DEPARTAMENTO DE ECONOMIA
PUC/RJ
Janeiro de 1988

TEXTO PARA DISCUSSÃO
Nº 186

CURRENCY SUBSTITUTION AND POLITICAL RISK: MÉXICO 1978-82

Pedro Bodin de Moraes[1]
Luis Serven

1. The authors are from Catholic University of Rio de Janeiro, Brazil, and FEDEA, Madrid, Spain. We wish to thank R.Dornbusch, P. Krugman, L.Taylor, and L.Telles for helpful comments and suggestions on an earlier version of this paper. Financial support from the Bank of Spain, CNPq-Brazil, and the Ford Foundation is gratefully acknowledged. Any remaining errorrs are our own.

1. Introduction

The issue of currency substitution has attracted a great deal of attention in recent years. This is undoubtedly due to its important implications for the design of both monetary and exchange rate policies. Individuals' increased ability to finance transactions without the use of domestic currency (the so-called 'dollarization') may undermine monetary control and independence, increase the sensitivity of domestic prices to foreign disturbances, and reduce the collection of seignorage by the government[2]. In addition, persistent episodes of dollarisation can lead to balance of payments crises.

The Mexican experience of the late seventies is a good example of this situation. During this period, Mexico combined unrestricted capital mobility with a formally floating - but practically fixed - exchange rate policy. An outstanding feature of the Mexican financial system was the existence of domestically issued assets denominated in dollars (mexdollars). The latter provided a mechanism that absorbed short-term capital flows without endangering the central bank's stock of foreign reserves.

---

[2] Girton and Roper (1981) discuss the effects of currency substitution.. See also Miles (1978) and Cuddington (1983).

Over the years, the evolution of the mexdollar/peso mix in investors' portfolios was a good indicator of the public's confidence in the sustainability of the exchange rate. By 1981, as runaway fiscal deficits reduced the publics' confidence in the sustainability of the exchange rate, the shift to mexdollars accelerated. However, the governments' repeated failure to adopt the necessary adjustment measures led in 1981-82 to massive capital flight, adding a new dimension to the problem: the political risks perceived by the public were now the dominant factor behind this different type of dollarization. These circumstances eventually led in August of 1982 to the elimination of the mexdollar system and the introduction of exchange controls.

The Mexican case is therefore of particular interest because it combines two types of dollarization: one due to devaluation expectations, that should result in shifts away from peso denominated assets, and another due to political risk factors, that should give way to shifts out of both pesos and mexdollars and into (true) dollars only.

We empirically analyze these issues in a currency substitution framework. We construct and test a simple three-currency model that allows us to distinguish both types of dollarizations, and apply it to the holdings by Mexican residents of peso, mexdollar, and U.S. dollar denominated demand deposits. The empirical results are very supportive of our approach; the

model seems to satisfactorily explain the events described above. An important conclusion is the finding of a significant degree of substitutability between the three alternative monies to which Mexican investors had access, contrary to results recently reported by Ortiz (1982).

The remainder of the paper is organized as follows. Section 2 briefly describes the evolution of the Mexican economy in the late seventies and the events that led to the financial crisis of 1982. The model is discussed in section 3. Section 4 describes the data set employed in the estimation of the model. Empirical results are reported in section 5. Finally, some concluding remarks appear in section 6.

2. The Mexican economy, 1977-1982

The year 1982 was critical for the Mexican economy. The country suffered one of its worst economic and political crises, that led to a massive real depreciation of the peso and to the introduction, for the first time in Mexico's modern history, of a system of exchange controls. Real GDP fell also for the first time in five decades, while the request by the Mexican authorities of a moratorium in their foreign debt payments ignited the Latin American debt crisis.

The behavior of the economy in 1982 contrasts sharply with its performance in the previous years. As shown in Table 1, during 1977-81 real GDP grew at an average annual rate above 7 percent, fueled by runaway public spending well above the increased revenues granted by the oil bonanza of the seventies. The public deficit expanded steadily to reach gigantic proportions in 1981-82, financed to a large extent by growing foreign indebtedness. Meanwhile, the peso was becoming increasingly overvalued. As a result, the current account gap gradually widened.

Table 1

Mexico:
Selected economic indicators, 1977-82

Years	1977	1978	1979	1980	1981	1982
Real GNP[a]	3.4	8.2	9.2	8.3	7.9	-0.5
Public deficit[b]	6.8	6.7	7.3	7.5	14.5	17.9
Current account[c]	-2.0	-2.6	-3.6	-3.9	-5.2	-1.7
Capital flight[d]	.0	-.1	.7	-3.6	-8.3	-8.3

Notes:
[a] Annual rate of growth
[b] As percentage of GNP
[c] As percentage of GNP
[d] Errors and omissions of the Balance of Payments, billion of dollars.

Source: Banco de Mexico

When the oil market started weakening in the second half of 1981 and world interest rates rose to historically high levels - adding substantial weight to the burden of foreign debt - the public sector failed to adopt the necessary adjustment measures. Stimulated by the inconsistency of the policies being pursued, speculation against the peso reached sizeable proportions, both in terms of 'dollarization' (see below) and in terms of capital flight.

The gestation of the crisis of 1982 can be better understood by looking at the developments that took place in Mexican financial markets during this period. For several decades, the Mexican banking system had offered to domestic investors deposits denominated in dollars (mexdollars). In an environment of unrestricted capital mobility, the mexdollar market provided an effective insulation device from short-term capital flows, absorbing a large part of the pressure that otherwise would have affected the foreign exchange market during times of financial turmoil, as in the months immediately before and after the 1976 devaluation. Mexdollars offered investors an alternative to U.S. dollars (or other foreign currencies) held abroad. From 1977 on, interest rates on mexdollar deposits were pegged at a two percent premium to the Eurodollar rates. The premium was later reduced and finally eliminated in November of 1978, and thus the returns on dollar and mexdollar assets became identical except for political uncertainty factors[3].

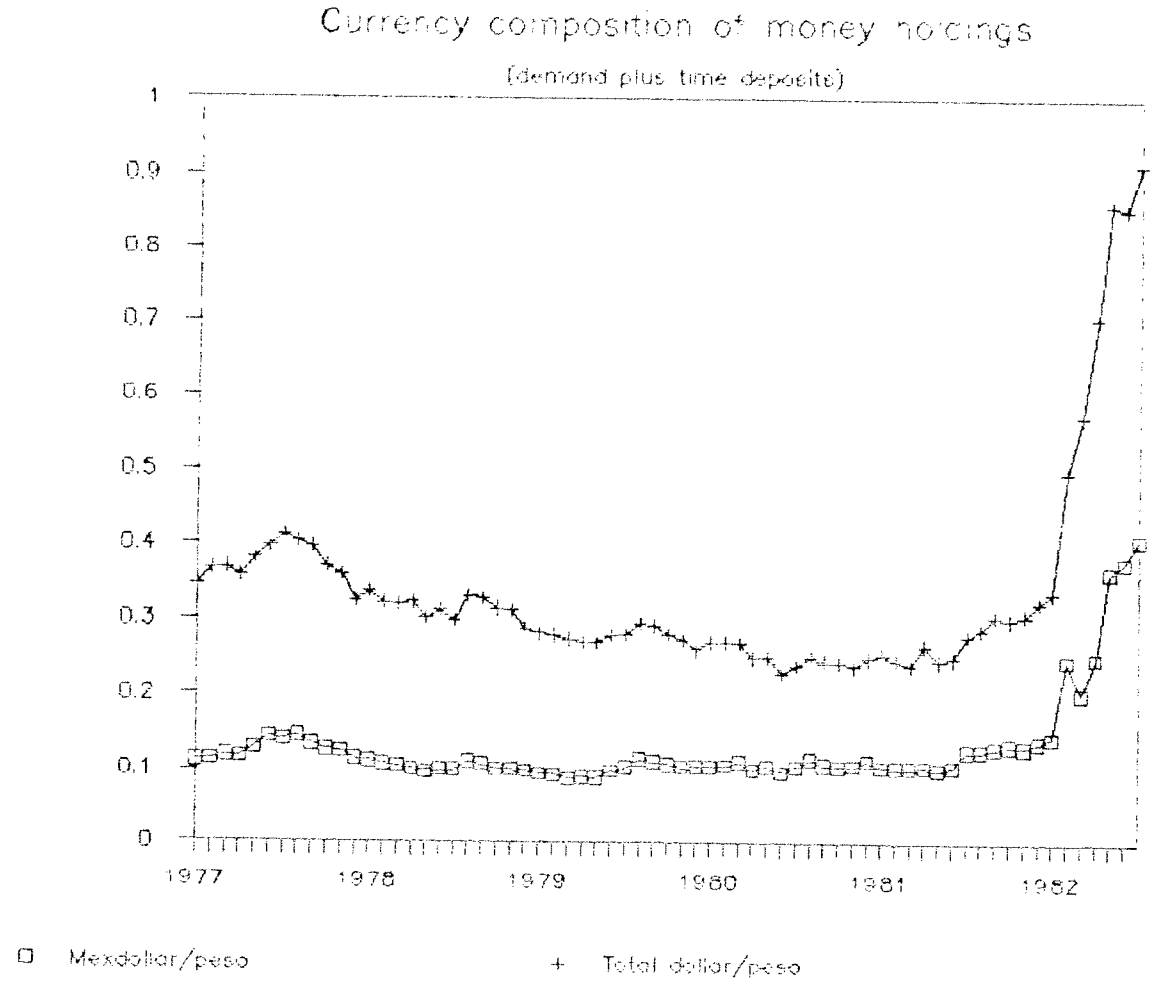
---

[3] A good historical description of the mexdollar system can be found in Ortiz (1982). See also Ize (1981) and Ortiz and Solis (1982).

This system worked quite well for years. The degree of 'dollarization' - that is, the share of dollar denominated deposits in the total deposits of the banking system - became an indicator of the public's confidence in the course of economic policy. As Figure 1 shows, dollarization kept a roughly stable profile from 1977 until the first half of 1981, declining at first from the high levels reached in the 1976 crisis and slowly rising after 1977. As the economic environment deteriorated in late 1981 and confidence in the policy being pursued weakened, dollarization accelerated. Capital flight also acquired sizeable proportions. Eventually, the peso was devalued 65 percent in February of 1982, and the government announced the adoption of an austerity program. However, the inability of the public sector to follow the proposed measures became immediately apparent, as reflected by the substantial wage increases granted during the first quarter of 1982 (30 percent in January plus an additional 34 percent in March). The financial environment continued to worsen; most notably, massive capital flight was now associated with a stagnant or decreasing degree of dollarization (see Figure 1). As emphasized by Ize and Ortiz (1983, 1987), the political uncertainty factor became so strong that it dominated exchange rate considerations, inducing the private sector to transfer the bulk of its assets abroad. The mexdollar market had ceased to serve its purpose, and the authorities - fearing a generalized run on mexdollars that would have exhausted the stock of foreign

reserves - eventually decreed in August of 1982 the inconvertibility of mexdollar deposits and the establishment of exchange controls.

Figure 1


Currency composition of money holdings
(demand plus time deposits)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1977
1978
1979
1980
1981
1982
Mexdollar/peso
Total dollar/peso

The generalized shift of investors into foreign assets held abroad despite the availability of mexdollar deposits is a remarkable feature of the final months of the mexdollar market, that reveals a substantial change in the political risks perceived by the public. While a thorough analysis of this phenomenon is beyond the scope of this essay, we shall briefly mention two of the explanations - not mutually exclusive - that have been proposed. It has been argued that the private sector may have foreseen oncoming social and political turmoil, as the government's postponement of the required austerity measures was in fact making the eventual adjustment more costly[4]. Alternatively, the growing budget deficit of the public sector may have triggered off expectations of default on its domestic debt commitments[5], eventually leading to a speculative attack on the stock of foreign reserves[6].

3. A model of currency substitution

---

[4] This view is emphasized by Ize and Ortiz (1983, 1985), who actually take the level of the real wage as an indicator of the degree of adjustment required and, therefore, of the expected political turmoil.

[5] See Blanco and Garber (1986) and Ize and Ortiz (1987).

[6] Another indication of the public's perception of political uncertainty is provided by the persistent rumors that spread in 1982, according to which punitive measures against the domestic assets of Mexican investors who held assets abroad were being considered by the authorities.

A number of empirical facts have contributed to raise the interest in the currency substitution problem. With the generalized adoption of flexible exchange rates, the expected return on foreign currency holdings is typically nonzero, giving investors a speculative - or hedging - motive to hold foreign money. As pointed out by some authors, this may render conventional money demand equations unstable. In addition, several Latin American countries - including, in particular, Mexico - have experienced important episodes of 'dollarization' or, in other words, substantial increases in the degree to which real and financial transactions are actually performed in dollars relative to those performed in domestic currency[7]. Our purpose in this section is to develop a simple model that can be used to explain the evolution of the dollarization process in Mexico in recent years, as well as the shift away from domestic assets that led to the financial crisis of 1982.

Several approaches have been used to model the currency substitution phenomenon. A number of studies (e.g., Marquez (1987) Miles (1978), Miles and Stewart (1980), Saurman (1983)) directly postulate a 'money services production function' or a transactions technology and study the money portfolio decision in isolation from other financial choices. These models, however, have been

---

[7] This is the definition provided by Ortiz (1982).

criticized because they may tend to exaggerate the magnitude of currency substitutability (see e.g. Cuddington (1982, 1983) and Thomas (1985)). More recently, some authors have reexamined the issue of diversification across monies from a broader perspective by introducing a transactions technology in conventional dynamic portfolio balance models. Along this line, Stulz (1984) and Thomas (1985) conclude that, if individuals are allowed to borrow in all currencies, then their optimal holdings of each money are independent of the degree of risk aversion and of the asset composition of their overall portfolio. In other words, the construction of the optimal portfolio of net assets is a separate problem from that of the selection of the optimal holdings of the alternative monies. The basic rationale behind this result is that since money is held only for transactions purposes, agents can retain the transaction services that money of a certain denomination provides without bearing the associated exchange (or purchasing power) risks by borrowing in that same currency. A key assumption for this result to hold is that individuals be allowed to issue liabilities (e.g., bonds) in each currency having exactly the same risk characteristics as the associated money. As long as this condition is met, the relative holdings of each money are just determined by relative holding costs, while the degree of currency substitutability - or, more precisely, the elasticity of relative currency balances with respect to relative holding costs - depends only on the characteristics of the transactions technology. Simple transactions-based models may therefore provide

a better approximation than portfolio-balance models to the currency substitution problem.

The model that we develop below follows the transactions-based approach to currency substitution. Throughout we adopt a two-currency framework; extension of the analysis to the n-currency case is straightforward.

We consider an individual who selects his/her optimal holdings of domestic and foreign currencies in order to minimize transactions costs. The transactions technology is described by a function $T(Y, M/P_y, EM^*/P_y)$, where T and Y denote respectively real transaction costs and the real volume of transactions to be carried out, M and M^* are nominal holdings of domestic and foreign currency, E is the exchange rate, and nominal currency holdings have been divided by the transactions deflator (P_y). It is assumed that $dT/dY > 0$, $dT/d(M/P_y) < 0$, $dT/d(EM^*/P_y) < 0$ and that T is convex in $(M/P_y, EM^*/P_y)$ for given Y. The representative individual minimizes T subject to the constraint

$$(1) \qquad M(1+R)/(1+r) + EM^*(1+R)/(1+r^*) \leq M_0$$

where R denotes the interest rate at which the individual can borrow, and r and r^* represent the expected rates of return on domestic and foreign currency holdings, respectively. The basic rationale behind equation (1) is given by Miles (1978): if the

amounts M and EM* are borrowed in order to be held as money balances, the total money assets that the individual must hold in order to repay the loan at the end of the period will be given by (1). The optimal values of M and M* are thus determined by maximizing the savings in transaction costs that can be attained with a given amount of total money holdings M_0. Hence, the representative individual solves the problem

$$\begin{aligned} &\text{Min} \quad T(Y, M/P_y, EM^*/P_y) \\ &\text{s.t.} \quad M(1+R)/(1+r) + EM^*(1+R)/(1+r^*) \leq M_0 \end{aligned}$$

The corresponding first order conditions for an interior solution are simply:

$$\begin{aligned} (2) \qquad & dT/dM + \tau(1+R)/(1+r) = 0 \\ & dT/d(EM^*) + \tau(1+R)/(1+r^*) = 0 \end{aligned}$$

or, more compactly,

$$(3) \qquad (dT/dM)/(dT/d(eM^*)) = (1+r)/(1+r^*)$$

In order to arrive at an expression suitable for empirical use, we specialize the transactions technology to

$$(4) \qquad T = AY^{\alpha} \left[k(Y)(M/P)^{-\beta} + k^*(Y)(EM^*/P)^{-\beta} \right]^{1/\beta}$$

which closely resembles the specification adopted by Marquez (1987), Miles (1978),or Stulz (1984). It should be noted that all these studies implicitly impose separability of the transactions technology in Y and (M/P,EM*/P), which effectively implies that relative marginal efficiencies are independent of the transactions volume. Hence this assumption automatically rules out the possibility of different fixed and/or marginal transaction costs for the different currencies, which a priori does not appear too implausible. If the assumption does not hold in reality, then the optimal relative holdings of the two currencies would depend on the volume of transactions carried out. Omission of this effect in empirical work would lead to inconsistent estimates.[8] In view of these facts, we choose to retain the flexibility of the specification in (4) without imposing separability. Using (4) together with (3), defining $\sigma = 1/(1+\beta)$ and after some manipulation we get

$$(5) \qquad \ln (EM^*/M) = \sigma \ln(k^*(Y)/k(Y)) + \sigma \ln((1+r^*)/(1+r))$$

In (5) the degree of substitutability between domestic and foreign currency is given by σ (the elasticity of substitution), while their relative efficiency in reducing transaction costs is

---

[8] This is in fact one of the arguments offered by Bordo and Choudri (1982) to show that Miles' (1978) empirical model is misspecified; in their estimation results they find a significant association between the relevant transactions variable and the currency composition of money holdings in Canada.

measured by $k^*(Y)/k(Y)$. Hence if both currencies are easily substitutable in the transactions process, $k(Y)$ and $k^*(Y)$ should be relatively close, and σ should be a large number. We shall further assume that $k(Y) = kY^g$, $k^*(Y) = (1-k)Y^{g^*}$. With these modifications, we have:

$$(6) \qquad \ln(EM^*/M) = \sigma\ln[(1-k)/k)] + \sigma(g^*-g)\ln(Y) + \ln[(1+r^*)/(1+r)]$$

Note that if for a given k we have that $g > g^*$, then the relative transactions efficiency of domestic currency increases with the volume of transactions, and therefore the composition of money holdings will tend to shift towards domestic currency as transactions grow. The opposite would happen for $g < g^*$. Separability would in turn amount to $g = g^*$, and $\ln(Y)$ would cancel in (6).

Finally, to concentrate in our problem, we extend (6) to the case in which individuals have access to three currencies: domestic currency (pesos), domestically issued dollars (mexdollars), and (true) dollars. Using p, md, and d to distinguish them, we rewrite in (7) the alternative pairings of the first-order conditions (3):

$$(7a) \qquad \ln(D/MD) = \ln[(1- k_{md} - k_p)/k_{md})] + \sigma(g_d - g_{md})\ln(Y) + \ln[(1 + r_d)/(1 + r_{md})]$$

$$(7b) \qquad \ln(ED/P) = \ln[(1- k_{md} - k_p)/k_p)] + \sigma(g_d - g_p)\ln(Y) + \ln[(1 + r_d)/(1 + r_p)]$$

$$(7c) \qquad \ln(EMD/P) = \ln(k_{md}/k_p) + \sigma(g_{md} - g_p)\ln(Y) + \ln[(1 + r_{md})/(1 + r_p)]$$

where now P, MD and D stand for peso, mexdollar and dollar holdings, respectively.

We still have to specify the returns r_i that investors anticipate on their holdings of currency i. For narrow definitions of the respective monies, the nominal interest rate paid on holdings of either currency can be taken to be zero. Therefore, the expected yield on dollars (in terms of pesos) is just given by the anticipated rate of depreciation of the peso. On the other hand, the expected return on domestically issued dollars depends on people's beliefs about the central bank's commitment to free convertibility of domestic into true dollars. As long as this commitment is fully believed, the anticipated returns on both types of dollars will be the same. However, if it is believed that with some probability the central bank may not honor its domestic dollar liabilities - or, equivalently, that a tax or partial default may be levied on holdings of domestic dollars - then the expected return on the latter will be diverge form the anticipated rate of depreciation of the peso. In addition, the expected nominal return on both domestic assets is affected by the perception of political uncertainty that can be modeled similarly as the anticipation with nonzero probability of a one-time tax on peso and mexdollar holdings. In summary, we have:

$$(8a) \qquad r_{p,t} = -\theta_{p,t}$$

$$(8b) \qquad r_{md,t} = ({}_t e_{t+1} - e_t) - \theta_{md,t}$$

$$(8c) \qquad r_{d,t} = ({}_t e_{t+1} - e_t)$$

where $\theta_{i,t}$ is the expected one-time tax (or equivalent fiscal measure) on holdings of currency i that investors anticipate as of period t, we have defined $e = \ln E$, and $_te_{t+1}$ is the expectation held at time t of the one-period ahead value of the log of the exchange rate. Note that an increase in the anticipated rate of exchange depreciation would, ceteris paribus, cause a shift in the composition of investors' money holdings towards both domestically issued dollars and (true) dollars, while an increase in G_p and G_{md} should result in a move away from domestic assets and into (true) dollars only. Our model can therefore allow for two different types of 'dollarization' processes.

4. Data

We estimate our model using monthly data from May 1978 until July 1982. While the terminal date is dictated by the disappearance of the mexdollar market, the starting date is given by the unavailability of data on Mexican private holdings of U.S. dollars abroad before May 1978.

All the data series are seasonally unadjusted. For this reason, seasonal dummies were included in the relative money

demand equations. All variables are expressed as end of period values. The data sources are described in the Data Appendix.

In order to keep homogeneity in the definition of the money holdings variables, and since no data on Mexican holdings of U.S. currency outside banks is available, the model is estimated using the ratio of demand deposits denominated in the respective currencies as the relevant measure of the dependent variable. Thus, holdings of U.S. dollars by Mexicans are measured by the demand deposits of unaffiliated Mexican residents in chartered U.S. banks. This variable excludes deposits held by the Mexican government and its agencies. Peso and mexdollar holdings are given by the respective volumes of demand deposits in the Mexican banking system.

The volume of transactions would perhaps be best described by real GDP, as conventionally assumed. Given its unavailability on a monthly basis, we adopted the industrial production index as an alternative.

To arrive at a measure of investors' anticipated rates of return on domestic assets, we need a measure of the political and/or default risks on pesos and mexdollars perceived by the public (i.e., the θ variables in equations (8)), that in principle are unobservable. However, in view of the discussion in section 2, it seems reasonable to assume that the major shift in asset

holders' perceptions took place when the unwillingness of the public sector to adjust its finances (or to reduce real wages) became patent, thus increasing the expected social and political costs of the eventual adjustment. Hence, we use two dummy variables taking a value of one after the wage increases of January and March 1982 respectively to provide a crude measure of the changes in perceived political risks. Note that this imposes identical timing (but allows for different magnitudes) on the effects of political risks on the expected rates of return of pesos and mexdollars.

In addition, the return on mexdollars has to be adjusted to reflect the developments in the mexdollar market. As described above, prior to November of 1978 interest rates on mexdollar deposits of different maturities were set by the authorities at a premium above the corresponding eurodollar rates. Because demand deposits in different currencies can be regarded to some extent as complementary with other less liquid deposits of the same denomination, a dummy that takes a value of 1 prior to November 1978 was included in the equations that involve mexdollar holdings.

Finally, to compute the anticipated return on dollar denominated assets a series for the future expected spot rate is needed. One common procedure is to take the futures peso/dollar exchange rate in the Chicago market. However, for most of our

sample period trade in peso futures only involved four different maturities per year, which prevents the use of futures prices in a monthly model like ours. Instead, we follow a different procedure and assume that investors' expectations of the rate of exchange depreciation are formed rationally. Hence, anticipated depreciation can be represented by its actual value plus a stochastic disturbance that should be uncorrelated with any information known when expectations were formed.

5. Empirical results

In view of the discussion in the previous section, the structural model of equations (7) and (8) can be rewritten in compact notation as

$$(9a)\quad \ln(D_t/MD_t) = a_1 + \sigma(g_d - g_{md})\ln(Y_t) + b_1 DLIB + c_1 DRISK1 + d_1 DRISK2 + \epsilon_{1t}$$

$$(9b)\quad \ln(E_t D_t/P_t) = a_2 + \sigma(g_d - g_p)\ln(Y_t) + \sigma(e_{t+1} - e_t) + c_2 DRISK1 + d_2 DRISK2 + \epsilon_{2t}$$

$$(9c)\quad \ln(E_t MD_t/P_t) = (a_2 - a_1) + \sigma(g_{md} - g_p)\ln(Y_t) + \sigma(e_{t+1} - e_t) - b_1 DLIB + (c_2 - c_1)DRISK1 + (d_2 - d_1)DRISK2 + (\epsilon_{2t} - \epsilon_{1t})$$

where DLIB is a dummy for the liberalisation of the mexdollar market and equals zero after November 1978; DRISK1 and DRISK2 are two dummy variables equal to zero prior to January and March 1982 respectively; and the ϵ_{it} are random disturbances with mean zero.

Since e_{t+1} in equations (9) is potentially correlated with the random disturbance term (which includes the expectational error incurred by individuals when predicting next period's

exchange rate), an instrumental variable procedure must be employed to estimate the model. We use the generalized method of moments developed by Hansen (1982), which explicitly imposes in the sample the theoretical orthogonality conditions between the multivariate error term and the set of predetermined variables, and allows also for conditional heteroscedasticity of the disturbances. Letting Z, X and y denote the matrices of instruments (i.e., the variables assumed orthogonal to the disturbances) and predetermined variables, and the vector of endogenous variables respectively, the asymptotically efficient estimator is given by

$$b = (X'Z\ \Omega^{-1}\ Z'X)^{-1}\ X'Z\ \Omega^{-1}\ Z'y$$

where Ω is the optimal weighting matrix. In practice, Ω is replaced by a consistent estimate defined by

$$\Omega = (1/T) \sum_{t} [Zt'\,ut\,ut'\,Zt]$$

where the ut are the residuals obtained from a preliminary (inefficient) estimate of b.

Obviously, the three asset demand equations (9) are not linearly independent, since any one of them can be written as a linear combination of the other two. The covariance matrix of the three-equation model is therefore singular, and we may arbitrarily

drop one equation for estimation purposes[9]. Notice that the cross-equation restriction that the two estimates of σ obtained from equations (9b) and (9c) be the same is equivalent to the restriction that expected depreciation not appear in equation (9a). Rejection of this restriction (in any of these alternative forms) could be a symptom of model misspecification.

Preliminary experiments showed that lagged effects of income and exchange depreciation could not be ruled out, a fact that should not be surprising with monthly data. We replaced both variables by simple averages of current and lagged values (two for income and four for exchange depreciation) that were not rejected by the data. We also found that the best specification for the political risk effect was given by DRISK2-DRISK1. This may indicate that a major cause for the loss of confidence in the domestic financial system - or, more precisely, in the ability of the government to honor its domestic debt commitments - was the concession of additional wage increases (with the associated deterioration of the public deficit) in March of 1982, over and above the recent January raises and in the midst of increasing external difficulties for the Mexican economy.

---

[9] However, the estimates thus obtained may not be invariant to the choice of which equation to exclude. To avoid this problem, we used an iterative procedure (see e.g. Berndt and Savin (1975)) for our system estimates.

In Table 2 we report single equation estimates of (9a) and (9b). Equation (9a) was estimated by OLS, and the estimated covariance matrix was corrected for heteroscedasticity (White (1980)). Equation (9b) was estimated by GMM, using the residuals from a preliminary 2SLS estimation to construct the weighting matrix. As additional instruments we used four lags of the rate of depreciation of the peso, the current and two lagged values of the premium in the futures market (available only quarterly) and a three-month average of the real exchange rate (computed with Mexican and U.S. industrial price indices). Both equations included also twelve seasonal dummies. It can be seen that all the variables carry the theoretically correct signs, and are also significant with the exception of the liberalization dummy. The point estimate of the elasticity of substitution in equation (9b) is about .4 and highly significant. The estimated income coefficients clearly indicate the nonseparability of the transactions technology, and suggest that - as should be expected - both pesos and mexdollars are preferable to dollars held abroad as a transactions instrument.

Despite the simplicity of the model, more than two thirds of the variance of each dependent variable are accounted for, and there is no indication of serial correlation of the residuals. We also report Hansen's J statistic for testing the overidentifying restrictions in equation (9b), which under the null hypothesys of a correct specification is asymptotically distributed as a Chi-

squared with 8 degrees of freedom. The test gives no sign of misspecification.

System GMM estimates of equations (9a) and (9b) are reported in Table 3. On the whole, the results appear rather satisfactory and supportive of our theoretical specification. All variables are highly significant, and again there is no sign of serial correlation of the residuals[10]. The point estimate of the elasticity of substitution is somewhat lower than in the single-equation results (0.39 vs. 0.42), but still shows clear evidence of currency substitability. The short-run elasticity of substitution is about .08.

While in the single equation estimates the hypothesis of equal (in absolute value) income coefficients seems acceptable, in the system estimates it is clearly rejected (chi-square = 12.7 with one degree of freedom). This in turn implies that the mexdollar/peso ratio is positively related to income, even though in principle one would expect pesos to be a better transactions instrument. While this result could be due the excessive simplicity of our transactions technology, we believe that it may arise from the fact that our transactions variable is also a proxy for wealth, with which the mexdollar/peso mix is likely to be positively correlated.

---

[10]We computed the first twenty autocorrelations of the residuals of each equation. None of them was significantly different from zero. The same result was obtained with the single equation residuals.

The estimated coefficients on the risk dummies suggest that the dramatic loss of confidence in the domestic financial system at the beginning of 1982 led to a sizeable shift out of pesos and mexdollars and into (true) dollars. In fact, we can verify that the shift from mexdollars was stronger, since our estimates indicate that the mexdollar/peso ratio was negatively affected by the perceptions of increased political risk[11]

As a further check on the specification of the model, we reestimated the first equation by GMM including the current and four lagged values of the rate of depreciation of the peso, and tested the exclusion of these additional variables. Notice that the rejection of this hypothesis would imply different values of σ in (9b) and (9c). The test yielded a chi-square statistic with five degrees of freedom and a computed value of 7.25, thus failing to reject the null hypothesis of a unique σ.

Finally, we also report in Table 3 two statistics for testing the model's global specification. The first is Hansen's J statistic for the test of the overidentifying restrictions. Again we cannot reject the validity of the instruments used in the estimation of the model. The second corresponds to a Hausman test

---

[11] The null hypothesis that DRISK does not appear in (9c) leads to a chi-square statistic with one degree of freedom and computed value of 6.7.

of the single versus the simultaneous equation estimates, and under the null hypothesis of a correct specification is distributed as a chi-square with 6 degrees of freedom. It also fails to reject the null hypothesis.

Table 2

Single Equation Estimates

	Equation 1[a]		Equation 2[b]	
	estimate	stand. error	estimate	stand. error
DRISK[c]	-0.568460	0.054921	0.468344	0.048170
DLIB	0.018151	0.039881	-	-
Y	0.703780	0.186718	-0.809064	0.162907
PREM	-	-	0.420073	0.026950
R^2	0.693989		0.674867	
DW	1.848173		1.900018	
Q(20)	19.045221		17.906398	
J(8)			11.549159	

R^2 is computed as 1-SSR/SST, DW is the Durbin Watson statistic, Q is the Box-Pierce statistic with the number of degrees of freedom in parentheses, and J is Hansen's statistic for testing the overidentifying restrictions with the number of degrees of freedom in parentheses. Twelve seasonal dummies were also included among the regressors.

Notes:
[a] OLS estimates. Standard errors are heteroscedasticity consistent.
[b] Generalized method of moments (GMM) estimates.
[c] DRISK is defined as DRISK2-DRISK1 (see text).

Table 3

System Estimates

	Equation 1		Equation 2	
	estimate	stand. error	estimate	stand. error
DRISK[a]	-0.509346	0.038518	0.423362	0.027901
DLIB	0.071851	0.012612	-	-
Y	0.912668	0.082297	-0.721592	0.098805
PREM	-	-	0.387717	0.012978
R^2	0.633296		0.675420	
DW	1.806833		1.907762	
Q(20)	16.126228		13.931583	
J(16)	19.892582			
H(6)	7.623740			

R^2 is computed as 1-SSR/SST, DW is the Durbin Watson statistic, Q is the Box-Pierce statistic with the number of degrees of freedom in parentheses, J is Hansen's statistic for testing the overidentifying restrictions with the number of degrees of freedom in parentheses, and H is Hausman's test statistic. Twelve seasonal dummies were also included among the regressors.

Notes:
[a] DRISK is defined as DRISK2-DRISK1 (see text).

6. Concluding remarks

Until the crisis of 1982, one outstanding feature of the Mexican financial system was the existence of locally issued dollar-denominated assets (mexdollars) in a context of unrestricted capital mobility. Mexdollars were intended to provide a safeguard against speculative attacks on the central bank's reserves in times of financial turmoil. Changes in devaluation expectations were reflected in changes in the degree to which real and financial transactions were carried out in dollars instead of pesos. However, the availability of mexdollars did not avoid the massive shift into foreign assets that developed in 1982, leading to the introduction - for the first time in Mexico's modern history - of capital controls and to a partial default of the central bank on its mexdollar liabilities.

We use a currency substitution framework to empirically analyze the dollarization process in Mexico. We start from an optimization model in which individuals are allowed to hold multiple currencies to reduce transaction costs, with alternative currencies being characterized by their different transactions efficencies and pecuniary returns. The model's first order conditions provide testable implications for the pattern of relative currency holdings as function of relative returns and transactions efficiencies.

Our treatment differs from previous empirical models of currency substitution in two important respects. First, we use a three-currency structural model which includes pesos, mexdollars, and dollars held abroad in the currency menu available to individuals. Second, and more important, we are able to distinguish between two types of dollarization processes: shifts into dollars - both true and/or locally issued - due to anticipations of exchange depreciation, and shifts into true dollars only, due to perceptions of political or default risk on domestic assets.

The model is then estimated using Mexican data for 1978-82. The results are very supportive of the theoretical specification. In particular, a significant elasticity of substitution between holdings of the three alternative currencies is found, in sharp contrast with results reported by Ortiz (1982). We also find reasonable characteristics for the implied transactions technology. The model is subject to a battery of specification tests that reveal no sign of misspecification.

While our representation of political uncertainty is admittedly crude, our empirical model does capture the basic limitation of the mexdollar mechanism: it was useful as a protective device against capital flight as long as the central bank's commitment to unrestricted convertibility was fully

believed. When the public lost confidence in this commitment, massive capital flight developed, leading to the collapse of the mexdollar system.

This also suggests that the issuance of foreign-denominated liabilities by the domestic authorities may serve its insulating purpose against transitory balance of payments difficulties, but cannot avoid the effects of long-run inconsistent policies. In the long run, mexdollars (or similar devices) just offer the authorities an added possibility to redistribute the costs of the eventual adjustment through a default on their domestic liabilities denominated in foreign currency.

Data Appendix

P - Peso demand deposits in the Mexican banking system. Source: Banco de Mexico.

MD - Dollar demand deposits in the Mexican banking system. Source: Banco de Mexico.

D - U.S. dollar demand deposits held by private nonaffiliated Mexican residents in U.S. chartered banks. Source: U.S. Treasury Bulletin.

Y - Mexico industrial production index. Source: Banco de Mexico.

E - Peso/Dollar exchange rate. Source: IFS.

f - Three-month forward peso/Dollar exchange rate. Source: IMM Yearbook.

References

Berndt, Ernst. T., and E. Savin (1975) "Estimation and Hypothesis Testing in Singular equations Systems with Autoregressive Disturbances", Econometrica 43, pp. 937-57.

Blanco, Herminio and Peter M. Garber, (1986) "Recurrent devaluation and the timing of speculative attacks", Journal of Political Economy 94, pp 148-166.

Bordo, Michael D. and Ehasan U. Choudri (1982) "Currency substitution and the demand for money: some evidence for Canada", Journal of Money, Credit and Banking 14, pp. 48-57.

Cuddington, John T. (1982) "Currency substitution: a critical survey from a portfolio balance perspective", Federal Reserve Bank of San Francisco Conference Supplement Economic Review, pp 37-63.

_____, 1983, "Currency substitution, capital mobility and money demand", Journal of International Money and Finance 2, pp. 111-135.

Girton, Lance and Don Roper (1981) "Theory and implications of currency substitution", Journal of Money, Credit and Banking 13, pp. 12-30.

Hansen, Lars P. (1982) "Large sample properties of generalized method of moments estimators", Econometrica 50, pp. 1029-1054.

Ize, Alain (1981) "Estabilizacion y sustitucion de activos en un sistema financiero con dos monedas y con expectativas de devaluacion", mimeo.

_____ and Guillermo Ortiz (1983) "Riesgo politico, sustitucion de activos y la dinamica de la tasa de cambio", mimeo.

_____ (1985) "The exchange rate and stabilization policies in Mexico: 1983-1985", mimeo.

_____ (1987) "Fiscal rigidities, public debt and capital flight", IMF Staff Papers, pp 311-332.

Marquez, Jaime (1987) "Money Demand in Open Economies: A Currency Substitution Model for Venezuela", Journal of International Money and Finance, vol. 6, pp. 167-178.

Miles, Marc A. (1978) "Currency substitution: perspective, implications and empirical evidence", American Economic Review 68, pp. 428-436.

_____ and Michael Stewart (1980) "The effects of risk ar return on the currency composition of money demand" Welwirtschafltliches Archiv 116, pp 613-626.

Ortiz, Guillermo (1982) "Currency substitution in Mexico: th dollarization" problem", Journal of Money, Credit and Bankin 15, pp.174-85.

_____ and Leopoldo Solis (1982) "Currency substitution and monetary independence: the case of Mexico", in J. Braga de Macedo et al., eds: The international monetary system, New York: Ballinger.

Stulz, Rene M. (1984) "Currency preferences, purchasing power risks and the determination of exchange rates in an optimizing model", Journal of Money, Credit and Banking 16, pp 303-316.

Saurman, David S. (1982) "Transaction costs, foreign exchange demands, and the expected rates of change of exchange rates", Journal of Money, Credit and Banking 14, pp. 20-32.

Thomas, Lee R. (1985) "Portfolio Theory and Currency substitution", Journal of Money, Credit and Banking 17, pp. 344-357.

White, Halbert (1980) "A heteroscedasticity-consistent covariance matrix estimator and a direct test for heteroscedasticity", Econometrica 48, pp. 817-838.

Abstract

The issue of currency substitution has attracted a great deal of attention in recent years due to its important implications for the design of both monetary and exchange rate policies. The Mexican experience of the late seventies provides a particularly good example because it allows the distinction between dollarization and capital flight, due to the existence of locally issued dollar-denominated assets (mexdollars). This paper uses a currency substitution model to analyze these issues. The model is empirically tested on Mexican data for the period 1978-82. The results show clear evidence of currency substitutability in contrast with previous studies.