SELECTING THE MONEY DEFLATOR BY AN ENCOMPASSING APPROACH: THE CASE OF ARGENTINA

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Abstract

This paper studies two models of money demand for Argentina. Although both econometric models characterize the whole sample, the main difference between them is the role the real exchange rate plays as a long run and short run determinant of real money holdings. In particular, the coefficient estimates of the real exchange rate indicated that the nominal exchange rate instead of domestic prices should be used as the money deflator. The model with money deflated by the exchange rate encompasses the model with money deflated by domestic prices according to in-sample and out-of-sample tests. Automatic selection corroborates this finding. The exchange rate appears to be a proper deflator not only for hyperinflation experiences but also 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 variations.

Keywords: Money Demand – Equilibrium-Correction – Encompassing – Automatic Selection

JEL: C22, E41

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1. Introduction

Econometric modelling of money demand over a long estimation period has often been complex 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 be worse. Apart from possessing the depicted features common to many countries, the Argentine economy experienced notorious changes in economic regimes. It showed 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 sample that includes all these economic periods, seems difficult to be obtained. It seems even more difficult to find 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 over 1977-2008. Since both models capture the main feature of the data, have suitable economic interpretation and show parameter constancy for such a sample period, encompassing tests are applied to further evaluate them. The demand for the aggregate M2 (defined as narrow money plus current and savings accounts 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 the interest rate, the nominal exchange rate and the inflation rate as the opportunity costs of money holdings. Two conditional Equilibrium-Correction models were estimated. The first model was developed in Ahumada and Garegnani (2009). The second model, although based on the same information set, differs from the previous one in the role that the real exchange rate plays as a long run and short run determinant of real cash holdings. 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, specifically, when a positive effect was found. However, the long run solution of this model indicates that the nominal exchange rate instead of domestic prices should be used as the money deflator, a result which can also be derived from an encompassing approach.

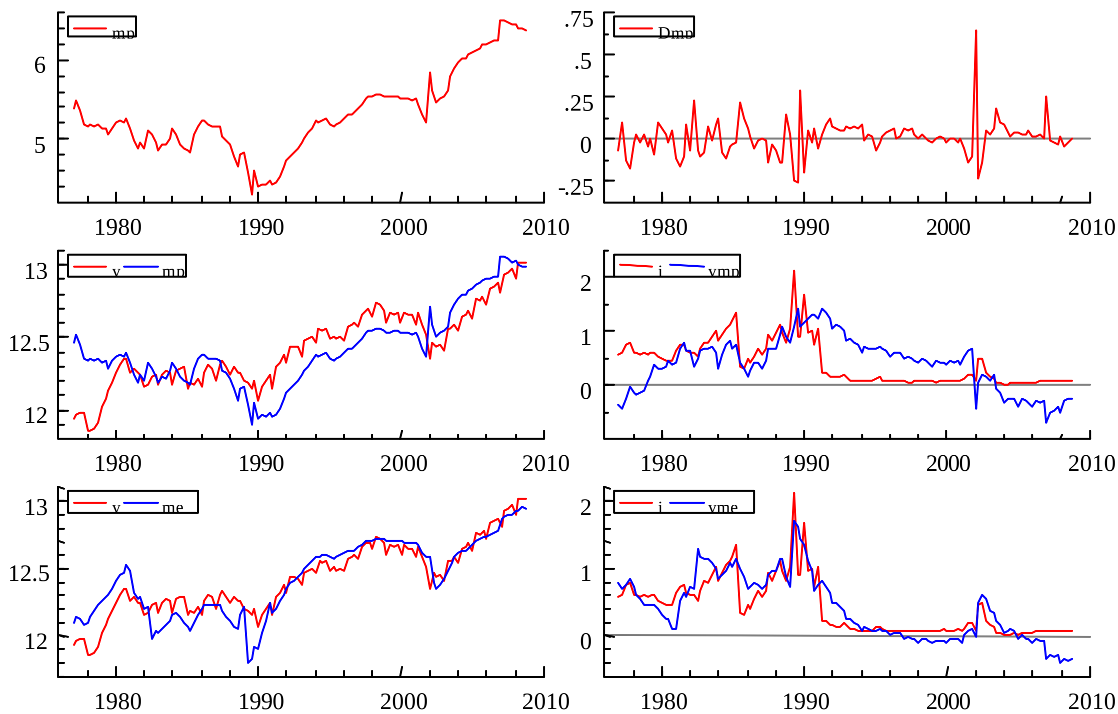
In the empirical studies of money demand nominal cash holdings are generally deflated by a price index as the GDP deflator or the Consumer Price Index. Exchange rate is confined as deflator for hyperinflation experiences mainly because of measurement problems. This paper shows that it can be also the case for economies prone to suffer chronic inflation like Argentina. Moreover, the selection of the money deflator could 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 (in-sample, out-of-sample and automatic selection) 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 over 1977-2008 (see Ahumada and Garegnani, 2009). Figure 1 shows the time plot of real M2 (deflated by the consumer price index), expressed in logs (mp) and in log differences (Dmp) along with transactions (y) and, as part of the log velocity (y-mp), jointly with the nominal interest rate (i). 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 accelerated in the mid-seventies when consumer prices passed the 50% annual rate and became a hyperinflation process in 1989 and 1990. The nominal 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 the “Austral Plan” 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 dramatic during the hyperinflation process of the end of 1989 and the beginning of 1990.

The upward trend in real money holdings started in 1991 along with a convertibility regime that backed the money base with external reserves to guarantee the one-peso to one-dollar rate of exchange. At the same time deep reforms were performed and a large growth in activity was experienced. This trend -both in real activity and real money- broke down 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 regime withstood these external shocks, it showed its first signs of the vulnerability. 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, access to capital markets by Argentina was severely restricted and this ended the financial liberalization experienced during the 1990s. 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 accelerate 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 the inflation rate, that reached a peak in the second quarter of 2002, it then returned to similar levels to those of the convertibility period. Argentine financial system tended to recover. Real money holdings started to increase continuously while the economy experienced a strong growth after the prolonged recession that it had suffered for several years. The economy grew steadily from 2002 to 2008 but in 2008 the rate of growth was below the observed in previous years, in a context of a deteriorating international financial conditions.

The last two figures allow us to observe the time behaviour of real money along with transactions and interest rates when using a different deflator. They 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 (2009) using quarterly data over 1977-2006 based on the transaction and precautionary motives for holding this money aggregate.[1] In both cases, real money (mp) depends on a measure of the volume of real transactions and the opportunity cost of cash holdings. We approximated transactions (y) by aggregate supply (GDP plus imports) and CPI inflation (infla), nominal peso-dollar exchange rate (e) and the domestic time deposit interest rate (i) were tried as

[1] See also Ericsson (1998) for the main issues related to money demand modelling.

opportunity costs.[2] Using the system-based procedure proposed by Johansen (1988 and 1992, see also Johansen and Juselius, 1990)[3] we found one long run (cointegration) relationship. The nominal interest rate was the only proxy of the opportunity cost that resulted as significant (its coefficient estimate was -0.7). Income elasticity equals 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. When the sample was extended until 2008 these results are basically maintained, although a weaker long run relationship was found, as it can be observed in Table 1.

Table 1

Cointegration Analysis 1977:1-2008:4							
λi	Ho:r=p	Max λi			Tr		
0.178	p == 0	24.97*	22.61*	21.0	37.83**	34.26*	29.7
0.092	p <= 1	12.22	11.07	14.1	12.86	11.65	15.4
0.005	p <= 2	0.6371	0.5769	3.8	0.6371	0.5769	3.8

β'			α			LR test(r=1)
mp	y	i				Ho: α_1=0; [0.0010] **
1	-1.26	0.82	-0.0513	-0.0255	-0.0038	Ho: α_2=0; [0.0684]
-0.34	1	0.97	0.0100	-0.0133	-0.0031	Ho: α_3=0; [0.1998]
0.18	1.89	1	0.0267	0.0866	-0.0027	Ho: β_2=-1; [0.6138]
						Ho: β_3=0.7; [0.8428]

Although inflation did not enter the long run relationship (but the interest rate includes the expected rate of it) price acceleration was found to be part of the dynamics. Including this effect along with the short run effects and the deviations from the equilibrium of Table 1, the next model, which has homoscedastic white-noise and normal residuals, was obtained,

Table 2

```
Dmp =   -0.2537         +0.1490 Dy_2        -0.2477 Di          -0.1250 Di_1
[HCSE]  [0.0746]        [0.0660]            [0.0209]            [0.0270]
        -0.0388 EqC_1   -0.6022 Dinflanethypp  + dummy variables
        [0.0107]        [0.1409]


 R^2=0.866 F(18,105)=37.671[0.0000]  σ=0.042  DW=1.71 Sample = 1978:1-2008:4
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[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. Although savings accounts pay interest, this rate has not been considered for since: (i) it was very low in comparison to the rate for time deposits and (ii) savings accounts were relatively small in the aggregate, particularly until the nineties. All variables are expressed in logs, infla as log differences and i as the log of one plus the rate (unit-root tests indicate that these variables can be considered as I(1)). See data sources in Appendix 1.

[3] Systems include 4 lags and also unrestricted dummies to get residual normality. A restricted trend was initially included but it was not significant. All results not reported are available upon request.

Residual and specification tests

```
AR 1- 1 F( 1,104) =      2.2719 [0.1348]
AR 1- 5 F( 5,100) =      1.7179 [0.1374]
ARCH 1  F( 1,103) =      1.7643 [0.1870]
ARCH 4  F( 4, 97) =     0.93966 [0.4444]
Normality Chi^2(2)=     0.35678 [0.8366]
Xi^2    F(23, 81) =     0.54492 [0.9495]
RESET   F( 1,104) =     0.13669 [0.7123]
```

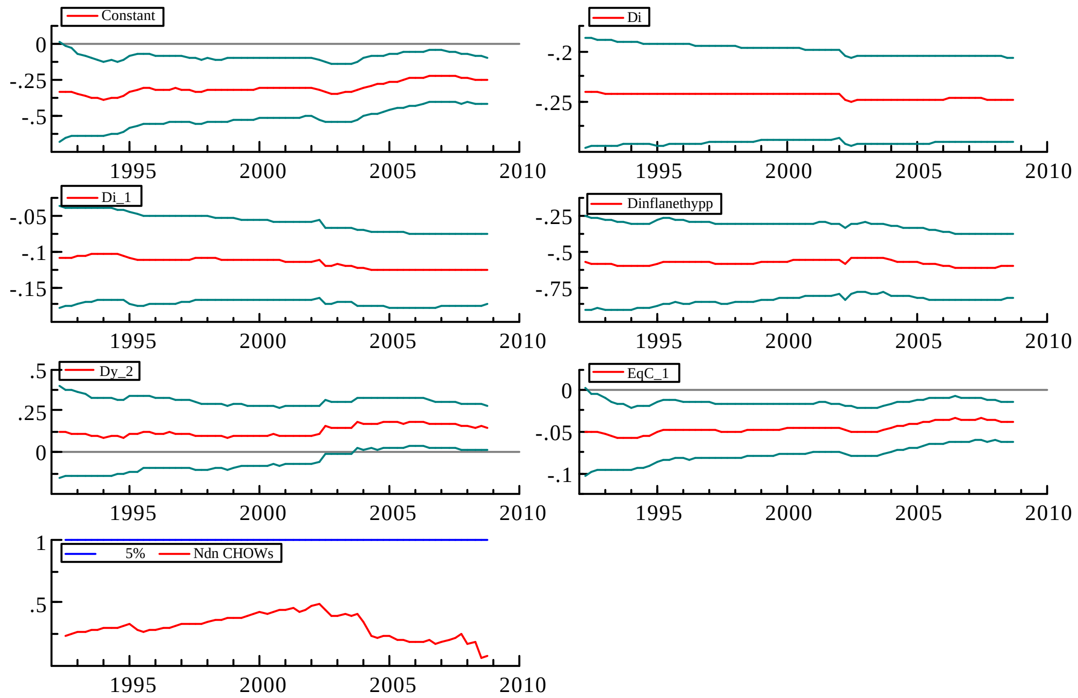
We can observe in Table 2 that the equilibrium-correction term (EqC_1) is significant and about 0.04 of the disequilibria is corrected in the first quarter in order to adjust the long run relationship between mp, y and i. There is also a short run lagged effect of aggregate transactions (Dy_2) of 0.15 approximately. Differences of the 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 0.37. Inflation enters this equation expressed as contemporaneous differences (Dinflanethypp) when the hyperinflation periods are dummied out but only for positive changes reflecting a sort of asymmetric response of money. Thus economic agents adapt their decisions to actual changes in the opportunity costs apart from expected rate of inflation embodied in the interest rate.[4]

Impulse dummies, which all coincide with periods of crises or monetary regime changes, were included in the estimated model: 1981:1, the end of the exchange rate regime known as “Tablita”; 1982:2, the Malvinas /Falklands conflict; 1983:4, the return to a democratic election, 1985:2, the stabilization plan known as “Austral Plan”; 1989:2-4 and 1990:3, periods related to the hyperinflation outbreaks; 1991:2, the beginning of the Convertibility regime; 2001:3-4 and 2002:1, the periods before the crisis and the period of the abandonment of the Convertibility regime and the announcement of the default on sovereign debt, 2003:3, the period considered as the end of the recession and 2007:1 the highest jump of mp since 2002.

Although as a whole it was a sample period of great macroeconomic variability, the estimated model, when the depicted dummies were included, showed parameter stability conditionally on the 4% residual standard deviation (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).

[4] For the shorter sample this effect enters two period lagged.

Figure 2



Even when the described model of Argentine money demand was not detected as misspecified (according to the reported diagnostic tests at traditional significance levels) it was additionally evaluated. We investigated if model errors were innovations to the whole available information set by testing the effect of the “real” exchange rate (ep) as an omitted variable, although in the previous analysis both nominal components were separately considered as determinants of money holdings. The 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 no effect of the real exchange rate (ep) at 5% significance level.[5]

Table 3

```
LM test for omitted variables
Add     F(3,102) =     3.6616 [0.0149] *

Added variables:
ep ep_1 ep_2
```

[5] The unrestricted autoregressive-distributed lag model (4 lags) for the same variables of Table 2 showed an omitted variables test: F(5,108) = 9.4123 [0.0000]**.

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 ep in logs) using 4 lags. This system showed that the there was one long run relationship between mp, ep, y and i. Inflation did not result significant and the coefficients of both ep 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 ep 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. Since the long run relationship found can be written as,

$$M_t / P_t = A \; Y_t \, i_t^{l} \; E_t / P_t \qquad (1)$$

then,

$$M_t / E_t = A \; Y_t \, i_t^{l} \qquad (2)$$

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: α_3=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	
β'			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: α_3=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 again a long run relationship with y and i. The income elasticity equals to 1 was not rejected. The nominal interest rate has a long run coefficient of approximately 0.42 for the whole sample. The Likelihood Ratio (LR) tests allow us to estimate a conditional model of me on y and i.. Therefore, the relationship between these three variables was modelled as another conditional equilibrium-correction model.

Apart from this new equilibrium-correction term (obtained from the previous system), 4 lags of the log differences of each variable and also the proxies of opportunity cost that did not enter the long run relationship were considered as part of the dynamics. The restricted model which has homoscedastic white-noise and normal residuals is presented in the next table.

Table 5

```
Dme =   -0.2921               +0.3526 Dme_1        +0.2552 Dy_3
[HCSE]  [0.0634]              [0.0540]             [0.0911]
        -0.1508 Dr            -0.9396 Der          +0.1704 Der_1
        [0.0279]              [0.0249]             [0.0720]
        -0.3128 Dinfla        -0.362 Dinflapos     -0.06652 EqC_1*
        [0.0234]              [0.1087]             [0.0130]
        -0.1052 Seasonal      -0.06983 Seasonal_1  -0.09044 Seasonal_2
        [0.0203]              [0.0185]             [0.0181]
        +0.06615 Seas9208     -0.04908 Seas9208_1  -0.07814 Seas9208_2
        [0.0196]              [0.0184]             [0.0191]
        + dummy variables


R^2=0.964183  F(22,102)=125.34 [0.0000]  σ=0.038  DW=1.81 Sample = 1978:1-2008:4
```

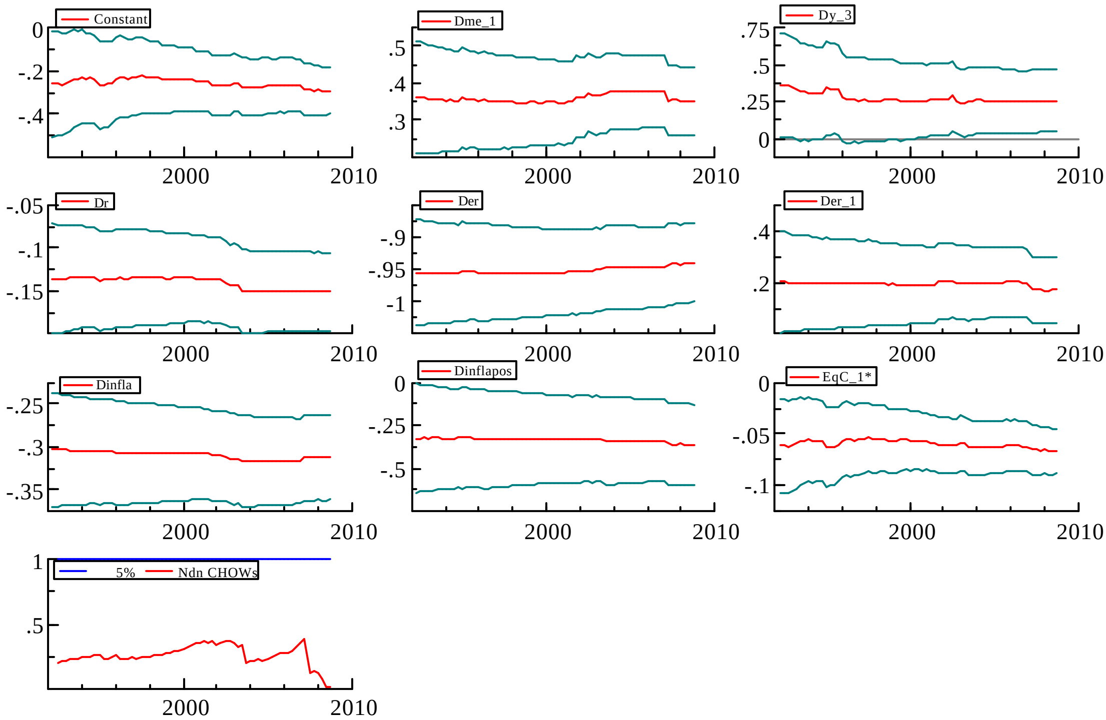
Residual and specification tests

```
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. Differences of the 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. This measure can be seen as an indicator of data based expected inflation. The rate of growth of the real exchange rate (Der) has a contemporaneous and one lagged effect of approximately -0.77 jointly. In this model the three opportunity costs matter for the short run.

Fewer impulse dummies were included in this model, basically a subset of the included in the other model (1982:2; 1990:2-3; 2001:3; 2002:1-2 and 2007:1) Changing seasonality was found before and after 1991. Stability was not rejected by the recursive estimation, as can be observed in Figure 3 .

Figure 3



Therefore, two different specifications of money demand (the equations of Table 2 and 5) can be considered as representations of the DGP of the Argentine M2. Although goodness of fit cannot be assessed by the R^2 because of the different normalisation of the explained variable, the model of *me* has a smaller residual standard deviation and fewer indicators included. Also the omission of *ep* and their lags in the first model indicate a better fit of 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 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 ,

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

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

where $ß_1$ and $ß_2$ 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,

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

Then, substituting (6) into (3),

$$y_t = b_1' x_{1t} + u_{1t}$$

$$y_t = (b_1' \Pi) x_{2t} + (u_{1t} + b_1' e_t)$$

$$y_t = b_2' x_{2t} + u_{2t}$$

and therefore, there are several hypotheses involved for H_0,

$$Ha : b_2 = \Pi' b_1$$

$$Hb : s_2^2 = s_1^2 + b_1' \Omega b_1$$

Ha and Hb are needed for parameter encompassing and for variance encompassing, respectively, whereas Hb implies variance dominance,

$$Hc : s_2^2 > s_1^2$$

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,

$$Ha : g = b_2 - \Pi' b_1 = 0$$

and by substituting $b_2 = \Pi' b_1 + g$ (unconstrained) in (4)

$$y_t = b_1' x_{1t} + g' x_{2t} + u_{2t} \qquad (7)$$

Thus, parameter encompassing can be tested by $g = 0$ 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 hypotheses 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",

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

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

$$y_t = b_1' x_{1t} + g' x_{2t}^* + u_{1j} \quad (9)$$

where the entire sample is used but $x_{2}*$ 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 Dme model would be better than the Dmp model it is only a necessary condition for encompassing as Section 4 indicated and 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 log differences 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). The Equilibrium Correction terms are different because in the case of the model of me money is deflated by E instead of deflated by P as in the model of mp. Besides the short run effects are in real terms in the model of me and in nominal terms in the model of mp.

Table 6

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Encompassing test statistics for Dm

Model me v Model mp    Form      Test          Form   Model mp v Model me
          1.02346    N(0,1)     Cox           N(0,1)          -43.2245
        -0.937077    N(0,1)     Ericsson IV   N(0,1)           15.2434
          10.4858    Chi^2(7)   Sargan        Chi^2(18)        101.585
          1.55566    F(7,94)    Joint Model   F(18,94)         50.9352
         [ 0.1584]                                            [ 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 me encompasses Model mp and Model mp does not encompass Model me. 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 a forecasting exercise was developed until 2008 (the out-of-sample includes 12 quarters). Although accurate forecasts can be obtained from a model, a linear combination of forecasts can be better and thus a pooling approach 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 for Dm	H0: model **me** forecast-encompasses model **mp**	H0: model **mp** forecast-encompasses model **me**
Forecast-differential encompassing[1]	-0.691	-2.586
Forecast-model encompassing - Dummy variables Forecast-period[2]	0.77894 [0.5085]	4.2477 [0.0002]**
Forecast-model encompassing - Dummy variables Regime Specific[3]	1.5856 [0.1978]	12.157 [0.0000]**
Forecast-model encompassing - Dummy variables Regime Specific[4]	0.7608 [0.5187]	6.3696 [0.0000]**
	Model **me**	Model **mp**
Root Mean Squared Error for Dm	0.023	0.078

[1]In both models the constant was not significant. t statistics are reported.
[2]F-statistics and p-value are reported.
[3]Dummy variables period 1991:2-2001:4. F-statistics and p-value are reported.
[4]Dummy variables period 2002:1-2008:4. F-statistics and p-value are reported.

Table 7 also reports the model encompassing tests (se equation (9) but to study if encompassing is restricted to certain economic regimes. They were calculated for two different regimes: during convertibility (1991:2/2001:4) and for the post convertibility period (2002:1/2008:4). They show that the encompassing results are not regime specific.

Encompassing can also be checked by automatic model selection (see Doornik, 2009). If a general unrestricted model (GUM) nests the models to be evaluated a parsimonious model can be search automatically. Diagnostic tests ensure that the models selected at each stage are data congruent and the procedure has been shown not to be path dependent.[6] In the case of studying encompassing of me and mp the GUM of Dm included the two equilibrium correction terms, Dp and De, all the variables with short run effects in nominal terms (real variables are re-parameterisation of them) and all the indicators in both models. Regarding the equilibrium correction terms the selected model only retained the deviations from the equilibrium of me with the t-statistic of 6.[7] Results are reported in Appendix 2.

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.

It is worth noting that the model with the P deflator has the next long run solution[8]

$$M_t = A\; Y_t\, i_t^{l}\; P_t \qquad (10)$$

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

$$M_t = A\; Y_t\, i_t^{l}\; E_t \qquad (11)$$

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

$$\log E_t = \log \mathrm{P}_t + e_{\mathrm{t}} \qquad (12)$$

That is, Equation (12) can be seen as an error- in-variable model of E_t on P_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 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

[6] Autometrics, in Oxmetrics 6.01, was applied for this model selection (Doornik and Hendry, 2009) .
[7] When the sample ends in 2005, the t-statistic is 4.13 and similar results are obtained.
[8] If the price elasticity were lower than unity then a weighted average of domestic prices and exchange rate would be the proper deflator.

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. 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) discussed. 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 studied two different econometric models of money demand for Argentina over 1977-2008, a sample period of large macroeconomic variability. Both models show specifications that can be considered as suitable approximations of the data generating process of Argentine money demand. Although they were built using the same information set, a significant effect of the real exchange rate suggested a different specification. Taking into account this variable, the main difference between the models can be expressed in terms of the money deflator. The nominal exchange rate instead of a usual domestic price index should be used to define the relative value of the demand for money over time.

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

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 terms of domestic prices, which can be interpreted as a test of parameter encompassing, can help to choose 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.

Appendix 1: Data Definitions and Sources

M2: Narrow money, current account and savings deposits in pesos of private sector at the end of period. Banco Central de la República Argentina. B.C.R. A.

Aggregate Supply: Gross Domestic Product plus Imports. ECLAC Bs.As. and Dirección Nacional de Cuentas Nacionales (INDEC).

Nominal Exchange Rate: Peso/Dollar. B.C.R.A.

Interest Rate: 30-59 day time deposits interest rates. B.C.R.A.

Inflation: ($p_t - p_{t-1}$) being p_t the log of general level of consumer prices.

Appendix 2:
Selected model by Autometrics for Dm nesting the explanatoty variables variables of Tables 2 and 5.

The estimation sample is: 1978(1) - 2008(4)

	Coefficient	Std.Error	t-value	t-prob	Part.R^2
Constant	-0.338095	0.05866	-5.76	0.0000	0.2475
Dme_1	0.303869	0.02792	10.9	0.0000	0.5398
Dinflap	-0.552643	0.1132	-4.88	0.0000	0.1911
De	0.0777241	0.02795	2.78	0.0065	0.0711
De_1	0.128415	0.02622	4.90	0.0000	0.1919
Dp	0.726147	0.03630	20.0	0.0000	0.7985
Di	-0.169248	0.02231	-7.59	0.0000	0.3630
EqC_1*	**-0.0741949**	**0.01227**	**-6.05**	**0.0000**	**0.2659**
seas7091	-0.0516525	0.01263	-4.09	0.0001	0.1420
seas7091_1	-0.0304987	0.01334	-2.29	0.0243	0.0492
seas7091_2	-0.0492737	0.01379	-3.57	0.0005	0.1123
d021	0.641529	0.04021	16.0	0.0000	0.7159
d022	-0.189781	0.04324	-4.39	0.0000	0.1602
d822	0.243874	0.03838	6.35	0.0000	0.2855
d902	-0.110853	0.04306	-2.57	0.0115	0.0616
d903	-0.117964	0.03919	-3.01	0.0033	0.0823
d834	0.106865	0.03738	2.86	0.0052	0.0749
d852	0.112625	0.03861	2.92	0.0044	0.0777
d013	-0.125152	0.03539	-3.54	0.0006	0.1102
d071	0.253948	0.03524	7.21	0.0000	0.3396
d014	-0.0738189	0.03562	-2.07	0.0408	0.0408
d912	-0.0807714	0.04039	-2.00	0.0482	0.0381
d811	-0.0783729	0.03733	-2.10	0.0383	0.0418

sigma	0.0349327	RSS	0.123249576
R^2	0.984687	F(22,101) =	295.2 [0.000]**
Adj.R^2	0.981351	log-likelihood	252.709
no. of observations	124	no. of parameters	23
mean(DLM)	0.183768	se(DLM)	0.255804

AR 1-5 test:	F(5,96)	=	0.56497 [0.7266]
ARCH 1-4 test:	F(4,116)	=	2.1041 [0.0847]
Normality test:	Chi^2(2)	=	5.1189 [0.0773]
Hetero test:	F(17,94)	=	1.5353 [0.0992]
RESET23 test:	F(2,99)	=	0.67582 [0.5111]

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