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Default Risk, Dollarization, and Currency Substitution in Mexico

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Preliminary, comments welcomed.

Abstract

Empirical evidence of currency substitution as measured by dollarization in Latin America usually accords with theoretical explanations [Calvo and Végh 1992 and Giovannini and Turtelboom 1993]. But some studies find anomalies. For example, Rogers (1992a and 1992b) finds that between 1978 and 1982, relative holdings of Mexdollars were negatively related to expected devaluation. The period when this effect was strongest immediately preceded the imposition of special controls on the conversion of Mexdollar deposits to currency, and the nationalization of the banks, in 1982. Accordingly, Rogers explains this phenomenon as being caused by "convertibility risk"; the convertibility or rate of return depends upon the level of reserves in the Mexican banking system. Although Mexican banks took open positions relative to their dollar accounts and other dollar denominated liabilities, these accounts were backed by reserve requirements and dollar denominated loans. The expected rate of return on Mexdollar deposits, therefore, depended on the solvency of the banking system. We investigate the often cited [Calvo and Végh 1992] but rarely tested link between dollarization, currency substitution, and bank solvency. In the Mexican case, we estimate demand equations for real peso and Mexdollar deposit demand. We find that measures of demand for Mexdollar deposits are negatively and significantly related to the share of bank loans that are overdue. As is consistent with hypotheses developed in this paper, the same cannot be said for measures of demand for peso-denominated deposits.

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Introduction

The literature on dollarization has recently moved in several new directions whose interconnections appear not to have been fully appreciated. On the one hand, Rogers (1992a and 1992b) presents econometric models that find negative and statistically significant relations between a measure of devaluation expectations and holdings of dollar-denominated accounts (Mexdollars) in Mexican financial institutions. These findings contrast with conventional theories of currency substitution, which posit that Mexicans would increase their Mexdollar holdings relative to their peso account holdings as expected devaluation increased. In explaining his counterintuitive results, Rogers relies on a "convertibility risk" argument. That is, he argues that a significant number of depositors (correctly) anticipated a breakdown of full convertibility between Mexdollars and actual dollars, and precipitated a run on Mexdollar accounts. In fact, the decline in Mexdollar deposits in the months before Mexico abridged convertibility is striking. However, while Rogers' results are consistent with the convertibility argument, he does not offer statistical tests to isolate to convertibility problems the cause of his counterintuitive results.

Moving the literature of currency substitution/dollarization in another direction, Calvo and Végh (1992) offer arguments that may not at first blush seem directly connected to Rogers' work. In a discussion of the problems an economy may have with full dollarization - in which, as in the case of Panama, a country simply uses another country's currency as its own - Calvo and Végh (1992) note that the system would be forced to operate without a lender of last resort. Calvo and Végh argue that this observation is particularly relevant if dollarization is implemented to cure a case of persistently high inflation, as was clearly the case in a number of Latin American countries in the late 1970s. Suppose the fiscal imbalance that motivated the government to inflate is not wiped out at the same time dollarization is adopted. Then banks will be under pressure to lend to the government and to enterprises that were previous beneficiaries of the revenue from inflationary money creation. As a result, "the quality of the loan portfolio held by domestic banks will tend to be poor according to international standards, a situation that could give rise to bank runs and a collapse of the financial system." [Calvo and Végh 1992:7].

Although Calvo and Végh do not discuss the issue, events bearing some similarities to their full-dollarization scenario may occur in the context of less-than-full dollarization. Not only may these events trigger the counterintuitive flight from Mexdollars that is described by Rogers, but a consideration of them may allow econometric tests to identify the process that generated this flight.

Suppose, for example, that an underlying fiscal imbalance surfaces at a time when dollar-denominated bank accounts are legal, or that a negative shock to the export sector occurs at this time. As before, the quality of the domestic banks' loan portfolio worsens. Defaults become likely and the central bank may be called upon to act as lender of last resort. Unlike the case in the Calvo and Végh (1992) paradigm, the central bank can still act as such a lender because dollarization is not complete.

Even so, a similarity to Calvo and Végh's (1992) paradigm surfaces whenever both the peso denominated debt and dollar denominated debt are issued in Mexico and dollar denominated debt is extended with the backing of Mexdollar deposits. The central bank can act as a lender of last resort to back peso-denominated deposits as long as it can print pesos, but it can act as a lender of last resort to back Mexdollars only as long as it has dollar reserves.

As a result, the process identified by Rogers may be detailed as follows. When the premium on forward pesos rises because of increased devaluation expectations, depositors would move further into Mexdollars because the dollar-denominated assets appreciate in terms of pesos in the wake of a devaluation - other things equal. But other things are not equal. Deteriorations in loan quality at the commercial banks trigger concerns over what Rogers' identifies as convertibility risk.

These deteriorations suggest that dollars sufficient to compensate nervous depositors may not be forthcoming in the form of repayments from borrowers. Since dollars are not flowing to businesses, the central bank will not be accumulating reserves either. As a result, agents who wish to hold dollars express their desires through other financial instruments than Mexdollar deposits, or hold cash dollars. That is, growth in the share of bad loans may be expected to dampen the demand for Mexdollars. Conversely, because the central bank can continue to serve as lender of last resort for deposits in the national currency, growth in the share of problem loans should not negatively affect the real level of peso deposits.

If this modification of Calvo and Végh's (1992) paradigm accurately characterizes the process that motivates Rogers' (1992a and 1992b) results, then the insertion of a measure of bank loan quality in Rogers' Mexdollar demand equations not only ought to have significant results, but the counterintuitive coefficient on the devaluation expectations variable ought then to take on the conventional sign. However, including a measure of bank loan quality into a similar money demand equation - but one for peso-denominated deposits - should **not** show that an increasing share of bad loans dampens demand for peso deposits.

We find that the insertion of a measure of bank loan quality into Rogers' dollarization model gives a result that is consistent with the arguments provided above. That is, when the left-hand-side variable is the real value of Mexdollar deposits in the Mexican banking system, the insertion of a ratio of past-due loans (cartera vencida) to overall loans (cartera total) as a right-hand-side variable takes on the expected negative sign and that - in contradistinction to Rogers' results, the forward premium takes on the conventionally expected positive sign. Moreover, in an equation that characterizes demand for peso accounts, the ratio of cartera vencida (as a right-hand-side variable) takes on a positive sign.

Justification from an Optimizing Framework

The following model is a variant of Calvo and Végh (1991). Consumers maximize consumption over an infinite horizon consuming a traded and non-traded good

$$\int_0^\infty e^{-\beta t} u(c_t^T, c_t^{NT}) dt \qquad (1)$$

Let e = EP^T/P or the real exchange rate, m = M/EP^T or real holdings of domestic currency deposits expressed in foreign currency prices of tradable goods, and f = F/P^T or real holdings of foreign currency deposits where E is the nominal exchange rate, P is the domestic price of non-traded goods, P^T is the foreign price of traded goods, M is the nominal amount of domestic currency deposits held by domestic residents, and F is the amount of foreign currency deposits held by domestic residents.

The first constraint is a liquidity in advance constraint. We assume that liquidity services are produced in accordance with a linearly homogeneous production function in m and f.

$$C_t^T + \frac{C_t^{NT}}{e_t} \leq l(m_t, (1 - \Theta)f_t), \quad l_1, l_2 > 0,\ l_{11}, l_{22} < 0,\ l_{12}, l_{21} > 0 \tag{2}$$

where Θ is the proportion of non-performing loans to total loans. Here we assume for simplicity that the central bank fully backs peso deposits but does not guarantee dollar deposits at all. $(1-\Theta)$ is the proportion of dollar deposits individuals expect to redeem at any point in time.

The second constraint defines the stock of assets available at any one time, a_t. We assume that individuals hold only foreign and domestic currency deposits.

$$a_t = m_t + (1 - \Theta)f_t \tag{3}$$

Finally, the intertemporal budget constraint is

$$a_o + \int_0^\infty e^{-rt}\left(\left(\frac{y_t^{NT}}{e_t}\right) + y_t^T - \left(\frac{c_t^{NT}}{e_t}\right) - c_t^T - \varepsilon m_t - \Theta f_t\right)dt = 0 \tag{4}$$

where ε is the (expected) rate of nominal depreciation of the domestic currency.

Maximizing equation (1) subject to equations (2), and (4) over consumption of traded and non-traded goods and holdings of domestic and foreign currency accounts (assuming r = ß) yields the following first order conditions.

$$\frac{1}{c_t^T} - \lambda_1 + \lambda_2 = 0 \tag{5}$$

$$\frac{1}{c_t^{NT}} - \frac{\lambda_1}{e_t} + \frac{\lambda_2}{e_t} = 0 \tag{6}$$

$$-\lambda_1 \varepsilon - \lambda_2 l_1 = 0 \tag{7}$$

$$-\lambda_1 \Theta - \lambda_2 (1-\Theta) l_2 = 0 \tag{8}$$

in addition to the constraints (2) and (4). Here, λ_1 is the Lagrange multiplier associated with constraint (4) and λ_2 is the Lagrange multiplier associated with constraint (2).

We can combine equations (5) through (8) to generate the following relationships

$$\frac{1}{c_t^T} = \lambda_1\left[1 + \frac{\varepsilon}{l_1}\right] \tag{9}$$

$$\frac{c_t^{NT}}{c^T} = e_t \qquad (10)$$

$$\frac{(1 - \Theta)\varepsilon}{\Theta} = \frac{l_1}{l_2} \qquad (11)$$

Equation (9) shows that consumers equate the marginal utility of tradable goods consumption to the shadow price of wealth multiplied by a measure of the price of tradable goods [Calvo and Végh 1991:14]. This price has two components: 1) the money price (= 1) plus the cost of producing liquidity services to buy one unit of the good (= ε/l_1). Equation (10) has consumers equating the marginal rate of substitution in consumption between tradable and non-tradable goods equal to the relative price of tradables. A further discussion of the properties of the standard outcomes of optimizing models can be found in Calvo and Végh (1991 and 1992).

The interesting result for our purposes, however, is contained in equation (11). This equation says that consumers equate the marginal rate of transformation in liquidity services to the relative price of each currency adjusted for the rate of insolvency of the banking system. Differentiating equation (11) with respect to Θ yields

$$\frac{\partial m}{\partial \Theta} = -\frac{\left[\frac{\varepsilon l_2^2}{\Theta^2} + f_t(l_{22}l_1 - l_{12}l_2)\right]}{\left[l_{11}l_2 - l_{12}l_1\right]} \qquad (12)$$

$$\frac{\partial f}{\partial \Theta} = -\frac{\left[\frac{\varepsilon l_2^2}{\Theta^2} + f_i(l_{22}l_1 - l_{12}l_2)\right]}{(1 - \Theta)\left[l_{12}l_2 - l_{22}l_1\right]} \tag{13}$$

Increases in the perceived insolvency of the banking system do not have an unambiguous effect on the demand for domestic and foreign currency deposits. However, two considerations should be kept in mind from equations (12) and (13). The first is that the effect on the demand for pesos of an increase in insolvency is always opposite to that of pesos. Mathematically, this stems from the fact that the numerators of equations (12) and (13) are the same and the denominators have opposite sign. That is, the denominator of equation (12) is everywhere negative and the denominator of equation (13) is everywhere positive. Second, if the direct effect on liquidity of an increase in insolvency - the first element of the numerator - dominates the secondary effects on liquidity - the second term, individuals will shift out of foreign currency deposits into domestic currency deposits if the solvency of the banking system deteriorates. We find this outcome to be the most plausible.

Differentiating equation (11) with respect to ε yields the usual results that an increase in expected devaluation decreases holdings of domestic currency deposits and increases holdings of foreign currency deposits. Here the denominator of equation (14) has a negative value while the denominator of equation (15) is positive.

$$\frac{\partial m}{\partial \varepsilon} = \frac{(1 - \Theta)}{\Theta} \frac{l_2^2}{\left[l_{11}l_2 - l_{21}l_1\right]} < 0 \tag{14}$$

$$\frac{\partial f}{\partial \varepsilon} = \frac{l_2^2}{\Theta\left[l_{12}l_2 - l_{22}l_1\right]} > 0 \tag{15}$$

Notice that increases in insolvency increase the sensitivity of demand for assets to changes in expected devaluation. Of course, to explore the full implications of this specification, we would need to model the banking sector, and the central bank and government to endogenously determine Θ. However, this would exceed the scope of this paper and is left to further research.

An Econometric Specification

The model of money demand we estimate is based upon those of Cuddington (1983), Branson and Henderson (1985), and Rogers (1992) and is consistent with the optimizing framework above. We assume that all assets held by individuals are imperfect substitutes. Domestic residents can hold a number of assets including domestic currency and foreign currency, domestic and foreign currency denominated accounts in the domestic banking system, domestic and foreign currency denominated domestic bonds, foreign bonds and deposits. Again, we focus on the demand for domestic (peso) and dollar currency (Mexdollar) bank accounts created by the Mexican banking system.

The demand for real peso balances takes the form[1]

$$\frac{M}{P} = m(\varepsilon,\ i,\ i_{mx} + \varepsilon,\ i^* + \varepsilon,\ y,\ f_1(\Theta))$$

$$m_1 < 0,\ m_2 < 0,\ m_3 < 0,\ m_4 < 0,\ m_5 > 0,\ m_6 > 0 \qquad (16)$$

$$g_1' > 0,\ m_6 g_1' > 0$$

where M is the value of peso (non-interest bearing) demand deposits, P is the price level, i is the 90-day Mexican Treasury Bill or CETES rate, i_{mx} is the three month dollar interest rate on Mexdollar accounts (assumed equal to zero), ε is the expected rate of depreciations, i^* is the three-month U.S. Treasury Bill Rate, y is industrial production in Mexico, Θ is the ratio of non-performing to total loans in the Mexican Banking system, and $g_1(\Theta)$ is a function which translates the non-performing loan ratio into individual perceptions of how much of the principal they will recover in the event of a systemic insolvency problem in the banking system. The sign of this function for peso deposits is indeterminate; it is a choice variable whose value is established by the Bank of Mexico's willingness to guarantee peso deposits. Underlying this function is a game, between the banks and the Bank of Mexico, that involves serious time consistency problems. Although Mexico did not have a deposit insurance scheme in this period, the strength of the time inconsistency of not backing peso deposits probably would render the sign of g_1' positive. We assume this to be the case.

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[1]A number of assumptions are implicit in these formulations. See Rogers (1992b) for an exposition starting from a full set of portfolio balance relationships.

The demand for real Mexdollar deposits is

$$\frac{EM^*}{P} = m^*(\varepsilon,\ i,\ i_{mx} + \varepsilon,\ i^* + \varepsilon,\ y,\ g_2(\Theta))$$

$$m_1^* < 0,\ m_2^* < 0,\ m_3^* > 0,\ m_4^* < 0,\ m_5^* > 0,\ m_6^* > 0 \tag{17}$$

$$g_2 < 0,\ m_6^* g_2^{\prime} < 0$$

where M^* are Mexdollar balances in dollars and E is the exchange rate (pesos/dollar).

The derivative of the expected percentage of principal regained in the event of a banking crisis for Mexdollars, g_2', is assumed to be negative in contrast to that for peso deposits. The Bank of Mexico can act fully as a lender of last resort in the case of pesos because it can create pesos. But the Bank of Mexico cannot create dollars and its ability to back Mexdollars in the case of a financial crisis depends upon its dollar reserves and its ability to accumulate them with exchange rate and monetary policies.

A semi-log formulation of these two equations is

$$\ln\left(\frac{M}{P}\right) = a_1\varepsilon + a_2 i + a_3\ln(y) + a_4\Theta \tag{18}$$

$$\ln\left(\frac{EM^*}{P}\right) = b_1\varepsilon + b_2 i + b_3\ln(y) + b_4\Theta \tag{19}$$

Most studies take the difference between equations (18) and (19) and then estimate the following equation

$$\ln\left(\frac{M}{P}\right) - \ln\left(\frac{EM^*}{p}\right) = (a_1 - b_1)\varepsilon + (a_2 - b_2)i + (a_3 - b_3)\ln(y) + (a_4 - b_4)\Theta \quad (20)$$

Estimating equation (20) instead of equations (18) and (19) would not allow us to identify the separate effects of systemic banking problems on the demand for each of these assets. Hence, we will estimate using a error-correction cointegration framework equations (18) and (19). Hence, we first test for the orders of integration and cointegration and then test the long-term and short-term determinants of the demand for each of these assets.[2]

Integration and Cointegration: The Demand for Real Pesos and Mexdollars

The data span January 1978 to October 1985, the opening and closing of forward peso trading in New York, for M, P, i, y, ε, E, and M^* measured in logarithms, and come from the Bank of Mexico's Indicadores Economicos. Expected depreciation, ε, is measured as the percentage difference between the three-month forward rate on pesos in New York and the spot rate. The proportion of non-performing loans (cartera vencida) to total loans in the Mexican banking system was calculated using data from the Comision Nacional Bancaria's Boletín Estadistico.[3]

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[2]We do not include the foreign interest rate i^* in the estimations. Its exclusion does not change the results in any significant way.

[3]Because of an accounting change in 1983, a dummy variable is used to control for the once and for all shift in measurement of non-performing loans in the estimation below.

Augmented Dickey-Fuller tests on the levels and first differences of the data appear in Table 1 with trend. All series contain a unit root but are stationary after first differencing.

The fact that the series are endogenous variables and are I(1) implies that for equilibrium in the markets for pesos and Mexdollars to hold, real pesos and Mexdollars must be cointegrated with variables on the right hand side of equations (3) and (4).[4] The long-term relationship corresponds to the cointegrating relationship(s) while the short-term dynamics bring the variables back to the long-term relationship after some type of shock. The natural way to estimate the dynamics is to identify the cointegrating vectors and then estimate the short-term dynamics in an error-correction specification [Engle and Granger 1987].

We use the maximum likelihood technique of Johansen (1988) and Johansen and Juselius (1990). It entails estimating the following error-correction representation of the (px1) vector time series X_t

$$\Delta X_t = \alpha \beta' X_{t-k-1} + \Gamma_1(L)\Delta X_{t-1} + \Gamma_2(L)\Delta X_{t-2} + \ldots + \Gamma_{k-1}(L)\Delta X_{t-k} + \mu + \varepsilon_t \quad (21)$$

where ß' is the cointegrating vector, $\alpha$is the error-correction coefficient, μ is a trend, and the Γ_i describe the short-term dynamics of the system.

We focus on identifying the long-term cointegrating relationships in this section while we leave estimation of the short-term dynamics to the next section. The

[4]Full scale structural specifications of an economy wide model may imply more than one cointegrating relationship exist.

cointegrating vector ß' is obtained by solving the following eigenvalue problem

$$|\lambda S_{kk} - S_{ko}S_{oo}^{-1}S_{ok}| = 0 \quad \textbf{(22)}$$

where S_{ij} are the residual moment matrices from the OLS regressions of ΔX_t and X_{t-k} on ΔX_{t-j}, i= 0, k and j = 1, ..., k-1. The estimated ß' corresponds to the matrix of eigenvectors while the (maximum) eigenvalues and their sum, i.e. the trace, are used to test the rank of the matrix $\Pi = \alpha\beta'$. The rank of Π corresponds to the number of independent cointegrating vectors r. Notice that if Rank(Π) = r = p, any vector is a cointegrating vector because the original series X_t is stationary. If Rank(Π) = r < p, then the series is I(1) and r cointegrating vectors exist. If Rank(Π)=r=0, no cointegrating vectors exist and a VAR based purely upon first differences describes the full dynamics of the system.

Tables 2 and 3 present tests for the number of cointegrating vectors for real peso deposit demand and real Mexdollar demand. The trace tests show at least two cointegrating vectors for real peso demand and at least three cointegrating vectors for real Mexdollar demand, while the maximum eigenvalue tests show two cointegrating vectors for real peso demand and three for real Mexdollar demand.

These tables also report the point estimates of the components of ß' and α for the largest eigenvalue and use likelihood ratio tests to see if they are significantly different from zero. All the coefficients of the ß's are significantly different from zero while all the α's are significantly different from zero except possibly the α for the real peso equation (0.05 < p-value < 0.1).

The estimated long-run relationships are as follows:

$$\ln\left(\frac{M}{P}\right) = -88.31\varepsilon - 8.57i - 0.53\ln(y) + 0.24\Theta \qquad (23)$$

$$\ln\left(\frac{EM^*}{P}\right) = 94.55\varepsilon + 0.256i - 8.95\ln(y) - 1.38\Theta \qquad (24)$$

In the long run, an increase in the non-performing loan ratio increases real peso demand and decreases real dollar deposit demand while an increase in expected devaluation decreases real peso demand and increases real dollar deposit demand. These results, therefore, account for the strange behavior found by Rogers (1992a and 1992b). Controlling for changes in non-performing loans restores the expected relationship between expected depreciation and the demand for real peso and Mexdollar deposits.

Short-Term Dynamics

Tables 4 and 5 present the results for single-equation error-correction estimates.[5] All the coefficients of the variables in each of the equations have expected signs but some are not significantly different from zero. For example, changes in peso interest rates, Δi,

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[5]Since all the α's are significantly different from zero none of the variables are weakly exogenous except perhaps real peso deposits [Johansen 1992a and 1992b and Ericsson 1992]. Because of the lack of sufficient weak exogeneity, estimating the parameters, in this case only the α's and Γ's, in a single equation context will produce inefficient results as the parameters are not variation free. These estimates, however, are still consistent and the results accord with the long term results reported above.

are only marginally significant at the fourth lag while changes in expected devaluation, ε, do not significantly affect real peso demand.[6]

On the other hand, the coefficients central to our hypothesis, namely the ones corresponding to the ratio of non-performing to total loans in both demand equations and expected devaluation the demand for real Mexdollars, are significantly different from zero and have the expected signs. Increases in the non-performing loan ratio, all else equal, cause an increase in real peso demand and a decrease in real Mexdollar demand. We argue in detail in the conclusion that this reflects the difference in the willingness and ability of the Bank of Mexico to back these assets as a lender of last resort. Also, increases in expected rates of devaluation significantly increase the demand for real Mexdollar balances contrary to the findings of Rogers (1992a and 1992b) but in accordance with most theories of currency substitution.

Conclusion

We have hypothesized that the mechanics that underlie Mexdollar depositors' concerns about convertibility risk [Rogers (1992a and 1992b] may involve an amended version of Calvo and Végh's (1992) lender-of-last-resort hypothesis. While Calvo and Végh's hypothesis encompasses regimes where full dollarization is operative, the

[6]Calvo and Végh (1992:18) and Thomas (1985) argue that in reasonably efficient financial markets, optimizing models imply a specification that includes either foreign and domestic interest rates or expected devaluation but not both. We did not want to make *a priori* assumptions about Mexican's abilities to borrow in pesos at a reasonable cost. Hence, the more general specification chosen here. The fact that interest rates do not show major significance in the short-term gives some credence to the optimizing specification for Mexico.

amended hypothesis accounts for regimes in which a domestic currency is still the legal medium of exchange but Mexdollar deposits are encouraged to serve as "insulation from the outflow of short-term capital." [Rogers (1992b; 188]. Here, the central bank can serve as a lender of last resort for peso-denominated accounts as long as it can create pesos. But this same central bank cannot create dollars. Accordingly, the central bank's ability to serve as a lender of last resort to cover dollar-denominated accounts lasts only as long as it has enough dollar reserves to commit to the process and the willingness to commit them. As a result, increasingly poor Mexican bank loan quality in a period like that of the late 1970s and early 1980s could have been expected to have a significantly negative effect upon the demand for Mexdollar accounts **but not upon the demand for peso-denominated accounts**. These last are implicitly covered by the central bank's peso lender-of-last resort function.

If the role of deteriorating loan quality has been accounted for in an equation that characterizes the demand for Mexdollars in such a period, then a variable (in the same equation) designed to capture devaluation expectations should take on the conventional positive sign. That is, other things equal, depositors may be expected to increase their demands for Mexdollars as expected devaluations increase. If our amended lender-of-last-resort hypothesis is correct, then adding statistical considerations of deteriorating loan quality should be tantamount to taking account of other-things-equal considerations. In sum, a fuller specification of a demand-for-Mexdollars equation should have allowed the equation to capture the conventional wisdom of dollarization theory.

These considerations are all confirmed by the model. Although our Mexdollar model is of the same construct as that of Rogers (except for our addition of the loan quality variable), and covers the same observation period that his does, the devaluation expectations variable in our Mexdollar demand equation takes on the expected positive sign, while it is negative in Rogers' model.

In addition, the sign taken on by our deteriorating loan quality variable (cartera vencida divided by cartera total) is negative and significant in the Mexdollar demand equation, but is actually positive in the peso account demand equation. These results are consistent with the version of the lender-of-last-resort hypothesis that we offer.

The results may also shed some light on another anomaly observed in countries with high inflation and currency substitution: in many cases, dollarization increases after inflation and exchange rates are stabilized.[7] In our view, if stabilization brings an improvement of banking sector health, the necessity of the central bank to act as a lender of last resort also should diminish,thus allowing for an expansion of dollar liabilities. Needless to say, further theoretical and empirical work is necessary.

Still, we hope that our model has enriched understanding of the mechanics underlying the convertibility risk phenomenon so gracefully characterized by Rogers (1992a and 1992b). We also hope that this model has helped to clarify some of the implications that central bank capacity and commitment may have for the phenomenon of dollarization.

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[7]Melvin and Ladman (1991), Melvin and Fenske (1992), and Clements and Schwartz (1992) document this phenomenon for Bolivia and Rodriguez (1992) documents it for Argentina and Peru,

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Table 1
Mexico: Tests of a Unit Root and Time Trend 1986:3-1990:2

a. Null Hypothesis: Variable has a Unit Root	
	Augmented Dickey-Fuller Test[a] Rho-Test
Variable	with time trend
ln(M/P)	-7.91
ln(EM*/P)[b]	-13.97
ε[b]	-17.90
i	-8.24
ln(y)	-7.99
Θ[b]	-1.825
Δln(M/P)	-52.86***
Δln(EM*/P)[b]	-44.03***
$\Delta\varepsilon$[b]	-167.25***
Δi	-61.59***
Δln(y)[b]	-89.59***
$\Delta\Theta$[b]	-227.34***

Notes:

(a) Four lags for levels and two lags for changes were used in these tests of stationarity for all variables. The lag structure was chosen by adding lags until the Q(21) statistic did not reject the null hypothesis of autocorrelated residuals. The test results were not sensitive to the choice of lag length.

(b) Variable significantly violates normality assumption either because of skewness or kurtosis using the tests developed in Jarque and Bera (1980).

Table 2

Mexico: Test for number (r) of Cointegrating Vectors

Real Peso Balances, Expected Devaluation, Output, Interest Rates, Non-performing Loans

[M/P, ε, ln(y), i, θ]

TRACE TESTS	H_o:r=0 H_1:r=5	H_o:r=1 H_1:r=5	H_o:r=2 H_1:r=5	H_o:r=3 H_1:r=5	H_o:r=4 H_1:r=5
test statistic	99.23***	58.53***	29.884	14.144	0.003
MAXIMUM EIGENVALUE	H_o:r=0 H_1:r=1	H_o:r=1 H_1:r=2	H_o:r=2 H_1:r=3	H_o:r=3 H_1:r=4	H_o:r=4 H_1:r=5
test statistic	40.70***	28.65**	18.74	14.14	0.003
UNRESTRICTED ESTIMATES	β_{rpeso}	β_{ε}	β_{lny}	β_{i}	β_{θ}
	1.000*** ($\chi^2_{(4)}$=25.98)	88.31*** ($\chi^2_{(4)}$=27.61)	0.53*** ($\chi^2_{(4)}$=21.37)	8.567*** ($\chi^2_{(4)}$=20.20)	-0.24*** ($\chi^2_{(4)}$=18.26)
	α_{rpeso}	α_{ε}	α_{lny}	α_{i}	α_{θ}
	-0.025* ($\chi^2_{(4)}$=8.565)	-0.005*** ($\chi^2_{(4)}$=24.93)	-0.012*** ($\chi^2_{(4)}$=23.50)	0.005*** ($\chi^2_{(4)}$=15.36)	0.083*** ($\chi^2_{(4)}$=18.29)

Notes: (a) Four lags were used in these tests of stationarity. The lag structure was chosen by adding lags until the Q(12) statistic did not reject the null hypothesis of non-autocorrelated residuals.

** signifies rejection of H_o at a 5% significance level, *** signifies rejection of H_o at a 1% significance level.

Table 3
Mexico: Test for number (r) of Cointegrating Vectors
Real Mexdollar Expected Devaluation, Output, Interest Rates, Non-performing Loans
[EM^*/P, ε, l(y), i, Θ]

TRACE TESTS	H_o:r=0 H_1:r=5	H_o:r=1 H_1:r=5	H_o:r=2 H_1:r=5	H_o:r=3 H_1:r=5	H_o:r=4 H_1:r=5
test statistic	134.32***	76.252***	37.798**	9.961	0.865
MAXIMUM EIGENVALUE	H_o:r=0 H_1:r=1	H_o:r=1 H_1:r=2	H_o:r=2 H_1:r=3	H_o:r=3 H_1:r=4	H_o:r=4 H_1:r=5
test statistic	58.68***	38.454**	27.837**	9.096	0.865
UNRESTRICTED ESTIMATES	β_{rmxd}	β_ε	β_{lny}	β_i	β_Θ
	1.000*** ($\chi^2_{(4)}$=26.90)	-94.55*** ($\chi^2_{(4)}$=29.33)	8.95** ($\chi^2_{(4)}$=10.44)	-0.256*** ($\chi^2_{(4)}$=20.31)	1.38*** ($\chi^2_{(4)}$=33.154
	α_{rmxd}	α_ε	α_{lny}	α_i	α_Θ
	-0.073*** ($\chi^2_{(4)}$=13.70)	0.002*** ($\chi^2_{(4)}$=16.98)	-0.017*** ($\chi^2_{(4)}$=20.72)	-0.014*** ($\chi^2_{(4)}$=24.94)	0.176*** ($\chi^2_{(4)}$=28.46)

Notes: (a) Six lags were used in these tests of stationarity. The lag structure was chosen by adding lags until the Q(12) statistic did not reject the null hypothesis of non-autocorrelated residuals.

** signifies rejection of H_o at a 5% significance level, *** signifies rejection of H_o at a 1% significance level.

Table 4
Mexico: Regressions for Real Peso Money Demand Growth $\Delta\ln(M/P)$

Variable	Parameter Estimate	Variable	Parameter Estimate	Variable	Parameter Estimate
Constant	-0.795*** (2.45)	EC_{-5}	-0.09*** (-2.72)	DUM(1983:1)	0.06 (0.128)
$\Delta\ln(M/P)_{-1}$	-0.60*** (-4.45)	$\Delta\varepsilon_{-1}$	-5.52* (-1.43)	Δi_{-1}	-0.497 (-0.424)
$\Delta\ln(M/P)_{-2}$	-0.12 (-0.75)	$\Delta\varepsilon_{-2}$	-3.08 (-0.82)	Δi_{-2}	0.95 (0.68)
$\Delta\ln(M/P)_{-3}$	-0.13 (-0.91)	$\Delta\varepsilon_{-3}$	-0.357 (0.113)	Δi_{-3}	0.30 (0.205)
$\Delta\ln(M/P)_{-4}$	-0.04 (-0.42)	$\Delta\varepsilon_{-4}$	-4.38 (0.99)	Δi_{-4}	2.12* (1.31)
$\Delta\ln(y)_{-1}$	-0.82 (-.82)	$\Delta\Theta^{(b)}_{-1}$	0.21*** (5.05)		
$\Delta\ln(y)_{-2}$	-0.55 (-0.44)	$\Delta\Theta^{(b)}_{-2}$	0.04 (0.87)		
$\Delta\ln(y)_{-3}$	-1.62* (1.33)	$\Delta\Theta^{(b)}_{-3}$	0.085** (1.735)	$Q_{(21)}$	14.1
$\Delta\ln(y)_{-4}$	0.95*** (0.98)	$\Delta\Theta^{(b)}_{-4}$	0.10** (2.05)	R^2	0.868

Notes: (a) t-statistics with 52 degrees of freedom appear in parentheses under the parameter estimates.

Table 5
Mexico: Regressions for Real Mexdollar Money Demand Growth $\Delta \ln(EM^*/P)$

Variable	Parameter Estimate	Variable	Parameter Estimate	Variable	Parameter Estimate
Constant	0.27 (0.32)	EC_{-7}	-0.008 (-0.42)	DUM(1983:1)	-0.37 (-0.61)
$\Delta \ln(EM^*/P)_{-1}$	-0.35^{***} (-2.37)	$\Delta \varepsilon_{-1}$	16.7^{***} (3.44)	Δi_{-1}	1.86 (1.20)
$\Delta \ln(EM^*/P)$-2	0.116 (0.76)	$\Delta \varepsilon_{-2}$	9.296^{*} (1.60)	Δi_{-2}	-0.79 (-0.47)
$\Delta \ln(EM^*/P)$-3	0.192 (1.27)	$\Delta \varepsilon_{-3}$	-4.25 (0.75)	Δi_{-3}	0.39 (0.21)
$\Delta \ln(EM^*/P)$-4	0.098 (0.65)	$\Delta \varepsilon_{-4}$	4.43 (0.73)	Δi_{-4}	-4.47^{**} (-1.755)
$\Delta \ln(EM^*/P)$-5	-0.17 (-1.22)	$\Delta \varepsilon_{-5}$	12.24^{**} (2.27)	Δi_{-5}	2.54 (0.94)
$\Delta \ln(EM^*/P)$-6	-0.73 (-0.71)	$\Delta \varepsilon_{-6}$	4.19 (0.93)	Δi_{-6}	-0.43 (-0.17)
$\Delta \ln(y)_{-1}$	0.72 (0.52)	$\Delta \Theta^{(b)}_{-1}$	-0.249^{***} (-4.23)		
$\Delta \ln(y)_{-2}$	0.43 (0.299)	$\Delta \Theta^{(b)}_{-2}$	-0.02 (-0.25)		
$\Delta \ln(y)_{-3}$	0.87 (0.67)	$\Delta \Theta^{(b)}_{-3}$	-0.007 (-0.10)	$Q_{(21)}$	14.1
$\Delta \ln(y)_{-4}$	-2.43^{**} (-1.755)	$\Delta \Theta^{(b)}_{-4}$	-0.004 (0.06)	R^2	0.805
$\Delta \ln(y)_{-5}$	0.84 (0.598)	$\Delta \Theta^{(b)}_{-5}$	0.058 (0.829)		
$\Delta \ln(y)_{-6}$	0.866 (0.71)	$\Delta \Theta^{(b)}_{-6}$	0.0175 (0.267)		

Notes: (a) t-statistics with 42 degrees of freedom appear in parentheses under the parameter estimates.

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