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FINANCIAL INNOVATION AND THE SPEED OF ADJUSTMENT OF MONEY DEMAND: EVIDENCE FROM BOLIVIA, ISRAEL, AND VENEZUELA

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ABSTRACT

Traditional studies of money demand for both developed and less developed countries have shown that there are periods of "missing money," that is, there is consistent overprediction of real balances. This paper uses cointegration techniques to study the effects of financial innovation on the demand for real balances in Bolivia, Israel, and Venezuela. The results show that financial innovation can account for the instability of money demand observed in these countries. In particular, I find that the long run demand for real balances shifted down. In addition, I show that the speed at which people adjust their demand for money when out of equilibrium increases following financial innovation.

Financial Innovation And The Speed of Adjustment of Money Demand: Evidence From Bolivia, Israel, And Venezuela.

Martina Copelman[1]

I. INTRODUCTION

Empirical studies of the demand for money have flourished in recent years. The reason for this large volume of literature can be explained by the importance of money demand in monetary policy. The income and interest elasticities of money demand are at the core of the most basic macroeconomic models such as the IS-LM; where the effectiveness of monetary policy (that is, its ability to affect the real side of the economy) depends on the elasticity of money demand. It is very important therefore, to find consistent estimates of these elasticities.

Following the seminal papers by Goldfeld (1973,1976) a large number of papers for both developed and less developed countries have shown that there have been periods of "missing money" that is, there is consistent overprediction of real balances. This has led to the conclusion that the money demand function is basically unstable.

Two principal explanations have been used to account for this instability of money demand. One is financial innovation and the other is currency substitution. Throughout the 1980's changes in financial markets have been very widespread, and have been particularly important in Bolivia, Israel, and Venezuela. All three of these countries suffered high inflations during the 1980's; two of them, Bolivia and Israel, were actually hyperinflations. In the mid to late 1980's Bolivia, Israel, and Venezuela

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embarked on stabilization programs designed to halt inflation.

The purpose of this study is to show that financial innovation leads to a faster speed of adjustment of money demand to its determinants, as well as to the instability of the observed demand for real balances. This is an aspect of the money demand literature which has hardly been explored, in particular in terms of the new cointegration methods. For Israel, Melnick (1991) shows that ignoring financial innovation is the principal cause for the lack of stability in the money demand equation. I will show that the long run demand for real balances not only shifted down, but that in the short run the effect of financial innovation has been to increase the speed with which people adjust their actual money holdings to their desired money holdings.

Engle and Granger (1987) have shown that using the traditional method of partial adjustment to estimate the demand for money may lead to misspecification and incorrect conclusions. It is important to take account of the fact that the variables used in the estimation are non stationary, something that is usually ignored. Ignoring the stochastic properties of real money balances, the transactions variable, and the opportunity cost variable can lead to OLS regression results which are statistically invalid. For this reason, I will use what has become the standard cointegration approach to estimate the demand for money for Bolivia, Israel, and Venezuela.

The remainder of the paper is structured as follows. Section II presents the model which provides the theoretical foundations for the empirical section. I use the Miller-Orr (1966) model of money demand and show that a decline in the transactions cost (which is a proxy for financial innovation), leads to a faster adjustment of money demand to its determinants. Section III provides a brief description of the events in Bolivia, Israel, and Venezuela. Section IV presents the cointegration methodology. In Section V I estimate the long run demand for money in all three countries using the cointegration methods of the previous section. In this section I also test for the stability of the demand for real balances and allow for both a one time shift and a change in the slope. In Section VI the short run demand for money is estimated as an error correction model and the change in the speed of adjustment is demonstrated.

Section VII concludes.

SECTION II. THE MODEL

The long run money demand function is represented in terms of the Miller-Orr (1966) model. The model is a transactions demand for money where the decision maker can hold two types of assets, 1) money which does not earn any interest and 2) a "bond" or other earning asset which pays interest at a rate i per dollar per day. In what follows I will use the inflation rate, π_t , as the relevant opportunity cost, since in all the three countries in the study interest rates were fixed for a large part of the sample.

The firm faces a stochastic cash flow that can be characterized by a sequence of t independent Bernoulli trials per day. In each trial cash balances can go up by x with probability p or can go down by x with probability q=1-p; where x is the "step size." Transfers of funds between the two assets can be made instantly at cost b. This is a cost which is incurred per transaction and is independent of the size of the transaction. A reduction in b decreases the cost of transactions and therefore, I will associate it with financial innovation as in previous studies. Finally, the minimum level of money holdings is normalized to zero.

The time path of cash holdings will evolve as in Figure 1, where h is the maximum holdings of cash that the individual will ever have, and z is the level to which balances are restored after a transfer. The optimal desired level of cash holdings can be derived by minimizing the total expected daily cost of this Ss policy given the two parameters h and z.[1]

The solution to this problem is an optimal level of cash holdings given by

$$m_t^* = \frac{h^* + z^*}{3} = \frac{4}{3}\left[\frac{3b}{4\pi} x^2 t\right]^{1/3} \qquad (1)$$

where

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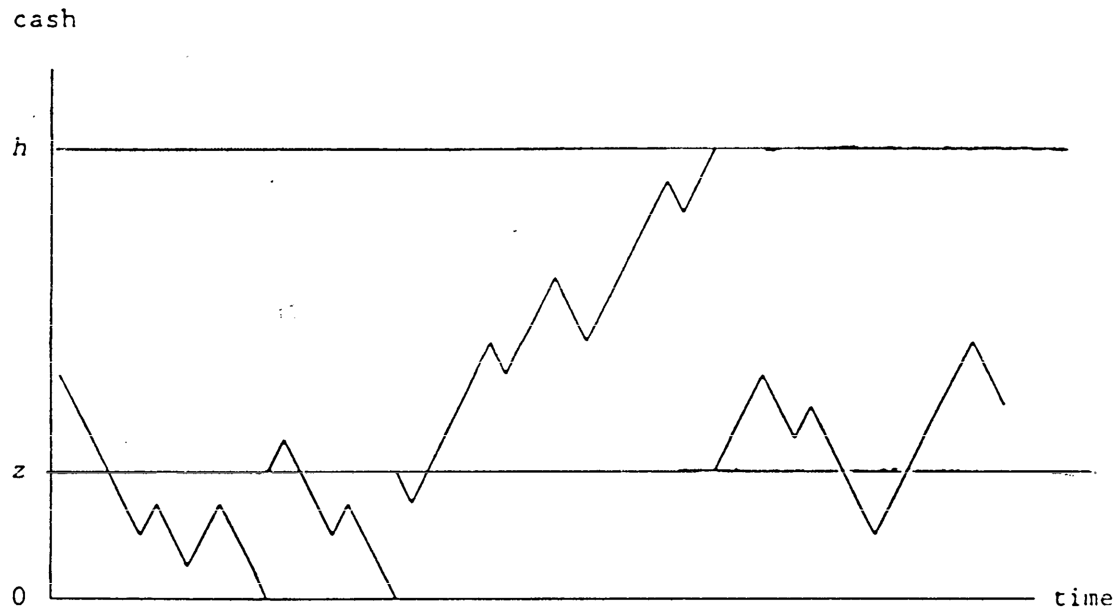
[1] See Miller and Orr (1966) pages 420-423 for the methodology and derivation of equations (1) and (2).

Figure 1



$$z^* = [\frac{3\ b\ x^2\ t}{4\ \pi}]^{1/3} \quad , \quad h^* = 3z^* \tag{2}$$

and where m_t^* denotes the optimal desired stock of real money balances and π_t is the inflation rate which is a proxy for the opportunity cost. Equation (2) gives the optimal upper bound as a function of the optimal return point. With this equation for the optimal level of cash balances in mind, we now proceed to determine the effects of financial innovation on both the speed of adjustment and the level of optimal money holdings.

In this context, financial innovation is proxied as a decline in the transactions costs, b. A lower transactions cost implies a lower real cost of transforming financial assets into money. Holding all else constant, this implies that financial innovation induces a reduction in the desired quantity of real money balances that are held. One can actually think of b as also including effects associated with the introduction of more instruments at the time of the financial liberalization which can be used to avoid holding more cash balances.

Equation (2) shows that a reduction in b will decrease h^* and z^*, narrowing the band of inaction of Figure 1; while equation (1) shows that m^* also declines. The idea is that when transactions costs decline, an individual will wait less time to adjust their money balances when they are out of equilibrium. Therefore, as agents adjust sooner than before, the speed of adjustment of desired money holdings in the economy as a whole increases.

Next, we take a brief look at the financial liberalization episodes that took place in each country.

SECTION III. A LOOK AT BOLIVIA, ISRAEL, AND VENEZUELA.

III.1 BOLIVIA

During 1984-1985, Bolivia experienced the highest inflation rate of Latin America and one of the highest in world history. Using Cagan's (1959) definition of a hyperinflation, that is 50% a month or higher, Sachs (1986) places Bolivia's hyperinflation as the seventh highest of the twentieth century. During approximately the year and a half which the hyperinflation lasted, the average monthly inflation rate reached 46%. In response to this, the Bolivian government introduced a stabilization program in late August of 1985. The hyperinflation quickly subsided and over the past few years has remained both low and fairly stable. This program was introduced in conjunction with an extensive liberalization of all markets, and financial markets in particular.

Morales (1988) describes the vast financial liberalization which was introduced in Bolivia. All interest rate ceilings were eliminated and capital market restrictions were also eliminated. Banks were allowed to operate in international trade and capital account transactions without restrictions. In addition, depositors were allowed to open dollar and dollar indexed accounts and banks could make loans in dollars or indexed to the dollar as well as any local currency loan they deemed valuable. These dollar accounts have lower reserve requirements than other accounts.

The effect of this financial liberalization was to expand the definition of M2, of which the deposits in dollars were the principal component. Short term dollar deposits and those indexed to the dollar increased dramatically, from less than $28 million in September of 1985 to $270 million in March of 1987. The large shift in people's portfolios was mostly due to the very high interest rates that were observed during this time, not only in pesos, but in dollars as well. Interest rates reached 32% in September 1985 and remained high for some time. Table 1 shows that dollar deposits reached about 78% of total commercial bank deposits in 1989, up from less than 30% prior to the deregulation. Even after the hyperinflation ended, the demand for real balances never returned to its previous level (see Figure 2), which is further evidence for the hypothesis that financial innovation caused the decline in real balances.

TABLE 1. BOLIVIA: Dollarized Deposits and Interest Rates

	1986	1987	1988	1989
1.Dollarized Deposits (% of total commercial bank dep.)	45.5	67.5	73.4	78.0
2. Interest Rates annual nominal rate for dollarized dep.	14.3	15.6	15.5	14.7

Source: Morales (1991)

BOLIVIA: INFLATION AND REAL M1

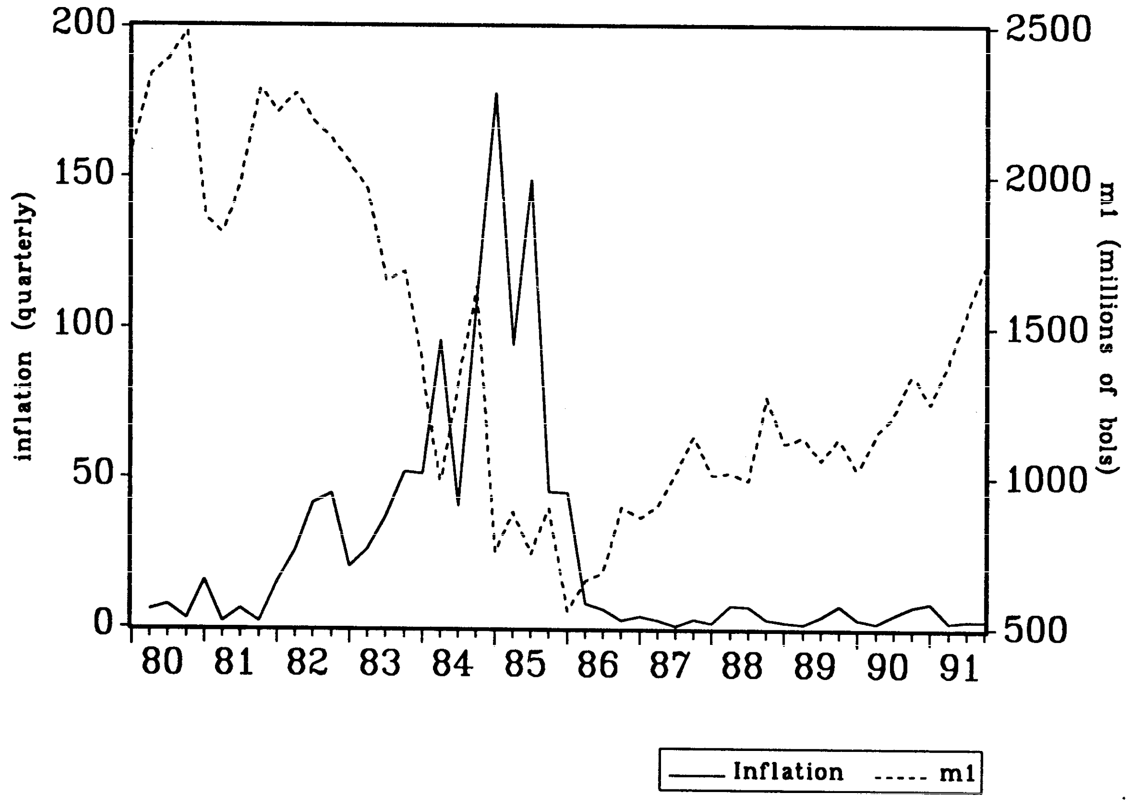
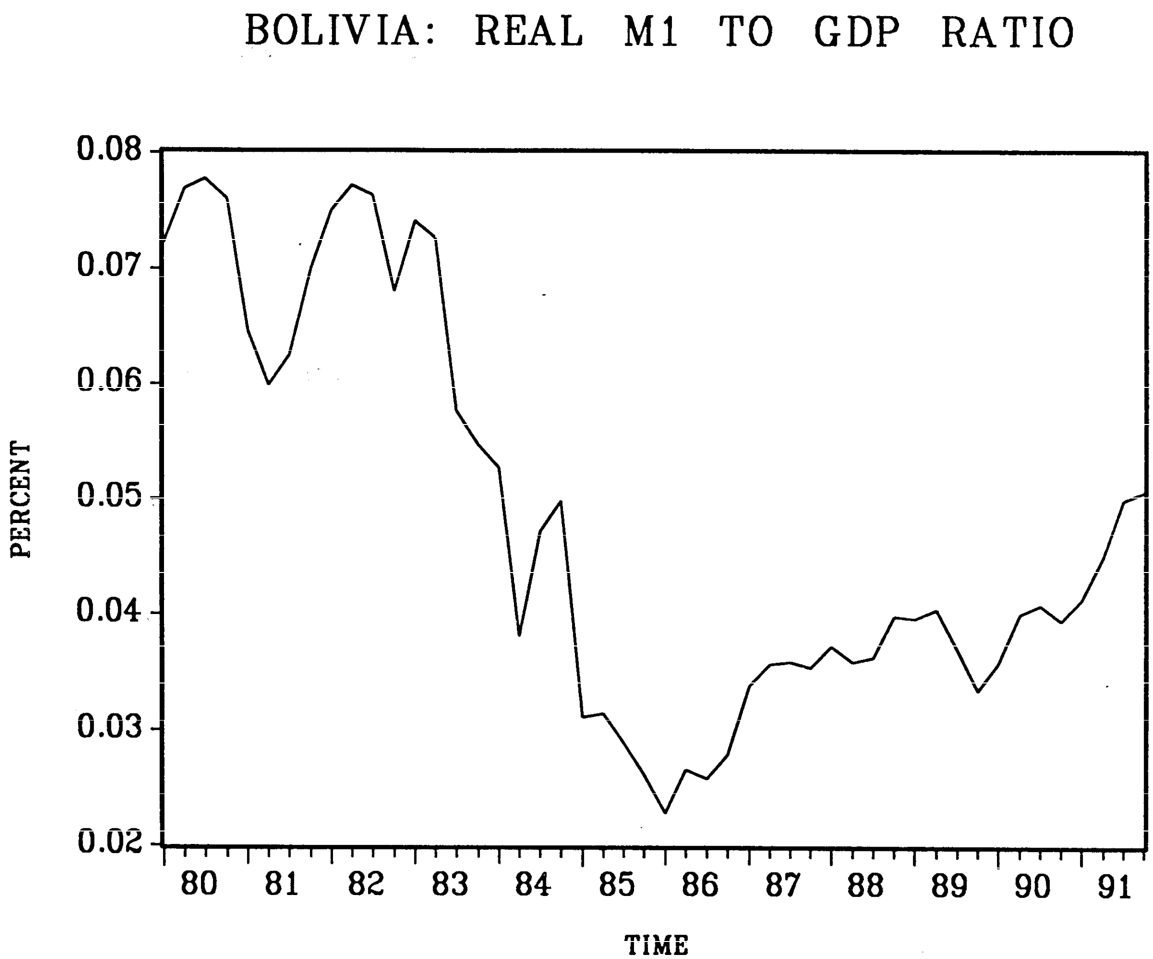


FIGURE 2A

FIGURE 2B



III.2 ISRAEL

In July of 1985, Israel introduced a stabilization program which was extremely successful in ending the hyperinflation. Unlike the Bolivian case, Israel did not immediately adopt all capital market reforms. The drop in real balances experienced by Israel occurred in the beginning of 1987 in conjunction with the adoption of several large and important financial market reforms.[11]

Previous studies of money demand in Israel (see for example Melnick (1991) and Ben-Bassat and Marom (1988)) have found a shift in the demand for real balances after the 1976 financial liberalization, however, most studies have not looked at the period after 1983. Figure 3 shows that real balances in the late 1980's were lower than in the early 1970's, even though inflation was down to the same levels and GDP was higher.

During the last quarter of 1986, Israel began a process of financial liberalization. The liberalization has taken the form of a unification and a reduction of mandatory liquidity ratios. Most importantly, in April of 1987 non financial firms were given full freedom to issue bonds. In addition, limitations on foreign-exchange linked credit were relaxed. In essence, the government's role in financial markets was severely reduced (Ben-Bassat 1988). This led to a narrowing of interest rate gaps in the capital market and a decrease in the average rate on government bonds. Since the deregulation and the stabilization program, new financial instruments have been a big part of Israel's money market, which have led to the decline in desired money holdings.

[11]In mid 1985, there was a change in the regulations designed to actually increase money demand, however, it was not succesful as can be seen in Figure 3 and documented in Ben-Bassat (1988).

FIGURE 3A

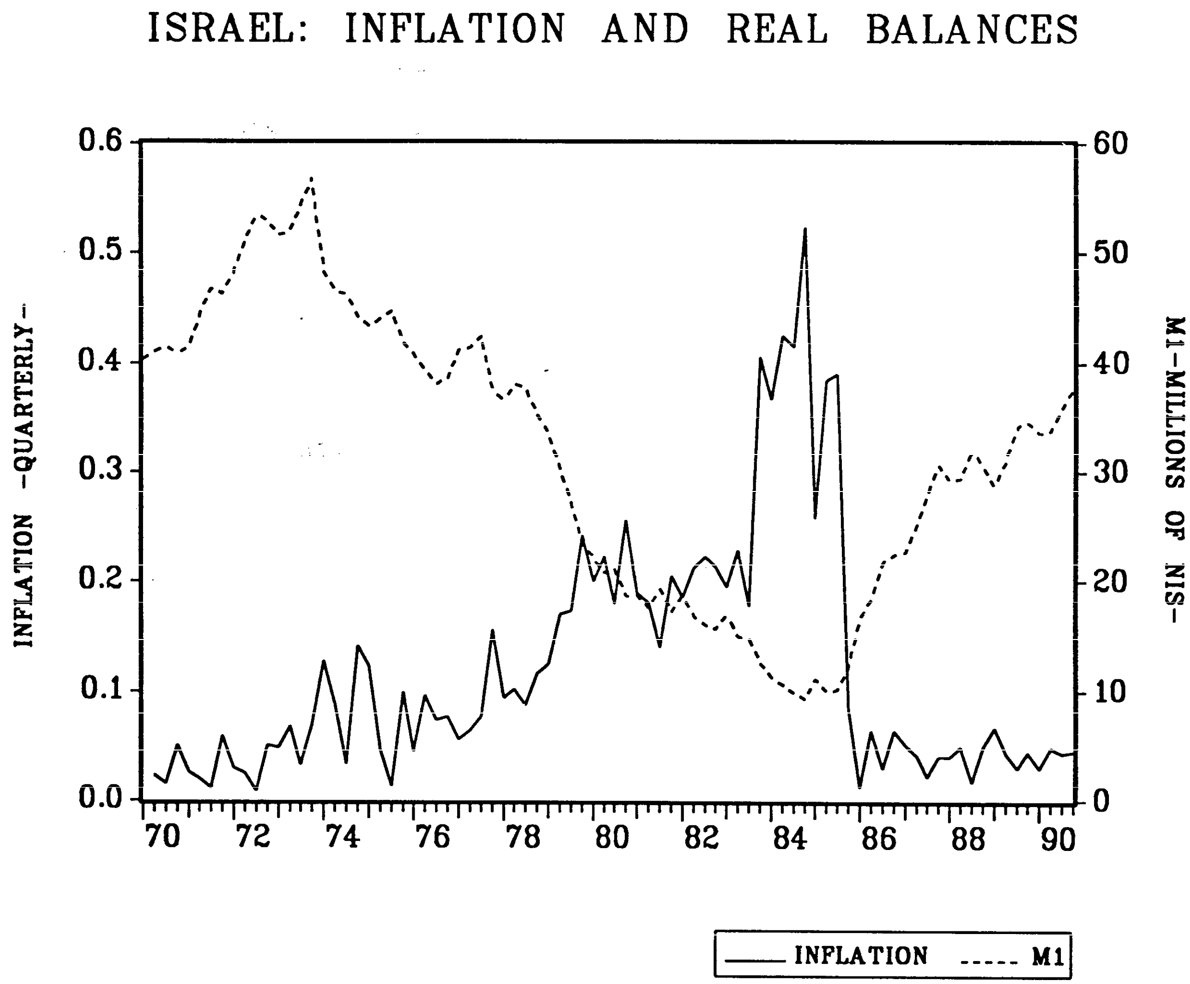
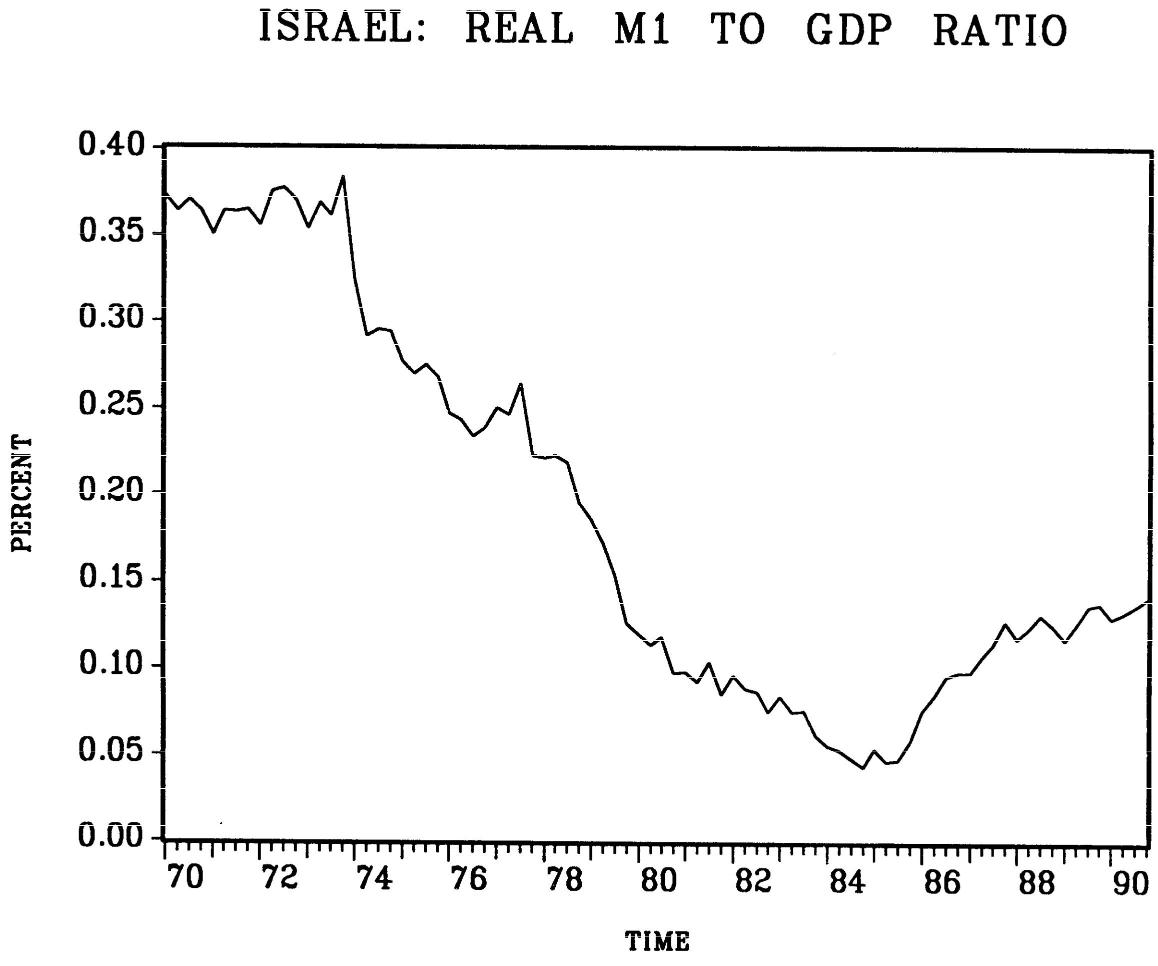

ISRAEL: INFLATION AND REAL BALANCES
INFLATION -QUARTERLY-
M1-MILLIONS OF NIS-
0.6
0.5
0.4
0.3
0.2
0.1
0.0
60
50
40
30
20
10
0
70
72
74
76
78
80
82
84
86
88
90
INFLATION
M1

FIGURE 3B



III.3 VENEZUELA

In 1989 Venezuela experienced a sharp drop in real money balances that cannot be accounted for with the traditional set of explanatory variables. Figure 4 shows real money balances and inflation during this period. The drop in money demand coincides with the beginning of a financial liberalization package introduced in 1989 along with the stabilization program which floated the exchange rate and removed all capital restrictions and access to the foreign exchange market.

FIGURE 4A

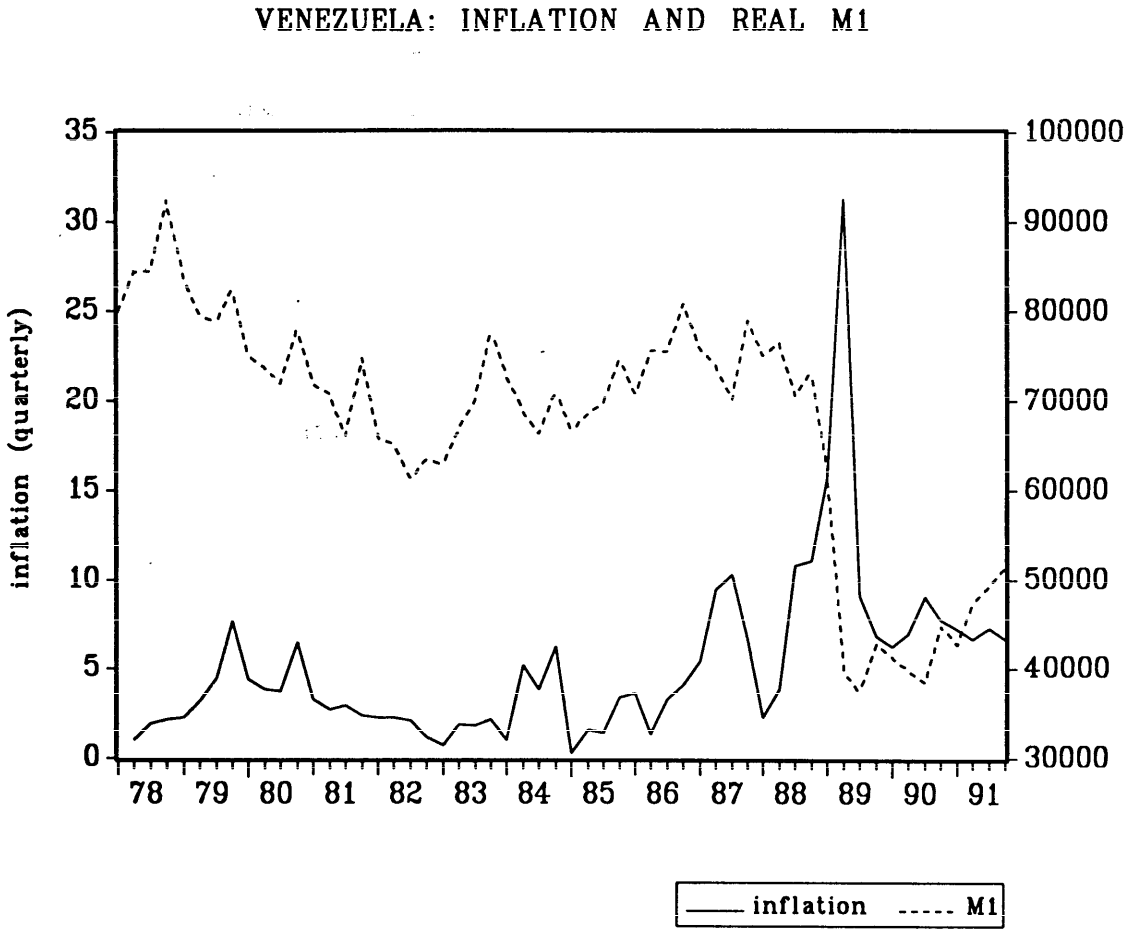
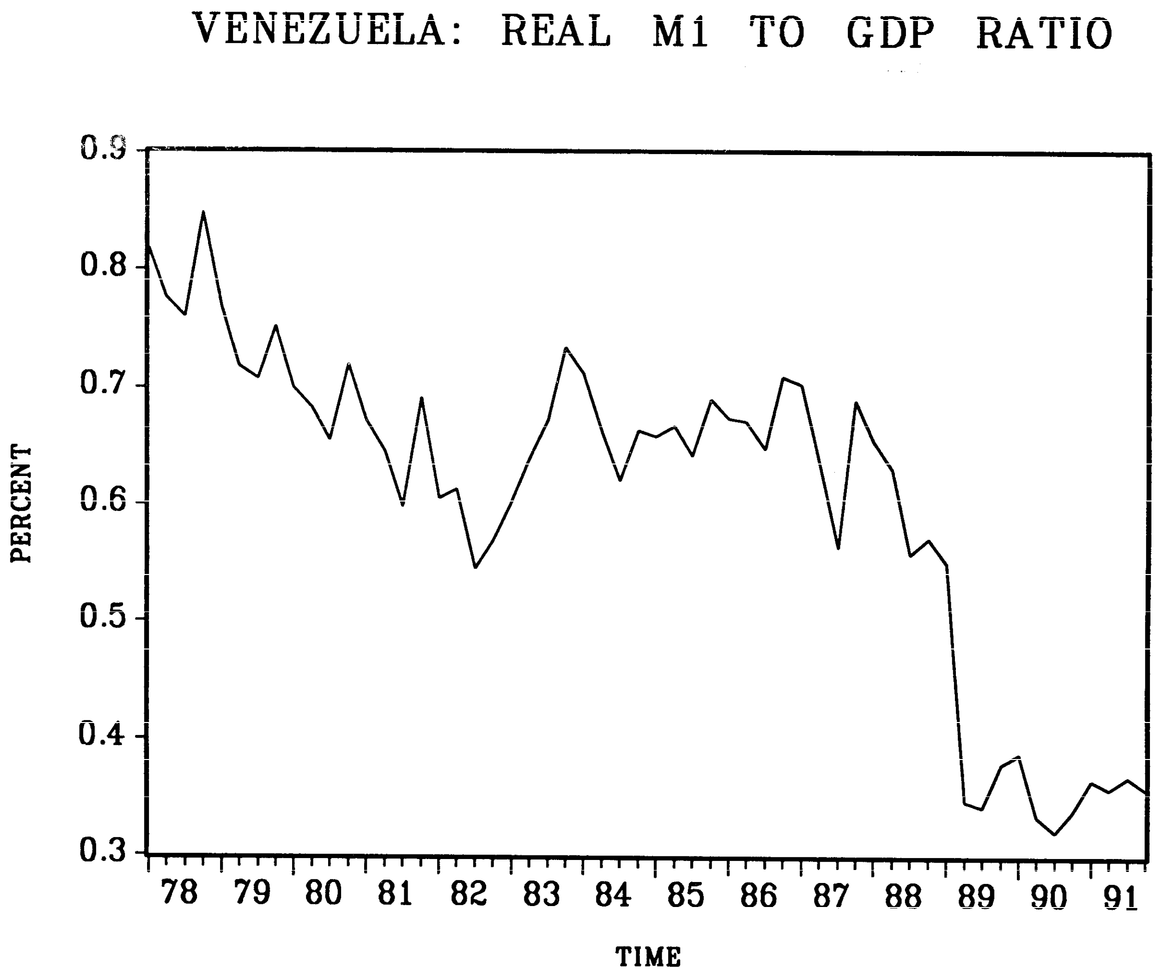

VENEZUELA: INFLATION AND REAL M1
inflation (quarterly)
35
30
25
20
15
10
5
0
m1 (billns)
100000
90000
80000
70000
60000
50000
40000
30000
78 79 80 81 82 83 84 85 86 87 88 89 90 91
inflation
M1

FIGURE 4B



Restrictions on nominal interest rates were lifted, new types of financial instruments such as savings and time deposit accounts, and new Central Bank bonds called "Bonos Zero Coupon" (or zero-coupon bonds) were introduced. The latter accounted for 55.7%, in 1990, of total flows in the gross flow of transactions in the stock market. In addition, the reserve requirements for demand deposits were unified and the role of the Central Bank as a lender of last resort was firmly established.

These reforms led to nominal interest rates of around 30% and to a strong recomposition of portfolios by agents in favor of highly liquid assets with very high returns, such as time deposits and savings certificates. In 1990 alone, time deposits and savings accounts increased at a real rate of approximately 119%. (See the Country Profile for Venezuela) This feature of the financial market reforms is not exclusive to Venezuela. All three countries introduced a wide range of new instruments with which people could save on money holdings. These new instruments create irreversibility effects on the demand for money (Piterman (1988)). This is one of the channels through which financial innovation has permanent effects on money demand.

Having looked at the financial innovation episodes in the three countries, I now turn to the estimation of the long run and short run money demand for each country. In the next section, I briefly discuss the cointegration approach to be used in the estimations.

SECTION IV.THE COINTEGRATION APPROACH

Traditional estimations of money demand have a partial adjustment specification which is estimated by OLS such as:

$$\ln m_t = \alpha_0 + \alpha_1 \ln y_t + \alpha_2 \ln \pi_t + \alpha_3 \ln m_{t-1} + \varepsilon_t \tag{3}$$

Conventional OLS analysis assumes that the error is not serially correlated and is not correlated with the regressors. More importantly, it assumes that all the regressors are either deterministic random variables or stationary. These assumptions give consistent OLS estimates and allow the use of t-statistics to determine the significance of different coefficients.

A problem arises, however, when the regressors are generated by a nonstationary process. In this case, the OLS estimates of equation (3) will not be consistent and regression results will be spurious. This implies that the distribution for the t and F statistics will diverge as the sample size increases giving incorrect critical values (Phillips (1986)). In order to estimate the long and short run demand for money correctly and be able to draw inferences on the elasticities, we must use the cointegration approach.

The cointegration approach deals with the case in which a linear combination of nonstationary variables is stationary. In general, a series X is integrated of order d if after differencing d times it is stationary ($X \sim I(d)$). Throughout the paper I will refer to series which are I(1) or difference stationary (d=1); that is after differencing once they are I(0). Let X_t be a vector of independent variables including a constant

$$z_t = y_t - \beta' X_t \qquad t = 1,2,3\ldots \tag{4}$$

then, if β is the vector which will make z_t stationary we say that X_t and Y_t are cointegrated with cointegration vector β (which need not be unique if X_t is multivariate). This cointegrating relation ($Y_t = \beta' X_t$) is interpreted as the long run relationship between Y and X, and z_t is known as the "equilibrium error", since it measures the degree to which the system is out of equilibrium.

Since the error is stationary, the relation between X and Y will return to the mean even though each series individually will move without that tendency. Allowance is made for the possibility of serially correlated but temporary divergences from this relationship. If X and Y are cointegrated, then OLS is the appropriate method to estimate the long run relationship among them, and the coefficient estimates will be consistent (Stock 1987). However, the test statistics will be meaningless. The long run money demand function can then be estimated by OLS if it is a cointegrating relationship.

The cointegration approach can also be used to estimate the short run demand for money. The representation theorem by Engle and Granger (1987) indicates that series which are cointegrated can be represented by an error correction model (ECM). This ECM representation corresponds to the short run relationship among these variables consistent with the long run cointegrating equation. The ECM representation is as follows:

$$\Delta y_t = a + b_j \sum_{j=1}^{k} \Delta y_{t-j} + c_j \sum_{j=0}^{k} \Delta X_{t-j} - d z_{t-1} + \varepsilon_t \tag{5}$$

where z_{t-1} is the "equilibrium error" from the cointegration equation. Since all the variables in the ECM are I(0), OLS estimation provides consistent estimates and good test statistics. In equation (5) agents marginally adjust y_t in response to lagged changes in itself and the X_t variables as well as disequilibria from the long run cointegrating equation (4). In this ECM framework, the matrix d can be interpreted as a measure of the speed with which the system corrects last period's equilibrium error. For this reason, it is usually called the adjustment matrix.

SECTION V: THE LONG RUN DEMAND FOR MONEY

The data for all the countries are quarterly from different sources. For Bolivia, the data are from 1980:1 to 1991:4 from UDAPE. The data for Israel are from the Bank of Israel from 1970:1 to 1990:4. The data for Venezuela runs from 1978:1 to 1991:4 and come from various IFS issues.[ii]

V.1 Testing for Unit Roots.

Prior to estimating the long run demand for real balances, each of the variables must be submitted to a unit root test since cointegration methods require that all the variables be I(1). To test the null hypothesis that each variable is nonstationary I ran both Dickey Fuller (DF) and augmented Dickey Fuller (ADF) tests on each of the following series: m is the log of real M1 (deflated by the CPI), y is the log of real GDP, and π is the log of the inflation rate.[iii] The general form of the test for any variable X is:

$$\Delta X_t = c + (\rho - 1) X_{t-1} + \sum_{j=1}^{k} \lambda_j \Delta X_{t-j} + \beta t + \eta_t \quad \textbf{(6)}$$

The DF test omits the summation and both of the tests are run with and without a trend. The number of lags, k, is four (4) which is common for quarterly data. To reject the null we require ρ to be significantly negative. Tables 2A to 2C show the results of the tests for the three countries.

[ii] The data for Israel were provided by Rafi Melnick from the Bank of Israel, and for Bolivia by UDAPE (Unidad de Analisis de Politicas Economicas) in La Paz.

[iii] For Venezuela, y is the log of real non oil GDP. All the series are seasonally adjusted except the inflation rate.

TABLE 2A: BOLIVIA-UNIT ROOT TESTS 1980:1-1991:4

Variable	DF(t)	ADF(t)	DF(nt)	ADF(nt)
levels				
y	-3.24	-0.63	-3.25	-0.96
π	-2.80	-2.25	-2.59	-1.90
m	-1.09	-0.88	-1.75	-1.53
1st. Difference				
Δy	---	---	-12.85	-2.50
$\Delta\pi$	---	---	-10.55	-3.25
ΔM	---	---	-7.71	-2.18
Critical Values 5%	-3.50	-3.50	-2.9	-2.9

TABLE 2B: ISRAEL-UNIT ROOT TESTS 1970:1-1990:4

Variable	DF(t)	ADF(t)	DF(nt)	ADF(nt)
levels				
y	-4.53	-4.66	-1.40	-1.97
π	-2.68	-2.49	-2.75	-2.58
m	-0.06	-1.51	-0.86	-1.74
1st. Difference				
Δy	---	---	-13.19	-3.37
$\Delta\pi$	---	---	-12.33	-4.10
ΔM	---	---	- 6.30	-2.58
Critical Values 5%	-3.50	-3.50	-2.9	-2.9

TABLE 2C: VENEZUELA-UNIT ROOT TESTS 1978:1-1991:4

Variable	DF(t)	ADF(t)	DF(nt)	ADF(nt)
levels				
y	-2.86	-3.09	-0.76	-0.39
π	-4.20	-2.54	-3.64	-1.96
m	-1.61	-1.94	-1.00	-1.09
1st. Difference				
Δy	---	---	-11.83	-3.19
Δπ	---	---	- 9.10	-5.13
ΔM	---	---	- 5.27	-3.02
Critical Values 5%	-3.50	-3.50	-2.9	-2.9

The evidence from these tests shows that we cannot reject the null hypothesis of a unit root in the levels of y, π, and m. There are a few exceptions for each country but by far the results using the ADF test show that these variables are I(1). For the first differences, all the tests reject the null at the 5% level. The exceptions in each of the cases almost always involves the DF test which is the least powerful of the two tests. Under this criterion, and taking into account the low power of these tests, I conclude that these series are nonstationary. Since the regressors of the money demand function are generated by an I(1) process, applying OLS analysis to it will lead to misleading results. The correct way to estimate the money demand function is to use the cointegration approach.

V.2 Cointegration Tests

The evidence above shows that these variables are not stationary, therefore to run OLS on a typical partial adjustment specification would not yield the appropriate coefficient estimates. To estimate a long run money demand for Bolivia, Israel, and Venezuela the following cointegration equation was estimated by OLS for each country.

$$m_t = \beta_0 + \beta_1 y_t + \beta_2 \pi_t + \mu_t \qquad \beta_1 > 0, \beta_2 < 0 \tag{7}$$

To test for cointegration (i.e. to test for the existence of a long run equilibrium relationship), I ran ADF and DF tests on μ_t (the "equilibrium error") to see if it was stationary. Line 1 of Tables 3A to 3C shows the results. The evidence for all three countries fails to reject the null hypothesis of no cointegration (i.e. that μ_t is I(1)) for all the tests. This means that equation (7) is not a stable long run money demand function for any of the three countries studied.

This result can be interpreted in terms of the model presented in Section II. If equation (1) represents the correct long run money demand function, lack of cointegration may be due to the fact that we are ignoring the role of the transactions cost variable, b. Previous papers on the demand for real balances have shown that the lack of stability can be due to "financial innovation." Where this is defined as technological, legal and institutional changes which allow people to economize on their money holdings (see Laban (1991), de Gregorio et al..(1992) and Roley (1985)). In particular, Melnick (1991) shows that for Israel, ignoring a proxy for financial services leads to the misspecification of the long run money demand function and the lack of stability. I will show that the lack of stability, as is evidenced by the lack of cointegration, of the long run money demand function in all three of these countries is due to the exclusion of a proxy for financial innovation.

If financial innovation is a relevant variable in the demand for money function, excluding it will prevent the rejection of the null hypothesis of no cointegration. Therefore, we can again have spurious regression results in equation (7).

Previously, financial innovation has been modeled as a fall in transactions costs represented by an intercept dummy (Laban 1991) or a time varying intercept (Arrau and de Gregorio 1991). In this model, I allow financial innovation to affect, *a priori*, the slope as well as the intercept of the money demand function. The effects of financial innovation are captured by a set of three dummy variables:
i) DX which is 0 prior to year X:1 and 1 thereafter
ii) DXY which is 0 prior to year X:1 and equal to y thereafter and iii) DXI which is 0 prior to year X:1 and equal to π thereafter. Where X is the year in each country sample where financial innovation occurs. In Bolivia X is 1986, in Israel it is 1987, and in Venezuela it is 1989. The modified long run money demand equation becomes:

$$m_t = \gamma_0 + \gamma_1 y_t + \gamma_2 \pi_t + \gamma_3 DX + \gamma_4 DXY + \gamma_5 DXI + \omega_t \qquad \textbf{(8)}$$

The estimated equations for each of the countries are as follows:

Bolivia

$$m_t = 17.93 - 1.46y_t - 2.93\pi_t - 43.89D87_t + 4.37D87Y_t + 2.4D87I_t \tag{9}$$

$$T=83 \qquad \bar{R}^2 = .81 \qquad DW = 1.5$$

Israel

$$m_t = 9.97 + .11y_t + .04\pi_t - 8.13D89 + .66D89Y_t + .26D89I_t \tag{10}$$

$$T=55 \qquad \bar{R}^2 = .82 \qquad DW = 1.1$$

Venezuela

$$m_t = -4.54 + 1.18y_t - .55\pi_t - 22.7D86_t + 2.14D86Y_t - .42D86I_t \tag{11}$$

$$T=47 \qquad \bar{R}^2 = .78 \qquad DW = 1.5$$

The standard errors are not reported since they have degenerate distributions. As is evident, the long run elasticities of real money balances with respect to income have the right sign, but they tend to be a bit high when compared with other estimates, except for Israel. The long run elasticities of money demand with respect to income are 2.91 for Bolivia, 0.77 for Israel, and 3.32 for Venezuela. The long run semielasticities of inflation have the right sign for both Bolivia and Venezuela, but not for Israel. These semielasticities all fall between -0.5 and -1, which is not unusual for less developed countries. The long run inflation elasticities are -0.5 for Bolivia, 0.30 for Israel, and -0.97 for Venezuela. These coefficient estimates will be consistent as long as the regressors are not cointegrated separately and the dummies are included. (See Tables 3A-3C, line 3). The R^2 are also very high and the DW statistics are fairly close to 2, indicating no serious problems with serial correlation.[11]

Line 2 of Tables 3A to 3C shows the results of the unit root tests on the equilibrium errors (ω's) of equations (9)-(11). It is clear that the dummy variables matter. For all three countries I can now reject the null hypothesis of no cointegration, which indicates that these equations provide a reasonable estimate of the long run demand for money in these countries. The evidence tends to support a downward shift, as well as a change in the slope of the long run equilibrium money demand function at the time when financial innovation occurred in these countries. All of the DX dummies come out negative and large.

Having estimated a stable long run demand for money, after taking into account financial innovation, I now estimate the short run demand for money and show how financial innovation can lead to a faster speed of adjustment of real balances to changes in its determinants.

TABLE 3A: COINTEGRATION TESTS: BOLIVIA

	DF(t)	ADF(t)	DF(nt)	ADF(nt)
1. Equation (8)	-2.5	-2.3	-2.1	-1.7
2. Equation (9)	-5.0	-2.3	-5.1	-2.3
3. Cointegration btn. y and π	-3.0	-1.7	-3.1	-1.9
Critical Values 5%	-3.5	-3.5	-2.9	-2.9

note: Four lags used for ADF

TABLE 3B: COINTEGRATION TESTS: ISRAEL

	DF(t)	ADF(t)	DF(nt)	ADF(nt)
1. Equation (8)	-3.8	-2.6	-3.7	-2.6
2. Equation (9)	-4.4	-3.5	-4.1	-2.8
3. Cointegration btn. y and π	-3.4	-2.5	-1.2	-0.75
Critical Values 5%	-3.5	-3.5	-2.9	-2.9

[11] The only exception is the regression for Israel that has a DW statistic of 1.1.

TABLE 3C: COINTEGRATION TESTS: VENEZUELA

	DF(t)	ADF(t)	DF(nt)	ADF(nt)
1. Equation (8)	-1.8	-2.4	-1.8	-2.2
2. Equation (9)	-5.0	-2.6	-5.0	-2.8
3. Cointegration btn. y and π	-3.5	-3.5	-1.8	-1.2
Critical Values 5%	-3.5	-3.5	-2.9	-2.9

SECTION VI: THE SHORT RUN MONEY DEMAND AND THE SPEED OF ADJUSTMENT: AN ERROR CORRECTION MODEL

Given the stable long run money demand which was estimated in Section V, I now turn to the estimation of the dynamic specification for real balances in the short run. Traditional studies of money demand for other countries have always used a partial adjustment approach which is relatively *ad hoc*. Salmon(1982) demonstrates that this mechanism will only reach the desired level of long run real balances if this level is constant in equilibrium, which as mentioned before is not the case when the variables are nonstationary. Additionally, Stock (1987) shows that inferences made on estimations by OLS when the lagged dependent variable is included as a regressor can lead to errors. Given these criticisms, and following the Representation Theorem by Engle and Granger (1987), I use an error correction model (ECM) to estimate the short run money demand for Bolivia, Israel, and Venezuela. This model is given by

$$\Delta m_t = \alpha_0 + \sum_{j=1}^{4} \alpha_{1j} \Delta m_{t-j} + \sum_{j=0}^{4} \alpha_{2j} \Delta y_{t-j} + \sum_{j=0}^{4} \alpha_{3j} \Delta \pi_{t-j} - \delta \hat{\omega}_{t-1} + \phi_t \tag{12}$$

Where Δ is the first difference operator, ω_{t-1} is the estimate of the "equilibrium error" from the cointegration equations (9)-(11) and ϕ_t is white noise. In order to estimate equation (12) for each of the countries in the sample, I follow the methodology employed by Hendry et al (1984). This method, of going from general to specific, applied to equation (12) implies that the equation is continuously simplified and reestimated. It is first estimated in its most general form with four lags for each variable except the error correction term. The final parsimonious representation is achieved after deleting all the insignificant variables. The results for the final version of each country's ECM are shown in Tables 4A-4C.

TABLE 4A: AN ERROR CORRECTION MODEL FOR BOLIVIA		
Dependent Var. is Δm	(1)	(2)
Regressors		
constant	0.004 (0.4)	0.008 (0.7)
Δm_{t-1}	0.43* (3.6)	0.40* (3.4)
Δm_{t-3}	0.50* (4.5)	0.51* (4.8)
Δy_t	1.6* (4.8)	1.4* (4.1)
Δy_{t-3}	-1.2* (-3.3)	-1.2* (-3.3)
$\Delta \pi_t$	-0.27* (-4.2)	-0.3* (4.42)
$\Delta \pi_{t-4}$	-0.12* (-2.5)	-0.10* (-1.9)
EC_{t-1}	-0.20* (-2.6)	-0.35 (-3.0)
DEC_{t-1}	------	-0.27** (1.7)
R^2	0.71	0.72
SSE	0.22	0.15
T	42	42

t-statistics are in parentheses, *= significant at 5%, **= significant at 10%

TABLE 4A: AN ERROR CORRECTION MODEL FOR ISRAEL		
Dependent Var. is Δm	(1)	(2)
Regressors		
constant	-0.005 (-0.8)	-0.004 (-0.7)
Δm_{t-1}	0.26* (3.9)	0.27* (4.0)
Δm_{t-3}	0.55* (3.2)	0.51* (2.9)
Δy_t	-0.84* (-9.5)	0.85* (-9.6)
Δy_{t-3}	-0.46* (-4.2)	-0.5* (-4.3)
$\Delta \pi_t$	-0.29* (-2.9)	-0.3* (-3.1)
$\Delta \pi_{t-4}$	-0.34* (-3.7)	-0.33* (-3.7)
EC_{t-1}	-0.10* (-2.9)	-0.09 (-2.7)
DEC_{t-1}	------	-0.31** (1.7)
R^2	0.69	0.69
SSE	0.17	0.16
T	79	79

t-statistics are in parentheses, *= significant at 5%, **= significant at 10%

TABLE 4A: AN ERROR CORRECTION MODEL FOR VENEZUELA		
Dependent Var. is Δm	(1)	(2)
Regressors		
constant	-0.005 (-0.7)	-0.006 (-1.0)
Δm_{t-4}	0.63* (6.2)	0.57* (6.1)
$\Delta \pi_t$	-0.96* (-5.2)	0.66* (-3.5)
EC_{t-1}	-0.29* (-3.9)	-0.16* (-2.0)
DEC_{t-1}	------	-0.52* (-3.6)
R^2	0.59	0.67
SSE	0.11	0.09
T	54	54

t-statistics are in parentheses, *= significant at 5%, **= significant at 10%

Column (1) of each table shows the error correction model for each country in its final form, after all of the insignificant variables have been eliminated. The model shows encouraging results for the short run income and inflation elasticities of money demand. For Bolivia, the short run income elasticity is 0.37, and the inflation elasticity is -0.4 which is within the range of previous studies for less developed countries. In addition, the coefficient on lagged money is about 0.92 which is consistent with other studies. For Israel, the income elasticity is 0.5 which is in line with theoretical specifications, the inflation elasticity is -1.0, and the coefficient on lagged money is about 0.3. Finally, the results for Venezuela are as follows: the inflation elasticity is approximately -0.9, and the coefficient on the lagged money term is 0.63. Since output was not a significant variable, its elasticity is not very reliable, but it is approximately 1. All the coefficients are highly significant.

Having estimated an appropriate short run money demand for these countries, I now turn to the principal question of the paper. In the model of Section II, I showed that a decline in the transactions costs, or what I have termed financial innovation, causes people to adjust their real balances faster than before. The error correction model, ECM, of equation (12) specifies that the change in m_t depends not only on the lagged values of y_t and π_t, but also on the equilibrium error that occurred in the previous period. Viewed in this error correction framework, the matrix δ, the coefficient on ω_{t-1}, can be interpreted as a measure of the speed by which the system corrects last period's equilibrium error. This is why δ is usually called the "adjustment matrix." In Tables 4A-4C, column (1) shows that the EC term is always of the right sign (i.e. it is negative) and highly significant. This implies that agents are taking into account the long run equilibrium error when adjusting their demand for real balances in the short run. When there is a positive error (i.e. when current money holdings are greater than the desired ones, $m_t > m_t^*$) in the long run equation, people will adjust their desired money balances downward.

Column (2) of Tables 4A-4C show the same ECM for each country but including an interactive dummy variable for the error correction term (DEC_{t-1}). Note that in each case the coefficient increases in absolute value, and is statistically significant. This confirms empirically what Section II sets out; that the speed of adjustment of money demand to its determinants increases when there is financial innovation. In essence, people adjust faster to deviations from the long run equilibrium relation. This makes sense since now financial institutions are more efficient and people can put their money in different assets at home.

SECTION VII: CONCLUSIONS

I have shown that financial innovation can increase the speed of adjustment of money demand to its determinants, and can lead to the instability typically found in other money demand studies. This is an aspect of the literature which has not been explored much, particularly in terms of the new cointegration methods.

Using the appropriate cointegration techniques, I have shown that by introducing a proxy for financial innovation, a stable long run money demand function can be obtained for each country. For Bolivia, Israel, and Venezuela, the empirical estimates show that the long run demand for money not only shifted down, but that in the short run the effect of financial innovation has been to increase the speed with which people adjust their actual money holdings to their desired money holdings. Viewed in the Miller-Orr transactions demand for money framework, a fall in the transactions cost variable means a shorter period in which desired money balances are not equal to the optimal money balances. The empirical evidence shows that the coefficient on the error correction variable increases in absolute value indicating that once financial innovation takes place any disequilibria between desired and actual money holdings will by eliminated faster.

REFERENCES

Arrau, Patricio, Jose De Gregorio, Carmen Reinhart and Peter Wickham, (1991), "The Demand for Money in Developing Countries: Assessing the Role of Financial Innovation," *IMF Working Paper* No.91/45

Baumol, W.J (1952), "The Transactions Demand for Cash: An Inventory Theoretic Approach," *Quarterly Journal of Economics*, 66, 545-556.

Ben-Bassat, A. and Marom, A. (1988), "Is the Demand for Money in Israel Stable? (1965-1983)," *Bank of Israel Economic Review*, N 60 (January), p.52-71.

Ben-Bassat, A. (1992), "Capital Market Reform in Israel," *Bank of Israel Economic Review*, N 65, p.17-30.

Blanchard, Olivier and Stanley Fischer, Lectures on Macroeconomics (Cambridge, Massachusetts: MIT Press, 1989).

Bruno,M and Meridor,L.R. (1991), " The Costly Transition from Stabilization to Sustainable Growth: Israel's Case," in Bruno M., S. Fischer, E. Helpman, N. Liviatan and L. Meridor eds.,Lessons of Economic Stabilization and Its Aftermath. The MIT Press

Cagan, P. (1956), "The Monetary Dynamics of Hyperinflation," in *Studies in the Quantity Theory of Money*, ed. M. Friedman, Chicago: University of Chicago Press, pp.25-117.

Campbell,J. and Perron,P. (1991), "Pitfalls and Opportunities: What Macroeconomists Should Know About Unit Roots." NBER Macro Annual 1991. M.I.T. Press.

Engle, R.F., and Granger,C.W.J (1987), "Cointegration and Error Correction: Representation, Estimation and Testing," *Econometrica*, 55, 251-276.

Engle, Robert F. and B.S. Yoo, "Forecasting and Testing Co-integrated Systems," *Journal of Econometrics*, (1987) 143-159.

Goldfeld, Stephen M., The Case of Missing Money," *Brookings Papers on Economic Activity*, (1976) 683-730.

Hafer, R. W., and Jansen, Dennis W.(1991), "The Demand for Money in the United States: Evidence from Cointegration Tests," *Journal of Money, Credit, and Banking*, Vol.23, No.2 (May 1991), 155-168.

Hendry, F.D., Pagan, A.R., and Sargan, J.D. (1984), "Dynamic Specification," in *Handbook of Econometrics* (Vol.2), eds. Z. Griliches and M.D. Intriligator, Amsterdam: North-Holland, pp. 1025-1100.

Laban, R. (1991) "Financial Innovation and the Stability of Money Demand: Evidence from Argentina and Chile," M.I.T Chapter 3 of Ph.D. thesis

Leiderman,L and Marom,A. (1988), "New Estimates of the Demand for Money in Israel," *Bank of Israel Economic Review*, N 60 (January), p.19-35.

Melnick, R.,(1988), "Two Aspects of the Demand for Money in Israel, 1970-1981," *Bank of Israel Economic Review*, N 60 (January), p.36-52.

Melnick, R., (1990), "The Demand for Money in Argentina 1978-1987: Before and After the Austral Program," *Journal of Business and Economic Statistics*, 8, N4, p427-434.

Melnick, R., (1991), "Financial Services, Cointegration, and the Demand for Money in Israel," Bank of Israel manuscript

Miller, Stephen M. (1991), "Monetary Dynamics: An Application of Cointegration and Error-Correction Modeling," *Journal of Money, Credit, and Banking*, Vol.23, No.2 (May 1991), 139-154.

Morales,J.A;(1991), "The Transition from Stabilization to Sustained Growth in Bolivia," in Bruno M., S. Fischer, E. Helpman, N. Liviatan and L. Meridor eds.,Lessons of Economic Stabilization and Its Aftermath. The MIT Press

Morales,J.A;(1988), "La Inflacion y la Estabilizacion in Bolivia," in Bruno M., G.Di Tella, R. Dornbusch, and S. Fischer eds.,Inflacion y Estabilizacion: La Experiencia de Israel, Argentina, Brasil, Bolivia y Mexico. El Trimestre Economico N.62

Offenbacher, E.K. (1988), "Empirical Studies of the Demand for Money in Israel: Introduction," *Bank of Israel Economic Review*, N 60 (January), p.1-18.

Perron, Pierre. (1988), "Trends and Random Walks in Macroeconomic Time Series: further Evidence from a New Approach," *Journal of Economic Dynamics and Control* 12 (1988) 297-332.

Phillips,Peter C.B.,(1986), "Understanding Spurious Regressions in Econometrics." *Journal of Econometrics*, N33,p.311-340.

Piterman, S. (1988), "The Irreversibility of the Relationship Between Inflation and Real Balances," *Bank of Israel Economic Review*, N 60 (January), p.72-83.

Stock, James H.(1987), "Asymptotic Properties of Least Squares Estimators of Co-Integrating Vectors," *Econometrica*, N 55, 1035-1056.

The Economist Intelligence Unit, Country Profile: Venezuela, Suriname, Netherlands Antilles. 1988-1992.

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