Currency Substitution as Behavior Toward Risk:

The Cases of Bolivia and Peru

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ABSTRACT

This paper examines the persistence of currency substitution in two of the most dollarized countries in Latin America, Bolivia and Peru. Currency substitution is related not only to the expected rate of depreciation but also to depreciation risk, proxied by transformations of the conditional variance of the rate of depreciation, through an application of the capital asset-pricing model (CAPM) to currency substitution. Results from both countries suggest that policies that simply focus on reducing expectations of exchange-rate depreciation, but do not diminish exchange-rate risk, will not be effective in reducing dollarization.

I. Introduction

The recent experience of "dollarization" or currency substitution in a number of Latin American countries is well known.[1] Facing extremely high rates of inflation and acute depreciations during the 1970's and 1980's, residents of these countries increased their holdings of US dollars in an attempt to protect the real value of their wealth. Moreover, as the severity of economic problems continued, the US dollar expanded its role in these economies to serve not only as a store of wealth but also a means of transactions and a unit of account [2]

Explaining the increased dollarization of these economies during times of increasing economic instability was not difficult. Based on variations of the model of currency substitution, a considerable number of empirical studies for Latin American countries found an inverse relationship between the ratio of domestic to foreign real money balances and the expected rate of change of the exchange rate.[3] However, the predictions of the model did not perform well during the 1990's when many Latin American countries undertook serious stabilization programs and reforms that brought down sharply the rate of inflation and exchange rate depreciation. In spite of drastically improved

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[1] The most "dollarized" countries in Latin America are Argentina, Bolivia, Peru and Uruguay.

[2] For a review of the main issues related to the process of dollarization in developing countries, see Calvo and Vegh (1992). Krueger and Ha (1995) refer to the simultaneous use of a domestic and a foreign money for transactions as "cocirculaton".

[3] The representative empirical studies of currency substitution in Latin America are: Ortiz (1983), Ramirez-Rojas (1985), Marquez (1985), Canto (1985), Fasano-Filho (1986), Rojas-Suarez (1992). While the theory of currency substitution was first developed in the context of industrial countries (see, for example, Miles (1978), Boyer (1978), Bilson (1978), Girton and Roper (1981) and McKinnon (1982)), theoretical models capturing the particular features of financial markets in developing countries were developed by Calvo and Rodriguez (1977) and Frenkel and Rodriguez (1982).

macroeconomic conditions, dollarization persisted.

This paper deals with the persistence of dollarization in two of the most dollarized countries in Latin America: Bolivia and Peru. In both countries, periods of hyperinflation and sharp depreciation of the exchange rate were associated with significant shifts from transactions in domestic currency into transactions in U.S. dollars. Also, in both countries, albeit at different times, comprehensive stabilization efforts ended the high inflation/large exchange rate depreciations period. Among the two countries, Bolivia was the earlier reformer, when a drastic stabilization program initiated in 1985 cut annual inflation from a rate of over 20,000 percent to less than 20 percent by 1986, where it remained during the early 1990's. In Peru, the stabilization program that started in the second half of 1990 brought down the annual inflation rate from its peak of about 3000 percent by mid-1990 to less than 40 percent by 1994. Throughout the past decade, in both countries, in times of extreme inflation, in times of stabilization and in times of post-stabilization success, dollarization continued.

What then explains the persistence of dollarization? Put in a different way, what factors may explain the decline in holdings of domestic real balances that the standard models of current substitution does not capture? Why did the currency substitution model cease to be a stable function following the reverse of the inflationary processes in Latin America? [4]

Recently, a number of alternative specifications have been advanced attempting to answer the question posed above. These models have largely

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[4] A similar problem became apparent in the United States after 1973 when the conventional demand for money function ceased to be stable. When the traditional model was estimated to include pre- and post-1973 years, the resulting parameter estimates gave unreasonable values. This puzzle came to be known as: "The case of the missing money" and a number of alternative formulations were developed to explain this phenomenon.

relied on transactions costs to explain irreversibilities in the dollarization process.

In the model of Guidotti and Rodriguez (1992) transaction costs in switching from one currency to the other (justified by the assumption of economies of scale in the use of a single currency) imply that there is a range of inflation where the degree of dollarization remains unchanged. Uribe (1995) develops a model where transactions costs in switching from one currency to another depend on the degree of dollarization in the economy. From the individual's point of view it is more costly to switch from the domestic currency to dollars if the economy is not dollarized than if it is. To de-dollarize, agents may then require a very low rate of inflation so as to induce them to regain skills in the use of the domestic currency. More recently, Peiers and Wrase (1995) explain dollarization persistence through network externalities--there exists efficiencies from establishing a network of dollar users, that cannot be reversed simply by a credible stabilization.

This paper offers an alternative rationale for the persistence of dollarization that is related neither to transaction costs nor learning externalities. Instead, we extend the standard model of currency substitution to argue that in economies that have experienced hyperinflations, dollarization is related not only to expectations of exchange rate depreciation but also to *risk* about such depreciation rates. In the context of economies where a single currency is used, the argument is not new. As stated by Khan (1977), hyperinflation episodes are characterized not only by high but also more variable rates of inflation. As evidenced by the experiences of Bolivia and Peru, the episodes of extreme inflation were also accompanied by sharp and volatile depreciations of the exchange rate (see Figures 1 and 2). Under conditions of high inflation and drastic depreciation of the exchange rate, when the value of real assets denominated in domestic currency decline sharply, increased risk about economic conditions becomes an additional factor inducing economic agents to a switch from domestic currency toward foreign currency.

In this alternative explanation, a reversal of the dollarization process requires not only a reduction in the expected rate of the exchange rate depreciation but also a less volatile expected rate of change of the exchange rate. If these conditions are met, however, persistence of dollarization can only be a temporary phenomenon as economic agents adjust to the new equilibrium rate implied by the more stable economic environment.

The currency-substitution model, from this perspective, performed well in the early stages of the high inflation episodes because the first moment of the currency depreciation was so large that it dominated all other factors, including omitted variables such as risk. However, in the later stages of dollarization, following the stabilization, risk factors became more important as the expected rate of depreciation fell to lower values.

The model we use, with expected depreciation and risk, proxied by the second moment of the rate of depreciation, incorporates the non-linearities and asymmetries stressed by the transactions-costs and learning models of dollarization. In this sense, our work is consistent with the predictions of these models.

The rest of the paper is organized as follows: Section II derives an equilibrium relationship between the ratio of domestic money to foreign money, the rate of depreciation and depreciation risk by extending a simple Capital Asset Pricing Model (CAPM) to the case where two monies are allowed to circulate. The CAPM model provides a rationale for including the second moment of depreciation, as a proxy for risk, as a determinant of the dollarization ratio. Section III analyses data for Bolivia and Peru and estimates a proxy for depreciation risk with generalized autoregressive conditional heteroskedastic (GARCH) methods. Analysis of a short-run dynamic model shows that the risk proxy is significant in both countries, and in Peru across a set of regime changes. Finally, Section IV assesses the broader policy implications of the empirical analysis, and concludes the paper.

II. The CAPM Model of Dollarization

The model in this section extends the methodology used by Sweeney (1988) to derive a demand for real money in an economy where two monies are held. In this framework the ratio of domestic to foreign money depends not only on the rate of change of the exchange rate but also on the *variability* or risk regarding the rate of change of the exchange rate.

Consider an economy where agents hold a portfolio of assets and need to decide on their holdings of real money. Domestic residents can hold both domestic money and foreign money. At a given domestic price level and exchange rate (defined as the domestic value of one unit of foreign money), the marginal convenience yields of real domestic money, m, and real foreign money, f, can be expressed as:

$$\ell_1(m, f, y) \qquad \text{with } \ell_{1m} < 0,\ \ell_{1f} < 0,\ \ell_{1y} > 0 \tag{1}$$

$$\ell_2(m,f,y) \qquad \text{with } \ell_{2m} < 0,\ \ell_{2f} < 0,\ \ell_{2y} > 0 \tag{2}$$

where $m = \dfrac{M}{P}$, $f = \dfrac{FS}{P}$

M = stock of domestic money

F = stock of foreign money

S = the exchange rate

P = the domestic price level

y = the level of real economic activity

Following Sweeney (1988) it is assumed that ℓ_1 and ℓ_2 are deterministic.[5] The negative signs of ℓ_{1f} and ℓ_{2m} indicate that m and f are substitutes; that is, the higher the holdings of real foreign balances, the lower the marginal convenience yield of holding domestic real balances. It is also assumed that $0 < \ell_{1f}/\ell_{1m} < 1$ and $0 < \ell_{2f}/l_{2m} < 1$ to indicate that both currencies are imperfect substitutes.

Since the domestic price level and the exchange rate are stochastic variables, the real returns of holding the two monies (R_m and R_f respectively) are:

$$R_m = \ell_1 - \pi \tag{3}$$

[5]As it will become evident below, this assumption greatly simplifies the analysis. For simplicity it is also assumed that the level of real income has the same effect on the marginal convenience yields of both currencies.

$$R_f = \ell_2 + \theta - \pi \tag{4}$$

where: π is the inflation rate and

θ is the rate of change of the exchange rate.

Following Sweeney (1988), one may use the Capital Asset Pricing Model (CAPM) to solve for the equilibrium values of m and f. Equilibrium in the CAPM is obtained when the expected return on real money equals the required rate of return on real money. Hence,

$$ER_m = \ell_1 - E\pi = RR_m \tag{5}$$

$$ER_f = \ell_2 + E\theta - E\pi = RR_f \tag{6}$$

where RR_m and RR_f denote the required rate of returns on real domestic and foreign money respectively, and E is the expectation operator.

The CAPM requires that for any asset i:

$$RR_i = E(R_z) + [E(R_g) - E(R_z)]\beta_i \tag{7}$$

where R_z is the return on the minimum-variance portfolio which is uncorrelated with the market portfolio, R_g is the return on the market portfolio, and

$$\beta_i = \frac{\sigma_{ig}}{\sigma_g^2} = \frac{\mathrm{Cov}(R_i, R_g)}{\mathrm{Var}(R_g)} = \rho_i(\sigma_i/\sigma_g) \tag{8}$$

with σ denoting the standard deviation and ρ_i the correlation coefficient between the return on asset i and the return on the market portfolio.

A common formulation for the expected rate on the market portfolio is:

$$E(R_g) = E(R_z) + a\sigma_g \tag{9}$$

Substituting (8) into (7) yields:

$$RR_i = E(R_z) + a\,\beta_i\,\sigma_g \tag{10}$$

Applying (8) and (10) to equations (5) and (6) and recalling that ℓ_1 and ℓ_2 were assumed deterministic functions, we obtain: [6]

$$\begin{aligned} \ell_1 - E\pi &= E(R_z) + a\sigma_g\rho_m(\sigma_\pi/\sigma_g) \\ &= E(R_z) + a\rho_m\sigma_\pi \end{aligned} \tag{11}$$

$$\begin{aligned} \ell_2 + E\theta - E\pi &= E(R_z) + a\sigma_g\rho_f\left(\frac{\sqrt{\sigma_\theta^2+\sigma_\pi^2+2\sigma_{\theta\pi}}}{\sigma_g}\right) \\ &= E(R_z) + a\rho_f\sqrt{\sigma_\theta^2 + \sigma_\pi^2 + 2\sigma_{\theta\pi}} \end{aligned} \tag{12}$$

The behavior of the demand for currencies in the steady state will now be investigated. In the steady state expectations are realized and levels of real variables are assumed to be constant, including those of m and f. Assuming that the stock of foreign money can be changed only through variations in foreign exchange reserves, a flexible exchange rate would imply

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[6]Notice that from equation (3), the assumption of ℓ_1 being deterministic, implies $\sigma_m = \sigma_\pi$. From equation (4):

$$\sigma_{R_f} = \sqrt{\sigma_\theta^2 + \sigma_\pi^2 + 2\,\sigma_{\theta\pi}}$$

a constant stock of F in the steady state. That is, $\theta = \pi$.

Therefore, the ratio of equations (11) to (12) in the steady state can be written as:

$$\frac{\ell_1}{\ell_2} = \frac{\theta + R_z + a\rho_m\sigma_\theta}{R_z} \tag{13}$$

Note that the steady-state equilibrium condition $\ell_2 = R_z$ implies that foreign currency becomes a "risk-free" asset in that its return is deterministic. Equation (14) expresses this in the following way:

$$\frac{\ell_1}{\ell_2} = b_0 + b_1\theta + b_2\sigma_\theta \tag{14}$$

where $b_0 = 1$

$b_1 = 1/R_z$

$b_2 = a\rho_m/R_z$

Since ℓ_1 and ℓ_2 are assumed linear functions, equation (14) implies:

$$\frac{m}{f} = d(\theta, \sigma_\theta) \qquad \begin{matrix} d_1 < 0 \\ d_2 < 0 \end{matrix} \tag{15}$$

Equation (15) shows, in the steady state, that the ratio of real holdings of domestic to foreign money is inversely affected by both the rate of change and the variability of the exchange rate.

Of course, the variability of the exchange rate may be related in a non-linear way to lagged levels of the exchange rate, so that the relationship may be more complex. Similarly, the short-run adjustment of the dollarization ratio may depend on the long-run relationship, in a linear or non-linear error-correction mechanism. So the implications of this steady-state relation among dollarization, depreciation, and risk for econometric analysis and short-run forecasting may involve taking first differences of some of these variables, as well as allowing for more complex non-linear mechanisms.

III. Empirical Implementation and Analysis

The above model suggests an relation among the ratio of domestic to foreign money, m/f, and the rate of depreciation, θ, and depreciation uncertainty or risk, σ_θ.

To explore and compare these relations in Bolivia and Peru, GARCH estimates of depreciation risk or uncertainty were first estimated by maximum likelihood methods. The GARCH parameters and lagged squared prediction errors generated time series for the conditional variance of depreciation for each country.[7]

We then examined the degree of integration of the dollarization ratio, the rate of depreciation, and the conditional variance, to find out which, if any, of these variables should be analyzed in levels or in first differences.

After our analysis of the stationarity properties of the variables, we regress the first-difference or level of the dollarization ratio on its own lagged values, as well as on lagged values of the depreciation rate and

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[7] The GARCH estimation process was introduced by Bollerslev (1986). A copy of the maximum likelihood program for estimation of the GARCH parameters, making use of the MATLAB Optimization Toolbox by Grace (1990), is available from the first author upon request.

exchange-rate uncertainty or risk, as well as on a constant and a dummy variable for December, which represents the annual vacation bonus or *aguinaldo* payment. We then reduce the equation, eliminate those lagged variables which prove to be insignificant, whose removal affected neither the signs nor significance of the remaining variables.

Finally, for the exchange-rate risk or uncertainty variable, we use both the conditional variance as well as two alternative transformations of this variable as arguments in the dollarization regressions. The first alternative was simply the square-root of the conditional variance, since risk is normally measured by the standard deviation rather than the variance of underlying series. The second alternative was a normalization of the standard deviation between zero and one, using the following log-sigmoid transformation:

$$\tilde{\sigma}_{\theta} = \frac{1}{1+e^{-\sigma_{\theta}}}$$

The log-sigmoidal transformation captures non-linearities inherent in the dollarization process: when risk is at sufficiently low or high levels, small changes in risk have little or no effect on the dollarization ratio, while changes from lower to very high levels, or falls from very high levels to low levels, may have more than proportional effects on the dollarization level.[8]

Since we are using an artificially generated variable in our regressions, it was necessary to estimate the general and specific equations with instrumental variable methods. In our estimation, we chose as

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[8] See Sargent (1994) for a more detailed analysis of this transformation for approximation and estimation in macroeconomics.

instruments the first three lags of the stationary dollarization ratio and the depreciation rate. The results proved to be robust to alternative selections of instruments based on longer lags.

A. Bolivia

For Bolivia, data on depreciation and dollarization come from the Central Bank of Bolivia. The dollarization ratio is taken as the ratio of dollar deposits to short-term deposits in domestic banks. Since data on dollar deposits were not available until after the stabilization, our sample of monthly data begins in 1986. Figure 1 shows the increase in the dollarization ratio after the fall in the monthly rate of exchange-rate depreciation from the hyperinflation levels in 1985 (not shown) to moderate levels after 1987.

Table 1 presents our empirical analysis for Boliva. Panel A contains the GARCH estimates for generating the proxy variable for depreciation risk or variability, σ_θ, for the observed depreciation rate. In GARCH models, this variable is known as the conditional variance. The GARCH process for the depreciation risk is done under the assumption that the logarithm of the exchange rate follows a random-walk process. Thus, the GARCH process takes the prediction error at time t to be the squared first-difference of the exchange rate.

Panel A shows the coefficients of the lagged squared prediction error and the lagged conditional variance. Both the lagged squared prediction error and the lagged conditional variance are significant. The autoregresstive coefficient for the conditional variance also shows moderate persistence.

For the conditional variance, an artificially-generated non-linear transformation of the rate of depreciation, we make use of Theorem 2 in Nelson (1990), who analyzed stationarity and persistence in GARCH(1,1) processes, as well as in integrated GARCH(1,1) processes. The coefficients of the lagged prediciton error and the lagged conditional variance in this case indicate that the conditional variance is an IGARCH(1,1) process. However, Nelson has shown that such IGARCH(1,1) processes are strictly stationary and ergodic.[9]

Panel B shows that one can reject at the five percent level the hypotheses of a unit root in the rate of depreciation, while one cannot reject the hypothesis of a unit root in the dollarization ratio, according to the critical values tabulated by MacKinnon (1990).[10]

In Panel C of Table I we report the coefficient estimates of the specific dynamic equation for the dollarization ratio.[11] The lagged first-difference of the dollarization ratio, the lagged depreciation rate, and the lagged risk variable, as well as the *aguinaldo* and the constant term are all significant. Further lags of the explanatory variables were insignificant.[12]

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[9] Nelson also proposes tests for stationarity of the conditional variance of series generated under a wider variety of stochastic processes.

[10] The augmented Dickey-Fuller tests and the MacKinnon test statistics are computed under the assumption of three lags, with neither constant term nor trend in the regression, at the 5% level of significance. However, the results proved to be robust to different lags as well as to the presence of constant and trend terms.

[11] Since the dollarization ratio is first-difference stationary, while the depreciation rate and the exchange-rate risk proxy are stationary, there was no need to investigate cointegration among these variables.

[12] The depreciation risk in this table is the logsigmoid transformation, but use of the conditional variance and the square root of the conditional variance generated similar results

The overall explanatory power of the regression is over .4, and the LM test of serial correlation is not significant at the 5 percent level. However, the Jarque-Bera test of normality, the ARCH test, and the White test of heteroskedasticity indicate the presence of non-linearities in the residuals.

B. Peru

Data on depreciation and dollarization come from the Central Bank of Peru. The depreciation rate is the parallel market rate, and the dollarization ratio is taken as the ratio of dollar deposits in domestic as well as foreign banks by Peruvians, to domestic short term deposits. Figure 2 pictures the adjustment of both of these variables. The shaded region between 1985:06 and 1990 represents a period of forced de-dollarization within Peru, when the Allan Garcia government banned dollar deposits in domestic Peruvian banks. The dollarization ratio during this interval represents ratio of dollar deposits in foreign banks, held by Peruvians, relative to short-term deposits.

Of course, this de-dollarization policy led to a capital outflow and an increase in dollar deposits outside the country. The increased dollarization ratio in late 1989, corresponding to the high exchange-rate instability, reflects the build-up of external dollar deposits as a substitute for domestic dollar deposits. In 1990, dollar deposits were again permitted within the

Peruvian banking system.[13]

To examine the interrelations among dollarization, depreciation, and depreciation risk, we examine two periods: 1978-1994, and 1990-1994, in Tables II and III.[14] In the full period estimation, we assume that increasing levels of the foreign deposits serve as a proxy of what would have been held in domestic banks. In the later period, we examine the interrelationships only after dollarized deposits were fully restored in the domestic banking system.

1. Peru, 1978-1994

For calculating depreciation risk, the GARCH estimation in Panel A of Table II shows that both the squared prediction error and the lagged conditional variance terms are significant. The coefficients show that the process is stationary IGARCH(1,1).

Panel B shows a pattern similar to the one observed for Bolivia: the dollarization ratio is integrated of order one, while the rate of depreciation is integrated of order zero. Both of these results are robust to a variety of assumptions regarding lag length and the specification of constants and trends in the Dickey-Fuller regressions. Following the Nelson criterion, we can also accept the GARCH conditional variance as stationary.

Panel C shows that only three variables turned out to have significant effects: the first two lags of the depreciation rate, and the lagged depreciation risk variable. Lagged first-differences of the dollarization

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[13] See Rojas-Suárez (1992) for a further description of the dollarization process in Peru.

[14] An analysis of the period prior to dedollarization yields results similar to those obtained in the full-period estimation.

ratio, a constant term, an *aguinaldo* dummy, as well as a dummy for the period of forced de-dollarization proved to be insignificant and were eliminated from the regression. The results reported in this panel make use of the logsigmoid transformation for exchange-rate risk. Use of the GARCH conditional variance or the standard deviation, rather than the logsigmoid normalization, gave results with the same signs, but lower levels of significnace, for similar lag lengths.

The overall explanatory power of the regression is low, slightly over .20, but the regression period covers a relatively lengthy period of highly volatile data. The regression diagnostics show that serial dependence can be rejected at the five percent level, while the Jarque-Bera, ARCH, and White tests show evidence of neglected nonlinear processes in the residuals. Finally, a Chow break-point test, with breaks at the time of forced de-dollarization in 1985, and the legalization of dollar deposits in 1990, proved to be insignificant.

2. Peru, 1990-1994

The major issue surrounding our analysis of the "later" Peru period is the treatment of the dollarization ratio after 1990. Is this series different from the dollarization ratio in the earlier period, prior to or during the forced de-dollarization policy?

While the Chow test, reported above, rejects "structural breaks" in 1985 and in 1990, Table III, Panel A, tells us that the evidence is mixed. The dollarization ratio is stationary under the augmented Dickey-Fuller test with a constant and one lag, but it is non-stationary under a constant and three lags. Given the lack of robustness of Dickey-Fuller test, and the relatively small sample size following 1990, our analysis will examine the relationships between dollarization, exchange-rate depreciation, and risk, under two assumptions: dollarization taken as a stationary variable, and dollarization taken as stationary in its first differences.[15] Our aim is to see if the results of the "later Peru" period are different from the full sample.

Panel B contains the estimation results under the stationarity assumption for the dollarization ratio. The lagged dollarization ratio, the depreciation rate, and the exchange-rate risk variable (taken here as the logsigmoid transformation of the GARCH series), are all significant. Neither the constant nor the *aguinaldo* were significant. The overall explanatory power of this equation is over .55. However, the regression diagnostics indicate that serial correlation cannot be rejected at the five percent level, and the Jarque-Bera and White tests--but not the ARCH test--suggest the presence of non-linear processes in the regression residuals.

The estimation results under the assumption of a first-difference stationary dollarization ratio appear in Panel C. As in the case of the full Peru period, only the first two lags of the depreciation rate and the risk variable were significant. However, the overall explanatory power of this regression is rather low, about the same as that of the full Peru estimation sample. While the diagnostics indicate no problem with serial correlation, the Jarque-Bera, ARCH, and White tests suggest that there are important non-linearities not accounted by the regressors and specification.

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[15] For the results reported in Table III, we did not re-estimate the GARCH process for the later Peru period, but used the sub-sample of the conditional variance series generated for whole period for the later-Peru estimation of dollarization. However, the results were robust to changes in the GARCH estimation bounds.

IV. Policy Implications and Conclusion

The main result of this paper is that dollarization, depreciation, and depreciation risk or uncertainty are interrelated across a variety of national experiences and regime changes within a country. Since the conditional variance term is a non-linear transformation of past prediction errors, our model provides an alternative rationale for asymmetries in dollarization, to those in previous studies.

We have used transformations of the GARCH model of depreciation risk as a proxy variable for risk. What if the exchange rate is fixed, as in the case of Argentina since 1991? In this case, expectations of depreciation can be proxied by the interest spread between dollar-denominated deposits and deposits in domestic currency.

Figure 3 pictures the spreads on peso/dollar deposits for maturities of one and two months, since April 1993. a GARCH model applied to these variables generates significant estimates for both the lagged squared prediction error and for the lagged conditional variance. This result indicates, albeit with few degrees of freedom, continued risk regarding depreciation.[16] Hence, even in Argentina, where the exchange rate has remained fixed, depreciation risk may be an important factor explaining the

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[16] The GARCH estimates for the equations are as follows:

$$\sigma_1^2=3.61+0.86\hat{e}_{t-1}^2+0.20\sigma_{t-1}^2$$
$$\sigma_2^2=0.00+0.06\hat{e}_{t-1}^2+0.86\sigma_{t-1}^2$$

persistence of dollarization. Policies which simply stabilize or completely fix the exchange rate but do not diminish exchange-rate risk will not be effective in reducing dollarization. On the contrary, if risk increases, dollarization may rise.

The analysis of this paper has implications for the direction of further research on reform policies, particularly in the macro and financial sector, in developing countries. Reducing risk may not only require credible and sustainable macroeconomic policy, but also effective supervision, accountability, and transparency of public and private financial institutions. In many dollarized countries, such accountability and transparency is still in its early stages.

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Fig 1 Bolivia: Dollarization and Depreciation

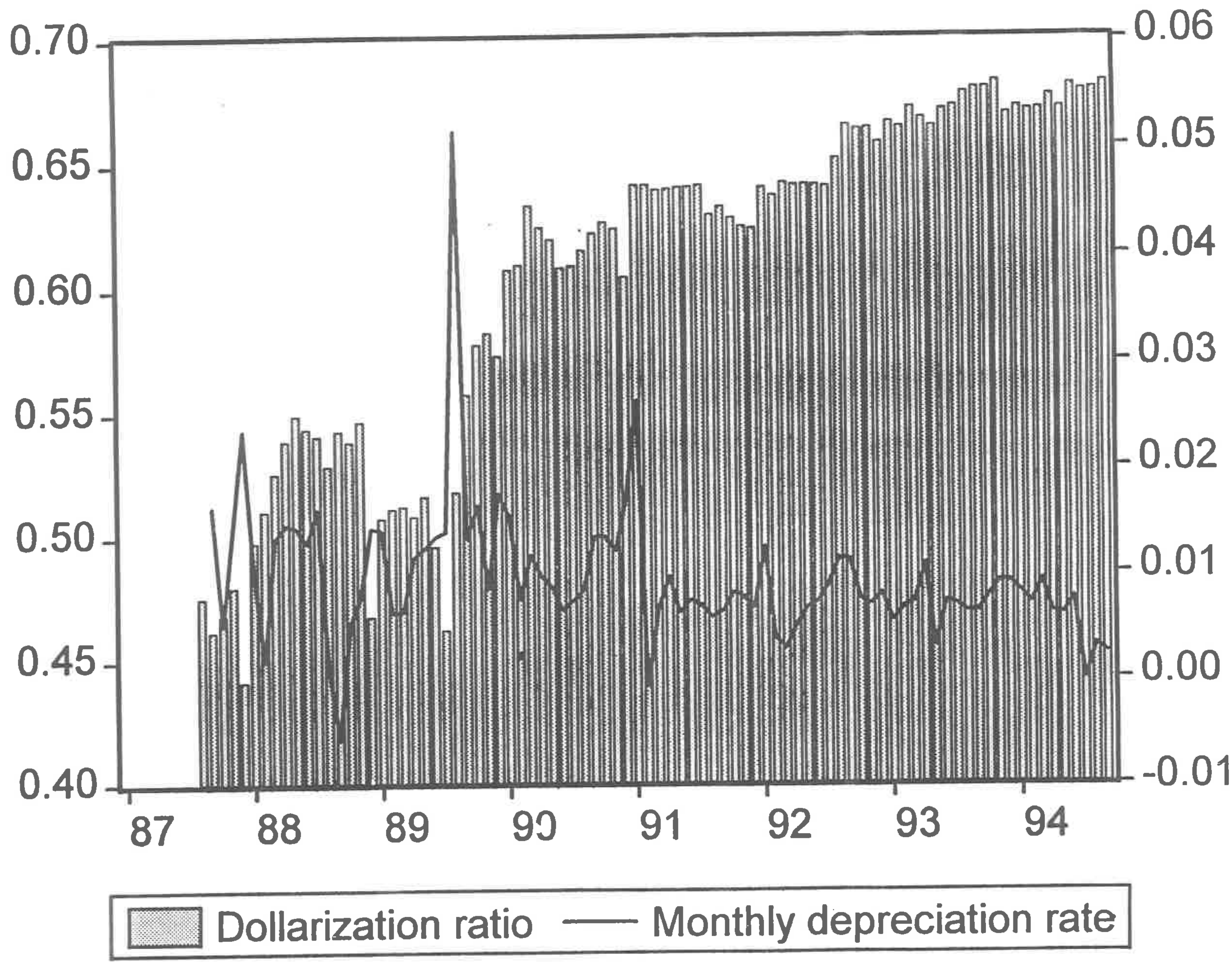

Fig 2 Peru: Dollarization and Depreciation

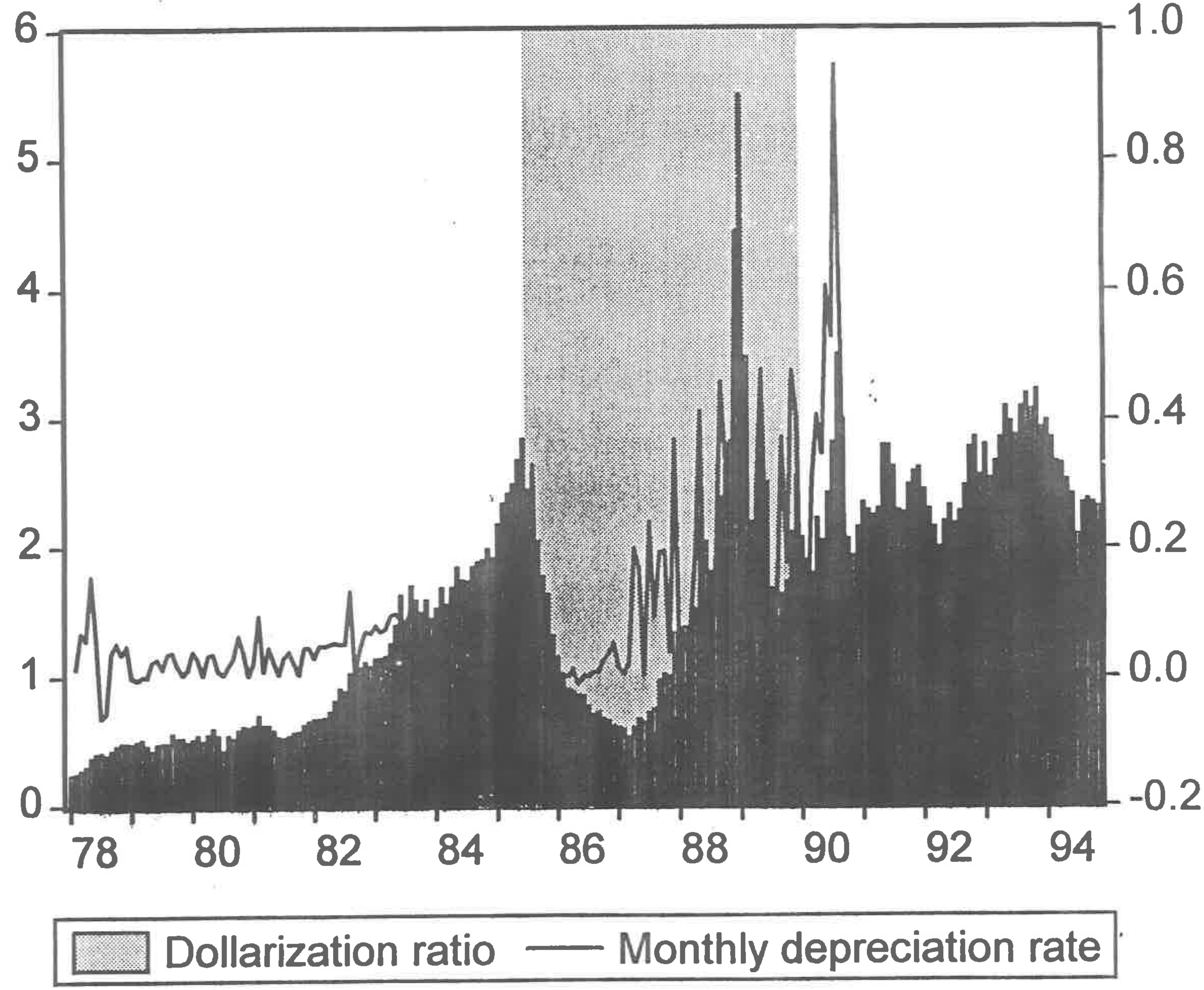

TABLE I: Bolivia, 1987-1994

Panel A: GARCH Process for Depreciation

Term	Estimate	T-Stat
cons	0.001	0.994
ARCH(1)	0.7037	0.0001
GARCH(1)	0.4397	0.0001

Panel B: Test of Stationarity of Variables

Variable	Augmented Dickey-Fuller Statistic	MacKinnon Critical Value
Dollarization ratio	-1.672	-2.89
Depreciation	-3.49	

Panel C: Instrumental Variables Estimation Results: Specific Model
Dependent Variable: First-difference of dollarization ratio
Instrumental variables: three lags of depreciation, three lags of first-differences of dollarization ratio
Adjusted sample period: 1987:12 - 1994:09

Regressor	Coefficient	T-Stat
First-difference, dollarization(-1)	-0.3471	-4.25
Depreciation(-1)	0.0081	4.13
Risk(-1)	0.0528	2.29
December dummy	-0.078	-1.68
Constant	-0.0375	-2.01

Regression Diagnostics	Value	Prob. Value
R-squared	0.412	
Durbin-Watson	1.8	
Jarque-Bera (normality)	49.2	0.0001
LM (Serial correlation)	2.54	0.08
ARCH	6.33	0.013
White (heteroskedasticity)	2.08	0.055

TABLE II: Peru, 1978-1994

Panel A: GARCH Process for Depreciation

Term	Estimate	T-Stat
cons	1.22	2.21
ARCH(1)	0.748	4.26
GARCH(1)	0.501	7.77

Panel B: Test of Stationarity of Variables

Variable	Augmented Dickey-Fuller Statistic	MacKinnon Critical Value
Dollarization ratio	-0.454	-2.57
Depreciation	-3	

Panel C: Instrumental Variables Estimation Results: Specific Model
Dependent Variable: First-difference of dollarization ratio
Instrumental variables: three lags of depreciation, three lags of first-differences of dollarization ratio

Adjusted sample period: 1978.08-1994.10

Regressor	Coefficient	T-Stat
Depreciation(-1)	0.0084	2.71
Depreciation(-2)	-0.01	-2.63
Risk(-1)	0.031	1.65

Regression Diagnostics	Value	Prob. Value
R-squared	0.2	
Durbin-Watson	1.95	
Jarque-Bera (normality)	1390	0.0001
LM (Serial correlation)	2.29	0.1
ARCH	28.9	0
White (heteroskedasticity)	9.67	0
Chow (break points in 85,90)	0.605	0.726

Table III: Peru, 1990-1994
Estimation Under Alternative Stationarity Assumptions of Dollarization
Adjusted sample period: 1990:01-1994.10

Panel A: Test of Stationarity of Dollarization Ratio

Lags	Aug. D-F Statistic	MacKinnon Critical Value
1	-3.35	-2.91
3	-2.01	

Panel B: Instrumental Variables Estimation Results: Specific Model
Dependent Variable: Level of dollarization ratio
Instrumental variables: three lags of depreciation, three lags of dollarization ratio

Regressor	Coefficient	T-Stat
Dollarization(-1)	0.782	9.65
Depreciation(-1)	0.0004	2.71
Risk(-1)	0.564	2.65

Regression Diagnostics	Value	Prob. Value
R-squared	0.56	
Durbin-Watson	1.48	
Jarque-Bera (normality)	8.47	0.01
LM (Serial correlation)	3.27	0.045
ARCH	1.43	0.23
White (heteroskedasticity)	3.41	0.004

Panel C: Instrumental Variables Estimation Results: Specific Model
Dependent Variable: First-difference of dollarization ratio
Instrumental variables: three lags of depreciation, three lags of first-difference of dollarization ratio

Regressor	Coefficient	T-Stat
Devaluation(-1)	0.0053	2.15
Devaluation(-2)	-0.008	-3.59
Risk(-1)	0.873	2.12
constant	-0.809	2.1

Regression Diagnostics	Value	Prob. Value
R-squared	0.21	
Durbin-Watson	2.14	
Jarque-Bera (normality)	11.85	0.002
LM (Serial correlation)	0.519	0.597
ARCH	12.97	0.0006
White (heteroskedasticity)	6.654	0.00001

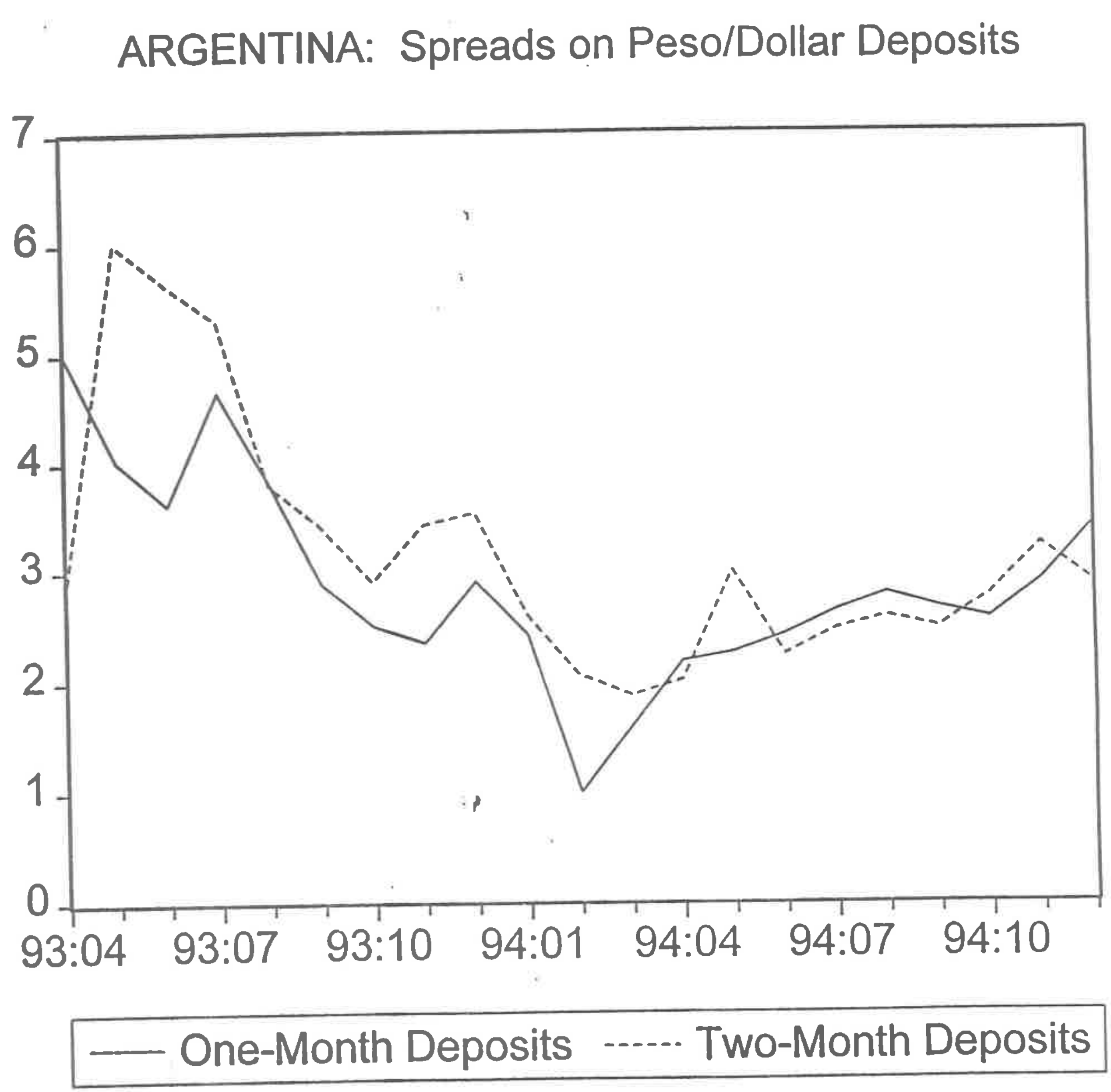
ARGENTINA: Spreads on Peso/Dollar Deposits
7
6
5
4
3
2
1
0
93:04
93:07
93:10
94:01
94:04
94:07
94:10
One-Month Deposits
Two-Month Deposits

Figure 3