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

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The demand for broad money in Venezuela is investigated 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 an interest rate differential, 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, whereas a higher interest rate differential has positive effects. The long-run relationship is finally embedded in a dynamic equilibrium correction model with constant parameters. These results have implications for a policy-maker. In particular, they emphasize that with a high degree of currency substitution in Venezuela, monetary aggregates will be very sensitive to changes in the economic environment.

## 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.<sup>1</sup>

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 holding 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

<sup>1</sup> See for instance Hendry and Ericsson (1991) for an overview of empirical studies for the UK and the USA.

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.

An analysis of Venezuela's experience is of interest for several reasons. First, Venezuela is an open economy, which despite some periods of exchange controls in the 1980s and 1990s, contributes to the world capital market. Second, 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. Finally, there have been very few empirical analyses of money demand for Venezuela, with the recent exceptions of Copelman (1996), Olivo and Miller (2000) and Ramajo (2001). However, 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):

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

where the nominal money demanded ( $M^d$ ) depends on the price level ( $P$ ), a scale variable ( $I$ ), inflation ( $\Delta p$ ) 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 McNown and Wallace (1992) is followed, 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, the suggested money demand function may therefore be written in its log-linear form:

$$m^d - p = \alpha_0 + \alpha_1 y + \alpha_2 \Delta p + \alpha_3 R^D + \alpha_4 R^F + \alpha_5 e \quad (2)$$

where lower case letters denote logarithms. Note, however that interest rates enter in levels. In Equation 2, long-run price homogeneity is imposed.  $y$  denotes real income (a scale variable),  $R^D$  and  $R^F$  are the interest rate on domestic money and the foreign interest rate respectively and  $e$  is the nominal exchange rate on domestic currency relative to foreign currency. The coefficients  $\alpha_0, \alpha_1, \alpha_2, \alpha_3, \alpha_4$  and  $\alpha_5$

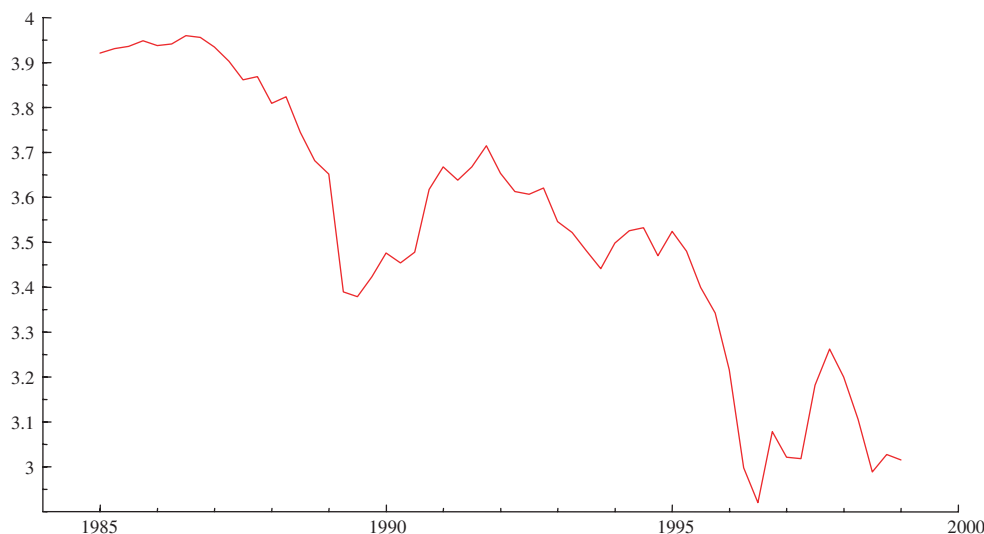


Fig. 1. Real money ( $m - p$ )

represent an intercept, income elasticity and the semi-elasticities on inflation, the interest rate on 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 when interest-bearing deposits are included in broad money, whereas an increase in the foreign interest rate is 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 quantity theory of money holds),  $\alpha_2 < 0$ ,  $\alpha_3 > 0$ ,  $\alpha_4 < 0$  and  $\alpha_5 < 0$ .

Equation 2 can be rewritten with a single interest rate and a spread, which may be easier to interpret economically, (see for instance Ericsson and Sharma, 1998):

$$m^d - p = \alpha_0 + \alpha_1 y + \alpha_2 \Delta p + \beta_3 (R^D - R^F) + \beta_4 R^F + \alpha_5 e \quad (3)$$

where  $\beta_3 = \alpha_3 > 0$ , and  $\beta_4 = \alpha_3 + \alpha_4$  which may be positive or negative depending on the magnitude of  $\alpha_3$  and  $\alpha_4$ . Clearly, if agents pay more attention to

foreign interest rates that domestic,  $\alpha_3$  will be small relative to  $\alpha_4$ , so  $\beta_4 < 0$ .

### III. Data Properties

The basic data series used in the estimation are quarterly 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) ( $E$ ), the interest rate spread between the 90 days deposit rate for Venezuela and the US Treasury Bill rate (Bond equivalent) ( $R^{D-F}$ ) and the US Treasury Bill rate ( $R^F$ ). 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 shows 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 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 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

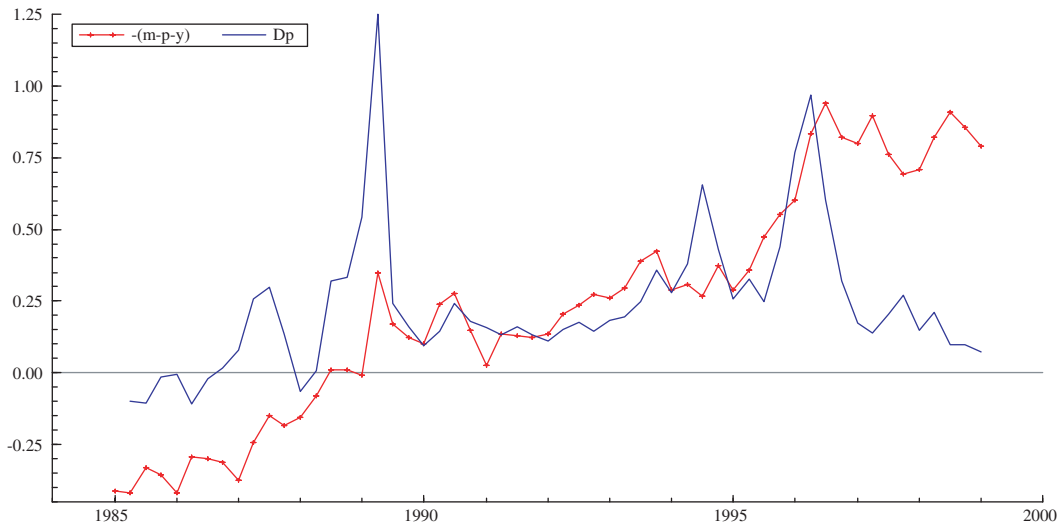


Fig. 2. Inflation ( $Dp$ ) and the inverse of velocity  $-(m-p-y)$



Fig. 3. Interest rate spread between deposit rate in Venezuela and US treasury bill rate (bond equivalent)

velocity also looks very similar to the inversion of  $m-p$  in Fig. 1, implying that transactions are not moving much relative to real money.

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

In the top panel in Fig. 4, the changes in the quarterly inflation rate ( $DDp$ ) is plotted together with the changes in the exchange rate ( $De$ ) (both being stationary), with the latter adjusted to match the mean of the former. The figure illustrates that large changes

(depreciations) of the exchange rate are associated with periods of increases in inflation, and the contemporaneous correlation coefficient 0.5.

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 Fig. 4, quarterly changes of domestic real money are graphed. Clearly, periods of increasing 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)

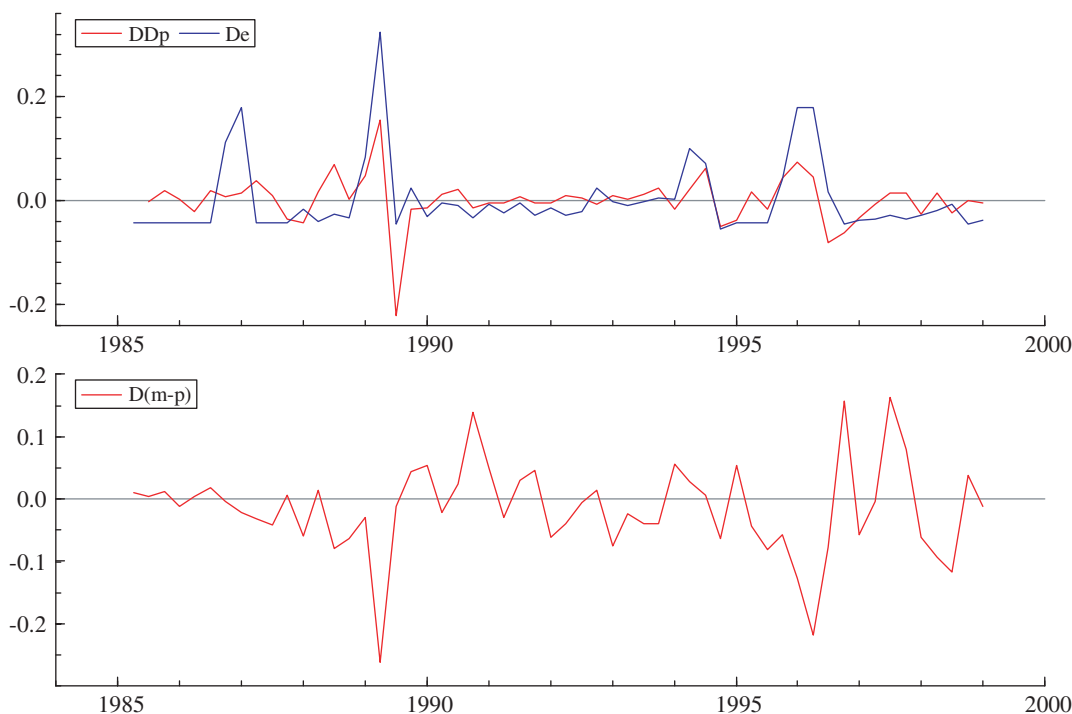


Fig. 4. Top panel: changes in inflation rates ( $DDp$ ) and the quarterly changes in the exchange rate ( $De$ ) Lower panel: quarterly changes in real money  $D(m-p)$

that are the main driving forces, remains an empirical issue that is answered below.

#### Test for unit roots

This subsection presents unit root tests for the variables used in the model. To test whether the underlying processes contain a unit root, we 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 prices and money were found to be nonstationary, 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 (see Ericsson, 1998). Thus, the cointegration analysis uses the  $I(1)$  variables:  $m-p$ ,  $y$ ,  $\Delta p$ ,  $e$ ,  $R^{D-F}$  and  $R^F$ .

#### IV. Long Run Behaviour and Cointegration

Cointegration provides an analytical and statistical framework for ascertaining the long run relationship between nonstationary 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, inflation, the exchange rate, the foreign interest rate and interest rate differential using the Johansen (1988, 1991) procedure. A vector autoregression (VAR) model with four lags was estimated, including a constant and seasonal dummies.<sup>2</sup> The number of lags for the VAR as a whole were chosen based on among other the Akaike information criteria and likelihood ratio (LR) tests.<sup>3</sup> The trace eigenvalue statistic ( $\lambda_{\text{trace}}$ ) strongly rejects the null of one cointegration in favor of two cointegration relationship at the 1%

<sup>2</sup> 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 more closed economy framework where the exchange rate is omitted from the analysis, the trend is no longer insignificant and cannot 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.

<sup>3</sup> Lag reduction tests suggested that both four and five lags were preferable. However, to ascertain sufficient degrees of freedom, four lags were chosen. Nevertheless, the results are virtually unchanged using five lags. Lag lengths of three or shorter indicate problems with autocorrelation and was therefore not investigated.

level, whereas the maximum eigenvalue statistics ( $\lambda_{\max}$ ) rejects the null of one cointegration in favour of two cointegration relationship at the 5% level (see Table A.2).

Section II in Table A.2 reports the two potential cointegration vectors ( $\beta'$ ), normalized on  $m-p$  and  $y$  respectively. The coefficients in the money demand equation have the anticipated signs as discussed above. The second cointegrating vector indicates a relationship between real output and key macroeconomic variables. However, it is hard to interpret the equations any further without adding restrictions. On the other hand, below it will be shown that the existence of a second cointegrating vector is not important for the interpretation of the money demand equation.

Section III in Table A.2 reports the same cointegration vectors normalized on  $m-p$  and  $y$  respectively, but now the null restriction has been imposed that the foreign interest rate does not enter the first cointegrating vector of real money demand, and that real money demand does not enter the second cointegrating vector.<sup>4</sup> In addition null restrictions are also imposed on the feedback effects of the disequilibrium on to the variables in the vector autoregression ( $\alpha$ ). The null restrictions on  $\alpha$  imply a test for weak exogeneity of a given variable for the cointegration vector, so that disequilibrium in the cointegration relationship does not feed back directly onto the corresponding variable. The tests show that all variables but real money are weakly exogenous for real money demand in the first cointegrating vector. In the second cointegrating vector, real money demand, prices and both interest rates variables are weakly exogenous for real output. The associated likelihood-ratio statistic for all restrictions is  $\chi^2(9) = 8.380$  [0.496] where  $\chi^2(9)$  specifies the asymptotic distribution under the null, 8.380 is the observed value of the statistic, and the asymptotic  $p$ -value is in brackets. Equation 4 reports the cointegrating vector for money demand (standard errors in parentheses below coefficients):

$$m - p = 1.212y - 1.749(\Delta p * 4) + 0.003R^{D-F} - 0.278e \quad (4)$$

(0.398)                      (0.738)  
(0.001)                      (0.032)

The coefficient on income is close to one, and the restriction of unit income homogeneity is not rejected.

The associated likelihood-ratio statistic when this restriction is added is  $\chi^2(10) = 8.693$  [0.562].

Inflation (measured at an annual rate) has a semi elasticity of  $-0.437$  ( $-1.749/4$ ), whereas the semi elasticity on the interest rate differential ( $R^{D-F}$ )\*100 is 0.32. The coefficients on  $R^{D-F}$  and  $\Delta p$  are therefore close to being equal in value and opposite in sign. Statistically the restriction cannot be rejected. The associated likelihood-ratio statistic is  $\chi^2(10) = 9.207$  [0.513]. 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 0.3 per quarter.

Finally, the elasticity on the exchange rate is significantly negative as expected, with a value of  $-0.28$ . This value is rather low, but consistent with what was found for Mexico in Bahmani-Oskooee and Malixi (1991).<sup>5</sup> Nevertheless, it indicates some degree of substitutability between domestic and foreign currency.

The estimated feedback coefficient for the money equation is  $-0.53$ , which is somewhat high compared to other country studies. Thus, lagged excess money induces smaller current money holdings, with a fast adjustment (53% within a quarter).

Finally, imposing in addition the restriction of unit homogeneity on GDP, the estimate of the cointegration relation is:

$$m - p = y - 1.880(\Delta p * 4) + 0.003R^{D-F} - 0.262e \quad (5)$$

(0.759)                      (0.014)

with the restricted feedback coefficient of  $-0.52$ . Hence, to sum up, all coefficients in the cointegrating vector satisfy the sign restrictions postulated in Equation 3. Valid weak exogeneity tests support the analysis of the cointegration vector in a single equation conditional equilibrium correction of money without loss of information.

So far, the second cointegrating vector has not been interpreted. It suggests that real output increases with inflation, falls with a higher interest rate differential and foreign interest rates and increases with an increased (depreciated) exchange rate (see Section III in Table A.2). None of these effects are controversial in the standard economic literature. However, it is noted that as real money is not part of the second cointegration vector of real output and is weakly exogenous for real output, the results are not essential for interpreting the real money demand equation.

<sup>4</sup>The choice of variables to be excluded from the cointegrating vectors are suggested by insignificant  $t$ -statistics.

<sup>5</sup>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.

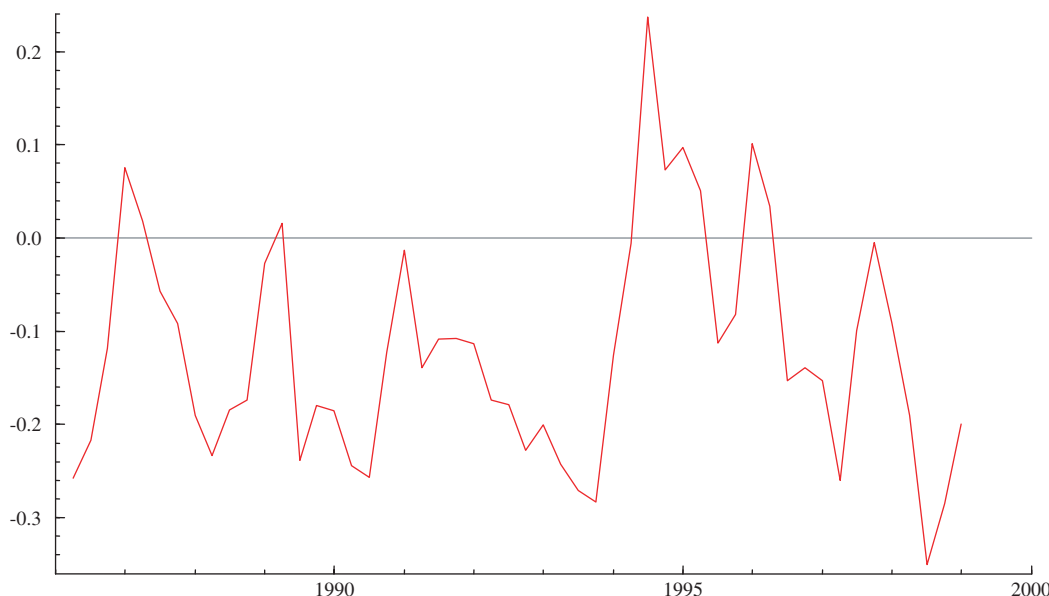


Fig. 5. Deviations of real money demand from the long run relationship (excess money)

Finally, as a test of the robustness of the results, the system was also re-estimated, by excluding the foreign interest rate *ex ante*, since it was not significant in the cointegration equation of real money demand. That is, cointegration between real money, real GDP, the interest rate differential, inflation and the exchange rate is tested for. The results suggest that the null of zero cointegration can be rejected in favour of one cointegration relationship. Imposing the restriction of unit homogeneity on GDP and weak exogeneity of all variables except real money, the estimate of the cointegration relation is almost identical to the one reported above in Equation 5:

$$m - p = y - 1.875(\Delta p * 4) + 0.003R^{D-F} - 0.265e \quad (6)$$

(0.765) (0.001) (0.015)

Figure 5 plots the deviations of real money demand from the long run relationship above (excess money). Periods of excess money are: 1986–1987, briefly in 1989 and during the banking crisis in 1994–1996.

## 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's 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 modelled 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.

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

### The equilibrium correction model

The EqCM model was estimated for the period 1985Q1–1999Q1 minus the included lags. With four lags in the VAR, the EqCM model was initially estimated by including three 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:

$$\begin{aligned} \Delta(m - p)_t = & 0.243\Delta(m - p)_{t-1} - 0.644\Delta^2 p_t \\ & - 0.003\Delta^4 R_t^{D-F} - 0.031\Delta R_t^F \\ & + 0.170\Delta e_{t-1} + 0.173\Delta e_{t-3} \\ & - 0.086 - 0.215DU_t \\ & - 0.44(m - p - y)_{t-1} - 1.082\Delta p_{t-1} \\ & + 0.001R_{t-1}^{D-F} - 0.11e_{t-1} \end{aligned} \quad (7)$$

(0.120) (0.162) (0.0006) (0.015) (0.079) (0.055) (0.028) (0.053) (0.076) (0.221) (0.0005) (0.021)

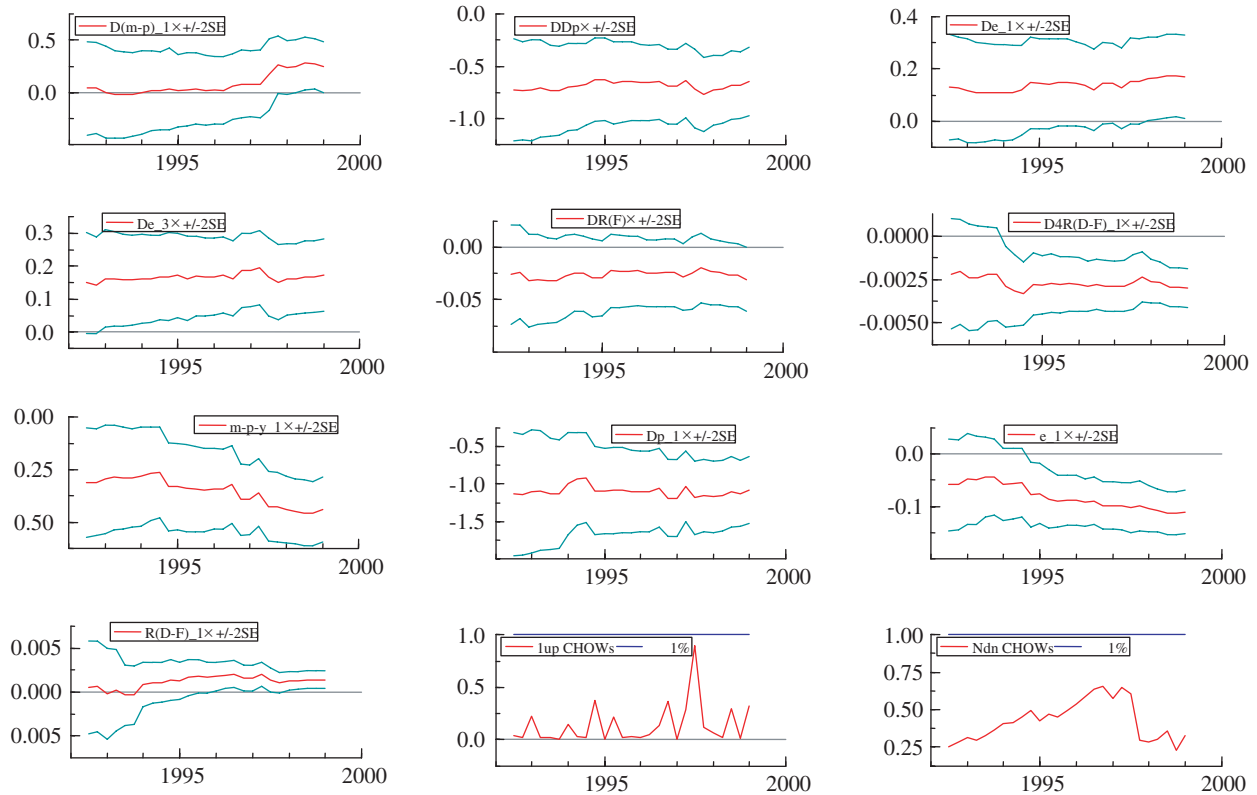


Fig. 6. Recursively estimated coefficient and test of parameter instability

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 parentheses below each coefficient and indicate that all coefficients are significant at the 5% level. Tests of autocorrelation, heteroscedasticity, non-normality, and incorrect functional form are calculated using PcFiml 9.0 (see Doornik and Hendry, 1997). All tests are satisfied at the 1% level.<sup>6</sup>

The coefficients on the equilibrium correction terms (written in four separate parts rather than as one cointegrating vector) are highly significant statistically, confirming that a long-run cointegration relationship exists between broad money, prices, real output, the interest rate differential and the exchange rate.<sup>7</sup> 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 will increase real demand for domestic money temporarily, as it takes time before one can substitute domestic for foreign currency. A temporary increase in prices, the foreign interest rate and the interest rate differential will reduce real demand for money temporarily. Contrary to what was expected, lagged effects of exchange rate depreciations increase demand for money temporarily. However, this may very well reflect the time lag it takes before one can substitute domestic for foreign currency, as in the long-run, an increased exchange rate reduces real demand as expected.

#### Parameter constancy

Parameter constancy is a critical issue for money demand equations. In particular to be able to interpret

<sup>6</sup> AR(1-4):  $F(4, 37) = 1.787$  [0.152], ARCH:  $F(4, 33) = 0.858$  [0.500], Normality:  $\chi^2(2) = 2.270$  [0.321], Hetero:  $F(21, 19) = 1.055$  [0.456] and RESET:  $F(1, 40) = 0.276$  [0.602].

<sup>7</sup> The cointegrating vector is split into four separate parts, to again verify the significance of each of the variables in the cointegrating vector. The inclusion of foreign interest rate explicitly among the parts in the cointegration vector was also tried, but as already suggested by the cointegration analysis, it came out insignificant and was therefore excluded from the long-run analysis.



the estimated equation as a money demand equation, it is necessary 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 shows the recursively estimated coefficients of all the variables 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 1997/1998, but these shifts 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 depreciations, this study models broad money demand 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, the interest rate differential 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 analysed by cointegration techniques, following which short-run dynamics are modelled. The resulting model appears to be a satisfactory representation of the data generating process of money holdings. The analysis also holds important conclusions for a policy-maker. In particular, it should be noted that with a high degree of currency substitution in Venezuela, the monetary aggregates will be sensitive to changes in the exchange rate and interest rates.

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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 the annual series of real GDP combined with monthly manufacturing production is used 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<sup>D</sup>* 90 days deposit rate for Venezuela. Source: IMF's *International Financial Statistics*.
- R<sup>F</sup>* US treasury Bill Rate (Bond equivalent). Source: IMF's *International Financial Statistics*.

**Table A1. Augmented Dickey–Fuller tests for a unit root<sup>a</sup>**

Variables	ADF(lags) <sup>b</sup>	<i>t</i> <sub>ADF</sub>	Variables	ADF(lags) <sup>b</sup>	<i>t</i> <sub>ADF</sub>
<i>m</i>	ADF(3)	–3.02	$\Delta m$	ADF(2)	–3.00
<i>p</i>	ADF(1)	–2.45	$\Delta p$	ADF(2)	–3.35
<i>y</i>	ADF(4)	–3.11	$\Delta y$	ADF(2)	–6.75**
<i>R<sup>D</sup></i>	ADF(2)	–2.72	$\Delta R^D$	ADF(3)	–4.58**
<i>R<sup>F</sup></i>	ADF(1)	–2.62	$\Delta R^F$	ADF(1)	–4.34**
<i>R<sup>D–F</sup></i>	ADF(2)	–2.71	$\Delta R^{D–F}$	ADF(3)	–4.69**
<i>e</i>	ADF(2)	–3.16	$\Delta e$	ADF(2)	–4.85**
<i>m – p</i>	ADF(3)	–3.06	$\Delta(m – p)$	ADF(5)	–4.21**

Note: <sup>a</sup>Critical values were taken from Fuller (1976). A constant and a time trend are included in the regressions.

<sup>b</sup>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 (1997).

\*\*Rejection of the unit root hypothesis at the 1% level.

**Table A2. Test for cointegration using the Johansen procedure<sup>a,b</sup>**

I. Hypothesis						
Eigenvalues		$\lambda_{\text{trace}}$	$\lambda_{\text{max}}$			
0.632	$r = 0$	131.07**	51.92**			
0.482	$r \leq 1$	79.15**	34.22*			
0.387	$r \leq 2$	44.93	25.44			
0.237	$r \leq 3$	19.48	14.08			
0.081	$r \leq 4$	5.40	4.39			
0.019	$r \leq 5$	1.01	1.01			
II. Two normalized cointegrating vectors ( $\beta'$ ), normalized						
$m-p$	$y$	$\Delta p$	$R^{D-F}$	$R^F$	$e$	
(1) 1.00	-18.7	19.8	-0.012	-0.53	1.08	
(2) -1.35	1.00	1.03	-0.001	-0.078	-0.39	
III. Two normalized cointegrating vectors ( $\beta'$ ), one added restriction on each cointegrating vector (standard errors in parentheses)						
$m-p$	$y$	$\Delta p$	$R^{D-F}$	$R^F$	$e$	
(1) 1.00	-1.212 (0.398)	1.749 (0.738)	-0.003 (0.001)	0.00	0.278 (0.032)	
(2) 0.00	1.00	-1.262 (0.220)	0.0009 (0.0004)	0.035 (0.004)	-0.042 (0.004)	
Standardized adjustment coefficients, $\alpha$ , (standard errors in parentheses)						
$m-p$	-0.53 (0.111)	0.00				
$y$	0.00	-0.77 (0.191)				
$\Delta p$	0.00	0.00				
$R^{D-F}$	0.00	0.00				
$R^F$	0.00	0.00				
$e$	0.00	-1.72 (0.526)				
$\chi^2(9) = 8.380 [0.496]$						

Note: <sup>a</sup>All test-statistics are calculated using PcFiml 9.0 (Doornik and Hendry, 1997). Critical values are taken from Osterwald-Lenum (1992).

<sup>b</sup>  $\lambda_{\text{max}}$  and  $\lambda_{\text{trace}}$  are the maximum eigenvalue and trace eigenvalue statistics.

\*\*The relevant  $H_0$  is rejected at the 1% critical level, \*the relevant  $H_0$  is rejected at the 5% critical level.