understandable, considering that in 1988, the monetary regime switched radically from a crawling peg exchange-rate regime that validated past inflationary shocks to a fixed exchange-rate regime focused on reducing the rate of inflation. Because our estimation sample encompasses both monetary policy regimes, however, it is possible that our model's parameters may incorporate the relatively inflationary stance of monetary policy during 1982-87, as well as the more anti-inflationary stance that prevailed in 1988-94. This could bias downwards the model's predictions of interest rate changes in 1994, thereby reducing our estimate of the deviation of interest rates from their expected behavior. To determine whether this bias was importantly influencing our results, we re-estimated the model (OLS) over the period of 1989 Q3-1994 Q4, a period that includes the exchange-rate based stabilization program alone. As indicated in Chart 9, the results are quite similar to those for the model estimated over the larger sample: the (negative) residual in 1994 Q4 is about 2.5 percentage points, which is comparable to the residual from the model estimated over the full sample, and below the 3.1 percentage point standard error of the regression.

These results all support the view that Mexican monetary policy in 1994 did not deviate significantly from its behavior in previous years. First, there was no obvious proactive loosening of monetary policy in that period. Second, while the authorities obviously did not tighten monetary policy sufficiently to prevent the devaluation, it is not obvious that this failure represented a significant deviation from past reactions to exchange market shocks. These conclusions are further supported by Chart 10. Chart 10 cumulates the model's predicted changes in interest rates so that, assuming that the level of interest rates was consistent with the Bank of Mexico's reaction function in 1993 Q4, the levels of actual interest rates can be compared with their predicted values. To this chart has been added the path of the interbank interest rate (tasa interbancaria promedio, or TIIP), which may represent a better measure of the tightness of liquidity than the Cetes rate. 'b As indicated in Chart 10, over the course of 1994, the spread between the THP and the Cetes rate increased substantially. As a result, the gap between the TIIP and the rate predicted by the reaction function widened by less over the year than did the gap between the actual Cetes rate and the predicted rate.

As a qualification to these results, we should note that, at least in retrospect, it has become evident that during 1994, the authorities should have been concerned not by the erosion of gross reserves alone, but also by the decline in reserves net of Tesobonos outstanding. Chart 11 indicates that the decline in "net" reserves was much sharper than the decline in gross reserves. Chart 12 compares the path of actual interest rates in 1994 to that of predicted interest rates, calculated both on the basis of "net" and "gross" reserves. It is obvious that if the authorities had been focused on a net reserves concept, the measured deviation of actual from predicted interest rates would have been much greater. However, the relative complacency with which both the authorities and the market viewed the build-up in Tesobonos, at least until late in 1994, suggests that the reaction function based on net reserves probably does not capture "normal" monetary policy behavior. In fact, as pointed out in Sachs, Tornell, and Velasco (1995), there were very few references in the financial market press to Tesobonos until after the devaluation already had occurred. " Hence, it is understandable that the authorities also failed to take the Tesobonos into account when making their monetary policy decisions.

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[16]Bank of Mexico officials argue that the Cetes rate may have understated the level of interest rates in the money market in 1994, since they were the only instrument some foreign investors would acquire, they were the instrument of choice for repurchase operations, and they were required to be held in the portfolios of certain domestic investment funds.

[17]According to the authors, prior to December 1994 a grand total of one article discussing *tesobonos* appeared in the Financial Times, New York Times, and Wall Street Journal (the New York Times ran one such article in July).

In sum, Mexican monetary policy, while sufficiently disciplined to have helped guide inflation downwards from nearly 160 percent in 1987 to 7 percent by 1994, was not appropriate to the task of maintaining the exchange rate peg under the increasingly more difficult conditions associated with the laterstages ofan exchange-rate based stabilization. Maintaining the peg would have required a sharper increase in interest rates than predicted by the reaction function, requiring, in turn, a change in the fundamental strategy underlying Mexican monetary policy.

The issue of sterilization brings this theme out clearly. Various observers, such as Sachs, et.al. (1995), have maintained that the authorities did not tighten monetary policy sufficiently in the face of downward pressure on reserves and the peso. In particular, they cite the Bank of Mexico's full sterilization of reserve outflows, which subverted the automatic adjustment mechanism associated with fixed exchange rate regimes, as indicative of the failure to tighten in the face of speculative attack. Had there been no sterilization of reserve outflows, Sachs et. al. argue, the pressure to devalue effectively would have been contained. However, Bank of Mexico officials (Mancera, 1995) counter that they had been sterilizing capital inflows for years, rightly attempting to prevent an undue loosening of monetary conditions, and that policy consistency required that they sterilize outflows as well. Following Sachs et. al.'s (retrospective) recommendations would have required significant changes in operating procedure, particularly since abandoning the policy of full sterilization most likely would have required abandoning the authorities' implicit policy of targeting the interest rate as well.

III.3 Monetary Policy in the Post-Devaluation Period

As described above, the 1994 Q4 data used in our analysis exclude movements in interest rates, exchange rates, and reserves after December 19, the date of devaluation. From December 20 through the end of the year, international reserves declined by $4.3 billion, the peso value of the dollar increased by about 45 percent, and 28-day Cetes rates rose from about 13 1/2 percent in the first two more sharply in the weeks immediately after December 20. On the one hand, such a move might have alleviated concerns that the devaluation would trigger an uncontained exchange rate-price-wage spiral. One the other hand, the loss of credibility associated with the devaluation itself, coupled with the extent of the government's prospective difficulties in refinancing a substantial amount of short-term debt--mainly Tesobonos--coming due in early 1995, might well have offset any show of tightening by the Bank of Mexico in any event.

Chart 13 also indicates that in 1995, monetary policy largely reverted to behavior consistent with the estimated reaction function, While the residuals in the first and second quarters of the year also are negative, they are well within two standard errors of the regression; moreover, some large residuals are to be expected in those quarters, given the marked swings in actual interest rates. It is interesting that the model appears to have moved back on-track in 1995, considering the apparent shifts in monetary policy that took place last year. Most importantly, the Bank of Mexico adopted an explicit monetary (specifically, net domestic credit) target, replacing seven years of reliance on the exchange rate as a nominal anchor. Nonetheless, in terms of its reaction to inflation, exchange rates, and foreign reserves changes, monetary policy in 1995 does not appear to have differed significantly from that prevailing in prior years.

IV. Conclusion

Based on our research into Mexican monetary policy, two findings should be highlighted. First, the substantial increase in the growth rate of Mexico's monetary base--from 7 percent in 1993 to 21 percent in 1994--probably reflected shocks to the demand for money rather than an excessive expansion of the money supply. This conclusion is based on the fact that our econometric equation for Mexican money demand exhibited very large residuals in 1994, even as its parameters remained stable, as well as the fact that interest rates rose in 1994, while a stimulator expansion of the money supply would have depressed interest rates. Hence, the 1994 bulge in the monetary base most likely did not reflect a proactive loosening of monetary policy leading to the deterioration in international reserves that precipitated December's devaluation.

Second, Mexican monetary policy in 1994 was not significantly looser than that implied by an estimated monetary policy reaction function. While interest rates rose somewhat more slowly than predicted by our model, the deviation was well within the range of error of the model. It is difficult to attribute a normative dimension to deviations of interest rates from the level predicted by our estimated reaction function, since there is no sense in which monetary policy during the 1983-94 sample period necessarily was close to optimal. That is, the fact that interest rates were close to their predicted level in 1994 does not mean that they were set appropriately under the circumstances. It does mean, however, that raising interest rates sufficiently to have prevented a devaluation would have required a concerted shift in the monetary authorities' reaction function at a time when the authorities were deeply concerned about the health of the banking system and, at least in the early part of the year, the weak level of economic activity. Therefore, it is in retrospect not surprising that the authorities chose to allow only moderate increases in interest rates, even though such a limited response to exchange market developments led to sharp declines in reserves and, eventually, the abandonment of the exchange rate peg.

The factors leading to the collapse of the peso in Mexico probably are present, in varying degrees, in almost all exchange-rate based stabilization programs. First, as noted in the introduction, an appreciation of the real exchange rate and widening of the current account deficit are recurring features of most such programs. These developments have been rationalized as reflecting the equilibrium responses to the increases in productivity and wealth associated with stabilization, but the Mexican crisis has made such sanguine interpretations more difficult to sustain. Second, in the initial phases of a credible stabilization program, responsible monetary policy may consist of no more than appropriate sterilization of capital inflows to prevent monetary conditions from loosening too quickly. The monetary authorities may find it difficult to adjust, for inertial as well as political reasons, to the greater demands posed by speculative attacks in the later stages of an exchange-rate based stabilization program, when an active and potentially painful tightening of monetary policy may be required. The Mexican authorities, for example. continued to sterilize reserve outflows all the way up to the devaluation itself.

Finally, if the Mexican example can be generalized, sustained disinflation may generate, in addition to real exchange rate appreciation, renewed access to international capital markets and heavy growth of internal private indebtedness. These developments, in turn, may lead to a weakening of economic activity, over-indebtedness, and problems in the financial sector, all of which may increase the difficulty of tightening monetary policy in the face of speculative attack.

These considerations do not necessarily invalidate the use of the exchange rate as an anchor to accelerate the disinflation process. On balance, exchange-rate based stabilization programs probably still are the most effective means of reducing inflation quickly. However, the Mexican experience points to the difficulties in sustaining such programs in their later phases. Hence, policymakers relying on the exchange rate as a nominal anchor probably should be prepared either to abandon that anchor or tighten monetary policy concertedly well before speculative pressures intensify.

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APPENDIX A

Table A-1: Estimation Results **for M2 Demand Function**
Dependent Variable: A Log Real M2

	OLS	Instrumental Variables
Constant	-1.80 (-2.96)	-2.01 (-3.20)
Interest Rate	-0.15 (-5.18)	-0.16 (-5.34)
Annual Interest Rate Change [i(t) - i(t-4)]	0.10 (2.64)	0.11 (2.91)
Log (Real M2/GDP) (-1)	-0.15 (-3.17)	-0.16 (-3.40)
Seasonal Q1	-0.15 (-9.74)	-0.15 (-9.64)
Seasonal Q2	-0.07 (-4.38)	-0.07 (-4.34)
Seasonal Q3	-0.10 (-6.68)	-0.11 (-6.71)
Adjusted R-squared	.77	--
Regression Standard Error	.036	.036
Durbin-Watson Statistic	2.33	2.30
AR	F(4, 34): 1.50	--
ARCH	F(4,30): 0.45	F(3, 28): 0.46
Normality	chi-square(2): 1.93	chi-square(2): 2.98
Heteroscedasticity	F(9, 28): 1.26	F(9, 24): 0.98
RESET	F(1, 37): 2.11	--

T-statistics in are parentheses.
(--) indicates the statistic is not applicable.

APPENDIX B: DATA

Currency:	Bills and coins in circulation; Bank of Mexico, Indicadores Economicos.
M2:	Currency, demand deposits, and short-term bank instruments; Bank of Mexico, Indicadores Economicos.
Interest Rate:	28-day Cetes interest rate; Reuters.
Interbank Rate:	Tasa interbancario promedio (TIIP); Bank of Mexico, Indicadores Economicos.
Real GDP:	Real GDP in 1980 pesos at an annual rate; INEGI (Instituto Nacional de Estadistica Geografia e Informatica)
CPI:	Consumer price index, 1978= 100; Bank of Mexico, Indicadores Economicos.
Real Exchange Rate:	Mexican-U.S. bilateral CPI-adjusted exchange rate; period average nominal exchange rate from International Financial Statistics, line wf; U.S. CPI from Intern Financial Statistics, line 64.
International Reserves:	Total reserves minus gold; International Financial Statistics, line 11.d .
Tesobonos:	Dollar value of stock of tesobonos held by private sector, including direct holdings and claims on the Bank of Mexico through repurchase agreements; Bank of Mexico.

APPENDIX C: DERIVING THE EMPIRICAL MODEL OF CURRENCY DEMAND

In this appendix we detail the specification search used to derive to parsimonious model of currency demand used in the text. The following notation is used below:

m - nominal currency	Qi - seasonal dummy for quarter i
p - price level	l- denotes the natural log
y - income	d - the first difference operator
i - interest rate	σ - the regression standard error
rm - real currency (m/p)	vel - velocity (py/m)

(standard errors in parenthesis)

Equation (1):

$lm_t = -11.983 + 0.78454\, lm_{t-1} - 0.014662\, lm_{t-2} - 0.21229\, lm_{t-3} + 0.12360\, lm_{t-4} + 0.77458\, lp_t$
(13.700) (0.26923) (0.29121) (0.24499) (0.19069) (0.35765)

$-0.82022\, lp_{t-1} + 0.58467\, lp_{t-2} - 0.23853\, lp_{t-3} + 0{,}0027725\, lp_{t-4} - 0.46297\, ly_t + 1.4830\, ly_{t-1}$
(0.70432) (0.73087) (0.69275) (0.38888) (0.59906) (0.60829)

$+ 0.54891\, ly_{t-2} - 1.0509\, ly_{t-3} + 0.28281\, ly_{t-4} - 0.13126\, i_t + 0.15735\, i_{t-1} - 0.078601\, i_{t-2}$
(0.53275) (0.55588) (0.51652) (0.090069) (0.10645) (0.11121)

$-0.0065470\, i_{t-3} + 0.036050\, i_{t-4} - 0.40106\, Q1 - 0.30780\, Q2 - 0.29971\, Q3$
(0.10577) (0.076612) (0,098301) (0.071156) (0.085905)

$\sigma = 0.0338663$

Equation (2):

$dlm_t = -11.983 + 0.10335\, dlm_{t-1} + 0.088687\, dlm_{t-2} - 0.12360\, dlm_{t-3} + 0.77458\, dlp_t - 0.34891\, dlp_{t-1}$
(13.700) (0.27893) (0.17486) (0.19069) (0.35765) (0.48112)

$+ 0.23576\, dlp_{t-2} - 0.0027890\, dlp_{t-3} - 0.46296\, dly_t + 0.21920\, dly_{t-1} + 0.76811\, dly_{t-2}$
(0.42045) (0.38888) (0.59905) (0.55252) (0.63415)

$-0.28282\, dly_{t-3} - 0.10826\, di_t + 0.049095\, di_{t-1} - 0.029508\, di_{t-2} - 0.036053\, di_{t-3} - 0.015539\, lp_{t-1}$
(0.51651) (0.17385) (0.14811) (0.12926) (0.076612) (0.026857)

$+ 0.48206\, ly_{t-1} - 0.023001\, i_t + 0.31881\, lvel_{t-1} - 0.40106\, Q1 - 0.30780\, Q2 - 0.29971\, Q3$
(0.69957) (0.15326) (0.24715) (0.098301) (0.071157) (0.085905)

$\sigma = 0.0338663$

Equation (3):

dim, = -4.2800 + 0.046926 dim,., + 0.11609 dim,.₂ -0.11832 dlm_{t-3} + 0.80961 dip, -0.23115 dlp_{t-1}
(3.1836) (0.25752) (0.16569) (0.18769) (0.34765) (0.42959)

+ 0.24107 dip,.z + 0.068151 dip,.~ -0.66126 ally, + 0.39592 ally,., + 0.96760 ally,-,
(0.41423) (0.36367) (0.48417) (0.45372) (0.52447)

-0.20959 dly_{t-3} -0.052718 di_t + 0.95759 di_{t-1} + 0.013679 di_{t-2} -0.020181 di_{t-3} + 0.092423 ly_{t-1}
(0.49347) (0.14284) (1.12242) (0.10399) (0.070491) (0.18673)

-0.072007 i, + 0.20253 $lvel_{t-1}$ -0.40915 Q1 -0.33227 Q2 -0.30378 Q3
(0.12587) (0.14177) (0.095884) (0.056390) (0.084370)

σ = 0.0333729

Equation (4):

dim, = -5.8208-0.073720 dim,-, + 0.88361 dip, + 0.19078 dip,-₁-0.15858 dly_t -0.29865 dly_{t-1}
(2.6481) (0.17087) (0.31300) (0.35961) (0.38664) (0.34655)

-0.0095666 di_t + 0.030486 di_{t-1} + 0.092146 ly_{t-1} -0.13777 i, + 0.30213 $lvel_{t-1}$ -0.35321 Q]
(0.092684) (0.062409) (0,14422) (0.084105) (0.094729) (0.073366)

-0.27531 Q2 -0.32668 Q3
(0.029542) (0.037486)

σ = 0.0340047

Equation (5):

dim, = -4.4121-0.055639 dlm_{t-1} +0.90727 dlp_t + 0.18358 dip,, -0.22779 ally, -0.31977 ally,.,
(1.4534) (0.16694) (0.30791) (0.35609) (0.36771) (0.34176)

+ o.oo54310 di_t + 0.045243 alit-l -0.16650 i_t + 0.30384 $lvel_{t-1}$ -0035906 Q1 - 0.27224 Q2
(0.0054310) (0.057439) (0.070419) (0.93811) (0.072116) (0.028879)

-0.32791 Q3
(0.032791)

σ = 0.0336888

Equation (6):

$$dlm_t = -4.2694 + 1.0228 \text{ dip}_t -0.15106\, i_t + 0.29442\, lvel_{t-1} -0.38842\, Q1 -0.26025\, Q2$$
(0.98600) (0.18140) (0.050047) (0.063614) (0.018003) (0.013773)

$$-0.33249\ Q3$$
(0.013668)

σ = 0.0320922

Equation (7):

$$dlrm_t = -4.2694 + 0.022823 \text{ dip}_t -0.15106\, i_t + 0.29442\, lvel_{t-1} -0.38842\, Q1 -0.33249\, Q2$$
(0.98600) (0.18140) (0.050047) (0.063615) (0.018003) (0.013773)

$$-0.33249\ Q3$$
(0.013668)

σ = 0.0320923

Equation (8):

$$dlrm_t = -4.2646 -0.14564\, i_t + 0.29409\, lvel_{t-1} -0.38813\, Q] -0.26055\, Q2 - 0.33280 Q3$$
(0.97275) (0.025175) (0.062754) (0.017630) (0.013388) (0.013281)

σ = 0.0316848

Tests of **Model Restrictions** (p-values in brackets):

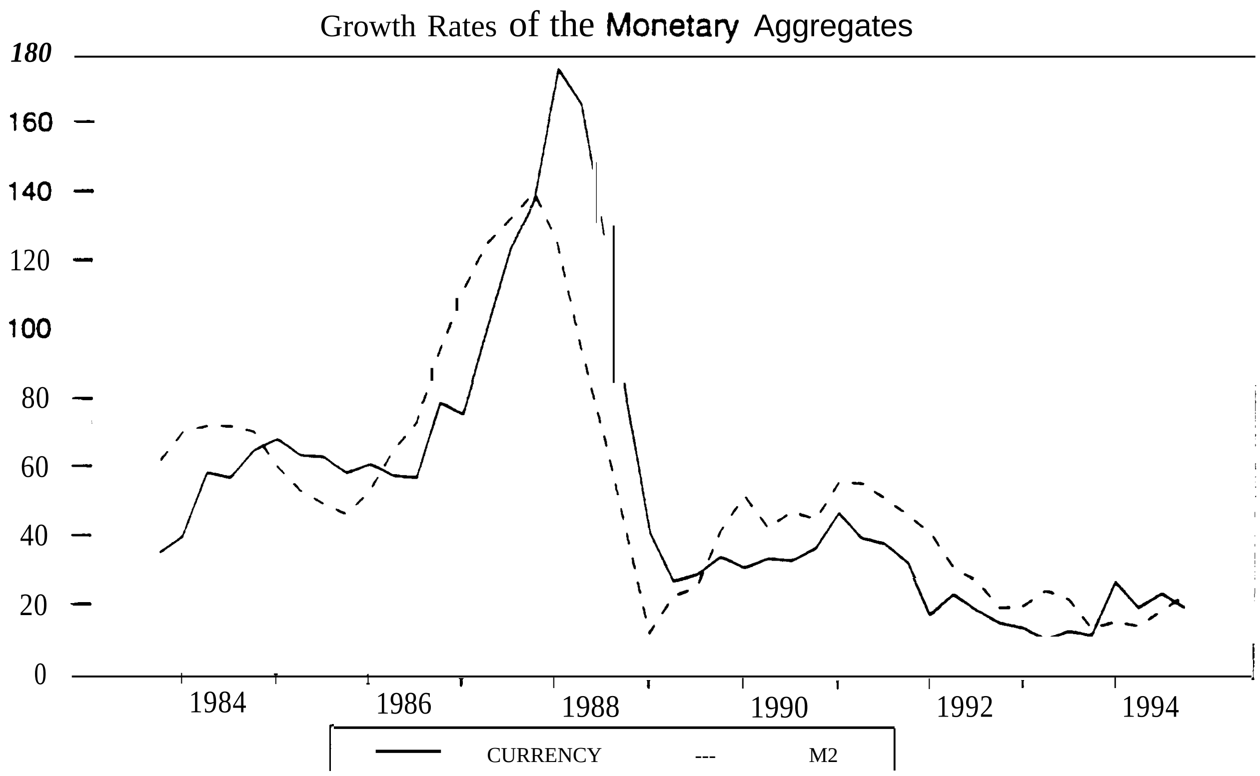
Model 3 vs. 4: $F(8, 23)$ = 1.1481 [0.3704]

Model 3 vs. 5: $F(9, 23)$ = 1.0676 [0.4215]
Model 4 vs. 5: $F(1, 31)$ = 0.40823 [0.5276]

Model 3 vs. 7: $F(15, 23)$= 0.80931 [0.6583]
Model 4 vs. 7: $F(7, 31)$ = 0.40658 [0.8909]
Model 5 vs. 7: $F(6, 32)$ = 0.41396 [0.8642]

Model 3 vs. 9: $F(16, 23)$ = 0.75964 [0.7109]
Model 4 vs. 9: $F(8, 31)$ = 0.35752 [0.9349]
Model 5 vs. 9: $F(7, 32)$ = 0.35688 [0.9203]
Model 7 vs. 9: $F(1. 38)$ = 0.015831 [0.9005]

Chart 1. Money Growth, Inflation, and Interest Rates



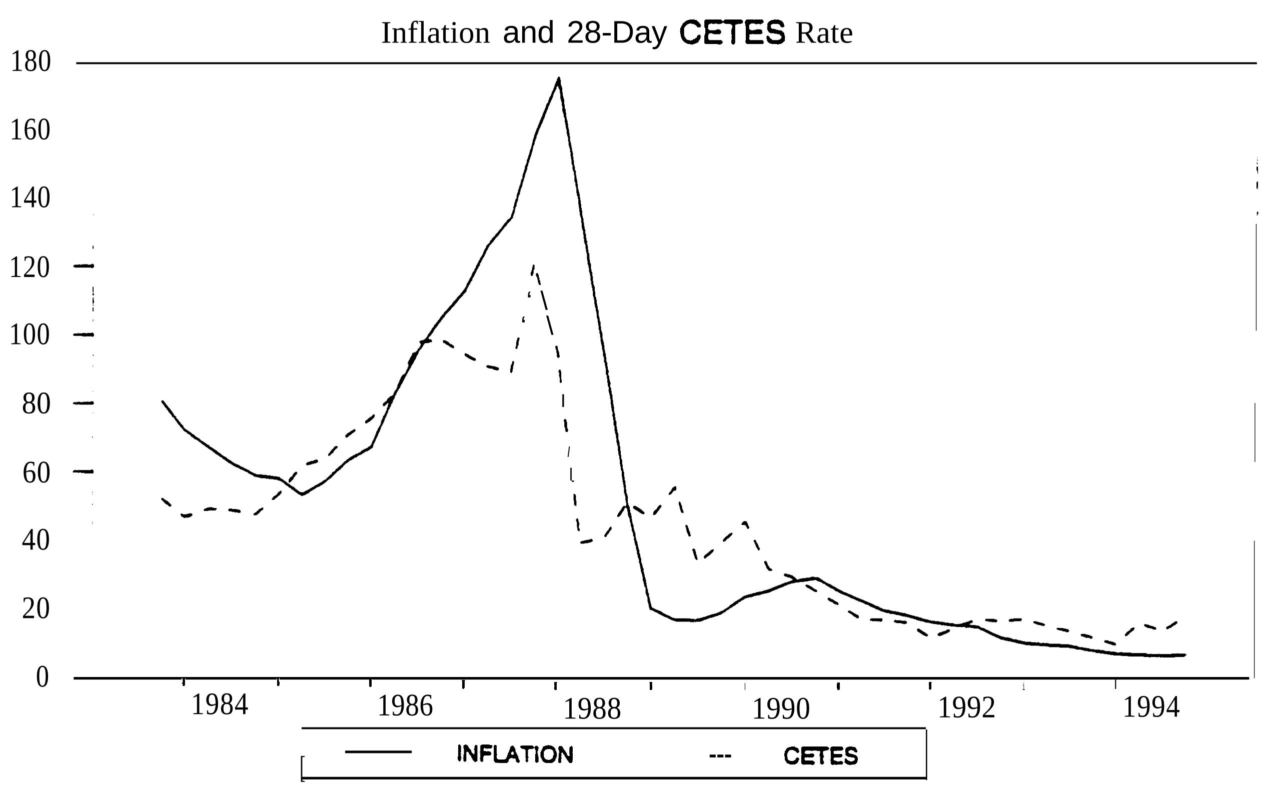
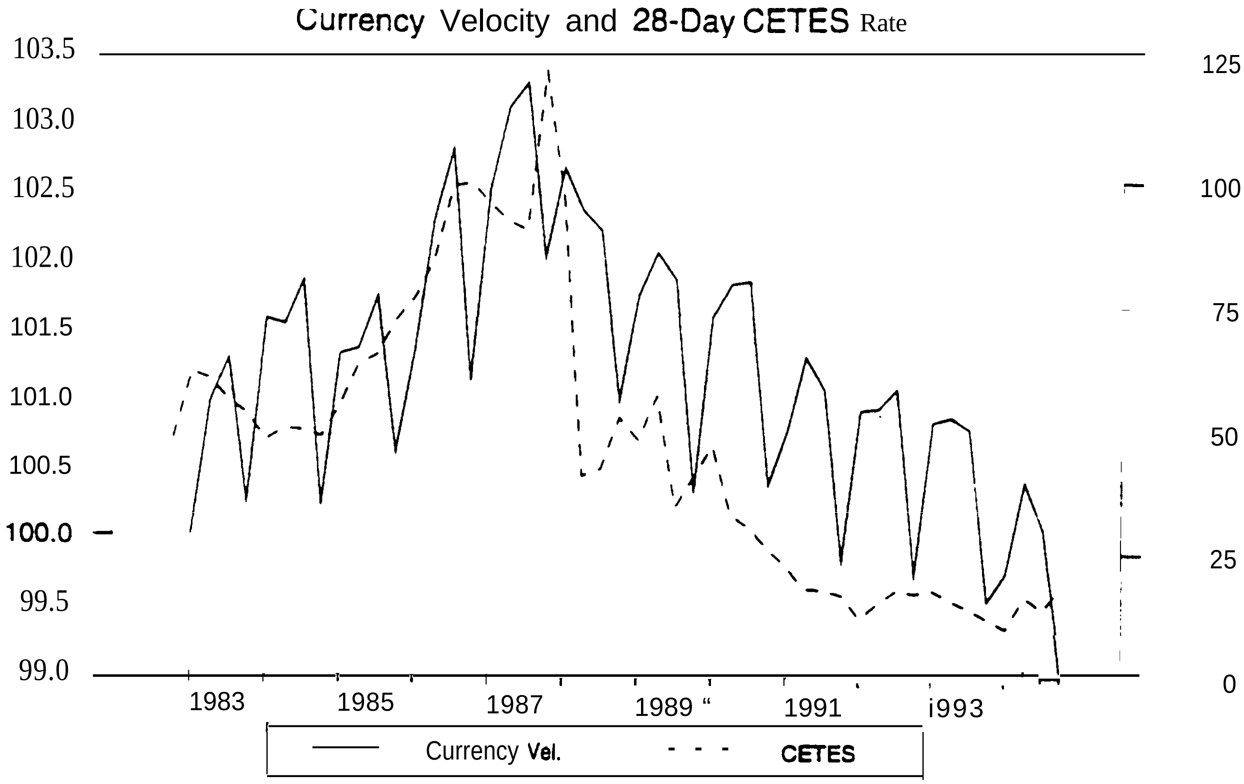


Chart 2. Velocity and Interest Rates



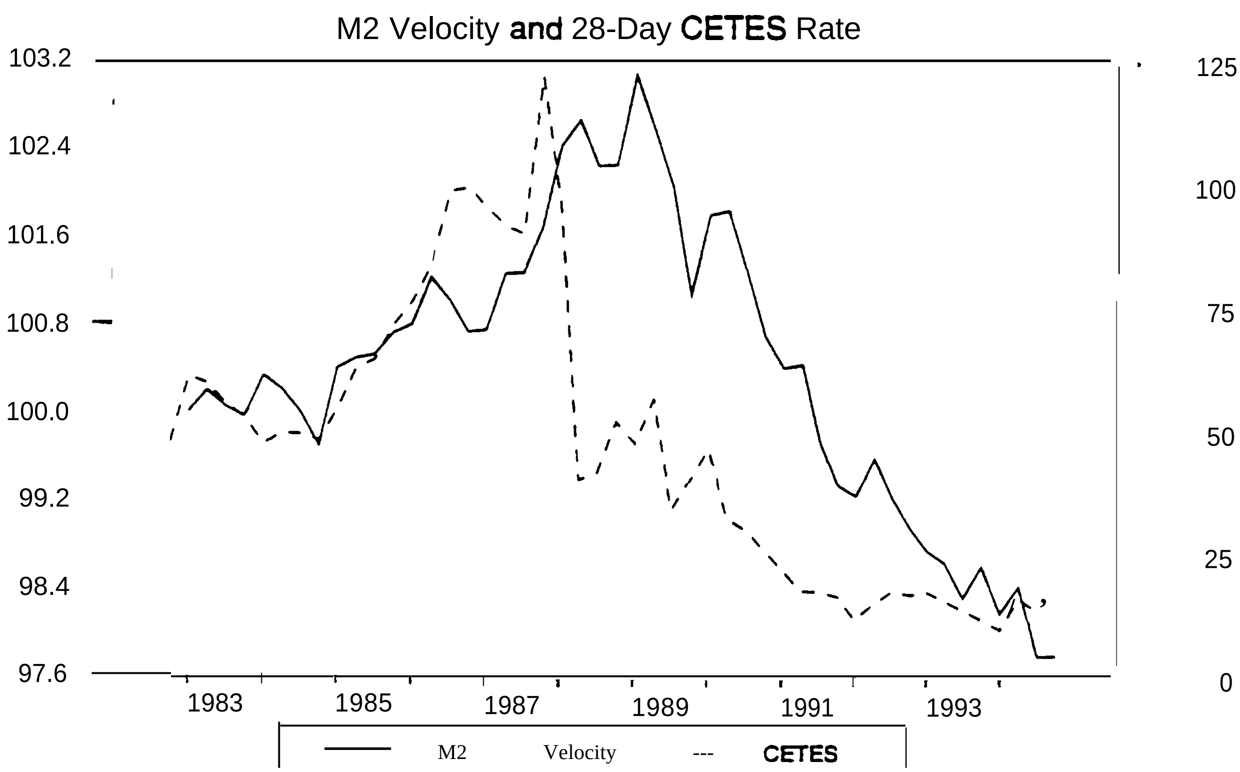


Chart 3. Parameter Constancy: OLS Money Demand Regression

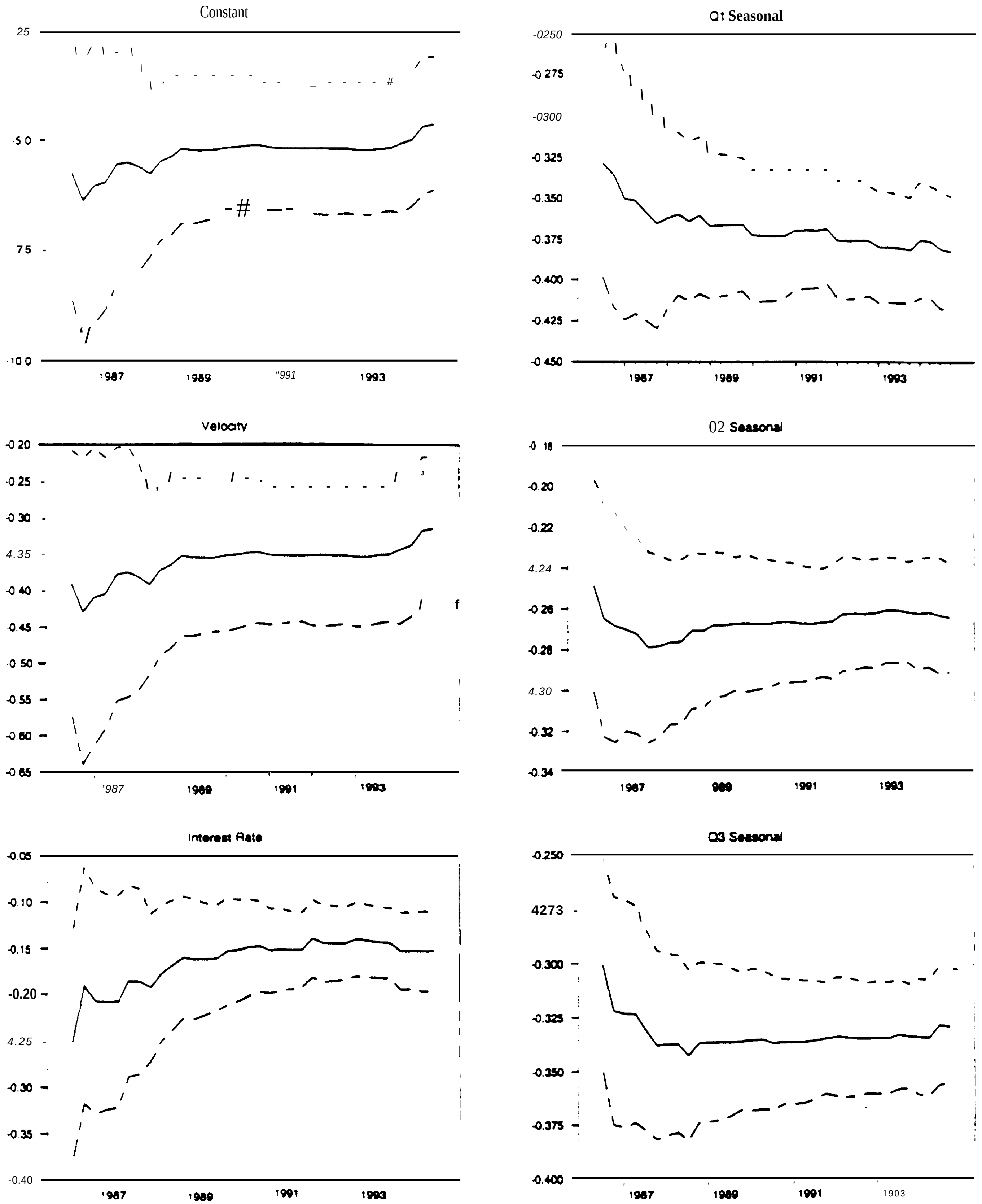


Chart 4. OLS Money Demand Regression

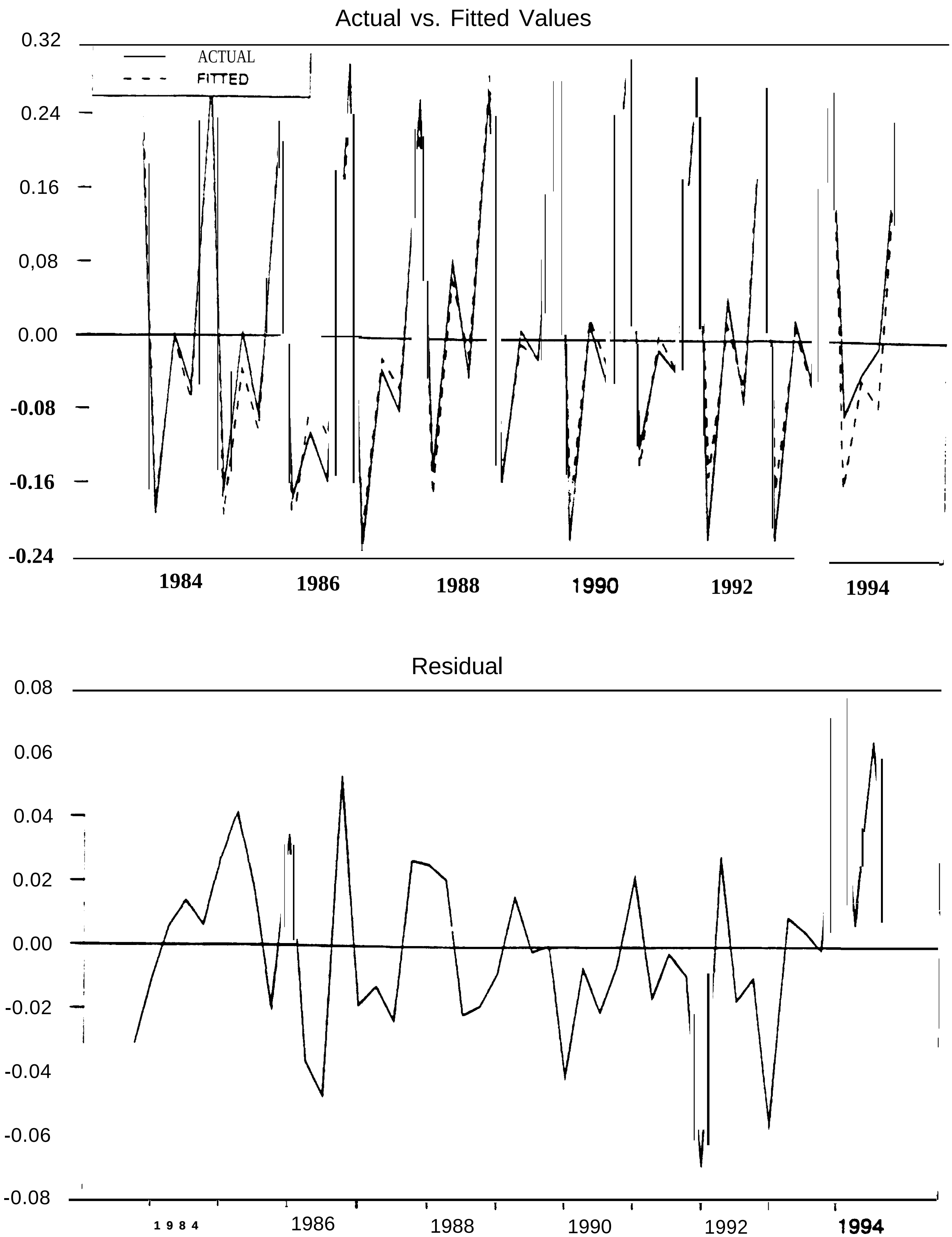


Chart 5. Parameter Constancy: OLS Reaction Function

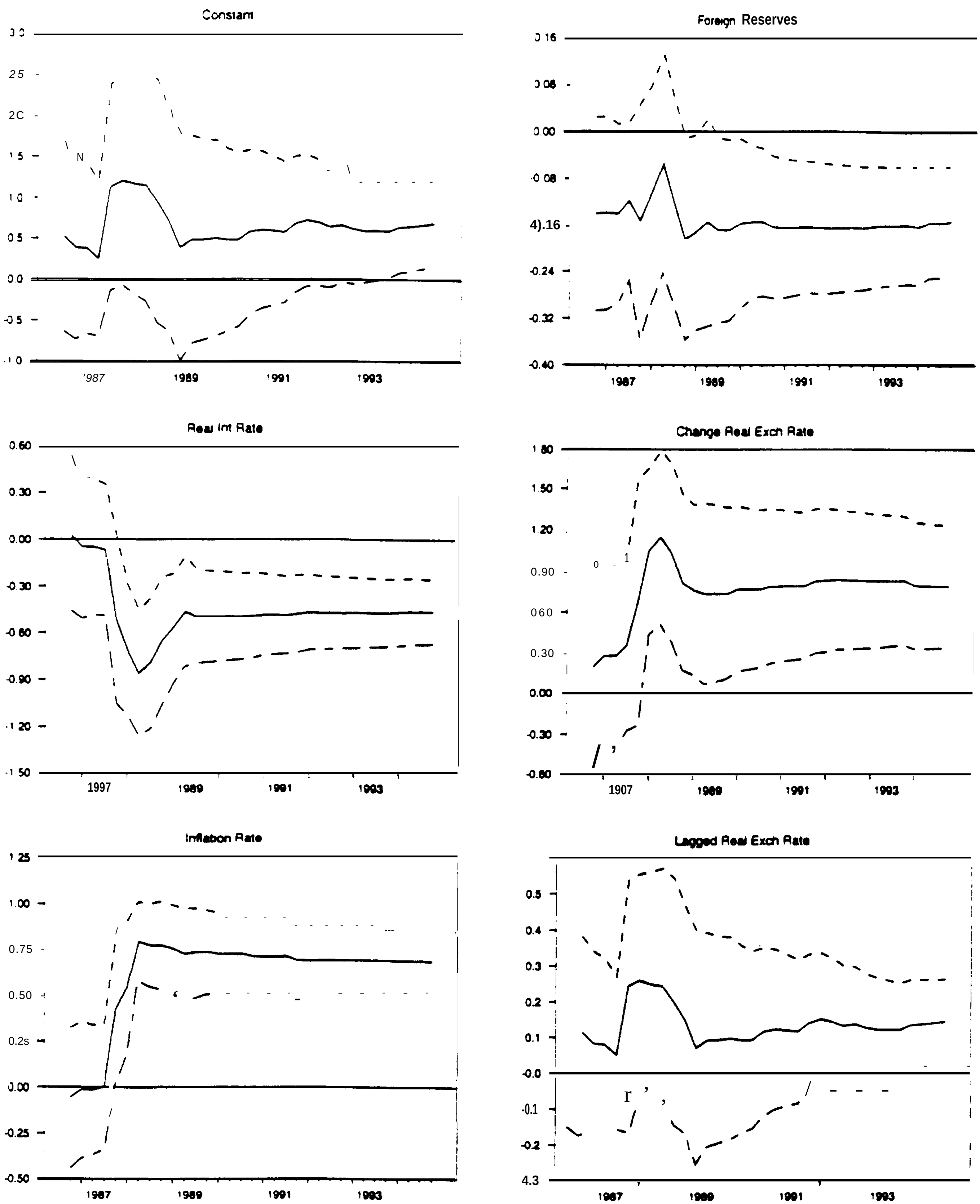


Chart 6. Rolling Chow Test

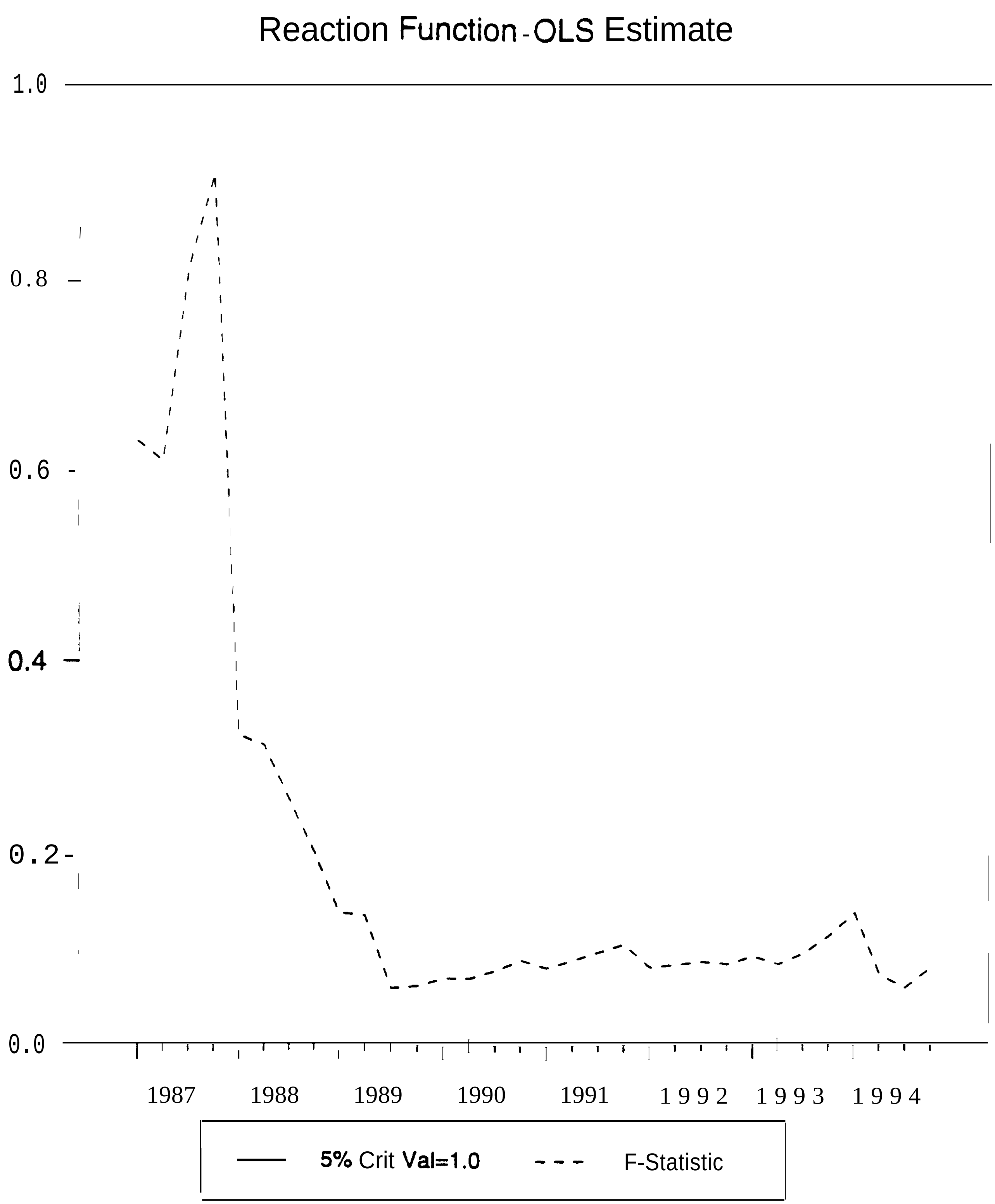
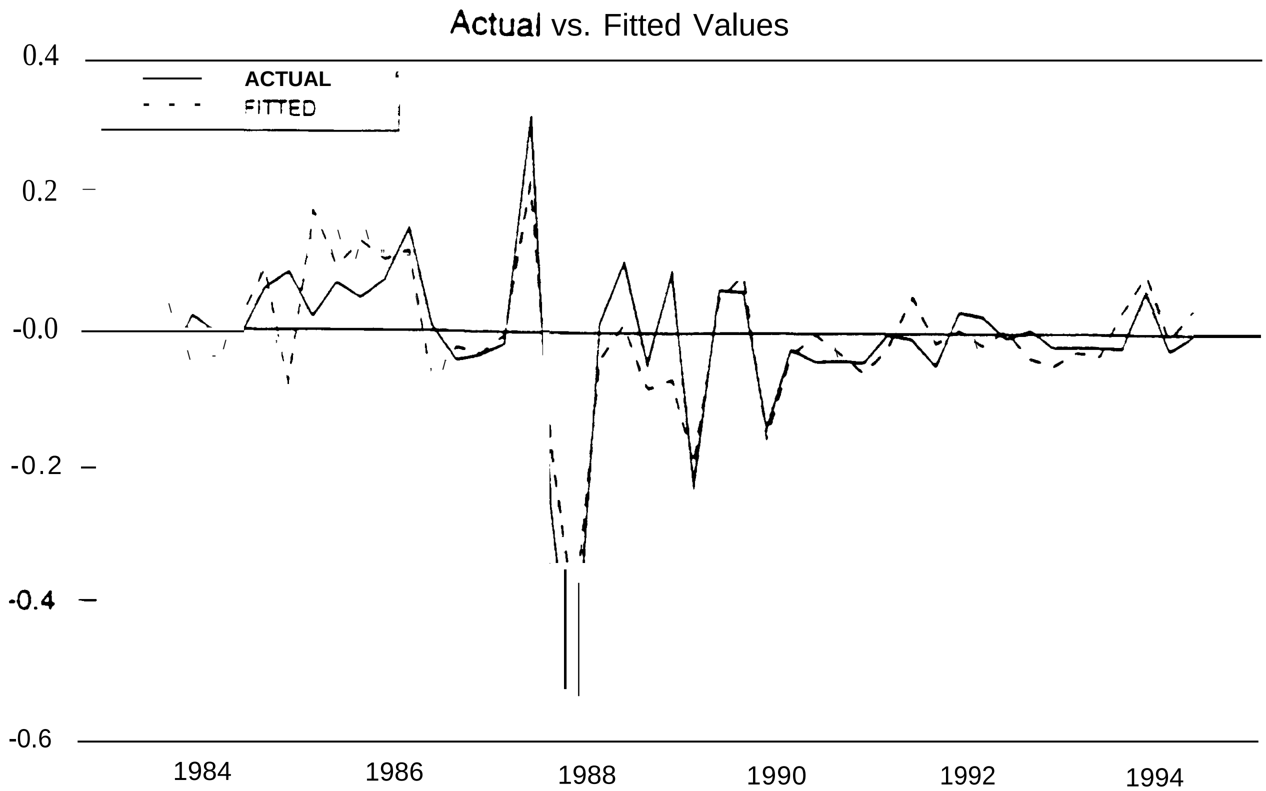


Chart 7. OLS Reaction Function



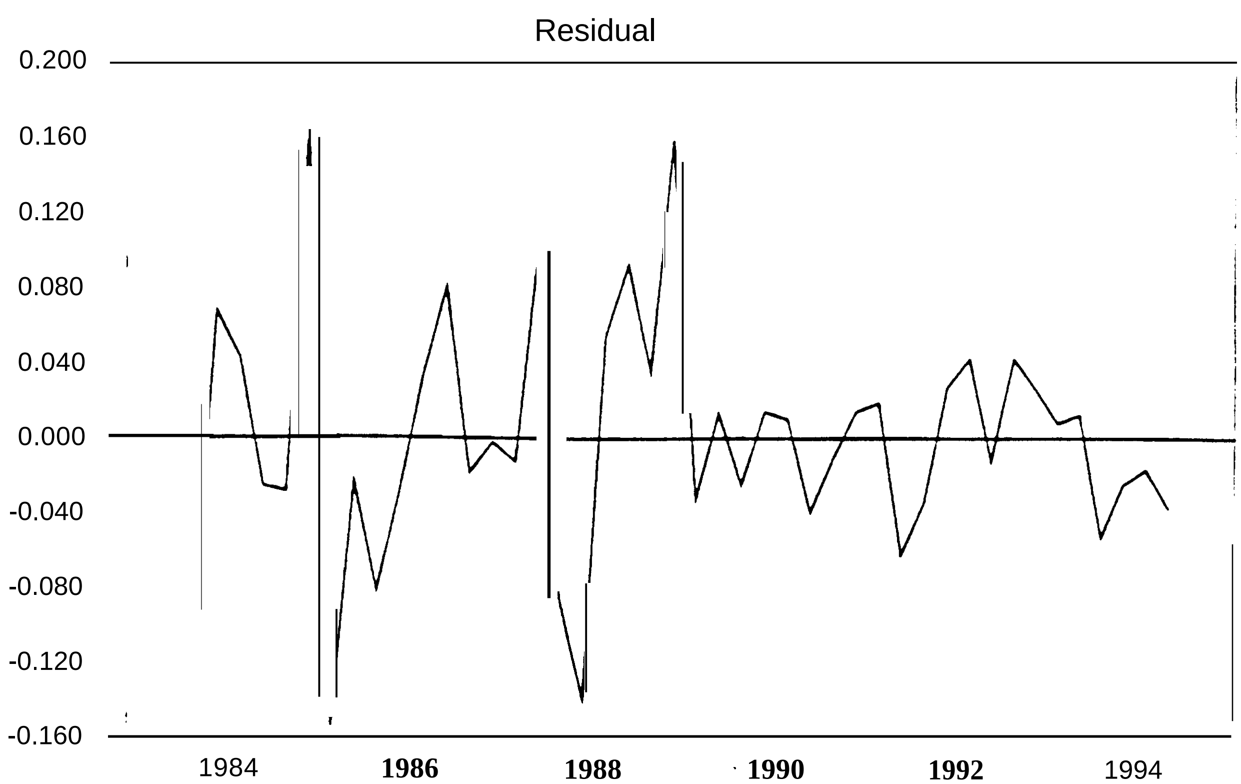
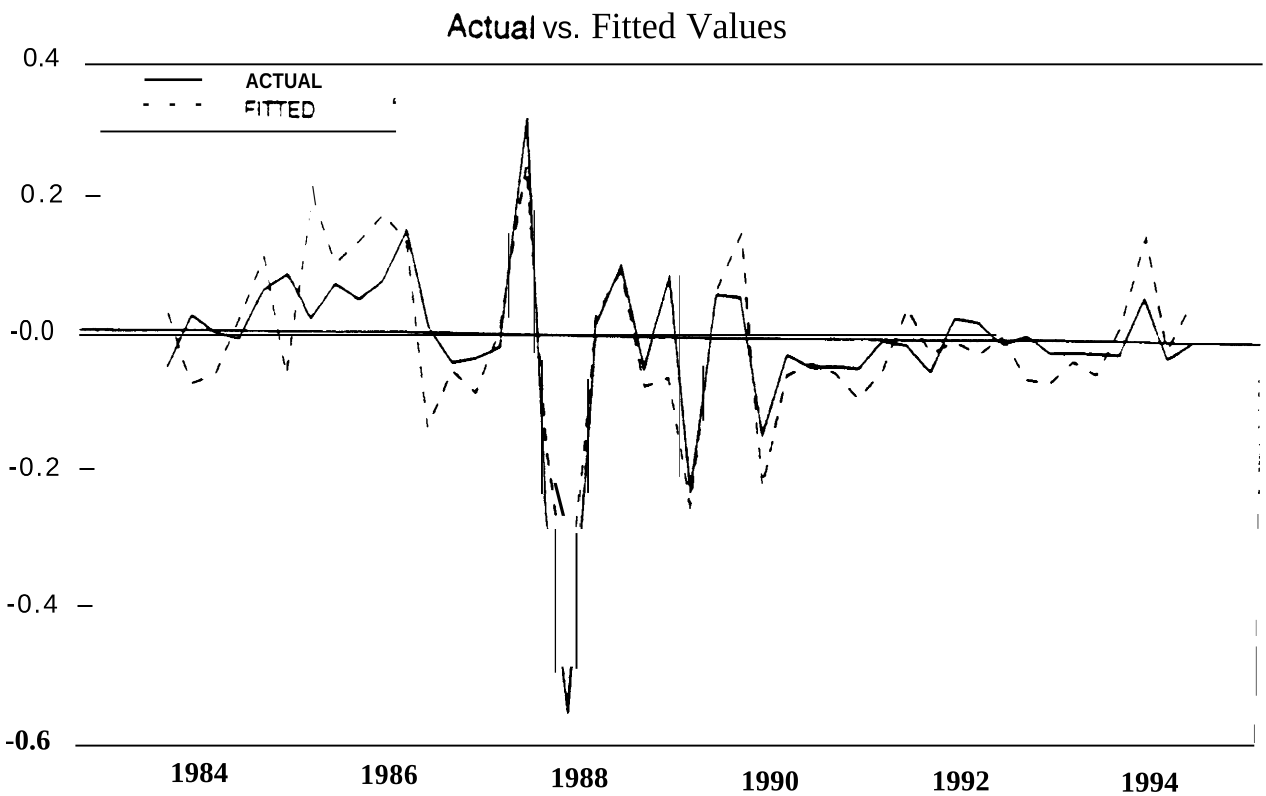


Chart 8. IV Reaction Function



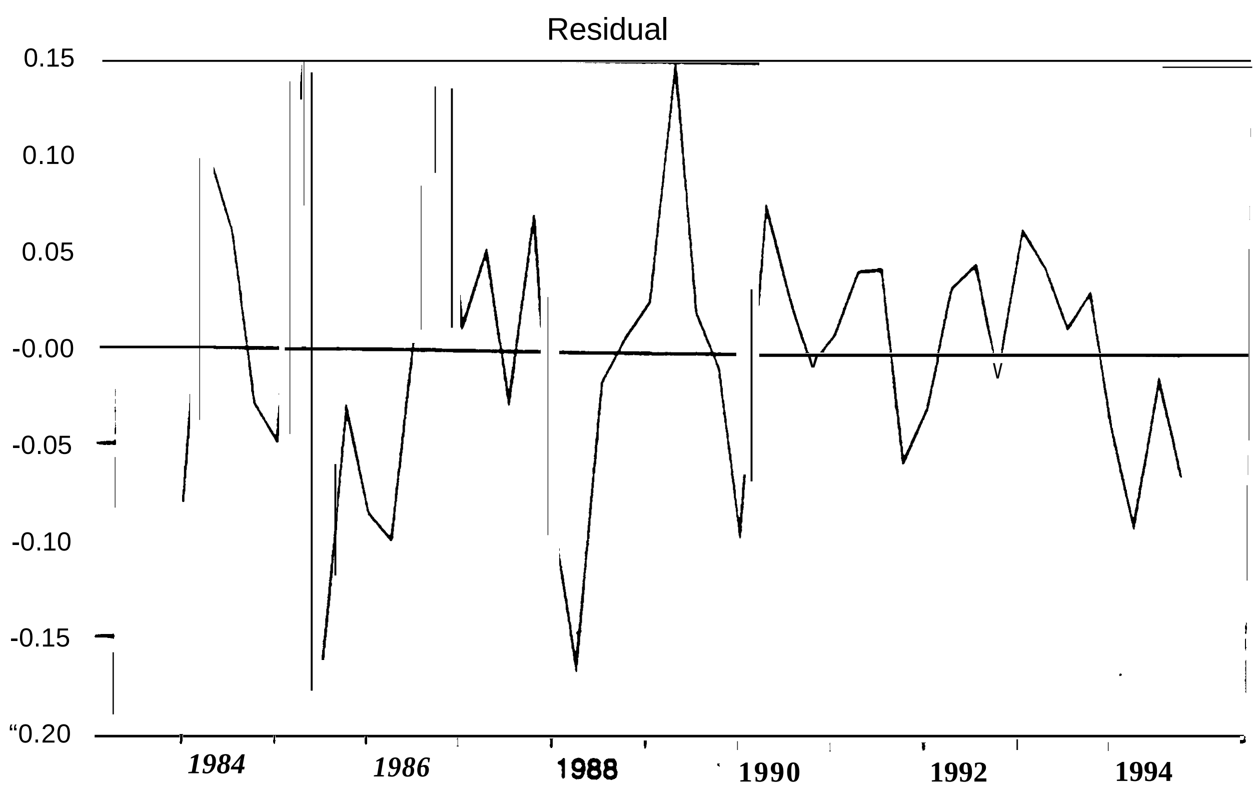


Chart 9. Reaction Function beginning in 1989: OLS

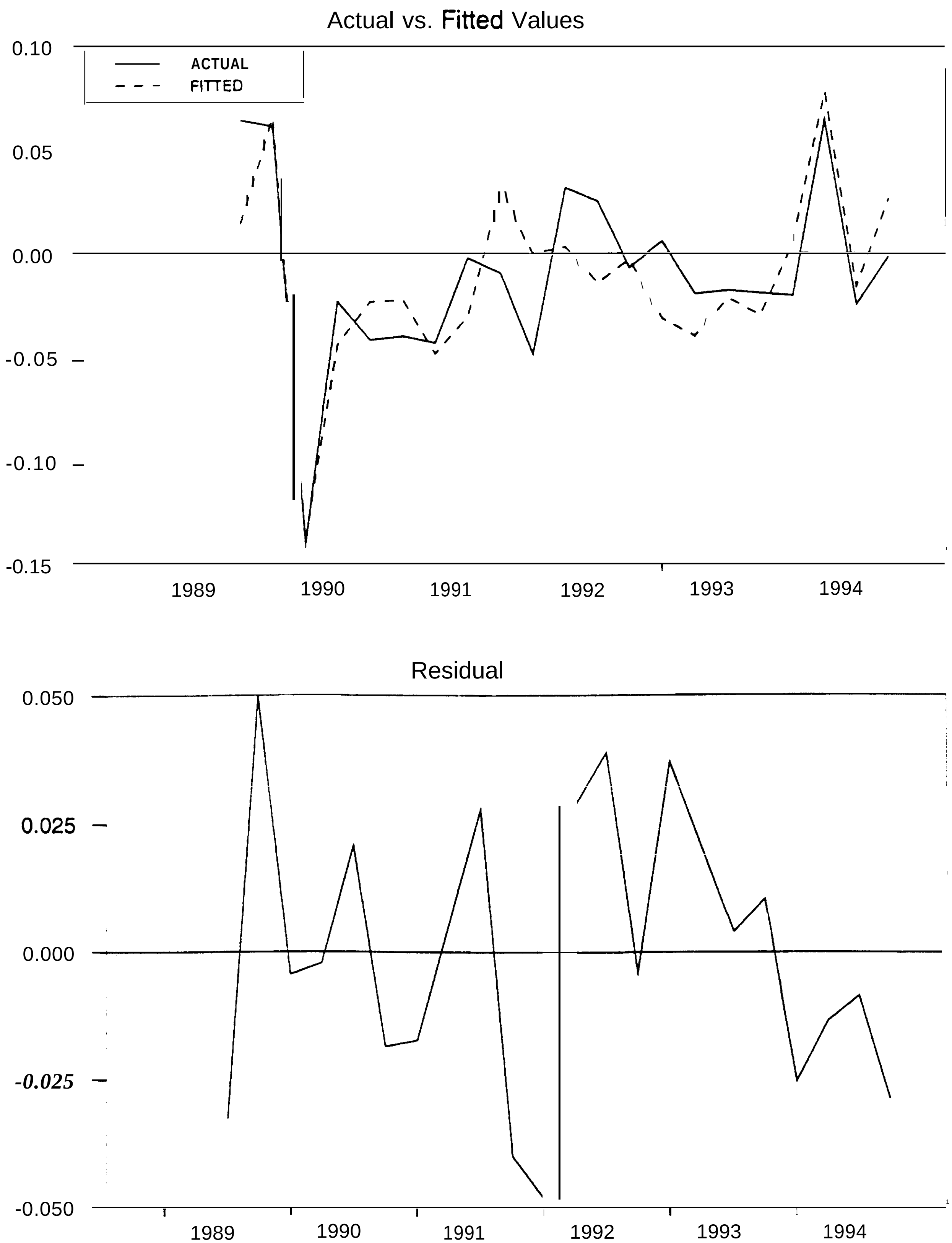


Chart 10. Interest Rate Levels

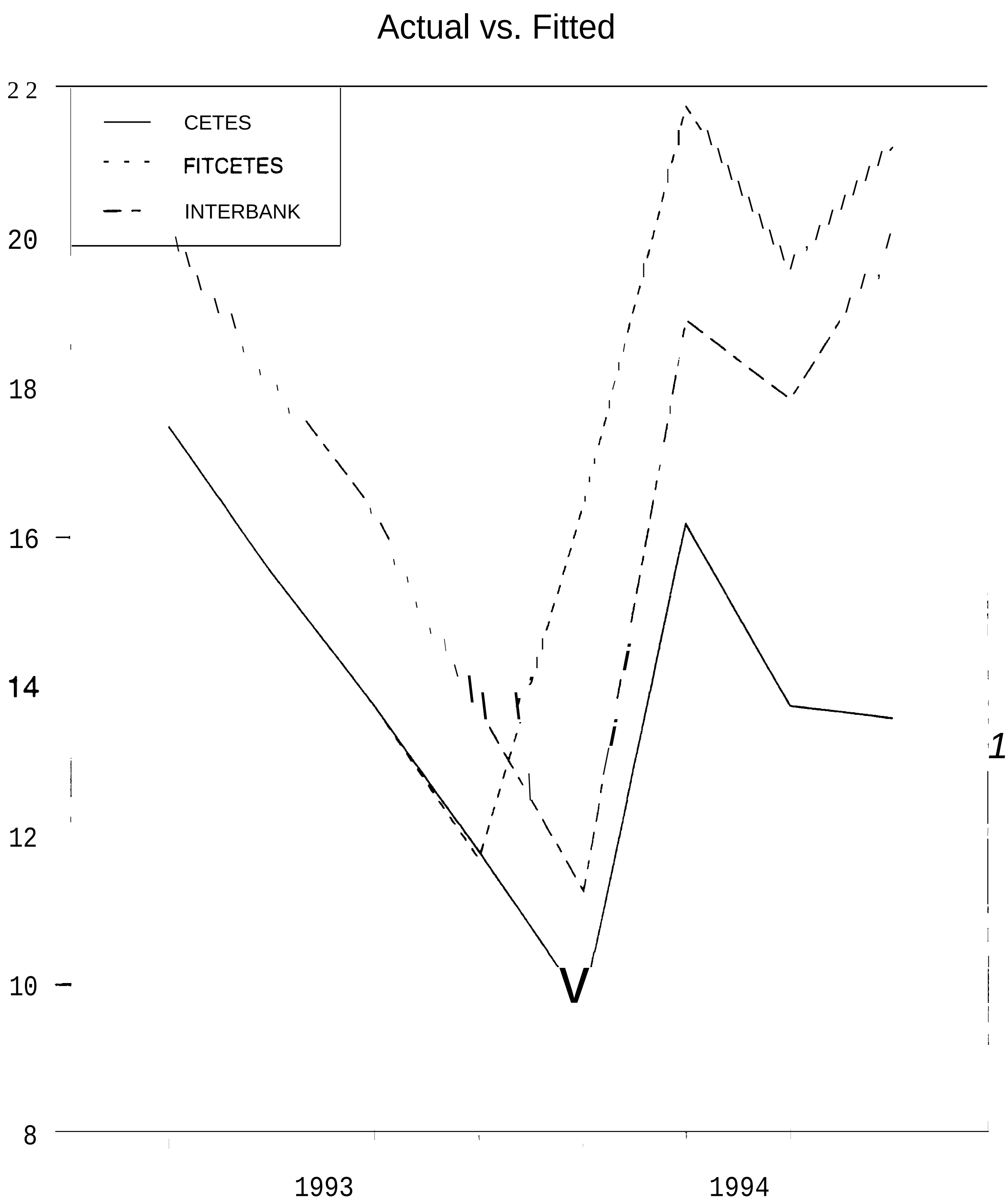


Chart 11

Mexican International Reserves and Tesobonos Outstanding

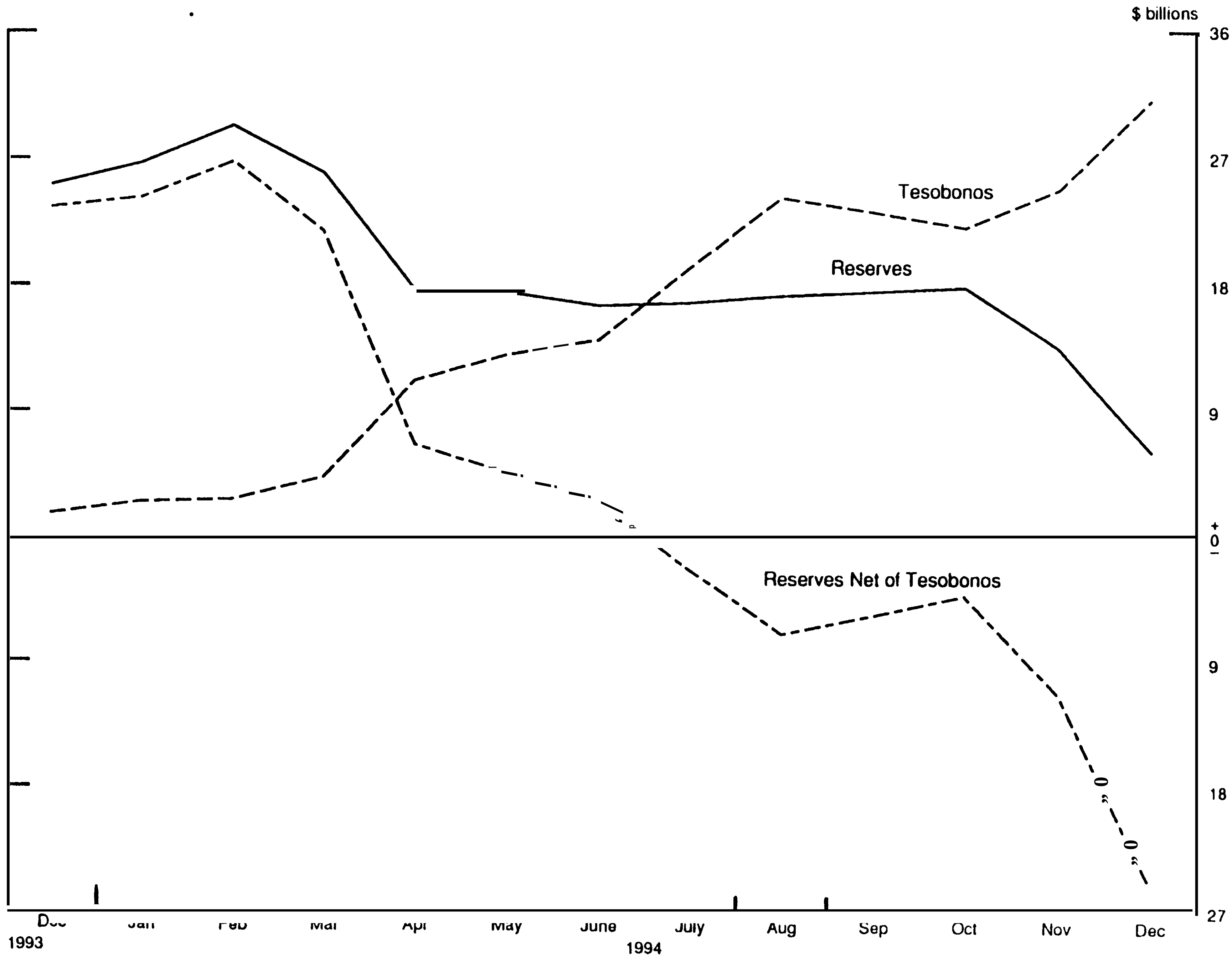


Chart 12. Predicted Rates using Gross vs. Net Reserves

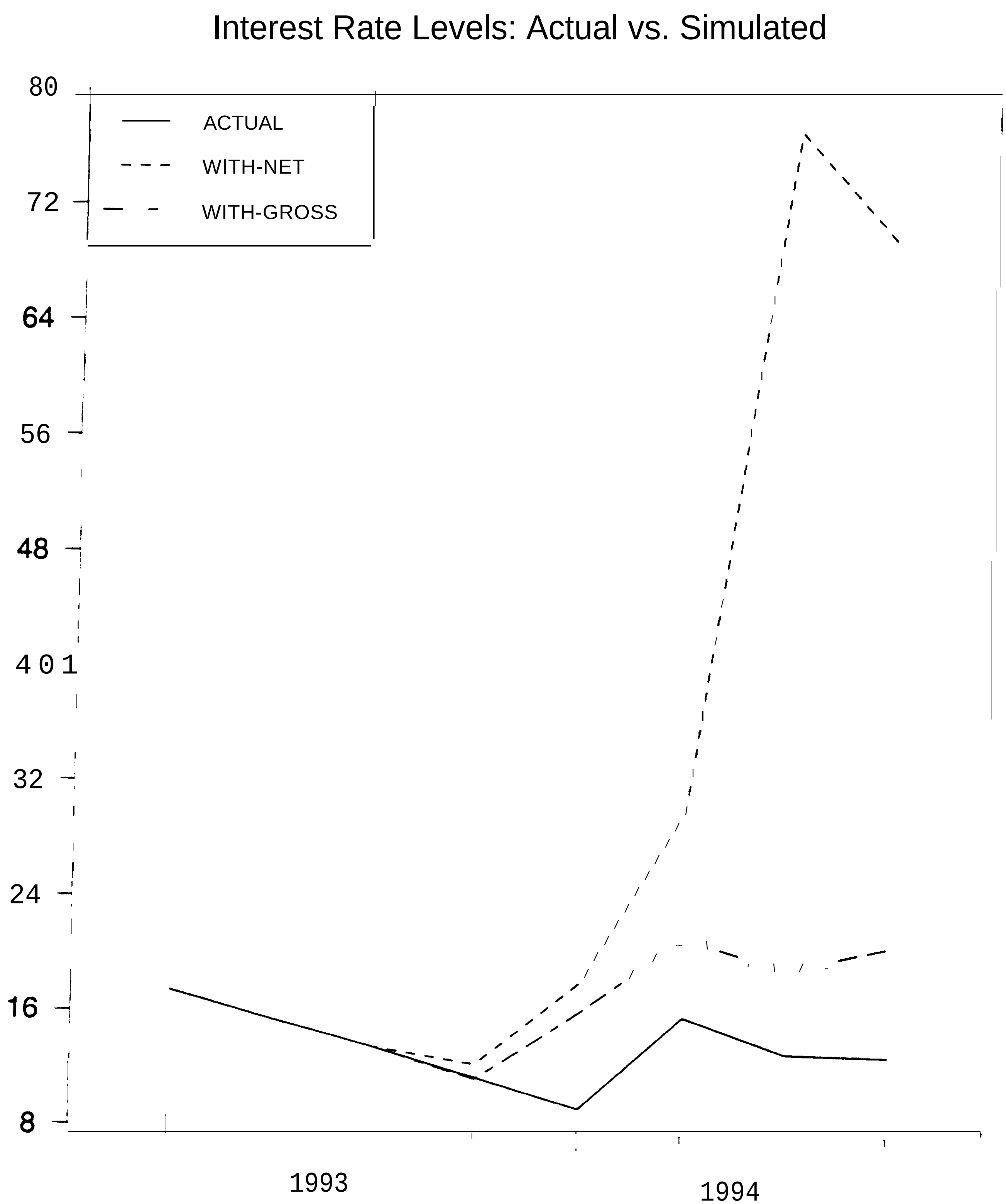
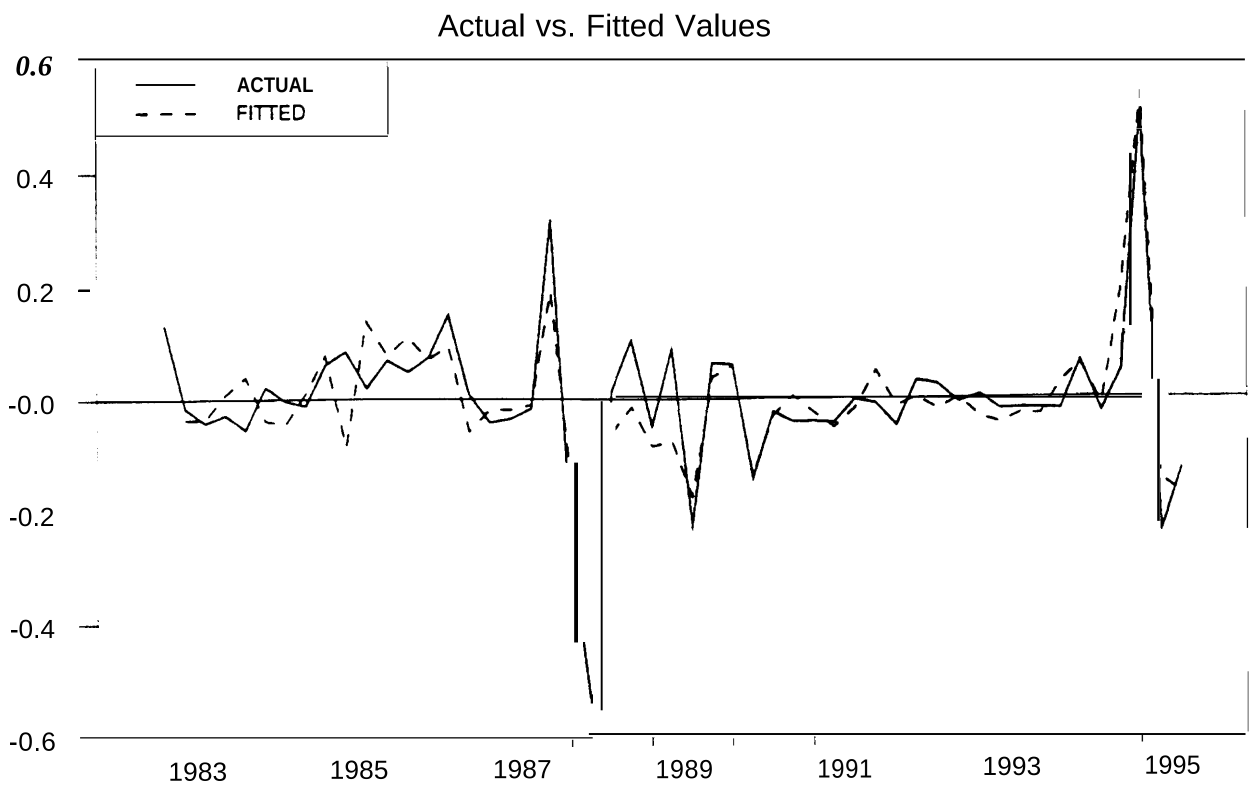


Chart 13. Reaction Function through 1995 Q3: OLS



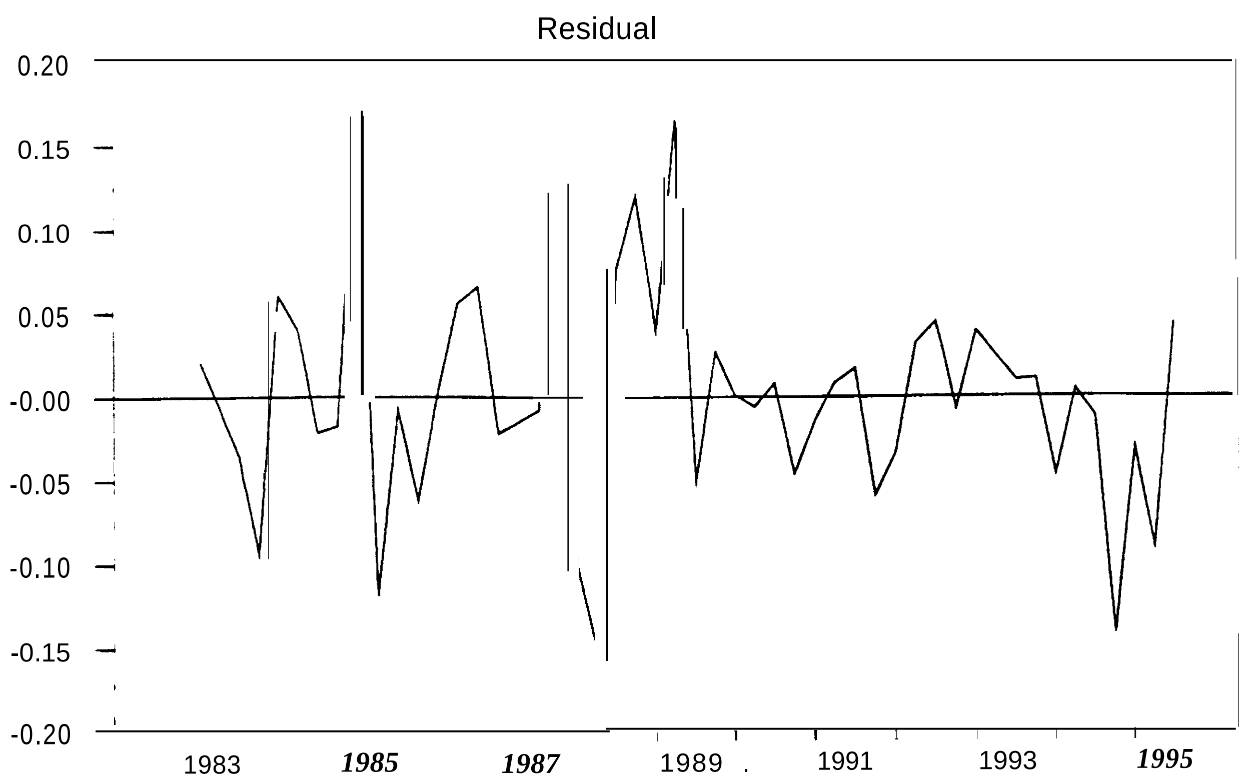
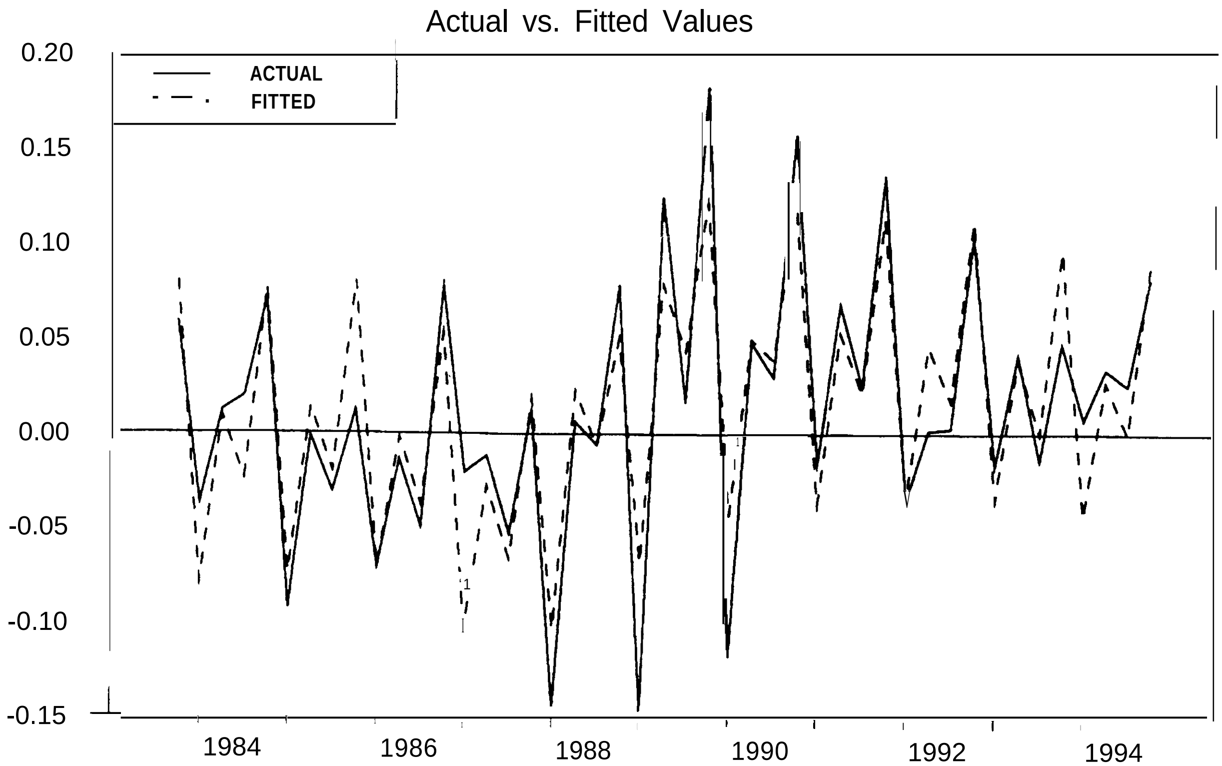


Chart A-1. OLS Real M2 Demand Function



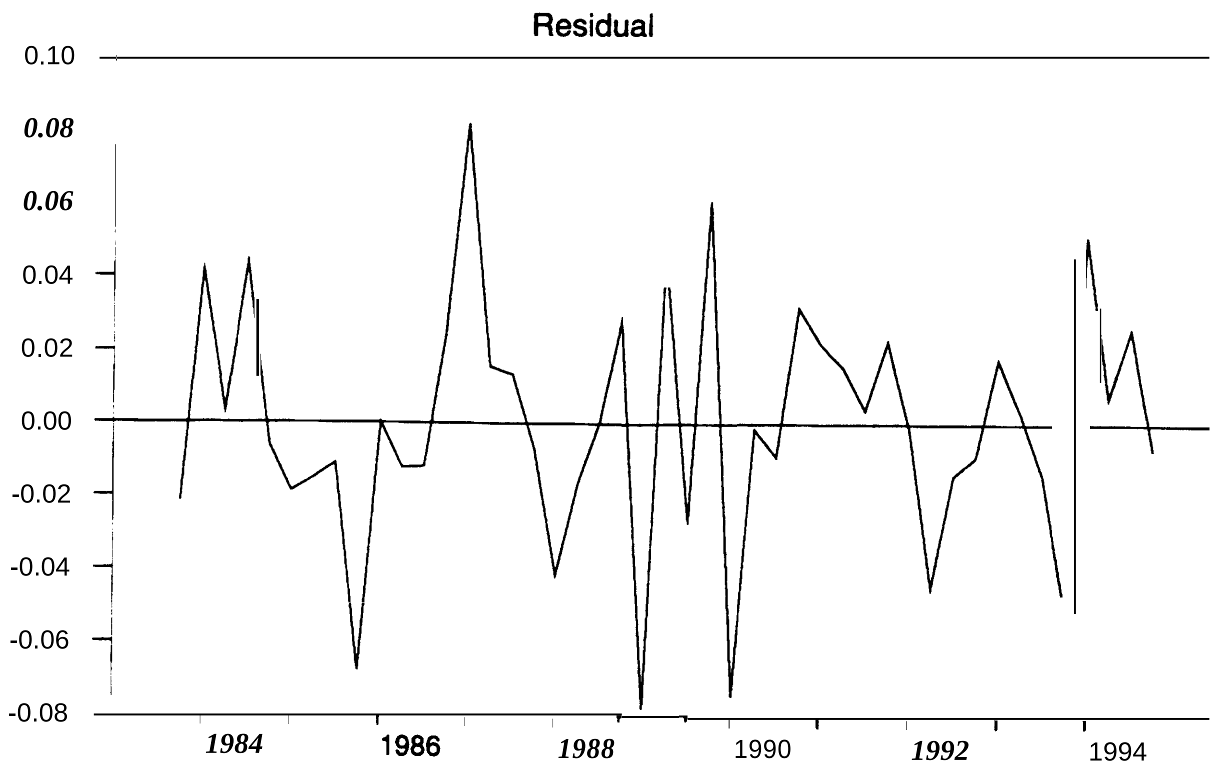
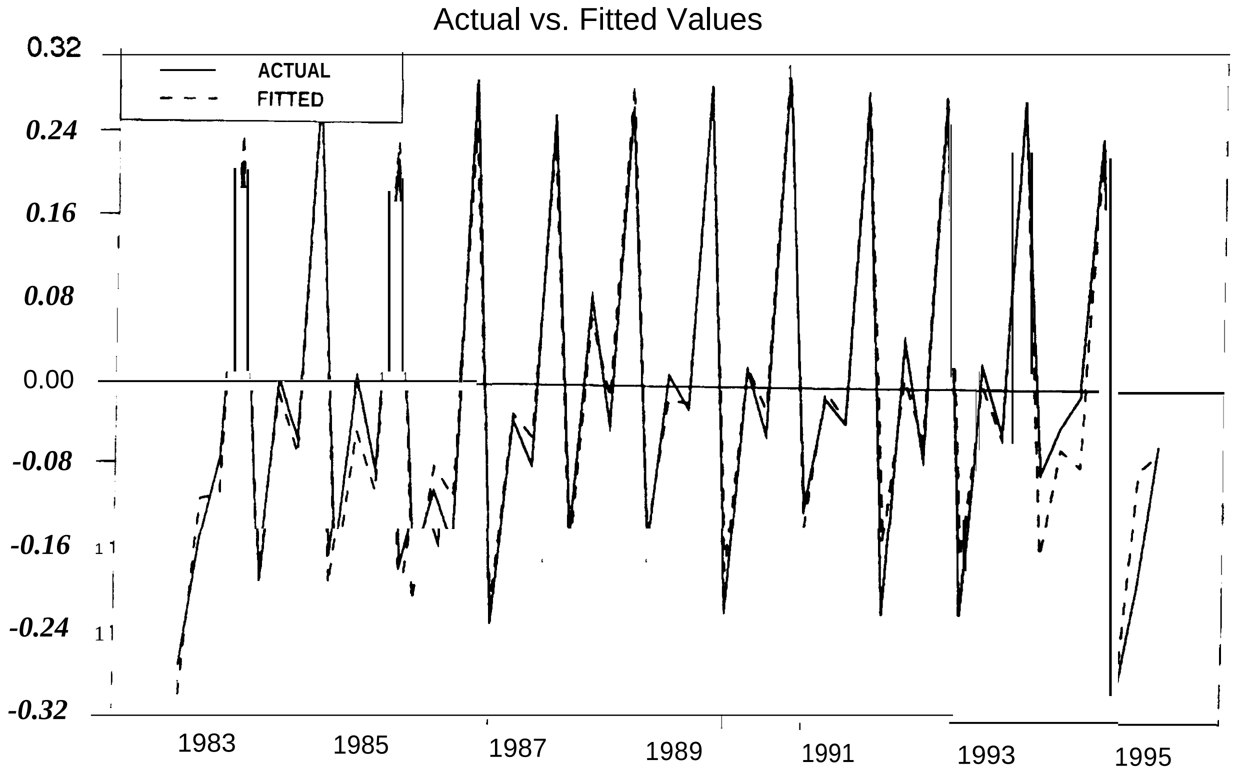
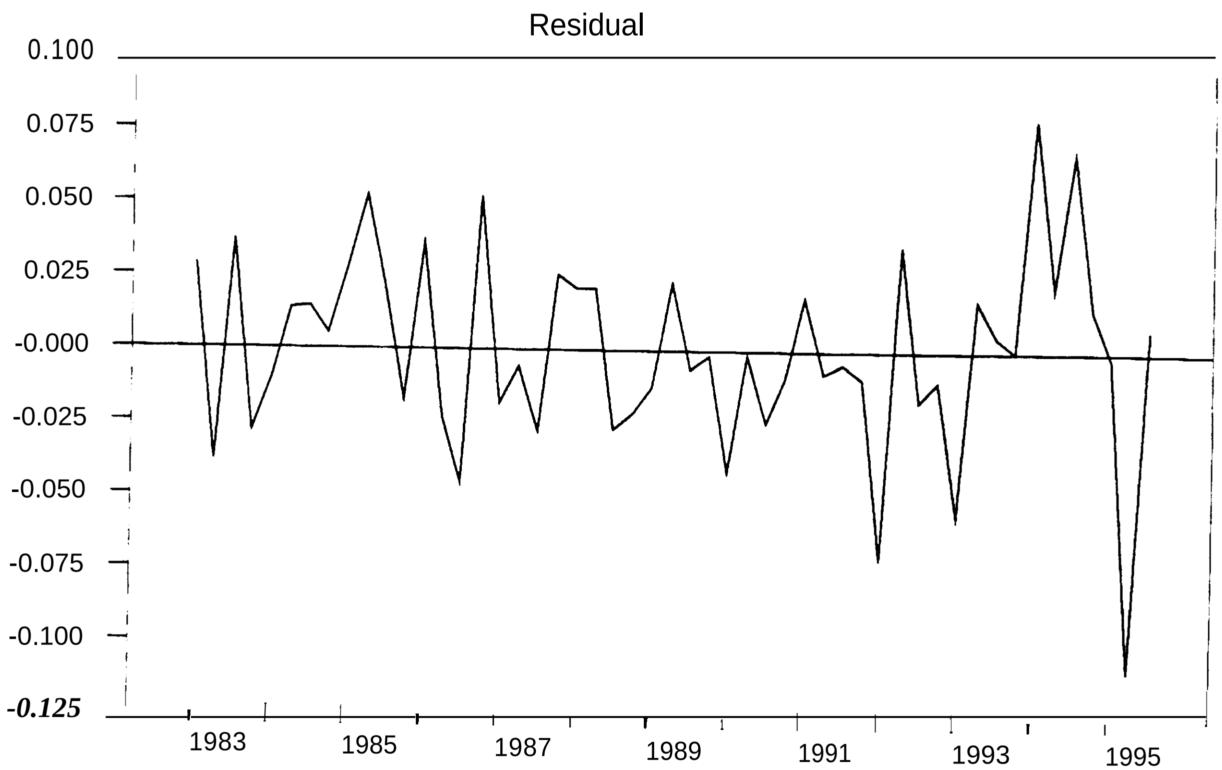


Chart A-2. OLS Money Demand through 1995:3





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