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A stable demand for money despite financial crisis: The case of Venezuela

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A stable demand for money despite financial crisis: The case of Venezuela

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March 14, 2003

Abstract: This paper investigates the demand for broad money in Venezuela, over a period of financial crisis and substantial exchange rate fluctuations. The analysis shows that there exist a long run relationship between real money, real income, inflation, the exchange rate and the domestic interest rate, that remains stable over major policy changes and large shocks. The long run properties emphasize that both inflation and exchange rate depreciations have negative effects on real money demand. The long run relationship is embedded in a dynamic equilibrium correction model with constant parameters.

Key words: Money demand, open economy, cointegration, dynamic specifications, equilibrium correction models

JEL Classifications: C22, C32, E41

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I. INTRODUCTION

A stable money demand function forms the cornerstone in formulating and conducting monetary policy. The income and interest rate elasticities of money demand are at the core of most basic macroeconomic models such as the IS-LM model, where the effectiveness of monetary policy depends on the elasticity of money demand. As a consequence, empirical studies that try to establish money demand functions have flourished, in particular since the early 1970s.[1]

Most of the empirical work so far, has been cast in a closed economy framework. In an open economy, individuals face a choice not only between different domestic assets, but also between holding domestic and foreign assets. Typically, wealth holders will evaluate their portfolios in terms of domestic currency. An expected exchange rate depreciation (that reduces the value of domestic assets held by foreigners and increases the value of foreign assets held by domestic residents), may therefore give rise to substitution of foreign currencies for domestic currencies, thereby reducing domestic money demand. Early studies that emphasize currency substitution in their analysis of money demand include Arango and Nadiri (1981), Girton and Roper (1981), Miles (1981), McKinnon (1982), Cuddington (1983) and Ortiz (1983).

This paper derives a stable empirical model for Venezuela broad money (M2), using cointegration methods as a tool for identifying long run relationships that can be embedded in a dynamic equilibrium correction model (EqCM) with constant parameters. The estimation of real money demand is cast in an open economy framework, as mentioned above. With a highly integrated world capital market, individuals face a choice not only between different domestic assets, but also between holding domestic and foreign assets.

An analysis of Venezuela's experience is of interest for several reasons. First, Venezuela experienced a severe banking crisis in the middle 1990s, where interest rates rose sharply and remained above 50% for more than a year, annual inflation rates reached three digit levels and the exchange rate was devalued multiple times. The monetary framework changed dramatically in this period, with the collapse of several banks. This paper investigates in particular the stability of a money demand equation over such a period, to establish if the shocks are absorbed in the long run.

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[1] See for instance Hendry and Ericsson (1991) for an overview of early empirical studies for the U.K. and the U.S.

Second, there have been very few empirical analyses of money demand for Venezuela, with the recent exceptions of Copelman (1996) and Ramajo (2001). However, both of these analyses are cast in a closed economy framework, and thereby neglect any open economy considerations.

Many Latin American countries have the last 20 years experienced very high and volatile exchange rate depreciations, associated with high inflation rates. Studies that have looked at the experience of Latin America, have typically found that an (expected) depreciation causes a decline in the long run demand for domestic currency, (see for instance Bahmani-Oskooee and Malixi, 1991, for an application to Brazil, Mexico and Peru). As one of many Latin American countries, Venezuela has experienced multiple exchange rate devaluations over the last two decades. The motivation of substituting foreign currencies for domestic currencies is therefore very much an issue also when investigating the demand for domestic currency in Venezuela.

The paper is organized as follows. Section II, briefly puts forward the economic theory underpinning the money demand estimation, whereas section III presents the basic statistical properties of the data. In section IV, cointegration techniques are applied and show that real money, income, inflation, the exchange rate and interest rates are cointegrated. Section V thereafter specifies a dynamic stable real money demand relationship, including the cointegration relationship. Section VI concludes.

II. Economic Theory

In standard theories of money demand, money may be demanded for at least two reasons: As an inventory to smooth differences between income and expenditure streams, and as one among several assets in a portfolio. Both demands lead to a long-run specification of the following form, e.g., Ericsson (1998):

$$M^d = g(P, I, \Delta p, R) \tag{1}$$

where the nominal money demanded (M^d) depends on the price level (P), a scale variable (I), inflation (Δp) and a vector of returns on various assets (R). The function g is assumed to be homogeneous of degree one in P, increasing in I, decreasing in both inflation and those elements of R associated with assets excluded from money and increasing in those elements of R for assets included in money.

The above framework assumes a closed economy. In an increasingly interdependent world, where capital movements have attained greater economic importance, the exclusion of foreign opportunity cost will give a too restricted view. In an open economy, individuals can choose to hold their wealth in both domestic and foreign assets. Several recent papers have therefore suggested that the standard money demand function should be augmented to include the return on holding foreign assets, like foreign money and foreign bonds. Based on the currency substitution literature, the variables included have often been the (expected) depreciation on the domestic exchange rate (indicating the return on foreign money) and a foreign interest rate (see e.g. Leventakis, 1993, and Khalid, 1999, for recent applications and Sriram, 1999, for a survey).

The inclusion of the depreciation rate of the exchange rate may, however, be problematic, as it is often stationary, and therefore can only explain the stationary part of real money demand. In the analysis below we instead follow McNown and Wallace (1992), who argue that the exchange rate should be represented in levels, so that one effectively can eliminate the non-stationarity of the money demand function. In the open economy framework, our suggested money demand function may therefore be written in its log-linear form:

$$m^d - p = \alpha_0 + \alpha_1 y + \alpha_2 \Delta p + \alpha_3 R^{own} + \alpha_4 R^{out} + \alpha_5 R^F + \alpha_6 e \qquad (2)$$

where lower case letters denote logarithms. Note, however that interest rates enter in levels. In (2), long run price homogeneity is imposed. y denotes real income (a scale variable), R^{own} and R^{out} are the interest rate on domestic money itself and the interest rate on domestic assets outside money respectively, R^F is the foreign interest rate and e is the nominal exchange rate on domestic currency relative to foreign currency. The coefficients α_0, α_1, α_2, α_3, α_4, α_5 and α_6 represent an intercept, income elasticity and the semi elasticities on inflation, the interest rate on domestic money, the interest rate on assets outside domestic money, the interest rate on foreign assets and the elasticity on the exchange rate.

The scale variable represents the transaction or wealth effect (real income) and is positively related to real money demand. The coefficient on the interest rate on domestic money is expected to be positive, whereas an increase in the return on domestic money outside money is negative, as it lowers the incentive to hold own money. An increase in the foreign interest rate is also expected to induce negative demand for money, as agents increase their foreign holdings by drawing down domestic money holdings. The inflation rate is expected to affect demand for money negatively, by inducing agents to hold real domestic assets (as well as foreign assets) instead of money in periods of rising inflation. Finally, an increase in the exchange rate implies that the expected return from holding foreign money increases, so that agents substitute domestic currency for foreign currency. To sum up, anticipated signs on the coefficients are $\alpha_1>0$, ($\alpha_1=1$ if the quantitative theory of money holds), $\alpha_2< 0$, $\alpha_3>0$, $\alpha_4<0$, $\alpha_5<0$ and $\alpha_6<0$.

III. DATA PROPERTIES

The basic data series used in the estimation are quarterly seasonally unadjusted values of the broad money stock (M) (money plus quasi money; M2), real gross domestic product (Y), consumer prices (P), the exchange rate (Bolivares per unit of US dollar) (E) and the 90 days deposit rate for Venezuela (R)[2]. Lower case letters will indicate logarithms below. The data spans from 1985Q1 to 1999Q1, reflecting sample availability, (see Appendix A for a further description).

Figure 1. Real money (m-p)

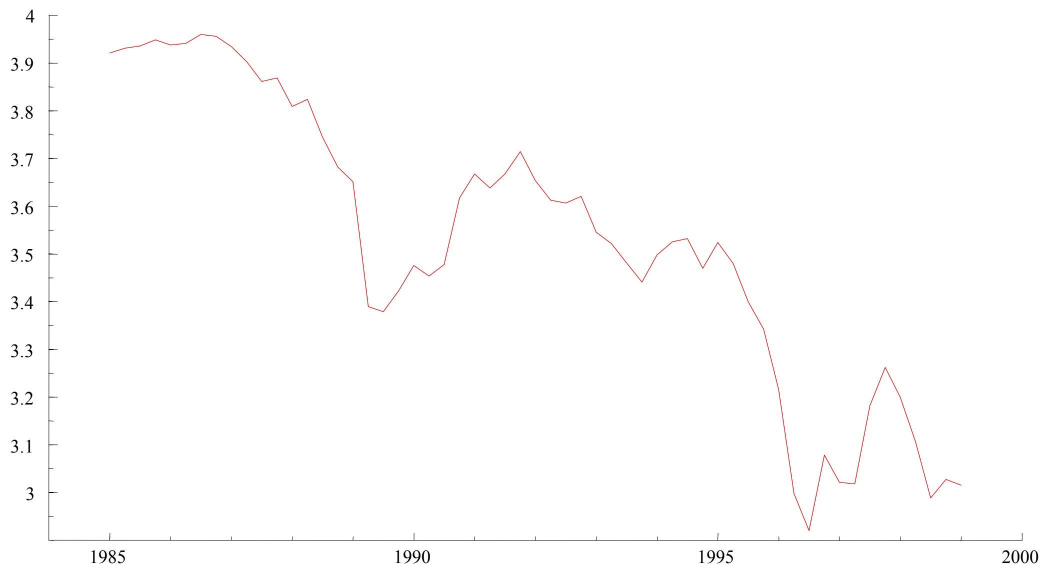


Figure 1 shows (the log of) quarterly domestic real money (m-p) from 1985 to 1999. Real holdings of money remained stable until 1987, after which it declined sharply. From 1989 to 1995 it increased somewhat (albeit with fluctuations within the period). The banking crisis in the

[2] Some other interest rate series were also tried in the estimation, but none of them came out significant and are therefore omitted here.

middle 1990s reduces demand for money sharply throughout 1995. Since then it has increased only slightly, with a temporary high peak in 1997-1998.

Figure 2. Inflation (dp) and the inverse of velocity –(m-p-y)

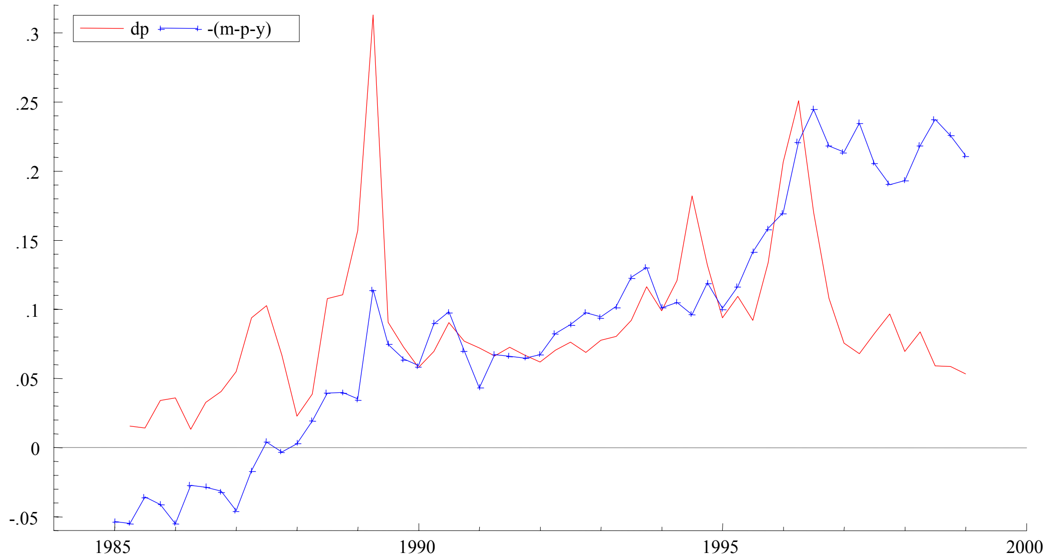


Figure 3. Deposit rate in Venezuela

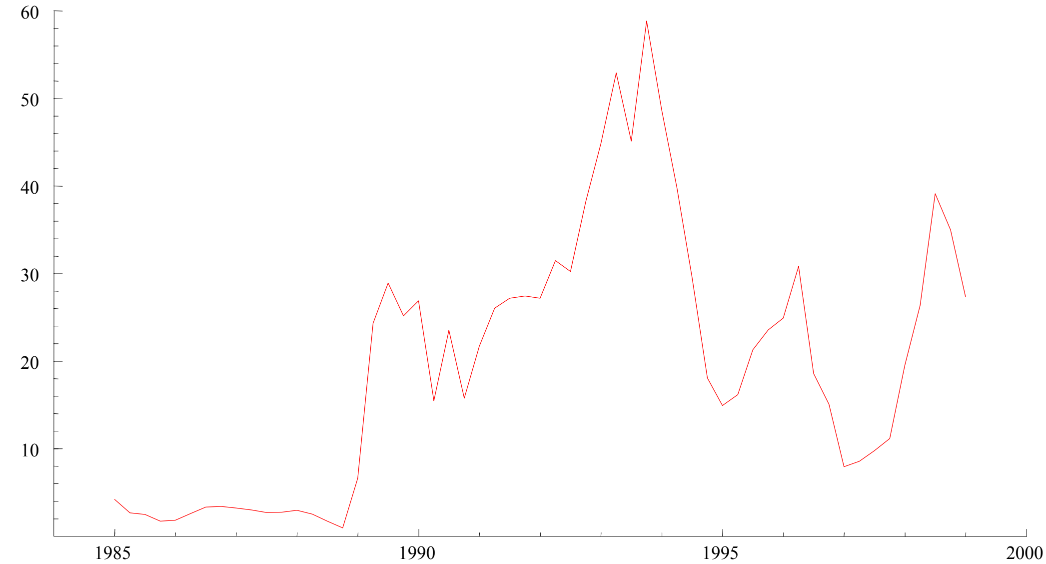
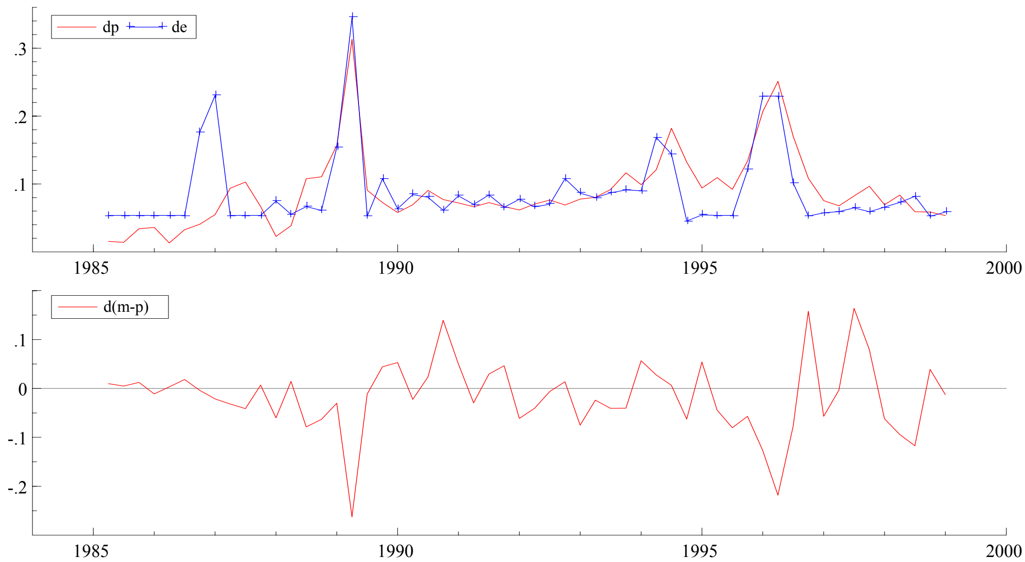


Figure 2 graphs the inflation rate (dp) together with the inverse of velocity -(m-p-y), with the latter adjusted to match the mean of the former. The figure suggests that neither of the variables are constant, and they move closely together (except for the fall in inflation rates in 1997). The inverse of velocity also looks very similar to the inversion of m-p in Figure 1, implying that transactions are not moving much relative to real money.

Figure 3 charts the 90 days deposit rate for Venezuela. The interest rate increased gradually from 1989 until its peak in 1994, just before the banking crisis, where it remained above 50% for more than a year. Since then it has fluctuated sharply, with new peaks in 1996 and 1998.

Figure 4. Top panel: Inflation rates (dp) and the quarterly changes in the exchange rate (de)
Lower panel: Quarterly changes in real money d(m-p)



In the top panel in Figure 4, the quarterly inflation rate (dp) is plotted together with the quarterly changes in the exchange rate (de), with the latter adjusted to match the mean of the former. The figure illustrates that large changes in the exchange rate are associated with periods of high inflation, and the contemporaneous correlation coefficient is as high as 0.7.

According to the traditional currency substitution model, the high periods of exchange rate depreciations, should increase the holdings of foreign currency relative to domestic currency, thereby lowering the demand for domestic money. In the lower panel of Figure 4, quarterly changes of domestic real money are graphed. Clearly, the high inflation and devaluation periods seem to coincide with a reduction of domestic real money, in particular in 1989, and in 1995-1996. However, whether it is inflation or it is the devaluation periods (or both) that are the main driving forces, remains an empirical issue that is answered below.

A. Test for unit roots

This section presents unit root tests for the variables used in the model. To test whether the underlying processes contain a unit root, I use the augmented Dickey Fuller (ADF) test of unit root against a (trend) stationary alternative (see Table A.1. in the appendix). All variables except the price and money were found to be non-stationary, that is integrated of order one, I(1). Nominal money and prices were integrated of order two I(2), so they are transformed to real money and inflation. Thus, our cointegration analysis uses the I(1) variables: m-p, y, Δp, e and R.

IV. LONG RUN BEHAVIOUR AND COINTEGRATION

Cointegration provides an analytical and statistical framework for ascertaining the long run relationship between non-stationary economic variables such as those mentioned above. Table A.2. in the appendix reports the test for Cointegration between the I(1) variables real money, real GDP, the interest rates, inflation and the exchange rate, using the Johansen (1988, 1991) procedure. A vector autoregression (VAR) model with 5 lags was estimated, including a constant and seasonal dummies. The number of lags in the VAR were chosen based on the Akaike information criteria and likelihood ratio (LR) tests. The maximum eigenvalue and trace eigenvalue statistics (λ_{max} and λ_{trace}) strongly reject the null of no cointegration in favor of one cointegration relationship at the 1% level.[3]

Table A.2 reports the potential cointegration vectors β' and the normalized weighing matrix α. The first row of β' is the estimated cointegration vector, which can be written in the form of (2) (standard errors in parenthesis below coefficients):

$$m-p = \underset{(0.26)}{0.88y} \; \underset{(0.47)}{-1.55}(\Delta p*4)) \; \underset{(0.0008)}{+0.004R} \; - \; \underset{(0.022)}{0.26e} \tag{3}$$

Each coefficient has its anticipated sign and is significantly different from zero. The restriction of unit income homogeneity is not rejected. The associated likelihood-ratio statistic is

[3] An initial estimation was also done by including a trend restricted to lie in the cointegration space in the VAR. However the trend turned out to be insignificant, and was therefore omitted from the cointegration analysis. Interestingly though, using a closed economy framework where the exchange rate is omitted from the analysis, the trend is no longer insignificant and can not be removed from the analysis. This could suggest that the trend captures the negative effect of the continuous rate of depreciation on real money demand.

$\chi^2(1) = 0.286[0.59]$, where $\chi^2(1)$ specifies the asymptotic distribution under the null. 0.286 is the observed value of the statistic, and the asymptotic p-value is in brackets.

Inflation (measured at an annual rate) has a semi elasticity of about –1.6, whereas the semi elasticity on the interest rate (R*100) is close to 0.4. The coefficients on R and Δp are therefore approximately equal in value and opposite in sign. Statistically the restriction cannot be rejected. The associated likelihood-ratio statistic is $\chi^2(1) = 2.699$ [0.26]. Thus, the nominal interest rate and inflation enter the long-run money demand function as the ex-post real rate, with a semi elasticity of about 0.4 per quarter.

Finally, the elasticity on the exchange rate is significantly negative as expected, with a value of -0.26. This value is rather low, but consistent with what was found for Mexico in Bahmani-Oskooee and Malixi (1991).[4] Nevertheless, it indicates some degree of substitutability between domestic and foreign currency.

The coefficients in the first column of α in Table A.2 measure the feedback effects of the disequilibrium onto the variables in the vector autoregression. The estimated feedback coefficient for the money equation is –0.77, which is rather high compared to other country studies. Thus, lagged excess money induces smaller current money holdings, with a fast adjustment (77% within a quarter).

The last row in Table A.2 reports values of the statistics for testing weak exogeneity of a given variable for the cointegration vector. That is equal to testing whether a row in α is zero. If a given row is zero, disequilibrium in the cointegration relationship does not feed back directly onto the corresponding variable. The test show that all variables but real money are weakly exogenous for real money demand.

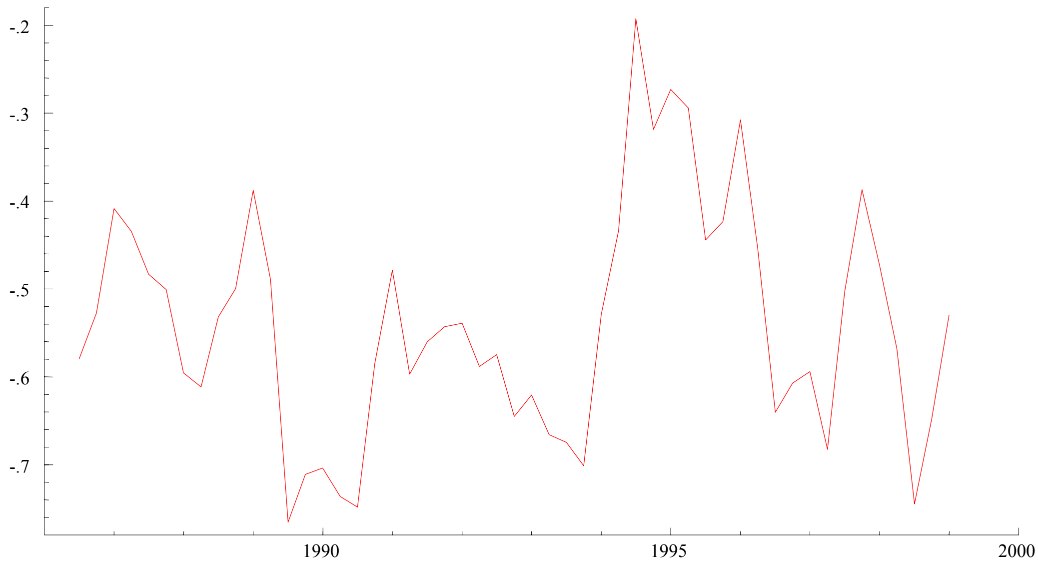
Finally, imposing the restriction of unit homogeneity on GDP and weak exogeneity of all variables except real money, the estimate of the cointegration relation is (standard errors in parenthesis below coefficients):

[4] Using a different approach to that employed here and a sample of annual data that ends in 1980, Marquez (1987) investigates to which extent domestic money balances in Venezuela are influenced by foreign exchange considerations. His results point to an elasticity of currency substitution in Venezuela in excess of one.

$$m - p \;=\; y \;\underset{(0.46)}{-1.72(\Delta p * 4)} \;\underset{(0.0007)}{+0.004R} \;\underset{(0.009)}{-\;0.27e} \qquad (4)$$

The associated likelihood-ratio statistic is $\chi^2(1) = 5.70$ [0.34]. The restricted feedback coefficient is -0.75. All the coefficients in (4) satisfy the sign restrictions postulated in equation (2). Valid weak exogeneity tests support the analysis of the cointegration vector in a single equation conditional equilibrium correction of money without loss of information. Figure 5 plots the deviations of real money demand from the long run relationship above (excess money):

Figure 5. Deviations of real money demand from the long run relationship (excess money)



Periods of excess money are:1986-1987, from the middle of 1988 and one year onwards, during the banking crisis in 1994-1996 and lastly in the second half of 1997.

V. A DYNAMIC MODEL OF MONEY DEMAND

With the results from the cointegration analysis and tests of weak exogeneity using the Johansen's procedure, this section develops a parsimonious, conditional single equation model for Venezuela broad money demand. Whereas the estimated cointegration relationship reveals factors affecting long term real money demand, in the short run, deviations from this relationship could occur reflecting shocks to any of the relevant variables. In this representation, short term dynamics are modeled by estimating first differences. Adjustment in response to the deviation of real money demand from the long run trend are taken into account by including the equilibrium correction term estimated in the previous section.

Section A develops the parsimonious EqCM from a general autoregressive distributed lag, whereas section B examines its statistical properties, including parameter constancy.

A. The equilibrium correction model

The EqCM model was estimated for the period 1985Q1-1999Q1 minus the included lags. The EqCM model was initially estimated by including 4 lags for all variables, in addition to the lagged level of all the variables in the cointegration vector. The final lag structure was determined based on the significance of each lag:

$$\begin{aligned}
\Delta(m-p)_t = {} & \underset{(0.10)}{0.27}\Delta(m-p)_{t-1} \underset{(0.13)}{-0.71}\Delta^2 p_t \underset{(0.0005)}{-0.003}\Delta^5 R_t \underset{(0.07)}{+0.19}\Delta e_{t-1} \underset{(0.05)}{+0.11}\Delta e_{t-2} \underset{(0.05)}{+0.15}\Delta e_{t-3} \\
& \underset{(0.07)}{-0.51}(m-p-y)_{t-1} \underset{(0.19)}{-1.26}\Delta p_{t-1} \underset{(0.0005)}{+0.002}R_{t-1} \underset{(0.02)}{-0.12}e_{t-1} \\
& \underset{(0.03)}{-0.11} - \underset{(0.05)}{0.22}DU_t
\end{aligned} \tag{5}$$

AR(1-4): $F(4, 35) = 0.68$ [0.608]
ARCH: $F(4, 31) = 0.60$ [0.662]
Normality: $\chi^2(2) = 0.02$ [0.988]
Hetero: $F(21, 17) = 0.25$ [0.998]
RESET: $F(1, 38) = 0.58$ [0.450]

where DU is a dummy that is one in 1997Q1 and zero otherwise (reflecting the end of the banking crisis). OLS standard errors are in parenthesis below each coefficient and indicate that all coefficient are significant at the 5 % level. Tests of autocorrelation (AR(1-4) and ARCH), heteroscedasticity (Hetero), non-normality, and incorrect functional form (RESET) are calculated using PcFiml 9.0 (see Doornik and Hendry 1997) and reported below equation (5). The model satisfies test of autocorrelation, heteroscedasticity, non-normality and incorrect functional form at the 1 % level.

The coefficients on the equilibrium correction terms (written in three separate parts) are highly significant statistically, confirming that a long run cointegration relationship exist between broad money, prices, real output, the interest rate and the exchange rate. The size on this coefficient implies that adjustment to disequilibria via the equilibrium correction term is fast. This is consistent with Copelman (1996), who shows that the speed of adjustment of money demand to its determinants increases when there is financial innovation, as that Venezuela has experienced after 1989.

In the short run, however, lagged changes in real money demand and lagged changes in the exchanger rate (depreciations) will increase real demand for domestic money, as it takes time before one can substitute domestic for foreign currency. Lagged changes in prices and domestic interest rates will on the other hand reduce real demand for money temporarily.

B. Parameter constancy

Parameter constancy is a critical issue for money demand equations. In particular to be able to interpret the estimated equation as a money demand equation, one needs to assure that the parameters are stable over the estimation period. Particular attention is paid to the severe banking crisis in the middle 1990s, to ensure that the different shocks are well absorbed into the model in the long run.

Figure 6. Recursively estimated coefficient and test of parameter instability

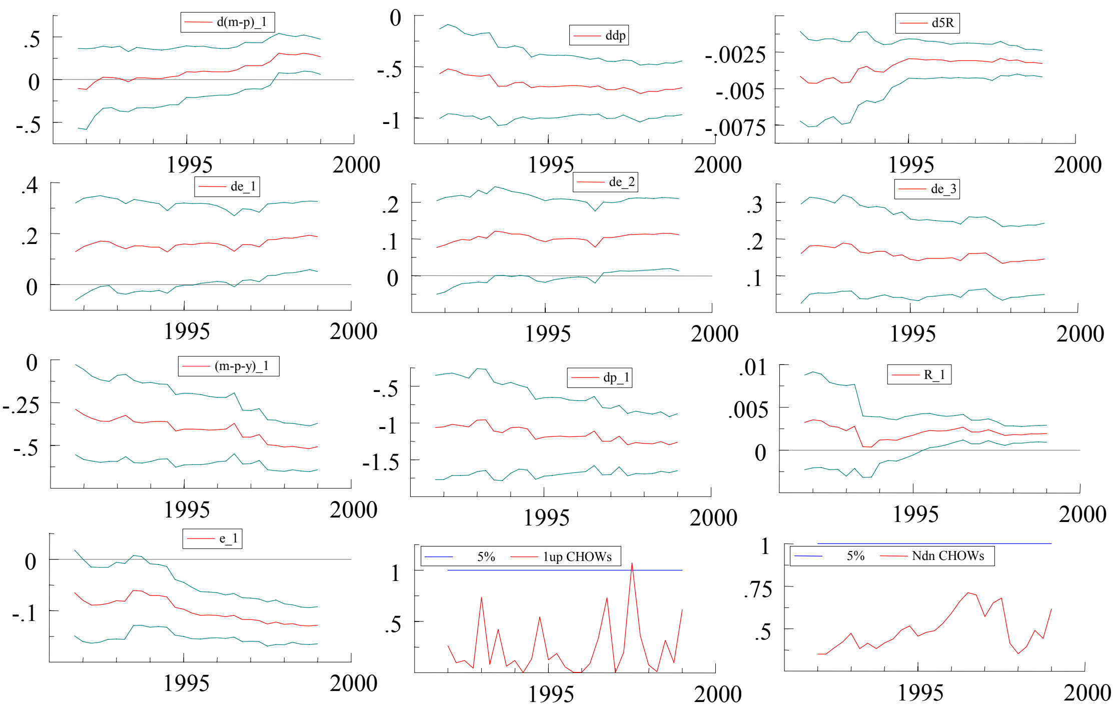


Figure 6 shows the recursively estimated coefficients of all the variable in the model plus/minus twice their recursively estimated standard errors. Coefficients vary only slightly and become more accurate with time as more information is accumulated and the standard errors decrease. Some parameters exhibit a small shift around 1996, but these shift are not significant enough to cause any significant parameter instability (see the Chow statistics below the coefficient estimates). The estimated money demand equation seems therefore to satisfy the necessary stability requirements.

VI. CONCLUSIONS

In an environment of increasing and varying inflation and constant subsequent exchange rate deprecations, this study models broad money in Venezuela. The estimation of real money demand is cast in an open economy framework. With a highly integrated world capital market, individuals face a choice not only between different domestic assets, but also between holding domestic and foreign assets.

The results identify a significant long run relationship between real money, real income, inflation, interest rate and the exchange rate that remains stable over major policy changes and crisis throughout the 1980s and 1990s. Hence, shocks are absorbed in the long run. Long run properties are analyzed by cointegration techniques, following which short run dynamics are modeled. The resulting model appears to be a satisfactory representation of the data generating process of money holdings.

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APPENDIX DATA AND MODEL SPECIFICATION

The basic data series are quarterly and seasonally unadjusted. The data spans from 1985Q1 to 1999Q1, reflecting sample availability.

M Broad money stock, M2, (money plus quasi money). Source: IMF's International Financial Statistics

Y Real gross domestic product. Source: Central Bank of Venezuela.

For the period 1985-1990, only annual data are available for real GDP, thus I use the annual series of real GDP combined with monthly manufacturing production to create the quarterly patterns within each year.

P Consumer prices. Source: IMF's International Financial Statistics.

E Exchange rate (Bolivares per unit of US dollar). Source: IMF's International Financial Statistics.

R 90 days deposit rate for Venezuela. Source: IMF's International Financial Statistics.

Table A.1. Augmented Dickey-Fuller tests for a Unit Root[a]

Variables	ADF(lags)[b]	t_{ADF}	Variables	ADF(lags)[b]	t_{ADF}
m	ADF(3)	-3.02	Δm	ADF(2)	-3.00
p	ADF(1)	-2.45	Δp	ADF(2)	-3.35
y	ADF(4)	-3.11	Δy	ADF(2)	-6.75**
R	ADF(2)	-2.71	ΔR	ADF(3)	-4.60**
e	ADF(2)	-3.16	Δe	ADF(2)	-4.85**
m-p	ADF(3)	-3.06	Δ(m-p)	ADF(5)	-4.21**

[a] Critical values were taken from Fuller (1976). A constant and a time trend are included in the regressions.
[b] The number of lags are determined by selecting the highest lag with a significant *t* value on the last lag, as suggested by Doornik and Hendry (1994).
** Rejection of the unit root hypothesis at the 1 % level

Table A.2. Test for cointegration using the Johansen procedure[a,b]

Eigenvalues	Hypothesis	λ_{max}	λ_{trace}
0.670	r=0	56.49**	96.41**
0.305	r≤1	18.56	39.92
0.223	r≤2	12.88	21.36
0.151	r≤3	8.40	8.49
0.002	r≤4	0.11	0.11

Standardized eigenvectors, β'

m-p	y	Δp	R	e
1.00	-0.88	1.55	-0.004	0.26
-0.43	1.00	3.36	-0.005	-0.14
-1.47	11.76	1.00	-0.017	-1.18
-118.20	1144.60	-2826.80	1.000	-25.45
-2.01	-10.72	-35.46	-0.034	1.00

Standardized adjustment coefficients, α

m-p	-0.77	-0.12	-0.03	0.00	0.00
y	0.14	-0.07	-0.01	-0.00	0.00
Δp	0.10	-0.04	0.02	-0.00	-0.00
R	-4.04	13.12	5.43	-0.01	0.05
e	0.04	0.13	0.01	-0.00	-0.00

Test of significance of a given variable

	m-p	y	Δp	R	e
$\chi^2(1)$	36.16**	9.40**	12.07**	21.38**	29.84**

Weak exogeneity test

	m-p	y	Δp	R	e
$\chi^2(1)$	23.49**	3.25	1.28	0.08	0.89

[a] All test-statistics are calculated using PcFiml 9.0 (Doornik and Hendry, 1997). Critical values are taken from Osterwald-Lenum (1992). [b] λ_{max} and λ_{trace} are the maximum eigenvalue and trace eigenvalue statistics.
** The relevant H_0 is rejected at the 1 % critical level