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Currency Substitution: The Recent Experience of Bolivia

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Abstract

This paper analyzes the determinants of currency substitution in Bolivia in the period following the 1984/85 hyperinflation. We find that expected exchange rate depreciation and actual interest rate differentials between boliviano and dollar deposits in the Bolivian banking system are statistically significant determinants of the degree of currency substitution. However, the explanatory power of these variables is low compared to variables that measure the degree of inertia in the currency substitution process. Thus, further reductions in inflation or higher interest rates for boliviano bank deposits are likely to have but a small effect on dollarization.

JEL Classification Numbers:

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### Summary

One of the more puzzling aspects of Bolivia's economic performance since 1986 has been the persistent increase of currency substitution in the domestic banking system. Foreign currency deposits have been permitted since 1985, when the de-dollarization decree of 1982 was suspended. Despite low inflation rates and a high degree of external stability achieved as a result of the successful 1985 monetary reform and adjustment program, Bolivia has been experiencing a rapidly increasing share of foreign currency deposits in the domestic banking system. The share of such deposits in broad money increased from less than 15 percent in early 1986 to over 76 percent in September 1991, and quasi-money is currently over 90 percent "dollarized." In view of the country's sustained macroeconomic stability, the surge in the degree of currency substitution raises the question of whether factors traditionally thought to drive this process, such as expected exchange rate depreciation and interest rate differentials between U.S. dollar and domestic currency deposits in the banking system, play a significant role in explaining the degree of currency substitution in Bolivia. If they do not, then little hope can be pinned on diminishing dollarization through traditional remedies, such as reducing inflation and increasing interest rates on boliviano bank deposits.

This paper analyzes the determinants of currency substitution in Bolivia during the period following the 1984-85 hyperinflation when--notwithstanding the success of the macroeconomic stabilization and adjustment program that began in August 1985--dollar deposits in the domestic banking system increased rapidly from 1986 through 1991. Consistent with previous research, the authors find that expected depreciation and interest rate differentials are statistically significant determinants of the degree of currency substitution. However, they note that the explanatory power of these variables is fairly low compared to that of variables measuring the degree of inertia in the currency substitution process. The results of the analysis suggest that reversing the process of currency substitution may be very difficult. Given the relatively low responsiveness of currency substitution to expected depreciation and interest rate differentials, and considering the fact that significant stabilization has already occurred, the authors conclude that there may be relatively little scope for reducing the current level of currency substitution in Bolivia in the near future.



## I. Introduction

Many developing countries have been subject to periods of extensive currency substitution, with foreign money substituting for domestic money as a store of value, unit of account, and medium of exchange. Previous research suggests that the demand for foreign currencies in excess of a normal transactions demand for trade and tourism may be triggered by policy measures that either affect returns on holdings of domestic money relative to foreign-currency denominated money balances or influence expectations regarding the future liquidity of domestic and foreign currency-denominated balances. <sup>1/</sup> An interesting side effect of currency substitution is the reversal of Gresham's Law, as Bernholz (1989) and Guidotti and Rodriguez (1991) have noted.

The recent experience of Bolivia with currency substitution provides somewhat of a puzzle. The degree of currency substitution has risen substantially in Bolivia, notwithstanding relatively low inflation rates (averaging 18.2 percent per year between February 1986 and September 1991) and a high degree of external stability resulting from the successful 1985 stabilization program. The share of foreign currency deposits in broad money increased from below 15 percent in early 1986 to over 76 percent in September 1991; quasi-money deposits in the domestic banking system are currently over 90 percent "dollarized."

This process in which foreign currencies gain increasing importance in the financial system is at the heart of what Melvin (1988) has termed a market-induced monetary reform on the demand side. In light of sustained macroeconomic stability, the observed surge in the degree of currency substitution in Bolivia raises the question of whether factors that are traditionally thought to drive currency substitution, such as expected exchange rate depreciation and interest rate differentials, play a significant role in explaining the degree of currency substitution in Bolivia. If they do not, then little hope can be pinned on traditional remedies (such as reducing inflation rates) for reversing this process.

This paper uses monthly data to analyze the determinants of currency substitution in Bolivia from 1986 to 1991. The paper is organized as follows. First, a short overview of the recent history of currency substitution in Bolivia is given. Second, a brief comparison of the Bolivian case with the recent experience of some other Latin American countries is presented. Third, a simple econometric model of currency substitution is delineated. Fourth, the empirical results are presented. Finally, some concluding remarks close the paper.

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<sup>1/</sup> See, for example, Tanzi and Blejer (1982), Lamdany and Dorlhiac (1987), or Cox and Parkin (1988) for a general analysis.

## II. A Brief History of Currency Substitution in Bolivia

Bolivia has a long history of currency substitution, mostly in the form of U.S. dollars substituting for domestic currency. Clavijo (1991) distinguishes between three main periods of dollarization in Bolivia's recent history. Up to the late 1970s, domestic currency dominated as a store of value, medium of exchange, and unit of account, but the country's deepening economic crisis increased the degree of dollarization between 1980 and 1985. U.S. dollar denominated bank deposits were suspended by decree in November 1982. However, with the acceleration of inflation, U.S. dollars continued to circulate and deposits were shifted abroad. <sup>1/</sup> As part of a comprehensive adjustment and stabilization program in mid-1985, the Bolivian authorities again permitted residents to hold U.S. dollar-denominated deposits in the domestic banking system.

Despite the success of the stabilization program of 1985, the degree of dollarization of the Bolivian economy increased steadily during the 1986-1991 time period (figure 1). The ratio of quasi-money balances in foreign currencies to total quasi-money rose from about 50 percent in 1986 to roughly 95 percent by September 1991. Moreover, as foreign currency checking deposits were permitted in 1987, narrow money also became partially dollarized, with over 15 percent in foreign currencies by September 1991. Bolivia's high degree of currency substitution has resulted in a situation where virtually all financial and non-financial transactions are indexed to the U.S. dollar, thereby effectively making it a dual currency economy. <sup>2/</sup>

As figure 1 reveals, dollarization increased each year from 1986 to 1991. Measured currency substitution increased sharply in 1986, even though ex-post yields strongly favored boliviano deposits. <sup>3/</sup> Annualized ex-post real monthly real rates of return for boliviano and dollar deposits equalled 28.5 and 8.9 percent, respectively, in 1986. <sup>4/</sup> This may indicate that boliviano deposits carried a big risk premium in 1986, a reasonable presumption in the wake of 1985's hyperinflation.

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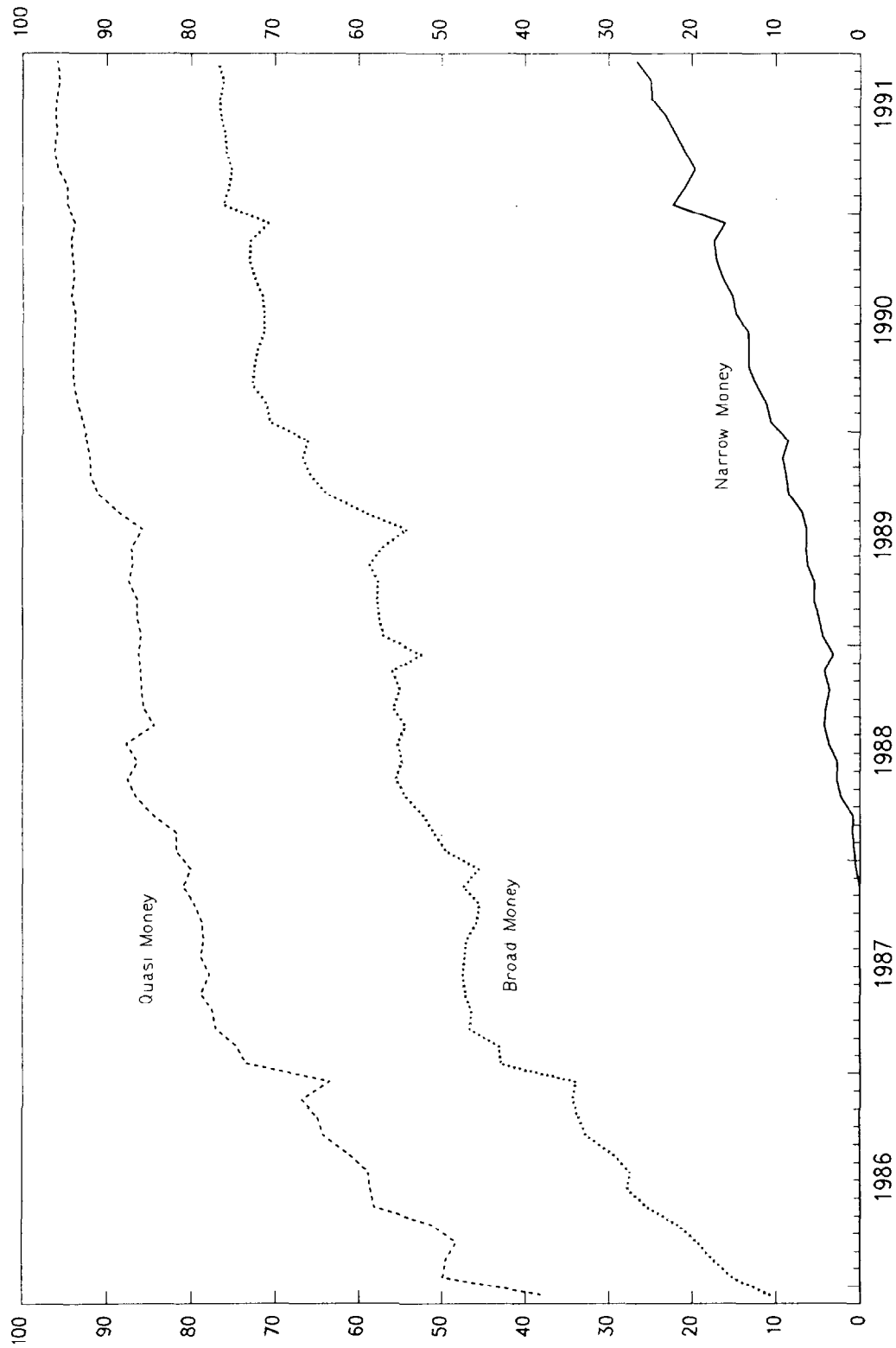
<sup>1/</sup> See Melvin and Afcha de la Parra (1989).

<sup>2/</sup> Bolivia currently maintains a managed float of the boliviano against the U.S. dollar with the official selling rate being determined at daily central bank auctions.

<sup>3/</sup> Our figures on currency substitution must be interpreted with caution, as foreign currency circulating as cash is not included as part of the money supply. Thus, some of the "currency substitution" recorded in 1986 and other years could be reflecting a change in the composition of foreign money, rather than a substitution of foreign money for its domestic counterpart.

<sup>4/</sup> The real boliviano deposit rate is defined as  $[(1+r)/(1+p)-1]$ , and the real return on dollar deposits is defined as  $[(1+e)(1+r)/(1+p)-1]$ , where  $e$  denotes the change in the exchange rate,  $r$  denotes the nominal interest rate paid on either boliviano or dollar time deposits, and  $p$  denotes the Bolivian inflation rate.

FIGURE 1  
BOLIVIA  
FOREIGN CURRENCY DEPOSITS IN THE DOMESTIC BANKING SYSTEM.<sup>1/</sup>

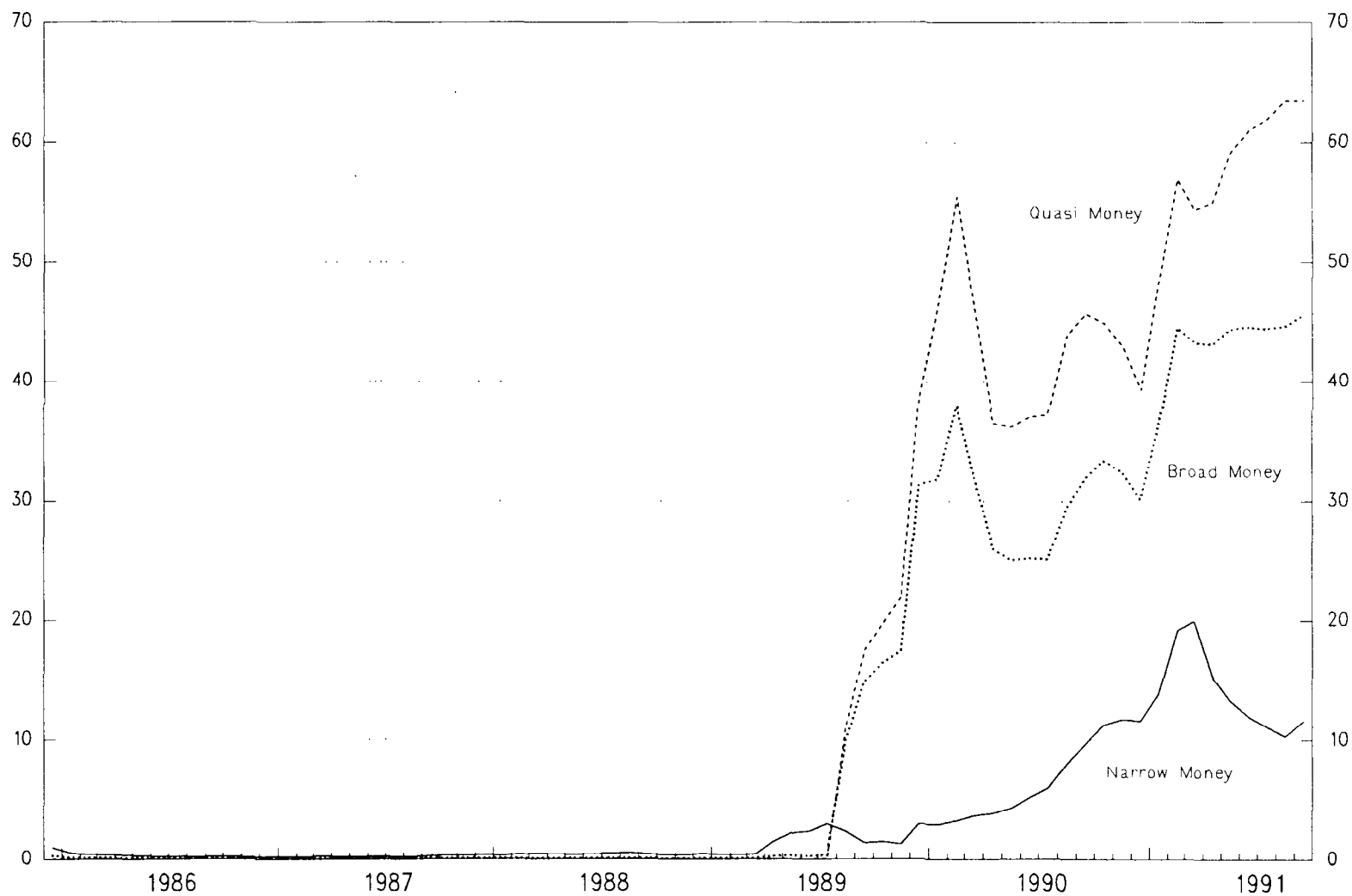


Source: Central Bank of Bolivia.  
1/ Percentage share of foreign currencies (valued at current exchange rates) in selected monetary aggregates during the December 1985 to September 1991 time period.





FIGURE 2  
 ARGENTINA  
 FOREIGN CURRENCY DEPOSITS IN THE DOMESTIC BANKING SYSTEM. 1/

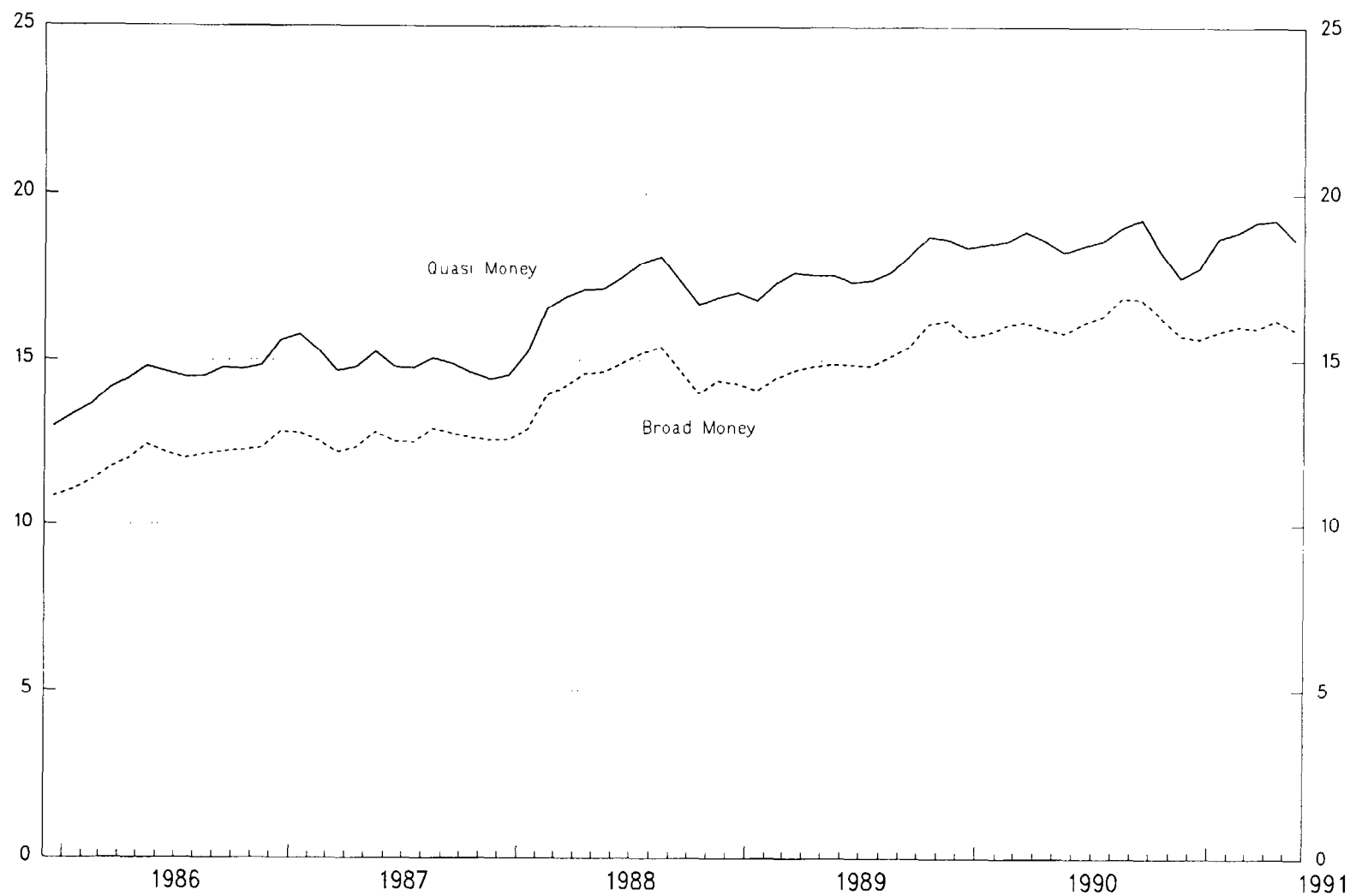


Source: Central Bank of Argentina.

1/ Percentage share of foreign currency deposits (valued at current exchange rates) in selected monetary aggregates during December 1985 to September 1991. Quasi money deposits in foreign currencies are only permitted in Argentina.



FIGURE 3  
CHILE  
FOREIGN CURRENCY DEPOSITS IN THE DOMESTIC BANKING SYSTEM.<sup>1/</sup>

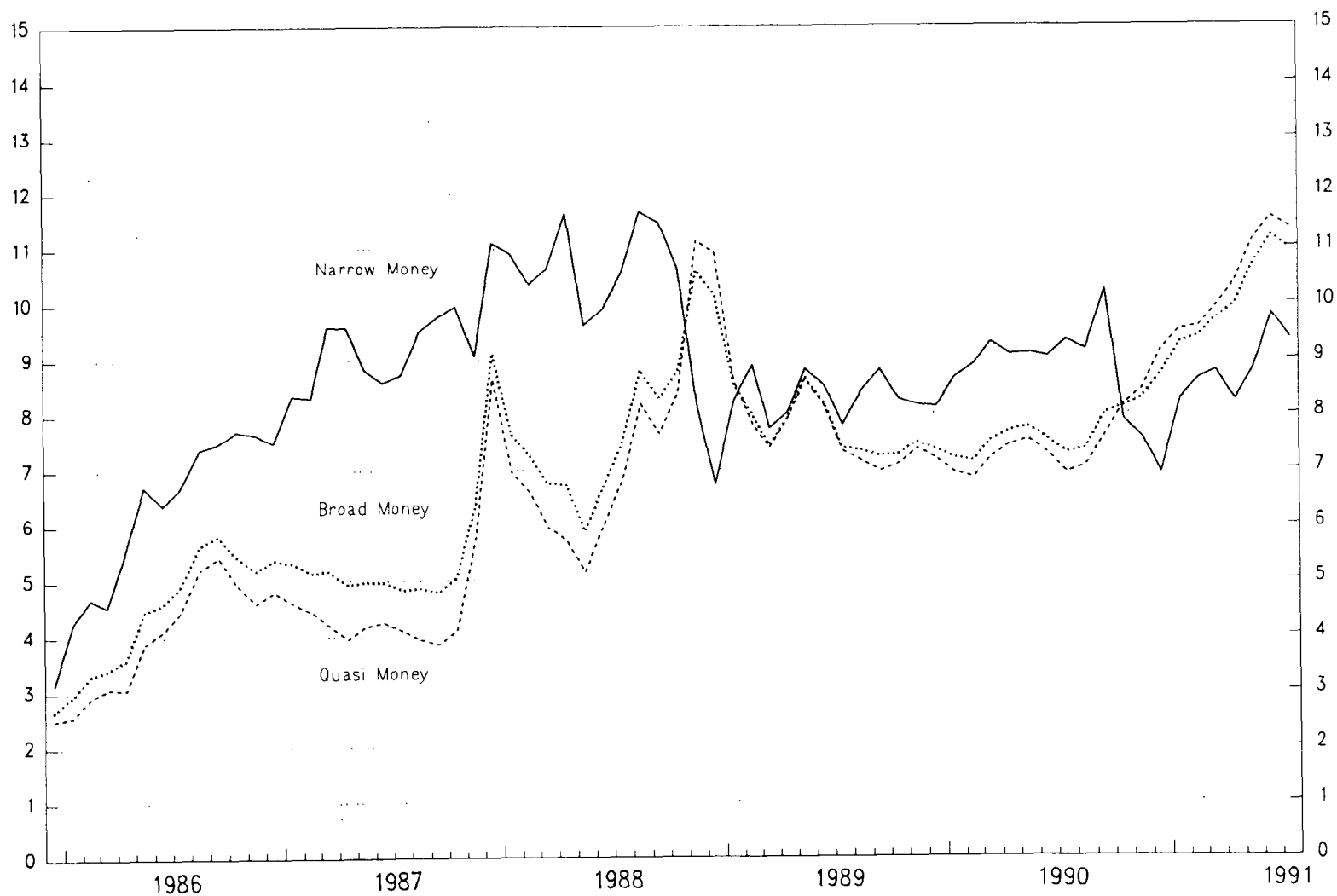


Source: Central Bank of Chile.

1/ Percentage share of foreign currencies (valued at current exchange rates) in selected monetary aggregates during the December 1985 to May 1991 time period.



FIGURE 4  
MEXICO  
FOREIGN CURRENCY DEPOSITS IN THE DOMESTIC BANKING SYSTEM. <sup>1/</sup>

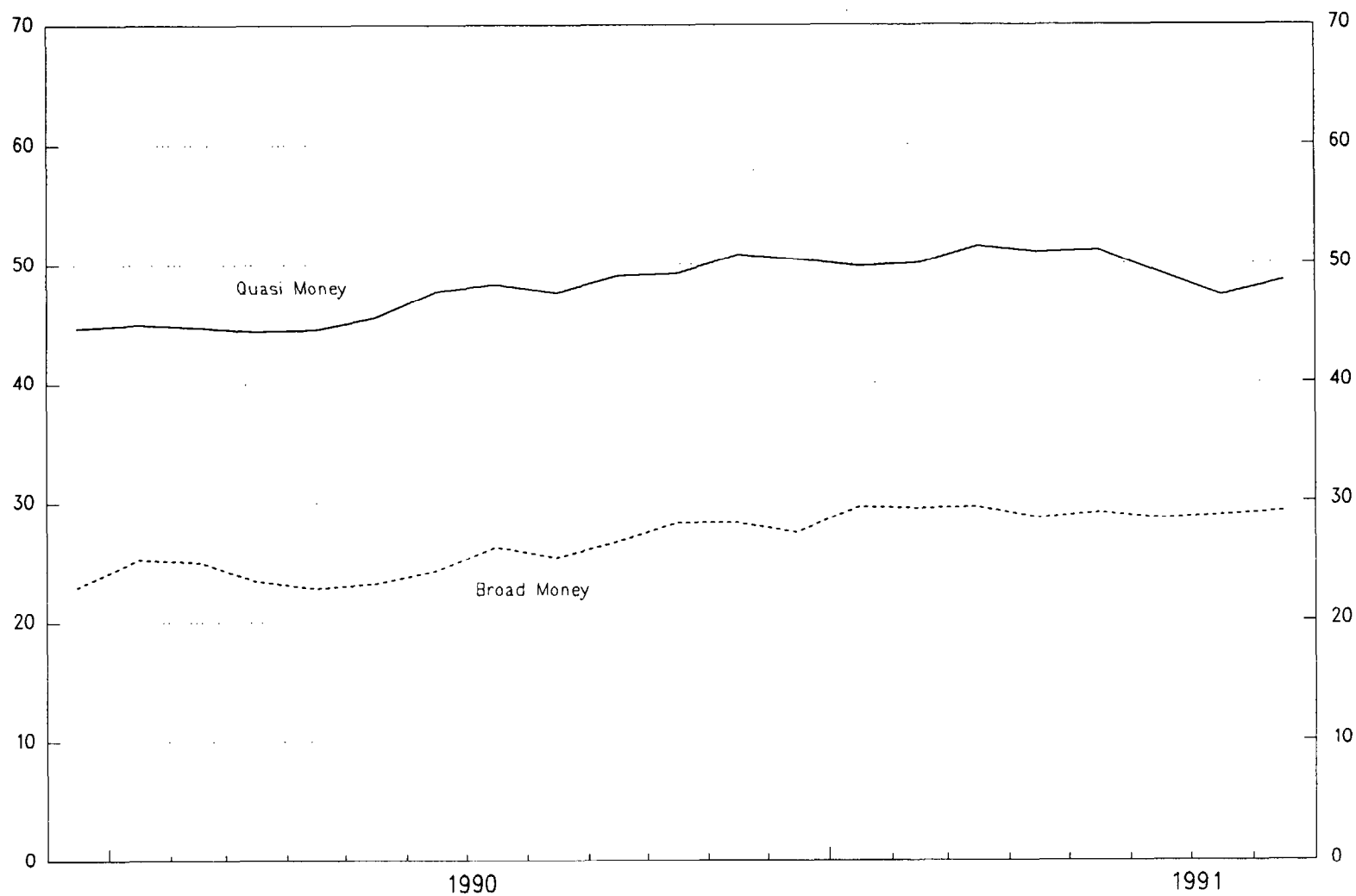


Source: Central Bank of Mexico.

<sup>1/</sup> Percentage share of foreign currency deposits (valued at current exchange rates) in selected monetary aggregates during the December 1985 to July 1991 time period.



FIGURE 5  
PARAGUAY  
FOREIGN CURRENCY DEPOSITS IN THE DOMESTIC BANKING SYSTEM. <sup>1/</sup>



Source: Central Bank of Paraguay.

<sup>1/</sup> Percentage share of foreign currency deposits (valued at current exchange rates) in selected monetary aggregates during the December 1989 to August 1991 time period.





FIGURE 6  
PERU  
FOREIGN CURRENCY DEPOSITS IN THE DOMESTIC BANKING SYSTEM. <sup>1/</sup>



Source: Central Bank of Peru.

<sup>1/</sup> Percentage share of foreign currency deposits (valued at current exchange rates) in selected monetary aggregates during the January 1990 to July 1991 time period.



Dollarization continued to increase from January 1987 to September 1991, with relative yields greatly favoring dollar deposits; during this time period, dollar and boliviano deposits earned an annual real return of 26.0 percent and 10.6 percent, respectively. Both the relative and absolute size of the real return on dollar deposits during this time period are quite surprising, especially in light of the relative returns that prevailed in 1986. Furthermore, it is puzzling that Bolivians chose to hold any boliviano time deposits at all from 1987-91 in light of their vastly inferior returns. This calls into question the responsiveness of dollarization in Bolivia to relative returns, an issue to be examined empirically in this paper.

The fact that dollarization increased during periods with radically different relative yields (1986 and 1987-91) may be suggestive of a structural break after 1986 in the relationship between currency substitution and relative returns. This issue is explored further in the paper, where we examine the structural stability of the relationship between relative yields and currency substitution.

### III. Currency substitution: Bolivia and Selected Latin American Countries

The extent of currency substitution appears much greater in Bolivia than in most Latin American countries, particularly in relation to those that have enjoyed a relatively high degree of macroeconomic stability during the 1980s. In mid-1991, the ratio of foreign currency to broad money amounted to just 15 percent in Chile (figure 3), about 12 percent in Mexico (figure 4), and about 30 percent in Paraguay (figure 5). Countries characterized by a high degree of dollarization, besides Bolivia, include Argentina and Peru (figures 2 and 6). Ironically, dollarization is most complete in Bolivia, which has enjoyed over the past six years the lowest rate of inflation among this group of highly dollarized economies. However, the relatively low inflation in Bolivia from 1986-91 was preceded by a hyperinflation, with prices increasing 23,000 percent in 1985. This suggests that currency substitution might be determined both by present and past macroeconomic conditions. <sup>1/</sup>

For the most part, research on currency substitution has focused on explaining the factors that cause economic agents to utilize foreign currency in lieu of its domestic counterpart. In general, the analysis of currency substitution has assumed that causality runs from economic instability (i.e, high rates of inflation and exchange rate devaluation)

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<sup>1/</sup> A theoretical framework that shows why currency substitution might not be reduced after economic stabilization is achieved is provided by Guidotti and Rodriguez (1991). It also should be noted that the relative degree of dollarization across countries is influenced by the rules and regulations governing access to foreign currency and foreign currency deposits. Bolivia's financial system and foreign exchange regime are among the most liberal in Latin America.

to currency substitution. However, several studies contend that currency substitution itself has an impact on the rate of inflation, the trade balance, and exchange rate behavior. <sup>1/</sup> Georgiou (1991), for instance, argues that, in the long run and with flexible exchange rates, the rate of change of prices and of the exchange rate will be higher in the presence of foreign currency deposits in the domestic banking system. Even if one accepts that causality may run either way, it is interesting to note that in Bolivia the degree of currency substitution continued to increase rapidly during the second half of the 1980s, a time period characterized by low inflation and relatively stable macroeconomic conditions.

#### IV. An Econometric Model of Currency Substitution in Bolivia

This section provides a simple econometric model to analyze the determinants of currency substitution in Bolivia. Before delineating the model, the general line of analysis in previous research is discussed briefly.

Past research may be split into two basic categories: (i) time series models and (ii) structural models. Papers in the first category include Canto's (1985) analysis of the Dominican Republic <sup>2/</sup> that employs a transfer function time series technique, and Virén's (1990) work on the United States that uses a vector autoregressive approach. Most researchers have eschewed time series techniques and opted for fairly simple structural models. While diverse in scope, the usual starting point for these models is a standard money demand function; less frequently a portfolio optimization approach is chosen. <sup>3/</sup> Econometric testing often involves estimating a reduced form money demand equation. This approach is followed in Ortiz' (1983) study on Mexico, Ramirez-Rojas' (1985) study on Argentina, Mexico, and Uruguay, El-Erian's (1988) study on Egypt and the Yemen Arab Republic, and Rojas-Suarez' (1991) study on Peru.

The model presented in this paper is based on a simple structural model as proposed by El-Erian (1988), which in turn resembles the models used by Ramirez-Rojas (1985) and Rojas-Suarez (1991), with the exception that it adds a variable measuring interest rate differentials on deposits. The model we use views the degree of currency substitution as a function of exchange rate expectations, interest rate differentials, and a stock adjustment mechanism that is represented by a lagged dependent variable. Unlike previous research, we add a deterministic time trend to the model to better capture the inertia present in the process of currency

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<sup>1/</sup> See, for example, Georgiou (1991), Engel (1989), or Isaac (1989).

<sup>2/</sup> Also see Canto and Nickelsburg (1987).

<sup>3/</sup> See, for example, Marquez (1987) for a portfolio optimization approach to currency substitution with applications for the case of Venezuela, or Guidotti and Rodriguez (1991) for an application to Bolivia, Mexico, Peru, and Uruguay.

substitution. The paper utilizes monthly data from January 1986 to September 1991.

The general functional form of the model used in this paper is expressed as follows:

$$M_t = M_t(e_t^*, dr_t, M_{t-1}, \phi, T);$$

where:

$e_t^*$ ...exchange rate expectations in period  $t$ ;

$dr_t$ ...interest rate differential in period  $t$ ;

$\phi$ ....monthly dummy variables;

$T$ ....a deterministic time trend;

$M_t$ ....some measure of the degree of currency substitution in period  $t$ ;

$M_{t-1}$ ..lagged dependent variable used to capture stock adjustment.

The dependent variable is measured as the natural log of the share of foreign currency deposits in total broad money. The data are restricted to the domestic banking system, that is, foreign currency circulating as cash and foreign currency deposits abroad are excluded. <sup>1/</sup> As a result, the variables measuring currency substitution tend to underestimate its actual extent. This may create problems when a change in the legal or institutional environment takes place. For example, a policy change permitting foreign currency deposits to be held domestically may cause residents to shift part of their foreign currency deposits held abroad back to the domestic banking system. While the overall extent of currency substitution may not be affected, a narrow measure of currency substitution that is based only on the domestic banking system would show an increase in the degree of currency substitution. Hence, explanations of the causes of currency substitution that are based on narrow definitions are only valid, in a strict sense, under an unchanged legal environment. For the time period considered here, a significant change in the legal environment did occur in late 1987, when dollar checking accounts were first permitted. In addition, some of the dollarization experienced during 1986, the first year of our sample, may represent the lagged response of economic agents to the legalization of dollar deposits in 1985. The impact of these factors on our econometric model is assessed by running Chow tests to assess the structural stability of our coefficient estimates over time.

Following Ramirez-Rojas (1985), the expected change in the exchange rate is proxied by differences in monthly inflation rates. The difference

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<sup>1/</sup> Melvin and Afcha de la Parra (1989) have recently suggested an interesting way of establishing a proxy for total foreign currency circulation in Bolivia that is based on data on check clearing.

in monthly inflation rates, as measured by the Bolivian and U.S. consumer price indices, are used to construct this variable. Following the convention in the literature, we use a proxy for expected devaluation rather than the actual change in the exchange rate, so as to avoid simultaneous equation bias. This bias can arise from the fact that our left-hand variable measuring currency substitution depends on the actual exchange rate in time period  $t$ .

Interest rate differentials are measured by the difference between domestic and foreign currency deposit rates in the Bolivian banking system. Recent studies of currency substitution in Latin America have not included this variable. <sup>1/</sup>

#### V. Econometric Results

Table 1 presents the results from the model as applied to monthly data from Bolivia for the period January 1986-September 1991. <sup>2/</sup> The fit of the model to the underlying data is quite good, as all the equations show a high adjusted  $R^2$ . Both Durbin's  $h$ -statistic and the Ljung-Box  $Q$ -statistic suggest that first order autocorrelation is not a problem. Ljung-Box and Breusch/Godfrey tests for autocorrelation of up to twelve lags also suggest no problems with higher order serial correlation.

Consistent with the intuitive predictions of the currency substitution model, the results show a positive relationship between currency substitution, exchange rate expectations, and interest rate differentials. However, the coefficient estimates for these variables are quite small, with the exception of the stock adjustment variable. In equation (2), for example, the semi-elasticity coefficient of 0.372 for the exchange rate variable implies that, in the short run, a reduction in the expected monthly rate of devaluation by a full percentage point would decrease the ratio of foreign money in broad money by less than one percent (.372 percent). In terms of the ratio that prevailed in September of 1991, this implies that this change in the rate of devaluation would decrease the share of foreign currency in broad money from 76.8% to 76.5%. When one takes into account the long-run impact that occurs through the presence of the lagged dependent variable, the reduction is greater (1.7 percentage points), but is still quite modest. Similarly, the equation indicates that a decrease in the spread between dollar and boliviano deposits of 10 percentage points would, in the long run, decrease the share of foreign money by just 2 percentage points. Given the low inflation

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<sup>1/</sup> For example, see Ramirez-Rojas (1985) and Rojas-Suarez (1991).

<sup>2/</sup> Quasi-money is defined here as the sum of domestic and foreign currency denominated time deposits. Broad money comprises of quasi-money, bolivianos in circulation, and domestic and foreign currency denominated checking accounts. Data were obtained from the Central Bank of Bolivia.

Table 1. Bolivia: Estimates of the Determinants of Currency Substitution

Equation	Constant	Time Trend	Exchange Rate Expectation	Interest Rate Differ- ential( $10^3$ )	Stock Adjustment	Adj. $R^2$	Durbin's h-statistic	Q- statistic
(1) Coefficient	-0.079* (5.16)		0.450* (3.74)	0.002 (0.01)	0.931* (65.98)	0.994	0.144	0.080
(2) Coefficient	-0.204* (4.77)	0.002* (3.10)	0.372* (3.08)	0.365# (2.03)	0.821* (21.76)	0.996	-0.278	0.070
(3) Coefficient	-0.234* (5.24)	0.002* (3.77)		0.261 (1.37)	0.795* (20.11)	0.994	0.644	0.369
(4) Coefficient	-0.143* (4.55)	0.001* (2.28)	0.325* (2.67)		0.883* (37.65)	0.995	-0.237	0.055

Note: Equations are estimated in semilogarithmic form using OLS on monthly data from January 1986 to September 1991. See text for a description of individual variables. Values in parentheses are t-statistics. The coefficients on the monthly seasonal dummies are not reported. Adj.  $R^2$  is the adjusted coefficient of determination; Durbin's h-statistic is the alternative for the D-W statistic in the presence of a lagged dependent variable; the Q-statistic indicates the Ljung-Box Q-statistic test for first order autocorrelation. \* denotes significance of the coefficient at the 99 percent level of confidence; # denotes significance at the 95 percent level of confidence.

that Bolivia has experienced since 1986, the scope for further decreases in inflation or in the rate of exchange rate depreciation are certainly limited. Also, regardless of the scope for further policy action, the equations suggest that lowering inflation would not significantly reduce dollarization. Similarly, while interest rates on boliviano deposits are already positive in real terms, the low responsiveness of currency substitution to interest rate differentials suggests that further increases in real interest rates on boliviano deposits may not significantly lower the degree of dollarization in Bolivia.

The large coefficient for the stock adjustment variable implies that economic agents do not immediately and fully adjust their holdings to variations in relative yields of foreign currency balances. The average coefficient of 0.86 on the stock adjustment variable from the four equations in Table 1 implies that only 14 percent of the adjustment between desired and current stocks occurs instantaneously, that is, in the current month. Consequently, actual holdings in any given month have a strong effect on behavior during the following month. The high value for the stock adjustment variable is consistent with the relatively small coefficient estimates for the interest rate and exchange rate variables mentioned above. The high explanatory power of the lagged endogenous variable suggests strong inertia in the process of currency substitution in Bolivia and the difficulty in reversing this trend. This finding is supported by the significant coefficient for the trend variable, which also helps capture autonomous adjustments in the degree of dollarization that are not necessitated by changes in economic fundamentals.

The exclusion of the time trend from the model renders the interest rate differential variable insignificant (equation 1). This is due to the fact that, over the time period of our sample, the nominal interest rate differential was decreasing, while currency substitution was increasing. Holding the time trend and other explanatory variables constant, the interest rate differential variable is significant (equation 2).

One may question the inclusion of variables measuring both the interest rate differential and a proxy for expected devaluation in the same equation, as interest rate differentials themselves could be considered a proxy for expected devaluation. In the case of Bolivia, however, inflation differentials are a better proxy for expected devaluation, as revealed by the correlation coefficients between actual devaluation, inflation differentials, and interest rate spreads. The correlation coefficient of actual devaluation rates and inflation rates over the time period of our sample is 0.70, but for interest rate spreads and devaluation it is just 0.41. In either case, equation (3) provides a regression where the inflation differential (our proxy for expected devaluation) is excluded but the interest rate differential is included. Equation (3) reveals that when the inflation differentials variable is excluded from the model, the interest rate variable becomes insignificant.

While monthly inflation rates have been quite modest in Bolivia in the post-hyperinflation period (averaging 1.4 percent from February 1986



to September 1991), they have shown a great deal of variability. 1/ Because of the variability of inflation, it may be the case that economic agents are demanding a substantial risk premium for holding financial assets denominated in bolivianos. To evaluate the impact of this risk premium on dollarization, we ran regressions that included the standard deviation of inflation over the most recent six month period. 2/ Our results with these regressions yielded insignificant coefficients for the risk premium variable. We also attempted to capture the risk premium in alternative regressions with a "worst-case scenario" measure of expected devaluation. In these regressions, it was assumed that economic agents expected the Bolivian monthly rate of inflation to be the highest of the rates experienced in time period  $t$ ,  $t-1$ , or  $t-2$ , rather than the observed difference between Bolivian inflation and U.S. inflation in period  $t$ . Expected devaluation in time period  $t$  is thus measured as the difference between the highest Bolivian inflation rate in period  $t$  through  $t-2$  and the observed U.S. inflation rate in period  $t$ . Of course, this procedure does not truly capture risk premia, but it is reasonable if one thinks that Bolivians are prone to worst-case scenario thinking in the post-hyperinflation era. In any case, using the worst-case scenario measure of expected devaluation yielded coefficient values that were practically identical to those in Table 1. Thus, our regressions utilizing crude risk premium measures indicate that short-run changes in this premium do not play a part in explaining dollarization in Bolivia. 3/

The results in Table 1 indicate that changes in the relative yield of dollar and boliviano deposits have but a small impact on currency substitution. The robustness of these results was further assessed by running regressions that measure currency substitution in terms of the foreign share of quasi-money, rather than broad money. Since quasi-money only consists of interest-bearing assets, one would expect higher coefficient values on the explanatory variables than obtained in Table 1. However, the results are largely similar, with coefficients on the interest rate differentials not exceeding one thousandth of one-percent. 4/ Thus, one cannot attribute the low elasticities obtained in Table 1 to the inclusion of non-interest bearing assets in our dependent variable measuring currency substitution.

Given the upward trend in the degree of dollarization experienced by Bolivia during the late 1980s, the issue of data stationarity must be addressed. Regressions on nonstationary data can lead to "spurious" relations between the different variables, which implies that the obtained

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1/ The standard deviation of the monthly inflation rate from February 1986 to September 1991 is 1.7 percent.

2/ For the first six observations of our sample, the standard deviation was calculated over a smaller number of observations.

3/ This does not imply, however, that the specter of renewed hyperinflation is unimportant, in the long run, for explaining currency substitution in Bolivia. We return to this topic further on pages 15-16.

4/ Results are available from the authors upon request.

OLS regressions estimates are inconsistent unless the variables are cointegrated. Cointegration means that one or more linear combinations of these variables are stationary even though individually they are not.

Testing for cointegration involves two steps. In a first step individual variables are checked for stationarity; if variables are found to be non-stationary, a second step involves testing for a cointegrating relationship. The first step of the procedure involves testing for a "unit root," which basically means testing whether a regression of a variable  $z_t$  on  $z_{t-1}$  yields a coefficient of one. The test is complicated by the nonstationarity of  $z_t$  under the null hypothesis. Dickey and Fuller (1979) suggest various options for handling this problem. The results from Dickey-Fuller (DF) and augmented Dickey-Fuller (ADF) tests performed on the variables of the model are reported in Table 2. The Dickey-Fuller tests suggest that all the variables are stationary, with the exception of the interest rate differential; under the augmented Dickey-Fuller test all variables are shown to be stationary. Thus, given the stationarity of the data, our simple model may be accepted without further transformations.

Chow tests reveal the stability of our coefficient estimates over time. The structural stability of the model was also confirmed by testing for the significance of an intercept dummy variable capturing changes in the legal environment governing dollar deposits in Bolivia. This dummy variable took on the value of 1 for observations from January 1986 to November 1987, as in this time period dollar checking deposits were not permitted. The legalization of US dollar checking deposits in December 1987 made it possible to convert US dollar cash holdings into liquid US dollar bank deposits. Accordingly, one would expect the coefficient value to be negative. However, our regression results reveal this dummy variable to be statistically insignificant.

Following the success of the 1985 stabilization plan, Bolivia enjoyed a strong repatriation of foreign currency deposits (Table 3). However, after 1986 foreign currency deposits held abroad started to increase. Thus, the continued dollarization of the Bolivian financial system after 1986 probably cannot be attributed to capital repatriation, but rather to a real substitution of foreign currency for its domestic counterpart. <sup>1/</sup>

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<sup>1/</sup> Data from the IMF's Balance of Payments Yearbook also reveal no large increase in private capital inflows or private transfers, except in 1986 when the capital account showed a US\$127 million increase in "short-term capital of other sectors" (line 96). However, the Balance of Payments Yearbook attributes the entire increase to deposits into the banking system of foreign currency already in circulation. Given the reduction in foreign deposits held abroad by Bolivians (Table 3), there is strong reason to believe that some of the increase in dollar deposits can be explained by capital repatriation.

Table 2. Unit Root Tests for Bolivia  
December 1985 - September 1991

Variables	DF-Test	ADF-Test
Degree of currency substitution	-7.70 *	-9.51 *
Interest rate differential	-2.71	-8.84 *
Exchange rate expectation	-19.56 *	-8.97 *

Note: DF-Test is the Dickey-Fuller test; ADF-Test is the Augmented Dickey-Fuller Test. Critical values for the two tests are: -3.78 at the 99 percent level, and -3.11 at the 95 percent level as reported in Table II in Dickey and Fuller (1981). The null hypothesis is that the variable is integrated of order 1; the null hypothesis is rejected when the value of the test statistic exceeds the critical value. \* denotes a variable for which the null hypothesis is rejected.

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Table 3. Foreign Deposits Held Abroad by Bolivians, 1985-1991  
(Billions of US\$)

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1985	QI	0.37	1988	QI	0.34	1991	QI	0.46
	QII	0.42		QII	0.38		QII	0.46
	QIII	0.38		QIII	0.40			
	QIV	0.39		QIV	0.40			
1986	QI	0.39	1989	QI	0.45			
	QII	0.31		QII	0.44			
	QIII	0.23		QIII	0.46			
	QIV	0.21		QIV	0.54			
1987	QI	0.28	1990	QI	0.56			
	QII	0.25		QII	0.50			
	QIII	0.30		QIII	0.44			
	QIV	0.32		QIV	0.48			

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Source: International Monetary Fund, International Financial Statistics, various issues.

As noted, the econometric results in Table 1 suggest that short-run changes in the relative yields of different currencies were not the driving factors in Bolivia's dollarization from 1986 to 1991. As such, it is worthwhile to explore some alternative explanations for why Bolivians remain so reticent to hold boliviano-denominated deposits. A recent paper by Guidotti and Rodriguez (1991) provides a promising theoretical approach for understanding the dollarization process in Latin America. According to the authors, some insight can be gained by focusing on the transaction costs incurred by economic agents when they substitute one currency for another. Given non-trivial transaction costs, currency substitution is only likely to occur once domestic and international inflation differentials are sufficiently large. Because of these sunk transaction costs, however, dollarization may not be reduced after inflation rates fall from a period of high inflation. The empirical relevance of this idea for Bolivia and other Latin American countries is difficult to ascertain, as Guidotti and Rodriguez provide no data on the size of these costs. Furthermore, the fact that many ordinary consumer transactions in Bolivia are undertaken in bolivianos shows that economic agents appear quite comfortable in switching between foreign and domestic currency, and that these transaction costs are quite modest. The notion of sunk transaction costs may have more relevance at the institutional level, however, as it may explain why Bolivian financial institutions appear disinterested in attracting boliviano deposits in the post-hyperinflation era. Further research is needed to assess the relevance of transaction costs in explaining the behavior of financial institutions in the dollarization process.

Apart from further investigating links between transaction costs and dollarization in Bolivia, there are a number of interesting lines of research that merit further investigation. More work is needed to explore the formation of expectations in Bolivia. Inasmuch as relative holdings of different currencies is a function of their expected returns, we need to learn more about how economic agents in Bolivia form their expectations. Perhaps the high propensity to hold dollar-denominated assets may be explained by the fact that Bolivians are still quite mindful of the heavy cost to those who did not hold dollars during the hyperinflation of 1984/85. As emphasized by Pastor (1991), many Bolivians may feel that the current macroeconomic stability of their country is still fragile and far from permanent. Given that there is always some possibility that hyperinflation and the associated exchange rate devaluations may return, it is rational to guard against this by holding dollar-denominated assets. In addition, the fact that ex-post real rates-of-return on dollar deposits have actually been higher than those associated with boliviano deposits has provided ample incentive for Bolivians to shift into dollar-denominated assets. In the absence of any risk premium being paid for holding bolivianos, it is curious that the shift to dollars was not more rapid. The low coefficient values reported in Table 1 confirm the notion that economic agents do not quickly alter their holdings of different currencies in light of differential yields. It appears plausible to view the entire time period from 1986 to 1991 as a stock adjustment period, in which economic agents were gradually

transferring their wealth into dollar-denominated financial assets. The fact that dollarization was not instantaneous may be due to informational rigidities or the fact that it is costly (in terms of time and effort) for economic agents to switch financial assets denominated in one currency into another. 1/

Another possible explanation for dollarization may lie in the growth of illegal economic activity in the 1980s. Most observers agree that coca activity has contributed to dollarization. In particular, the high transaction costs of laundering coca earnings may help explain the high degree of currency substitution in countries like Bolivia and Peru. 2/ Still, the quantitative impact of illegal activity on the degree of dollarization is unknown. Finally, there is a need to assess whether or not the observed increase in dollar bank deposits represents currency substitution or simply a change in the composition of foreign currency holdings from cash to bank deposits.

#### VI. Concluding Remarks

The econometric results provided by this paper imply that currency substitution in Bolivia is likely to persist, even if substantial policy efforts are made to reduce inflation or increase interest rates on boliviano bank deposits. While economic agents do alter their holdings of foreign currency in light of expected depreciation and interest rate differentials, inertial factors appear significantly more important in determining currency substitution in Bolivia. Future research efforts should be directed toward understanding the forces behind this inertia, especially with respect to the formation of expectations and the role of financial intermediaries in the process of currency substitution. Future research could well benefit from measures of the money supply that include foreign currency in the hands of the public. Given the tentative state of our knowledge on dollarization in Bolivia, further study is warranted.

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1/ This point expands on the idea put forth by Guidotti and Rodriguez (1991), who emphasize the costs to economic agents of changing currencies. However, these authors only emphasize the costs of changing currencies for transaction purposes. As noted above, casual empiricism suggests that these costs are very modest in Bolivia.

2/ We are grateful to Vito Tanzi for this point. Also, see Melvin and Ladman (1991) for an attempt to link dollarization and the illegal economy in Bolivia.

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