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Using a Money Demand Model to Evaluate Monetary Policies in Brazil

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Abstract

This paper uses a money demand model to evaluate monetary policies under different regimes in Brazil. The consistency between monetary liquidity and the inflation rate path is considered. The concept is applied to the Brazilian case by modeling *M*1 and its components. Based on unit root and cointegration tests, a growth-rate model is chosen, which considers all the interventions that happened during the sample period (1980-1999). It is shown that a variable seasonal pattern, which is a linear function of the nominal interest rate, increases the model ability to explain seasonal changes in the money demand. Despite the economic instability that marked Brazilian economic history during the last two decades, the model shows good fit and predictive power. Finally, it is shown that unsuccessful macroeconomic stabilization programs were marked by excessive liquidity, with money supply exceeding expected conditional money demand during intervention periods. The results suggest that to track monetary aggregates can be useful to policy makers even under a regime where interest rates are the main policy instrument.

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1 Introduction

As an increasing number of countries adopt different inflation targeting regimes to guide their monetary policy, the academic interest on the topic grows. Yet, the applied econometric work on the subject is mostly concerned with the estimation of the aggregate demand and Phillips curves. In those models, different concepts of money are generally irrelevant. Money is typically treated as an endogenous variable, and most of the time it is not even part of the modeling process.

This paper departs from the usual approach by examining how a money demand model can be used as a direct tool to check the consistency of monetary policies through the evaluation of the actual $M1$ liquidity, given inflation and output forecasts. It is proposed that this approach can be a valuable addition to the policymaker toolbox, and it has the advantage of being fairly independent from the monetary policy regime of choice. It also has the advantage of relying on measurements of monetary aggregates, which are possibly the most readily available and reliable data in a Central Bank, hence minimizing problems of timeliness and measurement errors typically associated with other variables.

The paper starts by showing how the theoretical principles behind a money demand model can be used to forecast adequate liquidity, given the policymaker projections of output and inflation conditional on an interest rate path. Differences between actual liquidity and predictions of the money demand model could indicate that the economic performance is not consistent with the projected scenarios.

The concept is used to study the Brazilian monetary policy history. Money demand represents a behavioral equation. It has the advantage thereafter of not being very sensitive to the monetary policy regime choice. Therefore, a money demand model can be used to evaluate the economy liquidity at any chosen point in time, even during different monetary regimes and stabilization plans.

To construct a money demand model for the Brazilian economy, tests for the presence of unit roots are performed. Next, Johansen's cointegration tests lead to the nonrejection of the null of noncointegration. A growth-rate model for $M1$ is chosen, carefully considering the interventions that happened during the sample period (1980-

1999). The same procedure is applied to model the two components of *M*1, demand deposits and currency.

A variable seasonal pattern, which is a linear function of the nominal interest rate, seems to fit well the data. In addition, despite the economic instability that marked Brazilian history during the last two decades, the model shows good fit and predictive power.

Aggregates broader than *M*1 cannot be used to evaluate monetary policies in Brazil, given the fact that broader aggregates historically carry a very large share of floating-rate assets, being positively correlated with nominal interest rates. *M*1, which in Brazil does not include interest-earning accounts, is thereafter the only monetary aggregate that clearly reflects liquidity expansions and contractions.

Finally, it is shown that unsuccessful macroeconomic stabilization programs were marked by excessive liquidity, with money supply exceeding expected conditional money demand during intervention periods. The results suggest that to track monetary aggregates can be useful to policy makers even under a regime where interest rates are the main policy instrument.

2 The Conditional Demand for Money

Consider, as an example, the baseline inflation-targeting model presented in Clarida, Galí and Gertler (1999). It has two equations, an IS curve and a Phillips curve:

$$x_t = -\phi\left[i_t - E_t\pi_{t+1}\right] + E_t x_{t+1} + g_t \qquad \text{(IS)}$$

$$\pi_t = \lambda x_t + \beta E_t \pi_{t+1} + u_t\,, \qquad \text{(Phillips)}$$

where x_t is the output gap, i_t is the nominal interest rate, π_t is the inflation rate, g_t is the possibly autocorrelated demand innovation and u_t is the possibly autocorrelated supply innovation. Note that no concept of money enters this system: the monetary side of the economy is entirely represented by the nominal interest rate, the policy instrument.

In the same paper, Clarida, Galí and Gertler justify the interest rate choice, in place of a monetary aggregate, as policy instrument: "Large unobservable shocks to money demand produce high volatility of interest rates when a monetary aggregate is used as the policy instrument. It is largely for this reason that an interest rate instrument may be preferable."

Monitoring one or more definitions of money could be however a useful monetary policy tool. Consider for example the money demand equation used in Clarida, Galí and Gertler (1999):

$$m_t = p_t + \kappa y_t - \eta i_t + v_t \quad (2.1)$$

One can easily see that, given projections for y_t, i_t and p_t, the conditional behavior of m_t can be forecasted using the model above. Econometric analysis will lead to probability intervals for m_t, which will depend on the statistical process driving v_t. Forecasted values could then be compared to the actual money measurement. Any substantial or systematic departure between those two values would indicate a possible inconsistency between the scenarios and reality (or, maybe, a money demand structural change). It would give the policymaker early alert regarding the economic status, since money measures tend to be available earlier and tend to be more reliable than inflation measures.

As an example, suppose that the policymaker has defined its interest rate target, which would be consistent with a certain projection for output and inflation. If she observes later that the actual monetary aggregate is above the projection coming from equation (2.1), she would know that maybe output is increasing faster than expected, or that perhaps price expectations are higher than what she thought they would be. In a case like that, the money demand model would be able to give early warning to the policymaker, helping her to take preventive measures.

Note that the European Central Bank uses a similar approach as one of the pillars of its stability strategy.[1] It studies the demand for a broad aggregate ($M3$) and defines its reference growth rate based on policy goals. Here, however, aggregate growth rates are suggested just as an additional economic indicator and not as instruments for monetary policy, which is the same approach adopted by the Bank of England and the Central Bank of Chile.[2]

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[1] European Central Bank (1999).

[2] Bank of England (2000) states that "the money supply does play an important role in the transmission mechanism but it is not, under the United Kingdom's monetary arrangements, a policy instrument. It could be a target of policy, but it need not be so. In the United Kingdom it is not, as we have an inflation target, and so monetary aggregates are indicators only." Central Bank of Chile (2000) states that "developments regarding

3 Modeling the Brazilian Money Demand

The concept presented in the previous section is applied to the Brazilian case. First, it is necessary to find which kind of money demand model best fits Brazilian data. The sample has 240 monthly observations, covering January of 1980 to December of 1999. Data are not seasonally adjusted.

As monetary variables, the Brazilian narrow money concept (*M1*) and its two components, currency (*CUR*) and demand deposits (*DD*), are employed. The IGP-DI (*P*) – the general price index from FGV – is used to deflate the monetary variables, leading respectively to *M1R*, *CURR* and *DDR*. The SELIC overnight rate (*I*) represents the nominal interest rate. The proxy for real output is the national consumption of electricity (*CE*). The effective reserve ratio (*RR*), defined here as the ratio of total reserves to demand deposits, is also considered in the money demand equations. The models are loglinearized, except in the case of the interest rate, which is transformed to an instantaneous rate.

Although energy consumption can be criticized as a proxy for output, it was chosen not only because it is available monthly but also because it is able to capture the growth of the underground economy in Brazil. Other activity variables have been employed, with less success. New proxies are now being investigated, regarding future money demand specifications, due to the electricity rationing in 2001.

First, tests for the presence of unit roots in the series are performed. Appendix 1 presents the results of the ADF unit root tests. The tests employ critical values from MacKinnon (1991) and two criteria to select the number of lags: Akaike information criterion and Schwert (1989) lag-selection rule. The results indicate that the unit root hypothesis can only be rejected for the *RRR*. The tests cannot reject the unit root hypothesis for the other variables, which henceforth are assumed as being integrated of order one.

To confirm the results above, the null hypothesis of presence of unit root against the alternative hypothesis of stationarity along a breaking or shifting trend is tested. This is

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monetary aggregates are relevant when evaluating the economy's overall progress and the impact of monetary policy on it, even though the Central Bank has no explicit or implicit goals regarding these aggregates."

particularly important in the Brazilian case, where interventions have happened from time to time. The chosen approach is described in Banerjee, Lumsdaine and Stock (1992), in which the selection of breaking points is endogenous, hence not incurring pretesting problems. The results are presented in Appendix 2. The hypothesis of unit root cannot be rejected, and, for some variables, the hypothesis of integration of order two cannot be rejected too. It will be assumed that the order of integration is one for every variable, with the exception of *RR*, which will be assumed stationary.

Given that most series have a unit root, cointegration tests are in order. If there were cointegration among the series, then an error-correction mechanism model would have to be used. On the other hand, if there were no cointegration among the series, then a growth-rate model (a model of first differences) would have to be employed.

Appendix 3 presents the results of cointegration tests. The Johansen (1990 and 1991) procedure is employed, with critical values given by Osterwald-Lenum (1992) and corrected following Cheung and Lai (1993). The null hypothesis of noncointegration for six systems of variables is tested. In three of them *RR* is included, since the unit root tests were not clear regarding the integration order of this variable. The null hypothesis of noncointegration is never rejected; thereafter a growth-rate model is chosen in place of an error-correction mechanism model.

Three different models are chosen, one for $M1$, one for currency and one for demand deposits. The unrestricted model structure is

$$\Delta M_t = \alpha_0 + \sum_{i=1}^{n} \beta_i \Delta M_{t-i} + \sum_{j=0}^{p} \chi_j \Delta I_{t-j} + \sum_{k=0}^{q} \phi_k \Delta CE_{t-k} + \sum_{l=0}^{r} \gamma_l \Delta RR_{t-l} + \sum_{m=0}^{s} \Lambda'_m \mathbf{D}_{t-m} + \mu_t \,,$$

where M represents a measurement of money, Λ_m is a vector of parameters, **D** is a vector of dummy variables, and μ represents the model innovation, which can be interpreted as being related to unobserved and independent changes in the velocity of circulation of money.

The dummy vector **D** is composed of four different sets of interventions. One is a sequence of step, ramp, and impulse dummies for stabilization plans in Brazil. An impulse dummy here is defined as the first difference of a step or a ramp dummy. The following plans are considered: Cruzado (step on March of 1986), Cruzado II (step on December of 1986), Bresser (step on July of 1987), Collor (ramp stepping up from March of 1990 to April of 1990) and Real (step on July of 1994). A dummy is also used to model the hyperinflationary period that followed the Verão Plan (ramp stepping up from June of 1989 to February of 1990). The second set of dummies is used to treat the effect of the CPMF tax (bank account debits tax). The third set takes care of deterministic seasonal components. The fourth deals with a variable seasonal component, which is a linear function of the nominal interest rate.

A redundant-variable likelihood ratio test is used as criterion to reduce the number of lags and variables in the unrestricted model, leading to a restricted version for each equation. Some observations follow.

The model for $M1$ includes: step or ramp dummies for Cruzado, Cruzado II, Bresser, Verão and Collor; impulse dummies for Cruzado, Verão, Collor and Real; step and impulse dummies for CPMF; deterministic seasonal dummies for February, September, October and December; and interest-rate dependent dummies for January and December.

The model for currency includes: step or ramp dummies for Cruzado, Cruzado II, Bresser and Real; impulse dummies for Collor and Real; no dummies for CPMF; deterministic seasonal dummies for January, February, June, July, September, October, November and December; and an interest-rate dependent dummy for December.

The model for demand deposits includes: step or ramp dummies for Cruzado, Cruzado II, Bresser, Verão and Collor; impulse dummies for Cruzado, Verão, Collor and Real; impulse dummies for CPMF; deterministic seasonal dummies for February, September, October and December; and interest-rate dependent dummies for January and December.

The dummies for the stabilization plans may be interpreted as capturing periods of chronic or temporary mismanagement of the monetary aggregate supply. To avoid preselection of interventions, all stabilization plans are treated with dummies in the unrestricted model, and later the redundant dummies are excluded. This procedure allows comparability between stabilization plans, as it will be done later on.

The interest-rate dependent variable seasonal dummies are necessary for the complete elimination of seasonal patterns from the model innovations. These dummies are defined as

$$VSD_m = \begin{cases} 0 \text{ if month } \neq m \\ I \text{ if month } = m \\ -I \text{ if month } = m+1, \end{cases}$$

being proxies for changes in the seasonal behavior of the agent when the cost of opportunity of holding money changes. It is verified that the seasonal pattern is accentuated by increases in the nominal interest rate.

Several explanations can be given to this phenomenon, among them the existence in Brazil of a "13th wage month," which coincides with the holiday season at the end of the year and which represented a higher proportion of the yearly income when nominal interest rates were high.[3] Another explanation is related to the asymmetric use of cash during work and vacation periods. In Brazil, the latter usually coincides with the last and first months of the year, due to the academic calendar. Money demand during vacations tends to be less elastic to nominal interest rates than during other periods. Households hold more money due to traveling and holiday expenses, not caring about the opportunity costs as much as during other periods (transactional reasons).

Appendix 4 shows the values of the long-run elasticities for the interest rate (*I*) and for the output proxy (*CE*). The values support the standard money demand theory. The elasticity for *CE* is however unexpectedly low in the equations for currency and demand deposits.

Appendix 5 shows the results of stability tests based on recursive out-of-sample forecasting. Figures 1, 2 and 3 report the results of the one-step ahead forecast statistics, while Figures 4, 5 and 6 report the results of the N-step ahead forecast statistics. Note that the models faired well on both tests. Those tests are particularly important for models that will be used as forecasting tools.

Finally, note that the effective reserve ratio (*RR*) is significant and is present only in the equation for demand deposits. Yet, its parameter is not economically significant, with a small short-run elasticity (-8.2%). No clear explanation can be provided to the statistical significance of this variable, but it seems that the banking system in Brazil tries to shift its costumers away from demand deposits when the reserve requirement ratio is very high,

[3] Insight offered by S. Werlang.

through the creation of substitute financial products. This could explain such economically small but yet statistically significant elasticity.

4 Evaluating Stabilization Plans

The money demand models developed in the previous section are used to evaluate six stabilization plans in Brazil: Cruzado (1986), Bresser (1987), Verão (1989), Collor (1990), Collor II (1991) and Real (1994).

The procedure is simple: the model for real *M*1 (*M1R*) is used to produce one-step-ahead out-of-sample forecasts starting from the first month of each stabilization plan. These forecasts take the output proxy (*CE*) and the nominal interest rate (*I*) actual values as given, as if they were the policy maker paths of choice for those variables. The expected nominal money growth rates are then obtained using a feasible scenario for a falling inflation rate that would be consistent with the intentions of a policy maker adopting a stabilization plan.

For this purpose, when preparing the inflation scenario, the actual inflation rate of the first month of each stabilization plan was combined with the inflation rates that occurred after the first month of the Real plan. This approach is chosen for two reasons. First, the actual inflation of the first month of a stabilization program is adopted because this rate is usually contaminated by an idiosyncratic carry-over effect. Second, the inflation of the Real plan is used as benchmark (second month and ahead) because it represented a successful stabilization program with good monetary management. Policy makers in charge of previous stabilization plans probably would agree that this scenario represents an actual case of successful disinflation in Brazil, which they could consider satisfactory as their own goal.

After feeding the model with paths for every variable, 95% probability intervals are constructed for growth rates of *M*1 during the twelve months following the adoption of the stabilization plan, which are then compared with the actual *M*1 growth. The results are presented in Appendix 6, Figures 7 to 12.

Note that the 95% probability intervals would encompass the actual *M*1 growth rates if a stabilization plan were supposed to succeed. *M*1 growth rates above the interval can be interpreted as resulting from excessive money growth or from an actual inflation rate that is above the inflation target, which is supposed here to be equivalent to the Real plan actual inflation path.

It is seen from Figures 8 to 11 that, in the cases of the Bresser, Verão, Collor and Collor II plans, the model indicates that the policy maker should have observed much lower $M1$ growth rates if she really wanted to have had the same degree of success of the Real plan.

Figure 7 shows that there was substantial monetary mismanagement during the first and second months of the Cruzado plan. From the third month on, however, $M1$ growth rates were consistent with a Real plan kind of disinflation.

It should be noted however that the Cruzado plan was marked by excessive aggregate demand, among other things caused by low nominal interest rates. Our method is able to show if money growth rates are consistent with a policy maker scenario for output, interest rate, and inflation rate, but it is not able to verify if the scenario is internally consistent. In the case of the Cruzado plan, inflation was kept artificially low by means of price freezing, with aggregate demand exceeding aggregate supply (markets would not clear).

Additionally, given the price freezing, the Real inflation rate path was probably too high for Cruzado plan standards. Given that the Cruzado plan could only be successful under zero inflation, the Cruzado actual $M1$ growth rates, although partially consistent with a stabilization based on market freedom such as the Real plan, were in reality too high for a stabilization program based on absolute price freezing. The data indicates thereafter that the Cruzado was also victim of monetary mismanagement.

Figure 12 shows that $M1$ growth rates during the implementation of the Real plan were consistent with a scenario of lowering inflation. It is not just coincidence that this plan was able to successfully disinflate the economy. The out-of-sample predictions of the money demand models indicate that there was a good management of the monetary growth rates.

Note however again that adequate money growth rates are a necessary but not a sufficient condition for a policy maker to attain an inflation target. Other procedures, such as the use of aggregate demand and supply structural models, must be used to check the consistency between interest rates, inflation rates and output growth. In other words, the scenario must be internally consistent.

Conclusions

This paper examined how a money demand model can be used to evaluate monetary policy under different regimes. The idea was to check the consistency between monetary liquidity and the inflation rate path.

The concept was applied to the Brazilian case by modeling $M1$ and its components. Based on unit root and cointegration tests, a growth-rate model was chosen, which considers all the interventions that happened during the sample period (1980-1999).

It was showed that a variable seasonal pattern, which is a linear function of the nominal interest rate, increases the model ability to explain seasonal changes in the money demand. Despite the economic instability that marked Brazilian economic history during the last two decades, the model showed good fit and predictive power.

Finally, using the model as a forecasting tool, it was showed that unsuccessful macroeconomic stabilization programs in Brazil were marked by excessive money-growth rates during low-inflation intervention periods. The results suggest that to track monetary aggregates can be useful to policy makers even under a regime where interest rates are the main policy instrument.

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Appendix 1

Table 1 – Unit Root Test, Level [a]

Series	Schwert Criterion [b]			Akaike Criterion (AIC) [c]		
	t	ϕ	p	t	ϕ	p
M1R	-1.67	0.974	14	-1.67	0.974	14
CURR	-2.00	0.963	14	-2.00	0.963	14
DDR	-1.61	0.975	14	-1.61	0.975	14
RR	-3.75*	0.826	14	-4.09**	0.817	13
I	-1.93	0.930	14	-3.36	0.907	1
CE	-1.50	0.954	14	-2.89	0.906	25

* null hypothesis of presence of unit root rejected at 5%;
** null hypothesis of presence of unit root rejected at 1%;
(a) augmented Dickey-Fuller (ADF):
$y_t = \alpha + \beta t + \phi y_{t-1} + \sum_{j=1}^{p-1} \psi_j \Delta y_{t-j} + \varepsilon_t$, critical values from MacKinnon (1991);
(b) $p = \text{int}\left[12(T/100)^{1/4}\right]$;
(c) maximum number of lags bound to 10% of the sample size.

Table 2 – Unit Root Test, First Difference [a]

Series	Schwert Criterion [b]			Akaike Criterion (AIC) [c]		
	t	ϕ	p	t	ϕ	p
M1R	-4.30**	0.150	14	-4.38**	0.175	13
CURR	-3.85*	0.087	14	-4.19**	0.050	13
DDR	-4.42**	0.141	14	-4.43**	0.180	13
RR	-4.62**	-0.48	14	-13.3**	-0.34	2
I	-4.91**	-0.88	14	-14.8**	0.033	1
CE	-4.40**	-1.50	14	-3.77*	-1.30	17

* null hypothesis of presence of unit root rejected at 5%;
** null hypothesis of presence of unit root rejected at 1%;
(a) augmented Dickey-Fuller (ADF):
$y_t = \alpha + \beta t + \phi y_{t-1} + \sum_{j=1}^{p-1} \psi_j \Delta y_{t-j} + \varepsilon_t$, critical values from MacKinnon (1991);
(b) $p = \text{int}\left[12(T/100)^{1/4}\right]$;
(c) maximum number of lags bound to 10% of the sample size.

Appendix 2

Table 3 – Sequential Unit Root Test, Level [a]

Series	Trend Shift [b]			Mean Shift [c]		
	$\tilde{t}_{DF}(\tilde{\delta})$	$\tilde{t}_{DF}^{min*}$	p	$\tilde{t}_{DF}(\tilde{\delta})$	$\tilde{t}_{DF}^{min*}$	p
M1R	-2.00	-2.67	14	-1.66	-2.26	14
CURR	-3.51	-3.51	14	-1.39	-2.00	14
DDR	-3.03	-3.04	14	-2.19	-2.20	14
RR	-3.96	-3.97	14	-1.90	-1.90	14
I	-3.30	-3.30	14	-0.50	-2.78	14
CE	1.413	-2.61	14	-1.59	-1.70	14

* null hypothesis of presence of unit root rejected at 5%;
** null hypothesis of presence of unit root rejected at 2.5%;
(a) According to Banerjee, Lumsdaine and Stock (1992):
$y_t = \alpha + \beta_1 \tau(k) + \beta_2 t + \phi y_{t-1} + \sum_{j=1}^{p-1} \psi_j \Delta y_{t-j} + \varepsilon_t$,
$p = \text{int}\left[12(T/100)^{1/4}\right]$;
(b) $\tau(k) = (t-k) \cdot 1(t > k)$, where $1(\cdot)$ is the indicator function;
(c) $\tau(k) = 1(t > k)$.

Table 4 – Sequential Unit Root Test, First Difference [a]

Series	Trend Shift [b]			Mean Shift [c]		
	$\tilde{t}_{DF}(\tilde{\delta})$	$\tilde{t}_{DF}^{min*}$	p	$\tilde{t}_{DF}(\tilde{\delta})$	$\tilde{t}_{DF}^{min*}$	p
M1R	-4.74**	-4.75**	14	-4.32	-4.45	14
CURR	-4.29	-4.29	14	-4.15	-4.15	14
DDR	-4.87**	-4.87**	14	-4.64	-4.64	14
RR	-4.64*	-4.72**	14	-5.37**	-5.37**	14
I	-5.40**	-5.40**	14	-3.24	-5.70**	14
CE	-5.17**	-5.17**	14	-4.33	-4.45	14

* null hypothesis of presence of unit root rejected at 5%;
** null hypothesis of presence of unit root rejected at 2.5%;
(a) According to Banerjee, Lumsdaine and Stock (1992):
$y_t = \alpha + \beta_1 \tau(k) + \beta_2 t + \phi y_{t-1} + \sum_{j=1}^{p-1} \psi_j \Delta y_{t-j} + \varepsilon_t$,
$p = \text{int}\left[12(T/100)^{1/4}\right]$;
(b) $\tau(k) = (t-k) \cdot 1(t > k)$, where $1(\cdot)$ is the indicator function;
(c) $\tau(k) = 1(t > k)$.

Appendix 3

Table 5 – Cointegration Test [(a)]

Series	Schwert Criterion [(b)]				
	1st LR	2nd LR	3rd LR	4th LR	p
M1R, I, CE	40.56	12.77	4.57		14
CURR, I, CE	38.12	13.50	4.01		14
DDR, I, CE	36.43	12.24	4.78		14
M1R, I, CE, RR	59.46	27.44	11.04	4.53	14
CURR, I, CE, RR	61.42	27.28	13.37	4.06	14
DDR, I, CE, RR	56.67	27.43	10.45	4.37	14

* significant at 5% - critical values corrected following Cheung and Lai (1993);

** significant at 1% - critical values corrected following Cheung and Lai (1993);

(a) Johansen likelihood ratio (LR) cointegration rank test, trace statistic, intercept and trend in cointegration equation, intercept and trend in VAR;
a significant 1st LR statistic indicates rejection of the null hypothesis of cointegration rank equal to zero (rejection of noncointegration);
a significant 2nd LR statistic indicates rejection of the null hypothesis of cointegration rank lower than or equal to one (rejection of noncointegration and of cointegration with one cointegrating vector);
a significant 3rd LR statistic indicates rejection of the null hypothesis of cointegration rank lower than or equal to two (rejection of noncointegration, cointegration with one cointegrating vector, and cointegration with two cointegrating vectors);
a significant 4th LR statistic indicates rejection of the null hypothesis of cointegration rank lower than or equal to three (rejection of noncointegration, cointegration with one cointegrating vector, cointegration with two cointegrating vectors, and cointegration with three cointegrating vectors);
critical values come from Osterwald-Lenum (1992) and Cheung and Lai (1993);
p represents the number of lags as in Johansen and Juselius (1990);

(b) $p = \mathrm{int}\left[12(T/100)^{1/4}\right]$;

Appendix 4

Table 6 – Long-Run Elasticities

Model	Parameter and t-Statistic [a]			
	I [b]	t_I	CE [c]	t_{CE}
M1R	-0.22	-6.56**	0.52	3.59**
CURR	-0.15	-3.64**	0.24	5.05**
DDR	-0.24	-6.97**	0.31	5.64**

** significant at 1%;

(a) t-Statistics calculated using the Delta method;

(b) $\chi^* = \dfrac{\sum_{j=0}^{p} \chi_j}{1 - \sum_{i=1}^{n} \beta_i}$;

(c) $\phi^* = \dfrac{\sum_{k=0}^{q} \phi_k}{1 - \sum_{i=1}^{n} \beta_i}$.

Appendix 5

Figure 1 – *M1R* One-Step Forecast Test

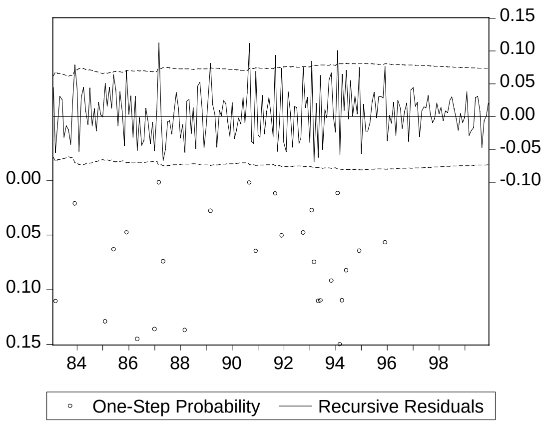


Figure 4 – *M1R* N-Step Forecast Test

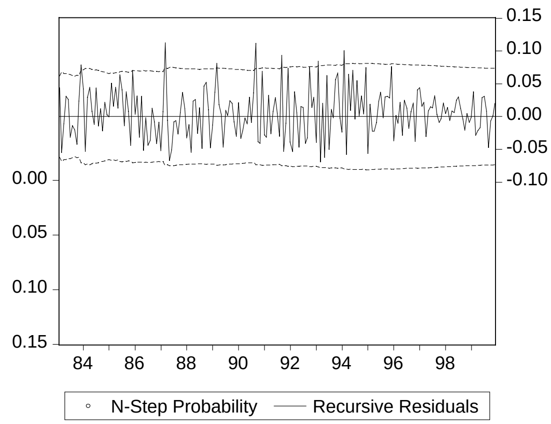


Figure 2 – *CURR* One-Step Forecast Test

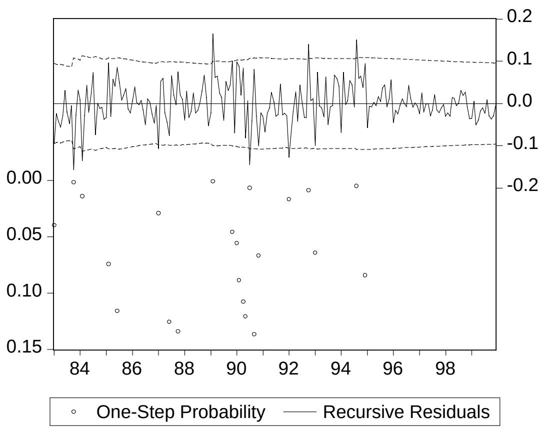


Figure 5 - *CURR* One-Step Forecast Test

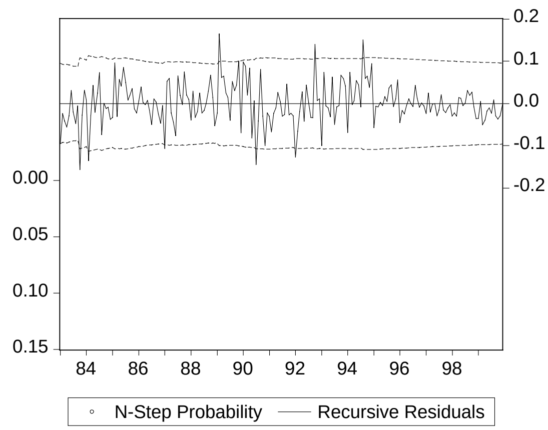


Figure 3 – *DDR* One-Step Forecast Test

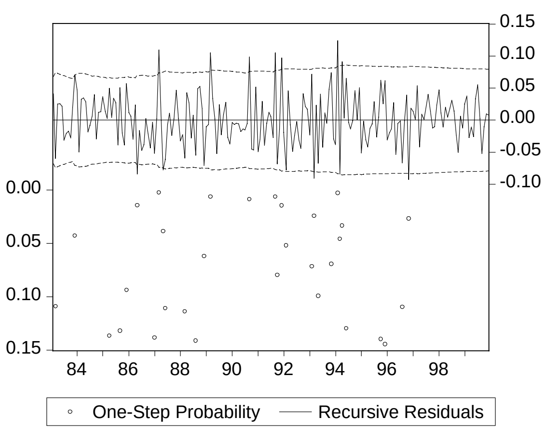
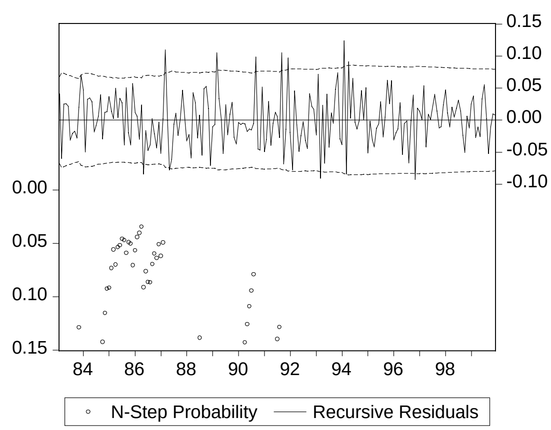


Figure 6 – *DDR* N-Step Forecast Test



Appendix 6

Figure 7 – *M1* One-Step Forecast – Cruzado

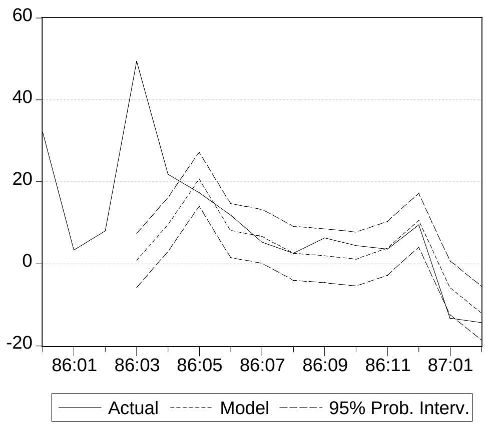


Figure 8 – *M1* One-Step Forecast – Bresser

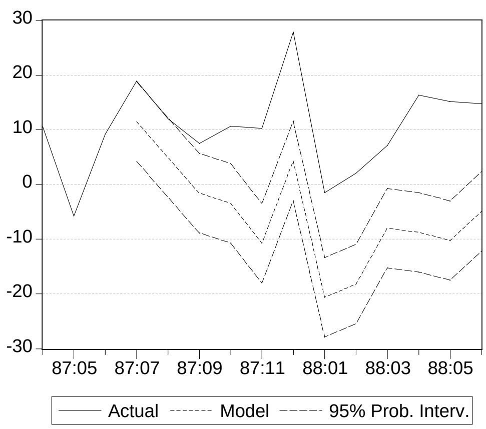


Figure 9 – *M1* One-Step Forecast – Verão

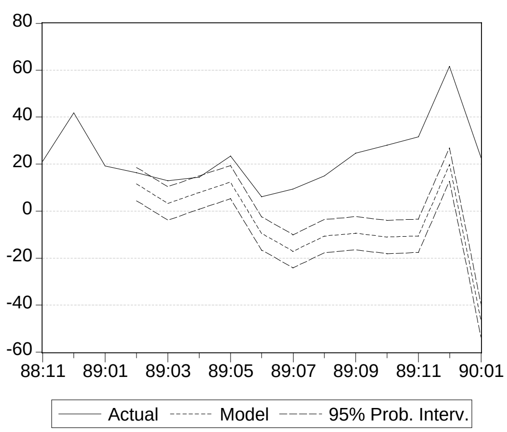


Figure 10 – *M1* One-Step Forecast – Collor

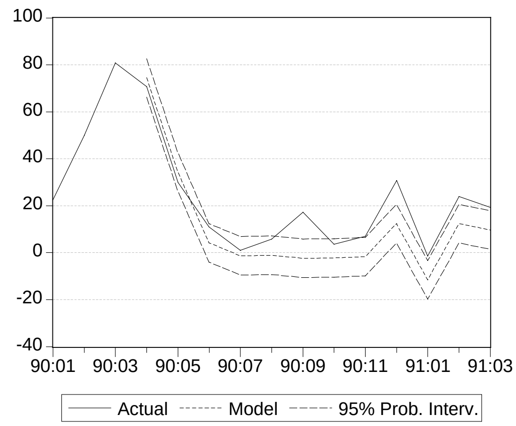


Figure 11 – *M1* One-Step Forecast – Collor II

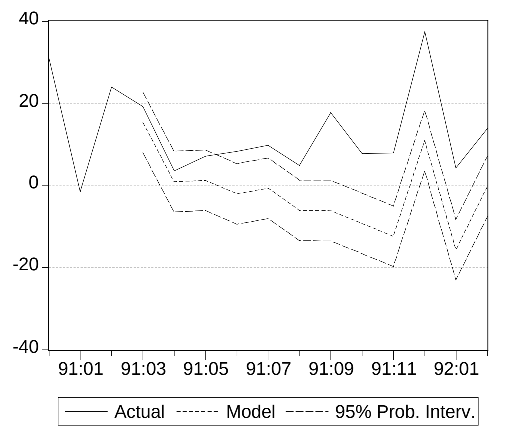
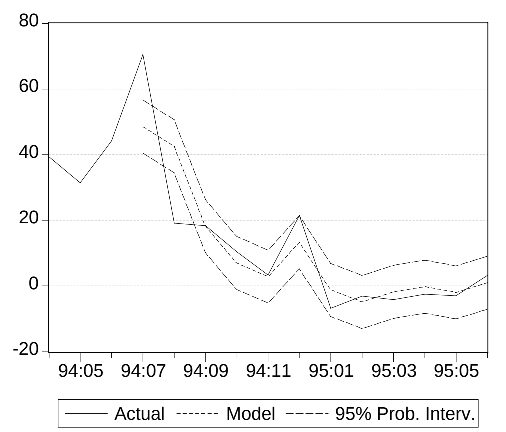


Figure 12 – *M1* One-Step Forecast – Real



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