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Abstract

This paper econometrically studies two models of money demand for Argentina. Both characterise the whole sample. Their main difference is the real exchange rate as a determinant whose coefficient estimates implied the exchange rate instead of prices should be used as the money deflator. The model with money deflated by the exchange rate encompasses the model with money deflated by prices. The exchange rate appears to be a proper deflator for hyperinflation experiences and for economies prone to suffer chronic inflation. The choice of the deflator is a key issue for monetary adjustments in response to real exchange rate modifications.

Resumen

Este trabajo estudia econométricamente dos modelos de demanda de dinero para Argentina. Ambos caracterizan apropiadamente el período analizado. Su principal diferencia es el tipo de cambio real como determinante. Las estimaciones de su coeficiente indican que el tipo de cambio nominal debe usarse como deflactor de los saldos monetarios en lugar de los precios. El modelo con este deflactor engloba al que usa precios. El tipo de cambio sería el deflactor no solo para hiperinflaciones sino también para economías con inflación crónica. La elección del deflactor es central para los ajustes monetarios asociados a modificaciones del tipo de cambio real.

*The views expressed herein are solely our own and should not be interpreted as those of the Central Bank of Argentina.

1. Introduction

Econometric modelling of money demand for a long sample period has often been not simple because of different regulations, banking techniques and new components that characterise the time-series of money aggregates. The case of Argentina during the last three decades could appear to be worse. Apart from possessing the depicted features common to many countries, the Argentine economy experienced notorious changes in economic regimes that implied periods of high and hyperinflation followed by a decade of price stability that abruptly ended along with a great variability in output and expenditure behaviour. In such a context an empirical model, which represents a well-defined money demand for a long period, seems to be difficult to obtain. It seems even more difficult to obtain two representations that capture the main features of the same data and have appropriate economic interpretation.

However, alternative representations can be possible since an econometric model is only an approximation to an unknown data generating process, which can be extremely complex and evolving. This aspect of empirical modelling is recognised by the encompassing notion that uses the information provided for the competing models to evaluate the specification of a given model. Its ability to account for the results of alternative models is a more demanding criterion than just a better fit.

This paper econometrically studies two models of M2 money demand for Argentina during a period of large macroeconomic variability (1977-2008). Since both models appear to properly characterise the data for such a period, encompassing tests are applied to further evaluate them. The demand for the aggregate M2 (defined as narrow money, current account and saving deposits in pesos) can be related to the transaction and precautionary motives for holding money. In both cases, real money depends on a measure of the volume of real transactions and the opportunity cost of cash holdings. We consider as opportunity costs of money the interest rate, the exchange rate and inflation.

We estimated two conditional Equilibrium-Correction models of money demand. Their specifications capture the main feature of the data, have suitable economic interpretation and in particular, show parameter constancy. The first model was developed in Ahumada and Garegnani (2008). The second model, although based in the same information set, differs from the previous one in the role of the exchange rate as a long and short run determinant. The real exchange rate is a key variable to understand the cyclical behaviour of the Argentine economy but it is not a usual determinant of money demand. However, the long run solution of the model indicates that the exchange rate instead of domestic prices should be used as the money deflator, a result which can also be derived from an encompassing approach.

In the empirical studies of money demand nominal cash holdings are generally deflated by a price index as the GDP deflator or the Consumer Price Index. Exchange rate is confined as deflator for hyperinflation experiences mainly because of measurement problems. This paper shows that it can be also the case for economies prone to suffer chronic inflation like Argentina. Moreover, the selection of the money deflator can mean more than a price index problem since it can involve differences in monetary adjustments to the same shock that requires real exchange rate variations.

The next section presents a description of the data from a historical perspective. Section 3 shows the results of estimating both equilibrium-correction models of money demand. Section 4 briefly reviews the notion of encompassing. Section 5 shows the results of performing encompassing tests and discusses what they mean for selecting the money deflator. Section 6 concludes.

2. Data Description

The next figures allow us to observe the macroeconomic variability that characterised the Argentine economy during the sample. Quarterly data over 1977-2008 are empirically studied. Figure 1 shows the time plot of real M2 (deflated by the consumer price index), expressed in logs (mp) and in log differences (Dmp). In this Figure two periods can be observed according to the underlying trend of real money: downwards until 1991 and upwards after this year.

Figure 1
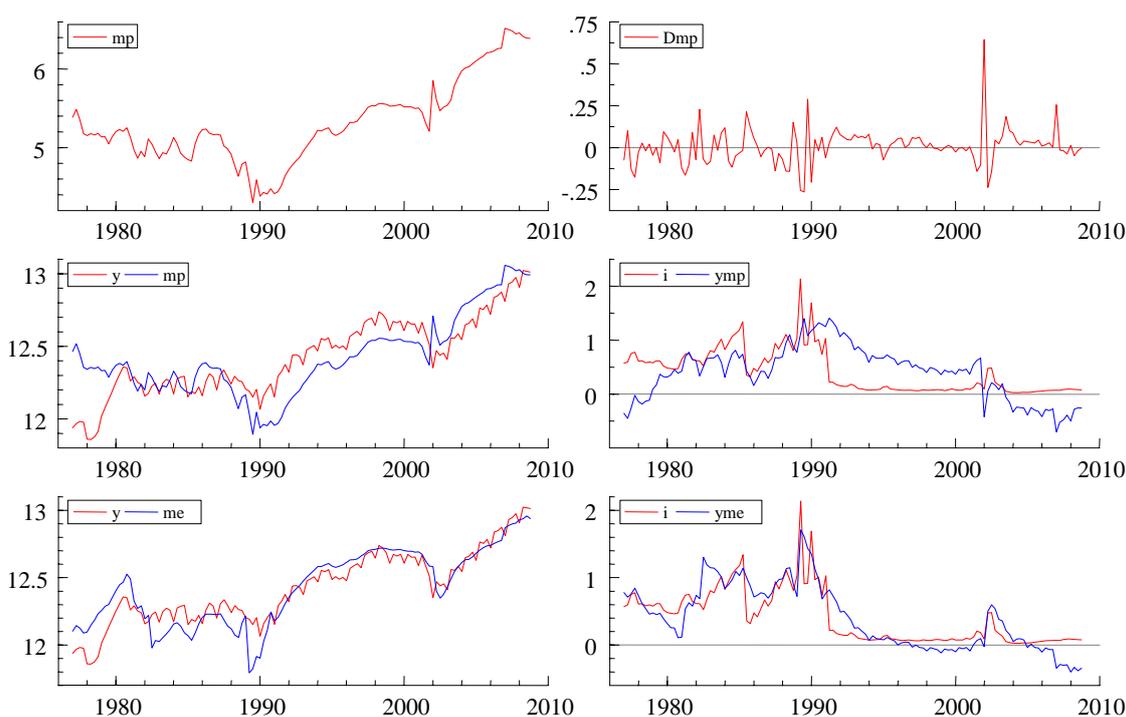
The first period (1977-1991) was also characterised by an upward trend in inflation that accelerates in the mid-seventies when consumer prices passed the 50% annual rate and becomes a hyperinflation process in 1989 and 1990. The interest rate reflects this behaviour. However, the downward trend of real money was accompanied by several attempts to stabilize inflation. In 1985 a stabilization program known as "Plan Austral" led to a temporary decrease in inflation and to an increase of money holdings, but inflation soon accelerated and the reduction in real money holdings was dramatically during the hyperinflation process of the end of 1989 and the beginning of 1990.

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The upward trend in real money holdings started in 1991 along with the Convertibility regime that backed the money base on external reserves to guarantee the one-peso to one-dollar rate of exchange. This monetary regime was undertaken at the same time that deep reforms were performed while a large growth in activity was experienced. This trend - both in real activity and real money- broke up in the second half of the nineties. The relative tranquillity of the first half of the nineties was temporarily interrupted in 1995 due to the regional consequences of the Mexican devaluation (known as "Tequila effect"). Although the Convertibility withstood these external shocks, it was a first evidence of the vulnerability of this monetary regime. The government external debt was increasing over time and began to be perceived as unsustainable once the economy entered a deep recession after the Russian (1998) and Brazilian (1999) crises.

Previous to the abandonment of the Convertibility regime it should be noted that in 2001 a financial and external crisis led to a reduction of real money holdings. The regime collapsed in January 2002 after the government announced the default on its sovereign debt and the abandonment of the currency board scheme. Before the crisis, the access to capital markets by Argentina was severely restricted ending the financial liberalization experienced during the 1990's. Although financial flows to emerging countries had been decreasing since the Russian crisis (the "sudden stop" of Calvo, Izquierdo and Talvi, 2002), after the sovereign debt default, the Argentine economy faced further credit restrictions arising from both external and domestic sources. Not only did capital outflows accelerated but also, at the same time, there was a domestic credit disruption because of financial restrictions and the asymmetric pesification of bank deposits and loans which took place after devaluation (Miller, et.al., 2004). Although the devaluation provoked a jump in inflation rate, that reached a peak in the second quarter of 2002, it then returned to similar levels to those of the Convertibility. Argentine financial system tended to recover and the real money holdings started to increase continuously, also motivated since 2004 by the strong growth that the economy experienced after the prolonged recession that had suffered for several years. The economy grew steadily from 2002 to 2008 but in 2008 the rate of growth is below the observed in previous years, in a context of a deteriorating international financial conditions.

The last two figures show the closer relationship of real money (me) and transactions and the interest rate and velocity when money is deflated by exchange rate instead of prices. The econometric analysis will be focussed on such behaviour. In the next section the results of estimating the two Equilibrium-correction models are presented and their parameter stability evaluated for the described sample period.

3. Estimation of the two equilibrium-correction models

The first model for M2 was developed in Ahumada and Garegnani (2008) using data until 2006 based on the transaction and precautionary motives for holding this money aggregate[1]. In both cases, real money depends on a measure of the volume of real transactions and the opportunity cost of cash holdings. We approximate transactions by aggregate supply (GDP plus imports)[2] and inflation, nominal exchange rate and the

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[1] See also Ericsson (1998) for the main issues related to money demand modelling.
[2] Aguirre et. al. (2006) and Gay (2004) considered GDP as transaction variable. Ahumada (1994) and Ahumada and Garegnani (2002) used Aggregate Supply as a proxy for transactions.

domestic interest rate were tried as opportunity cost[3]. We present here the results for 1977-2008 period.

The estimation started with the analysis of cointegration[4] using the system-based procedure proposed by Johansen (1988 and 1992, see also Johansen and Juselius, 1990). A first system included the money aggregate (m), the level of prices (p), the aggregate supply (y), inflation (infla), the nominal interest rate of time deposits (i) and the nominal exchange rate peso-dollar (e)[5]. The results showed one long run (cointegration) relationship. A long run elasticity of prices equal to one was found and m was normalized as m-p (mp). Inflation and nominal exchange rate variables were not significant as long run determinants. The smaller system is presented in Table 1. The nominal interest rate, the only proxy of the opportunity cost that resulted as significant has a long run coefficient of approximately 0.30. The transactions elasticity equal to 1 was not rejected. Also the Likelihood Ratio (LR) tests indicated that we can estimate a conditional model of mp on y and i at traditional significance levels. Therefore, the relationship between these three variables was modelled as a conditional univariate equilibrium-correction model.

Table 1

Cointegration Analysis 1977:1-2008:4							
λi	Ho:r=p	Max λi			Tr		
0.198	p == 0	28.18*	26.86*	25.5	44.49*	42.41	42.4
0.114	p <= 1	15.47	14.75	19	16.31	15.55	25.3
0.007	p <= 2	0.8387	0.7994	12.3	0.8387	0.7994	12.3
β'			α			LR test(r=1)	
mp	y	i				Ho: α_1=0; [0.0054] **	
1	-1.26	0.31	-0.067	-0.078	0.002	Ho: α_2=0; [0.2084]	
-0.14	1	0.79	0.011	-0.041	-0.001	Ho: $\alpha3$=0; [0.3352]	
0.21	0.71	1	0.025	0.091	-0.012	Ho: β_2=-1; [0.7244]	

Apart from the equilibrium-correction term and 4 lags of the log differences of each variable, the proxies of opportunity cost that did not enter the long run relationship were re-considered but as part of the dynamics. The restricted model which has homoscedastic white-noise and normal residuals is presented in Table 2.

Table 2

```
Dmp =    -0.39134        +0.3026 Dmp_1      +0.1611 Dy_2        -0.1905 Di
[HCSE]   [0.1553]        [0.0813]           [0.0665]            [0.0459]
         -0.08300 Di_1   -0.03802 EqC_1     -0.1629 Dinfla      -0.0471 Dinflap_4
         [0.0329]        [0.0148]           [0.0412]            [0.0159]
         +0.2406 d822    +0.1365 d892       -0.1795 d893        +0.6606 d021
         [0.0066]        [0.0364]           [0.0673]            [0.0168]
         -0.3224 d022    +0.2588 d071
         [0.0577]        [0.0058]


 R^2 = 0.799 F(13,112)=34.338[0.0000]  σ=0.051  DW = 1.70
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[3] Although saving accounts pays interest, this rate has not been considered because of the following reasons: (i) it has been very low in comparison to the rate of time deposits and (ii) its low participation in the aggregate at least until the nineties.
[4] Unit-root tests indicate that the variables we considered are I(1), they and all results not reported are available upon request.
[5] All variables are expressed in logs, infla as log differences and i as the log of one plus the rate. Unrestricted dummies were also included to get residual normality. A restricted trend was included but it was not significant.

Residual and specification tests

```
AR 1- 1 F( 1,110) =     1.0768 [0.3017]
AR 1- 5 F( 5,106) =     1.5477 [0.1813]
ARCH 1  F( 1,109) =    0.83945 [0.3616]
ARCH 4  F( 4,103) =    0.47124 [0.7567]
Normality Chi^2(2)=     5.5189 [0.0633]
Xi^2    F(20, 90) =    0.67247 [0.8429]
Xi*Xj   F(41, 69) =    0.55732 [0.9773]
RESET   F( 1,110) = 0.00027481 [0.9868]
```

We can observe in Table 2 that the equilibrium-correction term (EqC_1) is significant and about 0.04 of the disequilibria is corrected in the first quarter in order to adjust the long run relationship between mp, y and i. There is also a short run lagged effect of aggregate transactions (Dy_2) of 0.16 approximately. In addition, the rate of growth of nominal interest rate of time deposits has a contemporaneous (Di) and one lag effect (Di_1) on the rate of growth of real money holdings; the total short run effect is negative and approximately 0.27. Inflation entered this equation expressed as contemporaneous differences (Dinfla) and also fourth period lagged but only for positive changes (Dinflap_4) reflecting a sort of asymmetric response of money. Both effects are negative. The delay in the last effect could be due to the period of time money holders need to adapt their decisions to actual changes in the opportunity costs apart from the interest rate that includes the expected rate of inflation.

Several dummy variables were included in the estimated model. They coincide with periods of crises or monetary regime changes: 1982:2, the Malvinas /Falklands conflict; 1989:2-3, the hyperinflation period; 2002:1-2, the abandonment of the Convertibility regime and the announcement of the default on sovereign debt and also 2007:1, the highest jump of mp since 2002:1.

Although, as a whole it was a period of great macroeconomic variability, the estimations showed parameter stability (the recursive estimates of the main coefficients are within the previous 2 times standard errors intervals and the N-descendant Break-Chow test shows values below the 5% significance critical value).

Figure 2
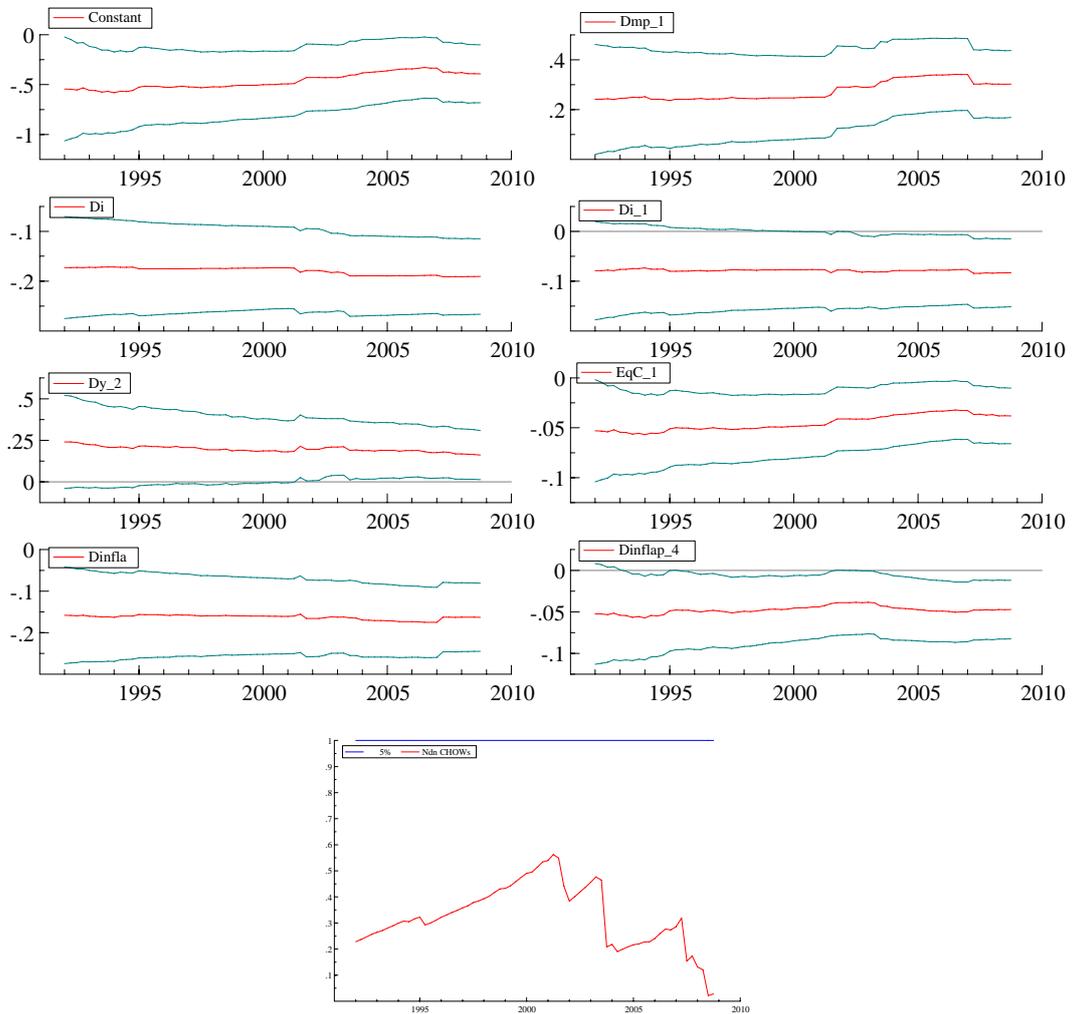
Therefore, the recursive estimations seem to indicate that this model can be use to explain M2 monetary aggregate in real terms. In order to further evaluate that model errors were innovations to the whole information set which was available, the "real" exchange rate (er) was tested as an omitted variable although in the previous analysis both nominal components were separately considered as determinants. Real exchange rate has been a key variable for the Argentine economy, not only for consumer decisions (Ahumada and Garegnani, 2004 and Ahumada and Garegnani, 2007) but also to explain its cyclical behaviour by wealth perception (Heymann and Sanguinetti, 1998). The omitted variable test indicates that we can reject the null of non-significance of the real exchange rate (er) contemporaneous and fourth quarter lagged at traditional significance levels.

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```
LM test for omitted variables
Add     F( 5,106) =     3.6991 [0.0040] **

Added variables:
er er_1 er_2 er_3 er_4
```

Given these results a new system was estimated considering real money (mp), the aggregate supply (y), inflation (infla), the nominal interest rate of time deposits (i) and the real exchange rate peso-dollar (E/P denoted as er in logs). This system showed that the there was one long run relationship between mp, er, y and i. Inflation did not result significant and the coefficients of both e and y resulted equal to one. A restricted system with a long run elasticity of y equal to 1 is presented in Table 4.1. The results showed that mpy is a function of er with a long run coefficient of 1. Although a positive relation between mp and e would be puzzling result, the unity coefficient indicates that E was the appropriate money deflator. To see this note that the long run relationship found can be written as,

$$M_t / P_t = A \ Y_t \ i_t^{\lambda} \ E_t / P_t \tag{1}$$

And therefore,

$$M_t / E_t = A \ Y_t \ i_t^{\lambda} \tag{2}$$

Whereas E_t / P_t was an omitted variable in the long run relationship of the first model where money is deflated by consumer prices, the estimates of the new system indicates a different long run solution given by (1) which can be written as (2), where the target money of the economic agents is money deflated by the nominal exchange rate. The selection of this money deflator will be further discussed in Section 5. The restricted system taking into account the new results is presented in Table 4.2

Table 4

Table 4.1

Cointegration Analysis 1977:1-2008:4							
λi	Ho:r=p	Max λi			Tr		
0.292	p == 0	43.92**	39.77**	21	57.55**	52.11**	29.7
0.095	p <= 1	12.71	11.51	14.1	13.63	12.34	15.4
0.007	p <= 2	0.9167	0.83	3.8	0.9167	0.83	3.8
β´			α			LR test(r=1)	
mpy	er	i				Ho: α_1=0; [0.0000] **	
1	-0.97	1.05	-0.099	-0.009	0.014	Ho: α_2=0; [0.4758]	
0.41	1	-1.08	0.013	-0.033	0.000	Ho: α3=0; [0.9294]	
0.28	-0.19	1	0.002	-0.006	-0.038	Ho: β_2=-1; [0.8466]	

Table 4.2

Cointegration Analysis 1977:1-2008:4							
λi	Ho:r=p	Max λi			Tr		
0.260	p == 0	37.9**	35.2**	21	46**	42.72**	29.7
0.062	p <= 1	8.1	7.521	14.1	8.1	7.521	15.4
0.000	p <= 2	0.000193	0.0001792	3.8	0.000193	0.0001792	3.8

$\beta´$			α			LR test(r=1)
me	y	i				Ho: α_1=0; [0.0000] **
1	-1.17	0.42	-0.0775	0.0055	0.0002	Ho: α_2=0; [0.9567]
0.39	1	1.83	0.0003	-0.0146	0.0001	Ho: $\alpha3$=0; [0.7280]
1.45	-2.64	1	0.0095	-0.0389	-0.0005	Ho: β_2=-1; [0.7310]

The results indicated that money deflated by nominal exchange rate (me) has a long run relationship with y and i. The Likelihood Ratio (LR) tests allow us to estimate a conditional model of me on y and i. The nominal interest rate has a long run coefficient of approximately 0.42 for the whole sample. The transactions elasticity equal to 1 was not rejected. Therefore, the relationship between these three variables was modelled as another conditional equilibrium-correction model.

The econometric analysis continued as previously, estimating an equilibrium-correction model that included the equilibrium-correction term of the previous system and 4 lags of the log differences of each variable; also the proxies of opportunity cost that did not enter the long run relationship were re-considered but as part of the dynamics. The restricted model which has homoscedastic white-noise and normal residuals is presented in next table.

Table 5

```
Dme =    -0.2921            +0.3526 Dme_1         +0.2552 Dy_3
[HCSE]   [0.06371]          [0.05424]             [0.0915]
         -0.1508 Dr         -0.9396 Der           +0.1704 Der_1
         [0.0281]           [0.02495]             [0.0723]
         -0.3128 Dinfla     -0.362 Dinflapos      -0.06652 EqC_1*
         [0.02345]          [0.1092]              [0.01306]
         -0.2039 d774       +0.2826 d822          -0.1218 d902
         [0.02266]          [0.02033]             [0.02565]
         -0.1400 d903       -0.1216 d013          +0.6563 d021
         [0.01791]          [0.009078]            [0.02105]
         -0.2183 d022       +0.2482 d071          -0.03905 Seasonal
         [0.0527]           [0.01023]             [0.01847]
         -0.02074 Seasonal_1  -0.01229 Seasonal_2  -0.06615 seas7791
         [0.01021]          [0.01196]             [0.01967]
         -0.04908 seas7791_1  -0.07814 seas7791_2
         [0.01845]          [0.01919]

R^2 = 0.964329  F(22,102) = 125.34 [0.0000]  σ=0.038  DW = 1.81
```

Residual and specification tests

```
AR 1- 1 F( 1,101) =    1.3116 [0.2548]
AR 1- 5 F( 5, 97) =    1.4996 [0.1971]
ARCH 1  F( 1,100) =    2.3987 [0.1246]
ARCH 4  F( 4, 94) =     1.418 [0.2340]
Normality Chi^2(2)=   0.68491 [0.7100]
Xi^2    F(30, 71) =   0.69607 [0.8639]
RESET   F( 1,101) =    1.5816 [0.2114]
```

For the log difference of me, the equilibrium-correction term (EqC_1)* is significant and about 0.07 of the disequilibria is corrected in the first quarter. There is also a short run lagged effect of aggregate transactions (Dy_3) of 0.25 approximately. This model shows another difference from the first model estimated, the interest rate has a short run effect on Dme but in real terms. The rate of growth of real interest rate (Dr) has a contemporaneous and negative effect of 0.15. Inflation acceleration also entered this equation contemporaneously, Dinfla and Dinflapos (for only positive changes) have negative effects of 0.31 and 0.36 respectively. The rate of growth of the real exchange rate (Der) has a contemporaneous and one lagged effect of approximately -0.77. In this case the three opportunity costs matter for the short run.

The dummy variables included in the model also coincide with the periods of crises, monetary regime changes and the abrupt jump in the money growth rate earlier commented. Seasonality behaviour of me was found for the whole sample but it was different before and after the beginning of the Convertibility regime.

Stability was not rejected by the recursive estimation, as can be observed in Figure 3 (even when the standard error of the regression is even lower in this model).

Figure 3
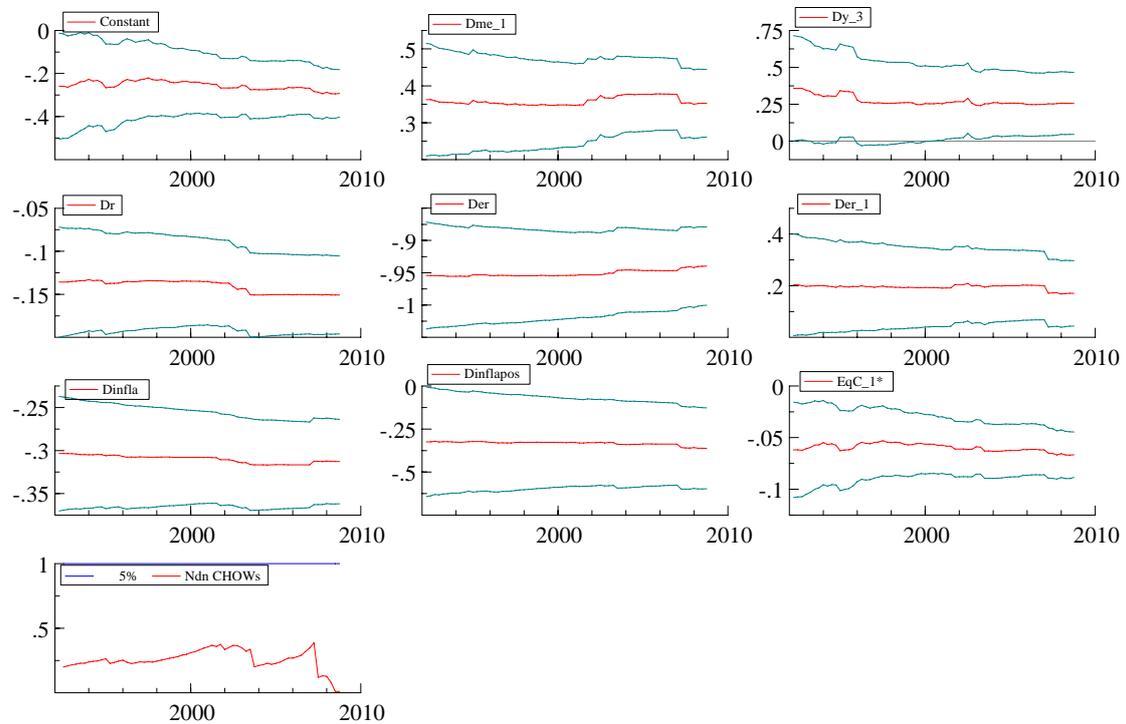
Therefore, two different specifications of money demand (the equations of Table 2 and 5) can be considered as representations of DGP of the M2. Although goodness of fit cannot be assessed by the R^2 because of the different normalisation of the explained variable, the standard error of the regression and the omission of er and their lags in the first model indicate a better fit for the second model. These results have also implications about encompassing, which will be discussed in the next two sections.

4. A review of the encompassing approach

An econometric model is only an approximation to an unknown data generating process which can be extremely complex and evolving. That is why several empirical models that missed some of the features of the DGP can be used to represent a same process. Since an investigator should evaluate an estimated model against the all available information the set of the admissible competing models provides a valuable source of information. Testing whether or not a proposed model can account for the results found by other is the objective of encompassing evaluation. Thus encompassing should be seen as "a far more critical component of progressive modelling strategies than pure model selections are" (see Richard, 1995 and Hendry, Marcellino and Mizon, 2008 for a recent view).

Thus the concept of encompassing has been developed as one of the evaluation criteria to assess how well an empirical model captures salient feature of the data through its ability to account for properties of alternative models. Although encompassing has been closely associated with non-nested hypothesis tests based on Cox (1962), Pesaran (1974) and

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Ericsson (1983), the concept of encompassing evolves as a progressive strategy through parameter and forecast encompassing (Mizon and Richard, 1986 Chong and Hendry, 1986, Ericsson 1992) as this section briefly reviews.

Suppose that two alternative non-nested linear models, *Model 1* and *Model 2*, claim to explain y_t ,

$$y_t = \beta_1' x_{1t} + u_{1t} \qquad\qquad u_1 \sim IN\!\left(0,\ \sigma_1^2\right) \tag{3}$$

$$y_t = \beta_2' x_{2t} + u_{2t} \qquad\qquad u_2 \sim IN\!\left(0,\ \sigma_2^2\right) \tag{4}$$

where β_1 and β_2 are *k1.1* and *k2.1* vectors of unknown parameters and x_{1t} and x_{2t} are *k1.1* and *k2.1* vector of explanatory variables, each has at least a variable which is not in common with those in the other, for simplicity assume that none are in common.

In the Cox-Pesaran approach, the hypothesis of H_0: *Model 1 "encompasses" Model 2* is evaluated by comparing the actual differences of likelihood functions (L) with the expected differences of likelihood in the case of Model 1 "were true" (under H_0).

$$\left[L_1(\hat{\alpha}_1) - L_2(\hat{\alpha}_2) \right] - E_1\!\left[L_1(\hat{\alpha}_1) - L_2(\hat{\alpha}_2) \right]$$

$$\alpha_i' = (\beta_i', \sigma_i^2) \qquad i = 1,2 \tag{5}$$

which can be expressed just as the differences of the variances $\hat{\sigma}_2^2$ and $\hat{\sigma}_{21}^2$ (under H_0), noting that

$$\hat{u}_{21} = (I - X_2 (X_2' X_2)^{-1} X_2') \hat{y}_{21}$$

Even though the notion of encompassing is implicit in this approach, it can happen that no model can encompass the other if also hypothesis of Model 2 "encompasses" Model 1 were tested and rejected. The notion of encompassing can be better perceived by taking into account that for linear models the DGP of the regressors are linked by,

$$x_{1t} = \Pi\ x_{2t} + \varepsilon_t \quad\text{with}\quad E(x_{2t}\varepsilon_t') = 0 \qquad E(\varepsilon_t\ \varepsilon_t') = \Omega \tag{6}$$

Then, substituting (6) into (3),

$$y_t = \beta_1' x_{1t} + u_{1t}$$

$$y_t = (\beta_1 \Pi) x_{2t} + (u_{1t} + \beta_1' \varepsilon_t)$$

$$y_t = \beta_2' x_{2t} + u_{2t}$$

and therefore, there are several hypotheses involved for H_0,

$$Ha : \beta_2 = \Pi' \beta_1$$

$$Hb : \sigma_2^2 = \sigma_1^2 + \beta_1' \Omega \beta_1$$

Ha are needed for parameter encompassing whereas *Hb* for variance encompassing and the latter implies variance dominance,

$$Hc : \sigma_2^2 > \sigma_1^2$$

In fact, it can be shown that *Ha* also implies *Hb*, being the three hypotheses implications of the omitted variable bias in (4) when (3) and (6) are the DGP (Hendry 1983, Hendry and Mizon 1986).

Parameter encompassing can be tested directly by *Ha* or by evaluating whether x_{2t} is irrelevant given (1), that is *Ha* can be expressed as,

$$Ha : \gamma = \beta_2 - \Pi' \beta_1 = 0$$

and by substituting $\beta_2 = \Pi' \beta_1 + \gamma$ (unconstrained) in (4)

$$y_t = \beta_1' x_{1t} + \gamma' x_{2t} + u_{2t} \tag{7}$$

Thus, parameter encompassing can be tested by $\gamma = 0$ with the standard F-statistics in the model (7) which jointly includes the regressors of both models. If encompassing is rejected the information provided by the alternative model can be used to improved the model which was evaluated.

Ericsson (1992) extends the evaluation of the three hypothesis for an out-of sample analysis. *Hc** becomes MSFE dominance, *Hb** becomes MSFE encompassing and *Ha** "forecast-model" encompassing, the latter implies *Ha* to be maintained for both in sample and out-of-sample. Based on Chong and Hendry (1986), he proposes a test which is invariant to non-singular transform of the model (that can be used for integrated variables as well) "the forecast *differential* encompassing",

$$y_j - \hat{y}_{1j} = \delta' (\hat{y}_{2j} - \hat{y}_{1j}) + u_{1j} \tag{8}$$

equation 8 tests if the first model forecast encompasses the second when $\delta = 0$.
The t- statistic of Equation (8) tests *Hb**.In order to test *Ha**, a F-statistic for $\gamma = 0$ can be obtained from the next equation,

$$y_t = \beta_1' x_{1t} + \gamma' x_{2t}^* + u_{1j} \tag{9}$$

where the entire sample is used but x_{2t}^* is zero over the estimation period and equal to x_{2t} for the forecast period. This is "the forecast *model* encompassing test" that can be seen as parameter encompassing test for the forecast period.

Both, in-sample and out-of-sample encompassing tests are applied to the money demand and used to discuss the money deflator in terms of the concept of parameter encompassing.

5. Encompassing evaluation of the money demand models

The two models of Section 3 are in this section evaluated by performing encompassing tests. Although the goodness of fit of the me model is better than the mp model (as also observed in Figure 1), section 4 shows that it is only a necessary condition for encompassing therefore other tests are performed both in-sample and out-of-sample.

Since the models should have the same explained variable in order to evaluate encompassing, both Equilibrium Correction models were re-estimated as Dm, the rate of change of money in nominal terms (and including De and Dp as regressors). Table 6 presents the results of four encompassing tests (see; Ericsson, 1983; Hendry and Richard, 1989; Mizon, 1984 and Mizon and Richard, 1986, and Ahumada, 1985 for an empirical study). Model 1 corresponds to me and Model 2 to mp. Apart from the short run effects in real terms in Model 1 and in nominal terms in Model 2, the Equilibrium Correction terms are different because in the first case money deflated by E instead of deflated by P.

Table 6

```
Encompassing test statistics

Model 1 v Model 2    Form          Test           Form      Model 2 v Model 1
        1.21619     N(0,1)        Cox            N(0,1)            -39.796
       -1.11704     N(0,1)        Ericsson IV    N(0,1)            20.6125
        4.8723      Chi^2(6)      Sargan         Chi^2(15)         80.9556
        0.802523    F(6,95)       Joint Model    F(15,95)          17.6529
       [ 0.5704]                                                  [ 0.0000]
```

The results show that for all the statistics evaluated (that cover both variance and parameter encompassing within sample, see Hendry and Doornik, 1997). Model 1 encompasses Model 2 and Model 2 does not encompass Model 1. Therefore, the model where money is deflated by E (and the *real* short run effects) can account for the results of the model where money is deflated by P (and the *nominal* short run effects) but not viceversa.

In order to investigate forecasting encompassing, both models were estimated until 2005 and an out-of-sample forecasting exercise was developed until 2008. Although the models

had good forecast accuracy a linear combination of the two forecasts can be a better option according to a pooling approach, which runs against encompassing (see Clements and Hendry, 1998, 1999, Timmermann, 2006). The forecast differential encompassing and the forecast model encompassing tests proposed by Ericsson (1992) are applied to the models of money demand (see equation 8 and 9). The results show that the model with money deflated by E forecast-encompasses the model with money deflated by P using both statistics.

Table 7

Forecast encompassing	H0: model **me** forecast-encompasses model **mp**	H0: model **mp** forecast-encompasses model **me**
Forecast-differential encompassing[1]	-0.9928	-2.591
Forecast-model encompassing - Dummy variables Forecast-period[2]	0.12791 [0.9433]	3.2458 [0.0025]**

[1]In both models the constant was not significant. t statistics are reported.
[2]F-statistics and p-value are reported.

These findings indicate that a money demand model with the exchange rate as deflator can account for the results found for the model where money is deflated by prices both in the in-sample and out-of-sample cases.

In relation to the encompassing discussion of Section 4, it is worth noting that the model with the P deflator has the next long run solution[6]

$$M_t = A \ Y_t \ i_t^{\lambda} \ P_t \tag{10}$$

whereas the model with the E deflator from (1) and (2),

$$M_t = A \ Y_t \ i_t^{\lambda} \ E_t \tag{11}$$

Therefore, parameter encompassing in terms of the long run solutions implies as in Equation (6) that,

$$\log P_t = \log E_t + \varepsilon_t \tag{12}$$

That is, for these approximations to the DGP of money demand, P_t has showed an error in variable for E_t.

From the previous results the exchange rate appears to be the appropriate deflator of money for Argentina whereas in most of the empirical studies of money demand nominal cash holdings are generally deflated by a price index as the GDP deflator or the Consumer Price Index. Exchange rate is used as money deflator basically for hyperinflation

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[6] If the price elasticity were lower than unity then a weighted average of domestic prices and exchange rate would be the proper deflator.

experiences. A recent example is Nielsen (2008) for Yugoslavian data, where money was deflated by the exchange rate instead of price index to use a measure of only one "good" and to avoid measurement problems. Price index is highly distorted during such experiences. But out of these cases, can the exchange rate be considered as a proper deflator of money?

Post-Keynesian theories of money demand focus on the medium of exchange function of holding money and leads to transaction models of inventories when the level of transactions are known and certain and precautionary models when flows are uncertain (see Sriram, 1999 for a survey). Also "cash in advance" models can be considered as part of transaction models, in which money holding is a sort of restriction to carry out purchases in a given period.

In any case real money deflated by "contemporaneous" price level suppose a perfect matching of money holdings and the expenditures of consumers perform at the given prices in the interval they are measured. When there is a lag between the measure of cash holdings and the period in which agents plan to acquire goods, some expectation on the prices in the near future should be formed[7]. When there is uncertainty about price behaviour and fear of inflation states, exchange rate today can result more useful than present prices for future price behaviour. This can followed from equation (12) when both variables are employed to reflect the unobservable P_{t+1}. E_t is a forward looking measure of the relevant prices not only for hyperinflation experiences but also for economies prone to suffer chronic inflation like Argentina.

The issue of selecting the money deflator is not innocuous to the monetary policy as Auernheimer and Ellis (1995, 2001) discus. They show that for open economies "the choice of the deflator can alter the adjustment of a monetary economy to various shocks in a qualitative , and hence important, way" (p. 1219) . Specifically, it concerns the shocks that generate changes in the relative prices between traded and non- traded goods, that is the real exchange rate. In a nutshell, when both E_t and P_t changes to modify the real exchange rate (E_t/P_t) they produce effects of different sign in real money depending on money is deflated by E_t or P_t and then different monetary adjustments to reach the new equilibrium.

6. Conclusions

This paper has econometrically studied two different models of money demand for Argentina during a period of large macroeconomic variability (1977-2008). Both of them show specifications that can be considered as suitable approximations of the data generating process of Argentine money demand, in particular parameter constancy cannot be rejected for both of them.

Although both models were based on the same information set, the effect of the real exchange rate as long and short run determinant suggested a different specification. Taking into account such effect, the main difference between the models can be

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[7] There would be more differences when the data are measured in longer basis, eg. quarterly with respect to monthly basis.

expressed in terms of the money deflator. The exchange rate instead of a usual price index can be used to define the demand for money in real terms.

The model that deflate money by the exchange rate which has also different short run effects (in real instead of nominal opportunity cost variables) encompasses the model with money deflated by prices, both in-sample and out-of-sample.

In this way, the exchange rate appears to be a proper deflator not only during hyperinflation episodes but also for economies prone to suffer chronic inflation like Argentina.

The omitted long run effect of the real exchange rate in a real money demand defined in the usual form, which can be interpreted as a test of parameter encompassing, can help to choice the deflator for different experiences. If the long run coefficient is unity the nominal exchange rate instead of a price index will be the proper money deflator (a significant but less than one coefficient will indicate a weighted average deflator). The relevant deflator is a key issue to analyse monetary adjustments in response to shocks that modify the real exchange rate.

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