The Kiel Institute for the World Economy
Düsternbrooker Weg 120,
D-24105 Kiel

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Financial Dollarization and Currency Substitution. An Empirical Study for Bolivia

by

Salvatore Dell'Erba and Martin Saldías Zambrana

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Abstract

The Bolivian puzzle is high and persistent financial dollarization notwithstanding deep macroeconomic stabilization that achieved stable and low inflation and the regulations encouraging domestic currency deposits. We analyze traditional and new approaches to explain dollarization in Bolivia. We first assess the currency substitution approach and then assess the empirical evidence for the financial dollarization approach. The results show that the macroeconomic variables capture only partially the phenomenon and a better assessment relies on other explanations such as the peso problem and the analysis of specific characteristics of the financial markets in Bolivia.

Keywords: Dollarization, Exchange rate regimes, Inflation, Bolivia
JEL Classification: E44, E59, G19

1. Introduction

There is a consensus in the literature about the negative effects of a high degree of financial dollarization in terms of constraints on the conduct monetary and exchange rate policies. Under a quasi-crawling peg regime, the scope for independent monetary policy and the scope of action against real shocks is quite limited due to unstable money demand and higher price elasticity to monetary shocks. In addition, there is a systemic risk of crisis for the financial sector in presence of currency mismatch, since exchange rate risk turns into credit risk (see Baliño et al., 1999, Levy Yeyati, 2005 and Morales, 2003).

The Bolivian economy is one of the highest dollarized countries within the group of partially dollarized economies. The foreign currency denominated sight deposits account for 35% of the narrow money aggregate and the overall foreign currency deposit[1] ratio to broad money is about 70%. If we consider the store of value component of this aggregate, the dollarization is almost complete (95,2% in October 2005).

The Bolivian puzzle is high and persistent financial dollarization notwithstanding the deep macroeconomic stabilization from the 1980s that achieved stable and low inflation and the regulations encouraging domestic currency deposits. The purpose of this paper is to analyze traditional and new approaches to explain dollarization in Bolivia. We first assess the currency substitution approach, i.e. the use of a foreign currency as a means of payments and unit of account, using the Clements and Schwartz (1993) paper as starting point. We then assess the empirical evidence for the financial dollarization approach, i.e. the holding by residents of foreign currency denominated assets and liabilities. This branch of the literature started in Ize and Levy Yeyati (1998, 2003) and has been already applied in cross-section data but not in a single country case, like the Bolivian one. The value added to the existent literature is the use of a cointegration framework to analyze jointly the currency substitution approach and to test the Minimum Variance Portfolio (MVP) model for the Bolivian case.

The paper is organized as follows. Section 2 provides a historical perspective of the real and the financial dollarization process in Bolivia. In Sections 3, we describe the currency substitution approach and the

[1] The broad money dollarization ratio is evaluated using the sight deposits, savings accounts and time deposits and other liabilities.

MVP Model used to explain financial dollarization, providing the theoretical support for our empirical work. Section 4 presents the variables of interest, provides the descriptive statistics and discusses some policies concerning dedollarization in Bolivia. Section 5 shows the results of our empirical investigation on the basis of the Clements and Schwartz and Ize and Levy Yeyati papers. Conclusions and some comments are in section 6.

2. Dollarization process in Bolivia

According to Morales (2003), the dollarization process in Bolivia started in the 1930s, after the Chaco War, when Bolivia abandoned the convertibility to gold and the American dollar started to be employed as unit of account for non-tradable goods and big assets such as machinery, vehicles and real estate. The process advanced after the inflationary periods form 1953 to 1957 and produced payments dollarization through long-term contracts denominated in dollars. Later on, in the 1960s, the dependence on foreign savings increased the degree of dollarization via loans payments and profit remittances to foreign direct investment. In the 1970s, due to the instability of the international financial system and in order to prevent capital flights to offshore deposits, time deposits denominated in dollars were allowed, increasing time deposits dollarization from around 20% to 44% between 1974 and 1979 (Antelo, 1996). However, Clements and Schwartz (1993) state that the Bolivian peso was predominant in all the functions of money until the late 1970s while Morales (2003) argues that already in the mid-seventies the degree of dollarization in all functions of money was significant.

In mid 1982, the government had inherited high fiscal deficits from the previous military governments. The debt service was already important and needed continuous inflows of foreign capital. Due to the international financial instability, the Bolivian government made extensive use of devaluations to adjust the fiscal balance, increasing the spread between the official and the parallel exchange rates, which progressively increased real dollarization. Moreover, due to a shortage in foreign currency reserves in the Central Bank, the public deficit was financed by monetary emission. By the second half of 1982, the year on year inflation rates began to beat 100% and was boosted by the interaction of many other elements. In 1984 the situation turned into hyperinflation, which peaked in September 1985 (23447%).

Already before the hyperinflation process, dollar deposits were being transferred abroad and in order to reduce the pressures on the exchange rate, the Bolivian government impeded in November 1982 by decree the dollar denominated deposits and established foreign exchange controls, leading to an increase of the black market in dollars. At the end of the crisis, the American dollar had replaced the Bolivian peso to a great extent as unit of account and medium of exchange for many purposes, as people distrusted their currency.

In the aftermath of the stabilization plan from August 1985, the financial system had shrunk and both deposits and loans in dollars were allowed again. There was a strong need for reserves and thus no minimum reserve requirements on dollar and dollar indexed deposits was imposed. This lead to a rapid increase of the deposits in dollars in the financial system until 1992-1994, when the share stabilized at high levels. In spite of the current high degree of financial dollarization, the wages and non-durable goods remain priced in Bolivianos.

3. Theoretical Framework

Currency Substitution Approach

The concept of currency substitution is one of the most ambiguous in economics (Giovannini and Turtleboom, 1992). For developing countries, this concept can be easily associated with periods of high and extensive inflation. In the presence of increasing and persistent opportunity costs in domestic currency holdings, agents shift their preferences to foreign money, which serves as a store of value, unit of account and medium of exchange (Morales and Reding, 2004). Many developing countries have faced and still face periods of extensive currency substitution, which is often referred to as “de facto” dollarization. The term dollar is used for matters of tractability, but equally applies to the use of foreign currency in the domestic economy. For a matter of precision, these definitions differ from the expression “official dollarization”, which consists in the adoption of the foreign currency as a legal tender, implying also the full convertibility of the domestic currency.

The literature has identified three possible aspects of the "de facto" dollarization, namely the payments dollarization, the real dollarization and the financial dollarization. The first definition refers to the use of a foreign currency for current everyday transactions. The second definition relates to the use of a foreign currency to price valuable and infrequently traded goods. The financial dollarization is the holding by residents of foreign currency denominated assets and liabilities. This concept provides an alternative view, which goes from the concept of currency substitution, to the concept of asset and liability substitution.

The traditional literature on currency substitution, somehow inconclusive in the empirical evidence, has provided valuable insights in the analysis of demand for foreign currency in excess of current use for trade and tourism purposes (Giovannini and Turtleboom, 1992). The demand for foreign currency can be triggered also by policy measures, which affect returns on holdings of domestic currency, or the expectations regarding future liquidity of domestic and foreign currency denominated balances.[2] This eventually ends up in the so-called reversal effect of Gresham's law, as pointed out in Guidotti and Rodríguez (1992).

The empirical analysis of currency substitution is extensive. It would be difficult to cite all the relevant approaches used, and would certainly go beyond the scope of the paper. We can say that there exist two main strands: one is the building of time-series models; another one is the use of structural models. In particular, in the case of developing countries, the main similarities between these studies are weak theoretical foundations. As stated in Brand (1993), the standard starting point is a general money demand function, of the form

$$\frac{M_t}{M_t^* e_t} = M_t(i_t^*, i_t)$$

[2] For an extensive analysis of dollarization in the Latin American context see Calvo and Végh (1992) or Savastano (1996).

where the current money holding is a function of domestic (i) and foreign interest rate (i*). This simple money demand function, implicitly assumes that interest rate parity condition holds, i.e. $i_t = i_t^* + \varepsilon$, where ε stands for the expected depreciation of the exchange rate.

Portfolio Approach or Minimum Variance Portfolio Model

One of the puzzling aspects of the dollarization phenomenon, especially in the Latin American countries like Argentina, Peru and Bolivia, is the behaviour of foreign currency deposits after the positive experience in the reduction of inflation during the 1990s. In spite of single digit levels of inflation, the level of dollarization has remained significantly high and persistent. This evidence lead to the development of this asset substitution view.

Ize and Levy Yeyati (1998, 2003) present a portfolio selection model to explain financial dollarization. The main difference between this model and the previous ones in the portfolio dollarization literature is the interaction of loans and deposits to determine the degree of financial dollarization. Under the assumption of uncovered interest rate parity, risk-averse residents in bi-monetary economies minimize the variance of the returns of their portfolio. A higher inflation rate volatility increases the domestic currency debt payments and the deposits risk, affecting the real returns, raising the dollarization degree in the financial system. By contrast, dollarization is reduced by a higher volatility of real devaluation, due to the reduction the hedging benefits of loans denominated in foreign currency and the real returns of deposits. They conclude suggesting that, in general, the combination of inflation targeting and a floating exchange rate regime would discourage the holdings foreign currency assts and liabilities and increase the share of local currency in the financial system.

4. Variables Description

In this section we present and describe the two dollarization ratios we compute to be the endogenous variables that measure the degree of financial dollarization in Bolivia. The explanatory variables are the

Bolivian and USA CPI inflation differential, the interest rate differential of domestic and foreign currency denominated savings deposits and the underlying dollarization ratio from the MVP model.

Dollarization Ratios

In the currency substitution literature, the dollarization ratio is measured by using financial dollarization ratios, since it is not feasible to determine the amount of foreign currency notes in an economy. Melvin and Ladman (1991) argue that there is no information on the dollar currency in circulation and its quantity depends on illegal activities such as drug trade. Feige and Dean (2004) argue that the right different measures of dollarization depend on whether currency substitution, asset substitution or simultaneously both take place.

In the financial dollarization approach, there is no need for proxy variables, since the financial dollarization ratios can be extracted from the money aggregates series published by the Central Bank of Bolivia. It is worth emphasizing that until 1996 the overall series took into account only the banking sector and in 1997 data from other financial institutions were incorporated. The small financial institutions generally showed higher dollarization ratios than banks but their portfolio is much smaller, so, their inclusion did not represent a structural break.

We constructed two dollarization ratios out of the components of the money aggregates. In the Bolivian financial sector there are four denominations for financial assets. We used the Bolivianos accounts and the "UFV accounts" as domestic currency deposits and the dollars and the Bolivianos with adjusted dollar parity as foreign currencies deposits.[3] Narrow Money Dollarization Rate (NMDR) refers to sight deposits and the Broad Money Dollarization Ratio (BMDR) refers to sight deposits, savings deposits and term deposits and other liabilities. The detailed construction procedure is summarized below and two graphs are presented in the Figure 1 in the Appendix.

[3] The Unidad de Fomento a la Vivienda (UFV) was introduced in 2002 as an index that uses the CPI as reference and whose aim is to substitute the dollar as reference for indexation in presence of inflation expectations. It is possible to denominate savings accounts and time deposits and other liablilities in this currency, whose returns are value added tax and financial transactions tax exented.

DOLLARIZATION RATIOS FROM THE MONEY AGGREGATES

Money aggregates

$$M1 = N + SD_{DC} \qquad M'1 = N + SD_{DC} + CD_{FC}$$
$$M2 = N + SD_{DC} + SA_{DC} \qquad M'2 = N + SD_{DC} + CD_{FC} + SA_{DC} + SA_{FC}$$
$$M3 = N + SD_{DC} + SA_{DC} + TD_{DC} \qquad M'3 = N + SD_{DC} + SD_{FC} + SA_{DC} + SA_{FC} + TD_{DC} + TD_{FC}$$

Then

$$NMDR = \frac{M'1 - M1}{M'1} \qquad BMRD = \frac{M'3 - M3}{M'3}$$

Where

N are domestic currency notes and bills in circulation

SD are sight deposits

SA are savings deposits

TD are time deposits and other liabilities

DC is domestic currency (Bolivianos and UFV)

FC is foreign currency and Bolivianos with adjusted parity

All the ratios are at high levels for most of the time, placing Bolivia among the highest dollarized economies. According to the descriptive statistics reported in Table 1 in the Appendix, the degree of fluctuation of the dollarization ratio is lower when the store of value component is included and remains at high levels regardless the real cycle. The Central Bank claims that the degree of transactions dollarization has decreased in recent years because of government policies concerning prices and wages (Morales, 2003). Since NMDR is the closest measure to transactions, this assumption is plausible.

Both ratios show a clear upward trend until the first half of 1994. We call this period "adjustment period". It represents the period when the inflation rate was gradually reduced after the stabilization program introduced in 1985. Some authors argue this trend is partially explained by the capital repatriation, flowing directly to foreign currency deposits. Yet the BMDR does not follow this trend for the period of analysis, but according to the Central Bank's annual reports (Banco Central de Bolivia, Memoria), there was a strong increase in time deposits, specially in foreign currency and short maturity deposits already in 1985 and 1986. As provider of store of value, the term deposit dollarization is closely linked to financial sophistication and financial market liberalization (Calvo and Végh, 1992) and to this respect, Bolivia is still underdeveloped. The sight deposits in dollars were permitted only in 1987, which explains the lag in the NMDR increase in relation to the one of BMDR.

However, a remarkable feature of these series is the sharp fall they exhibit since mid 2004. Although this part of the sample is excluded from the empirical analysis, because it alters the estimation reliability, there are four factors explaining this facts and they are related to direct Central Bank market-friendly de-dollarization policies. The first one is the introduction of the Unidad de UFV in 2002 as financial innovation into the financial system that provided higher real returns than the dollar deposits for time deposits and savings deposits. However, we found that only after April 2004 savings deposits started being denominated in this currency. Moreover, the Central Bank removed reserve requirements for time deposits in Bolivianos to increase the role of the domestic currency as store of value. The third and most important driver is the introduction of the Financial Transactions Tax (FTT).[4] This tax was the result of the coordination of the monetary authority and the central government and succeeded in lowering the ratios because the fiscal exemptions are not applicable to dollar denominated credit/debit operations. Finally, from 2005, the central bank increased the bid-ask spread of the exchange rate from two up to six cents and then ten cents, increasing the transaction costs of operations in dollars, and discouraged foreign currency loans via changes in the open market intervention. This examples prove that there might be some chance to increase the scope of monetary policy in a highly dollarized economy.

The Interest Differentials in Bolivia

In this section, we present some features of interest rates in Bolivia, since the spread between the one applied on domestic currency and the other applied on dollars are explanatory variables of financial dollarization in this paper. In the literature, the interest rates differential is a forward-looking variable and is often used as a proxy of depreciation. We use it following Clements and Schwartz (1993) and introduce it as well in the cointegration framework.

[4] The Financial Transaction Tax (Impuesto a las Transacciones Financieras) was introduced in July 2004 and taxes every financial transaction above 1000 USD at a 0.3% rate. It was created for Government revenue purposes and the Bolivianos and UFV deposits are exented, in order to encourage de-dollarization in the financial sector.

The monetary authority regulated the interest rates until 1985. Since 1986 the banks are allowed to set their own interest rates in all currencies and the amounts of loans. Further financial reforms were run in the aftermath of the stabilization plan concerning supervision and control.

Following the liberalization, the interest rates of the financial system in Bolivia remained at high levels. The main cause of this phenomenon was the uncertainty and the incomplete credibility of the success of the structural reforms, which increased the risk perception of the economic agents and so the spread between assets denominated in Bolivianos and dollars. Spread has been reduced since 1993-1994 and at present this spread is at historical minimum levels (see Figure 2 in Appendix).

Ferrufino (1993) argues that one important driver of the interest rates in Bolivia is the insufficient credit risk management of financial institutions, which is closely related to the share of non-performing loans. The financial institutions partially hedge risks by increasing the interest rates of loans, especially in smaller financial institutions. Nina (1995) highlights also that the Bolivian financial system lacks of futures markets and suffers from asymmetric information and imperfect competition. Some other determinants of the interest rates are the lack of experience of banks in a deregulated environment, the short maturity of the time deposits and high transaction costs (Roy, 1998).

Inflation Differential

The inflation differential is a variable often used in the currency substitution literature as a proxy for exchange rate depreciation expectations (Clements and Schwattz, 1993 and Civcir, 2003). This variable has a clear downward trend for Bolivia since the structural reforms in the aftermath of the hyperinflation crisis (See Figure 2 in Appendix).

In addition to sound macroeconomic policies, the exchange rate policy targeted the real exchange rate via managed floating regime after 1985 and a quasi crawling peg, later on. Hence, the differential between the Bolivian and U.S. year-on-year CPI inflation rates plummeted. Moreover, after the late 1990s economic crisis, it was even negative. Although recently it picked up, low and stable inflation differential remain.

Underlying Dollarization Ratio

To tests empirically whether the MVP model can explain actual financial dollarization the Ize and Levy Yeyati (1998, 2003) derived an analytical expression called Underlying Dollarization Ratio (UDR), which is the following:

$$UDR = \frac{\sigma_{\pi}^{2} + \sigma_{\pi,RD}}{\sigma_{\pi}^{2} + \sigma_{RD}^{2} + 2\sigma_{\pi,RD}}$$

where

σ_{π}^{2} is the variance of the inflation rate

σ_{RD}^{2} is the variance of the real depreciation

$\sigma_{\pi,RD}$ is the covariance of the inflation and real depreciation rates

The underlying dollarization ratio used in this analysis is constructed using the six-year rolling variances and covariance of the inflation and the real depreciation rates and is denoted as UDR6. The inflation rate is the monthly year-on-year rate of change of the Consumer Price Index (CPI) and the real depreciation is computed subtracting these inflation rates from the monthly year-on-year rates of change of the nominal exchange rate.[5] Robustness test verified that the econometric results can be significantly affected by different length of the moving windows used in the calculation of the underlying dollarization ratio. The main results of this paper use the six-year moving window for the comparison purposes with those of previous studies.

However, in the constructed 6-year UDR the downward trend in the ratio is evident (Figure 2). The first part of the series is affected by the gradual reduction process of the inflation rate after 1985. The increase of this ratio is also reported in Ize and Levy Yeyati (1998, 2003) as a consequence of the adoption of the crawling-peg exchange rate regime that reduced the fluctuation of the real exchange rate. The Central Bank changed the exchange rate policy in June 1994, enlarging the set of currencies of reference to target the real exchange rate. Moreover, since June 1997 the six-year variance of the real depreciation is higher than

[5] The CPI data were obtained from the National Institute of Statistics (INE) and the exchange rates series from the IFS database.

the one of the inflation rate and the covariance turned gradually smaller. Hence, the ratio declined and presents negative values for the most recent part of the sample.

5. Empirical Results

In this section we present first the test of the currency substitution approach in Clements and Schwartz (1993) in a single equation framework and assess its reliability in explaining also financial dollarization. Then, the same analysis is developed in a cointegration framework, in order to amend the single equation limitations. Finally, we discuss and present briefly some other empirical applications of the other potential arguments claimed in explaining financial dollarization in Bolivia, i.e. the peso problem and network externalities.

Single Equation Results

The currency substitution phenomenon in Bolivia has been analyzed in a work by Clements and Schwartz (1993). Using an similar approach to the one described in Section 3, they use the following specification

$$CSR_t = CSR_t(\varepsilon_t^*, dr_t, CSR_{t-1}, \phi, T)$$

where

CSR_t represents the currency substitution ratio in period t

ε_t^* represents the exchange rate expectations in period t

dr_t represents the interest rate differential in period t

ϕ is monthly dummy variables

T is a time trend

One aim of our investigation is to update and assess the results obtained in the Clements and Schwartz paper, with an extended dataset. It is interesting to check the robustness of the results obtained by the authors in a period of prolonged low and stable inflation, as has been the case for Bolivia in the 1990s. We use the same dependent variable used in their work, i.e. the natural log of the share of foreign currency deposits in total broad money[6] (BMDR). In addition, the same analysis is performed for the narrow money dollarization ratio (NMDR). The idea is to assess a financial dollarization in addition to currency substitution, which depends on the inclusion of the less liquid assets in the money aggregates used in the ratios.

A natural arising question is the interpretation of the regressors. Inflation differential is a proxy used to capture the expected depreciation of the Boliviano. Given the interest rate parity condition to hold, the interest rate differential could serve the same result as a proxy. In the case of Bolivia, Clements and Schwartz (1993) argue that the inflation differential is a better proxy, due to a higher correlation with actual devaluation than with the interest rate spread, and we follow this assumption and include both variables. To extend the analysis to the concept of financial dollarization, the relevant endogenous variable is BMDR, since the NMDR is a better proxy for the currency substitution approach (Feige and Dean, 2004).

In Table 2 (see Appendix) we report the results obtained from ten single equation estimations of the dollarization model that uses BMDR as dependent variable in each of the two subsamples: January 1989 – June 1994 and July 1994 – April 2004. The regressors are: the interest rate differential between savings deposits in domestic and foreign currency (IRSDIF); the differential between USA and domestic inflation rates (INFDIF); the underlying dollarization ratio (UDR). A linear trend is considered for both subsamples and a quadratic trend is used in the second subsample. The stock adjustment is the lagged regressor of the dependent variable, in order to capture the persistence of the dollarization phenomenon.

A striking feature of the results is the sign of the coefficient of inflation differential, which is negative in both subsamples, a strongly counterintuitive result, even though it is in most cases statistically insignificant (only for two models in the second subsample). During the 1990s the inflation differential has steadily decreased, to a level fairly below 5%. The relative volatility of inflation over real depreciation has been

[6] A similar model has been recently replicated by Reding and Morales (2004), where the authors were more interested in testing for the presence of network externalities in the Bolivian dollarization.

approximately around zero, and the power of the inflation differential in predicting depreciation has been reduced.[7]

Another worth mentioning result is the constant significance and, specially, strong magnitude of the adjustment coefficient, which reveals the strong persistence in the dollarization phenomenon in Bolivia. The estimated coefficients for the interest rate differential show the same problem of the coefficients of inflation differential and are significant only in absence of the interest rate differential. The underlying dollarization ratio has no explanatory power in the first subsample and shows a negative sign. In the second subsample, the results are just in some cases consistent with the theory. The inflation is still insignificant.

The specification of these models for the NMDR is the same in the first sample. In addition, an AR(1) term was needed in the second subsample in order to eliminate serial correlation. The results are reported in Table 3 (see Appendix) and are similar to the results commented above. It is noteworthy that the stock adjustment coefficient turns negative in presence of the autoregressive term, but remains strongly significant. The inflation differential and the interest differential do not provide additional explanatory power and the underlying dollarization ratio is significant in absence of the trends but also negative.

These results do not differ much from those in Clements and Schwartz (1993), i.e. strong persistence, low significance of other explanatory variables and high goodness fit. Moreover, the F-test for global significance is high and hence colinearity is very likely. Finally, the unit root tests described below show non-stationarity in all variables. Our conclusion is that the results in a single equation framework are likely to be unreliable and spurious.

Financial Dollarization Analysis in a Cointegration Framework

The behaviour of the time series seems non stationary. In order to test this, we used augmented Dickey Fuller (ADF), Phillips-Perron and KPSS tests in the two subsamples. The lag length in the ADF tests was

[7] The authors report a correlation of .70 for inflation differential and nominal depreciation, and .41 for interest rate differential and nominal depreciation. In our sample (January-89- April 04), they are respectively .52 and .45.

automatically determined by the Schwarz information criterion. The results of the tests are in Table 4 in the Appendix.

In both subsamples, during the adjustment period, the inflation differential, NMDR and BMDR exhibit a constant trend. After the financial system liberalization, the savings interest rate differential started a downward trend, but it is not so clear before 1994 because of the uncertainty of the financial markets in Bolivia following the reform in 1985. The Underlying Dollarization Ratio (UDR) shows the same behaviour. These tests lead to reject the stationarity of all the variables analyzed. Only the NMDR is stationary in the second subsample. Although not reported, the rest of variables is integrated of order one.

The cointegration approach is an interesting analytical and econometric framework to detect long-run equilibrium relationships between integrated economic variables. In this section we test for cointegration according to the procedure developed by Johansen (1988, 1991) and Johansen and Juselius (1990).

In order to test for the number of cointegrating relationships, these approaches provide two different procedures, namely the Trace and Maximum Eigenvalue tests. Table 5 reports the results for the cointegration tests estimated in the first sample on NMDR, IRSDIF and INFIDIF. The number of lags selected was two according to different selection criteria. Both statistics find one cointegrating equation. The next step consists in the estimation of a Vector Error Correction (VECM) following the procedure outlined by Johansen (1995), which merges the concepts of cointegration and error correction in a multivariate vector autoregressive (VAR) modelling framework. Johansen approach is superior to single equation estimation, in that the explanatory variables are initially treated as endogenous.

Table 5 reports the results for the cointegrating vector, which can be interpreted as the long-run equilibrium relationships in the data, while the table "Adjustment Parameter Vector" reports the loading coefficients of the α vector, which determines the speed of adjustment towards equilibrium.

The results clearly show the statistical significance of the variables, once a trend both in the cointegrating equation and the VAR was included. The reported values of the semi-elasticities for the coefficients are consistent with the findings of Clements and Schwartz (1993). The adjustment parameter vector reveals the insignificance of the loading coefficient of the interest rate differential, which could be interpreted as a sign of weak exogeneity of this variable in the system. However, the negative sign of the constant in the estimated vector reveals the presence of misspecification. The possibility is that the two variables included in the system, INFDIF and IRSDIF, have the same explanatory power, because they both serve as a proxy for expected depreciation. The argument goes, if they are equivalent, their coefficient should be the same.

The Johansen (1995) procedure allows for testing for restrictions on the long- and short-run dynamics ex-post. Johansen (1995) proposes a likelihood ratio test that can be used to statistically assess the validity of linear restrictions imposed on the estimated parameters. The imposed restriction is statistically significant, as shown in Table 5. The parameter then have both the expected sign and are statistically significant. Their magnitude is then in the range found by Clements and Schwartz.

To check for the robustness of the results, we estimated the same cointegrating relation in the second sub-sample. We remind in this section, that UDR was not considered in the estimation of Narrow Money dollarization, as we consider Broad Money a more powerful indicator of financial dollarization and portfolio selection. In Table 6, we report the estimations of the cointegration test, the β and α vector for the second subsample.

The table reports one cointegrating equation. The estimated beta vector shows this time, that IRSDIF holds, while INFDIF is significant but with the negative sign. This is not a surprise, since the idea of dividing the sample was pursued to consider the structural break caused by the adjustment of monetary policy by the Central Bank. We believe that this negative sign can be interpreted as a lack of credibility in the new policy pursued by the Central Bank.

The results show also in the adjustment parameter vector, the insignificance of both IRSDIF and NMDR. We test for the weak exogeneity hypothesis of these two variables imposing zero restriction on their coefficients in the α vector. The LR test confirms the hypothesis, and interestingly, the IRSDIF long-run coefficient becomes consequently less significant. The conclusion from the estimation of NMDR, is that the currency substitution approach to dollarization still explain the behaviour of the first subsample, but fails to find a strong explanatory power in the second one, after macroeconomic conditions stabilized.

The second part of the analysis in the cointegration framework is concerned with the portfolio approach to financial dollarization, hence the dependent variable is the Broad Money Dollarization Ratio (BMDR). In the first subsample we found one cointegrating equation (see Table 7 in Appendix). We estimated a VECM first using three variables (BMDR, IRSDIF and INFDIF) and a trend. The estimates of IRSDIF and INDIF are in this case significant but show the opposite sign, while the contrary is valid for the linear trend. The adjustment parameter vector suggests that IRSDIF does not play a role in the adjustment process. A restriction of same coefficients for IRSDIF and INFID is tested and cannot be rejected, and thus, these variables may contain the same information, contrary to Clements and Schwartz (1993) presumption.

If the UDR is included in the VECM (see set of equations 4 in Table 8), in order to test the MVP model, we find as well one only cointegrating equation. The cointegration parameter shows long-run significant long run effects of all variables and in accordance to the theory. The exception is IRSDIF again. Moreover, the adjustment process is only on the UDR.

Table 8 reports the results of the cointegration test and the subsequent estimates from the VECM, considering BMDR, IRSDIF and INFIDIF in the second subsample. The presence of one cointegrating equation is not rejected. The long-run coefficients appear to be almost insignificant for IRSDIF and significant for INFIDIF, but again with the negative sign. The magnitude of both is very low, and the restriction of zero long-run effect of IRSDIF is not rejected by the LR test, pointing out that the traditional currency substitution approach is not powerful in explaining current patterns in Bolivian dollarization phenomenon.

The second step was to add the UDR variable, to check for the alternative explanation proposed by the literature (see results in Table 8). There is one cointegrating relation found, but the result from the VECM show that only the inflation differential is the significant explanatory variable, the UDR is almost zero with the incorrect sign. The adoption of restriction, clearly points in the direction of a very parsimonious model, where actually up to five variables can be excluded, leaving the estimated VECM with just one structural variable, again the downward trending inflation, conflicting with a rising dollarization.

To this point, it is noteworthy to state that neither the currency substitution nor the MVP model could be reliably assessed in a single equation framework and the cointegration framework has no univocal results. The dollarization phenomenon in Bolivia had a strongly hysteresis and thus the empirical econometric assessment is proved to be highly awkward. Hence, other explanations in the literature arose to tackle this shortcoming, i.e. the peso problem and the network externalities generated by financial markets malfunctions.

"Peso" problem and Other Explanations for the Dollarization Phenomenon in Bolivia

According to IMF (2003) and Morales (2003), dollarization could be an outcome of a lingering peso problem. The agents' rational forecasts of discrete events, could drive up the spread of interest rates, fostering the current pace of dollarization, no matter how the current macroeconomic situation is in deed. This is somehow what appears from the econometric results. A backward-looking variable as the underlying dollarization ratio fails to explain the current dollarization ratios, because it fits better in normal conditions, where hedging portfolio strategies are conducted in a more stable expectations environment. In the Bolivian case, people still continue to anticipate discrete change in the distribution of economic determinants of the current exchange rate regime that will lead to depreciation (Morales, 2003). This is also the reason why there is a negative correlation with the inflation differential, which is somehow a further evidence of the low credibility attached to the Central Bank monetary policy.

Following Morales (2003), the possible presence of a peso problem in Bolivia could be tested by the following equation, which is a version of the interest rate parity condition.

$$\ln\frac{1+i_{t-12}}{1+\pi_t} = C(1) + C(2)\ln(1+i^*_{t-12}) + C(3)\ln\frac{1+d_t}{1+\pi_t}$$

where *i* stands for the interest rate in domestic currency; *i** stands for the interest rate in foreign currency; π the rate of inflation and *d* is the nominal depreciation.

Table 9 (see Appendix) reports the resulting estimation from the previous specification. The test shows rejection of the null hypothesis, implying the validity of the peso problem. The Durbin-Watson statistics reveal the presence of autocorrelation in the residuals, which makes the results less robust and the underlying peso problem therefore more binding. There is a problem with the data due to the presence of a strong non-linearity in the behaviour of the series adopted, as reported in Morales (2003).

The analysis so far served also as an illustrative purpose on the inherent difficulties in the empirical analysis related to the currency substitution and dollarization issue. We believe that the UDR effectiveness in adding explanatory power to financial dollarization is greater in a cross country analysis, and turns weaker in a single country framework for construction reasons, since a moving window is needed. However, other portfolio balance considerations have support of other theoretical models (see Cuddington et al., 2002 and IMF, 2005) and are related to some characteristics of the Bolivian financial market that cannot be captured by the macroeconomic variables we used in our analysis, i.e. the implicit guarantees of the banking system shouldered by the central bank, the absence of an effective bankruptcy framework, the intermediation costs and the thin financial market. Altogether, these factors distort perception of cost of dollar borrowing and the risk of currency mismatch and thus, stimulates financial dollarization.

9. Conclusions

The purpose of the paper was to explain the behaviour of Bolivian dollarization and to find possible explanations for its extremly high level. In order to carry out this analysis, we have gone through an assessment of the relevant theories that have been recently developed to provide an explanation to the puzzling persistency of high dollarization level, notwithstanding the macroeconomic efforts of Central Bank in keeping inflation both low and stable. The Ize and Levy-Yeyati Minimum Variance Portfolio theory provides a valuable benchmark to assess the plausible level of dollarization in this case. The analysis of the MVP was conducted without neglecting the traditional currency substitution view, which has been extensively used in the Latin American context.

The empirical evidence provided the failure of both the MVP and the traditional currency substitution variable to explain the Bolivian dollarization process. Following Morales (2003), a plausible explanation has been found in the presence of a strong peso problem in the Bolivian economy, which currently affects the interest rate spreads on deposits, one of the main explanatory variable of the current dollarization.

These results have shown some strong econometric problems in the time series treatment. In particular, non-linear relations, colinearity and non stationarity of time series, were among the main shortcomings. Therefore a cointegration analysis has been implemented to test the MVP theory and the results showed similar problems. The final result confirmed again the failure of the MVP to explain significantly the dollarization,.

We previously highlighted the importance of the peso problem as a possible explanation for the failure of the MVP model in explaining financial dollarization in Bolivia. Castro and Morón (2005) argue on a similar ground for Peru that the decrease in the volatility of inflation relative to that of the real exchange rate in the second part of the 1990s was relatively faster than the decline in observed dollarization ratios, opening a gap between observed and predicted measures. From the high level of the 1980s, the ratio has declined fast, until the crisis of the late 1990s. After that, it is approximately below the unity, making it a plausible hypothesis that the Bolivian Central Bank is following an implicit inflation targeting.

The relatively underdevelopment of Bolivian financial markets and some malfunctions of the financial system regulatory framework are certainly other factors explaining the broad use of time deposits as a store of value function. The recent effort of the Central Bank towards a market-friendly dedollarization strategy through UFV, FTT and the increase of costs in dollar deposits has been proved significant in lowering the ratios. This is an important evidence, but it still seems to be a big challenge due to the problematics that peso problem considerations still add to the inherent financial fragility of the Bolivian economy.

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APPENDIX. Figures and Tables.

Figure 1. Dollarization Ratios.

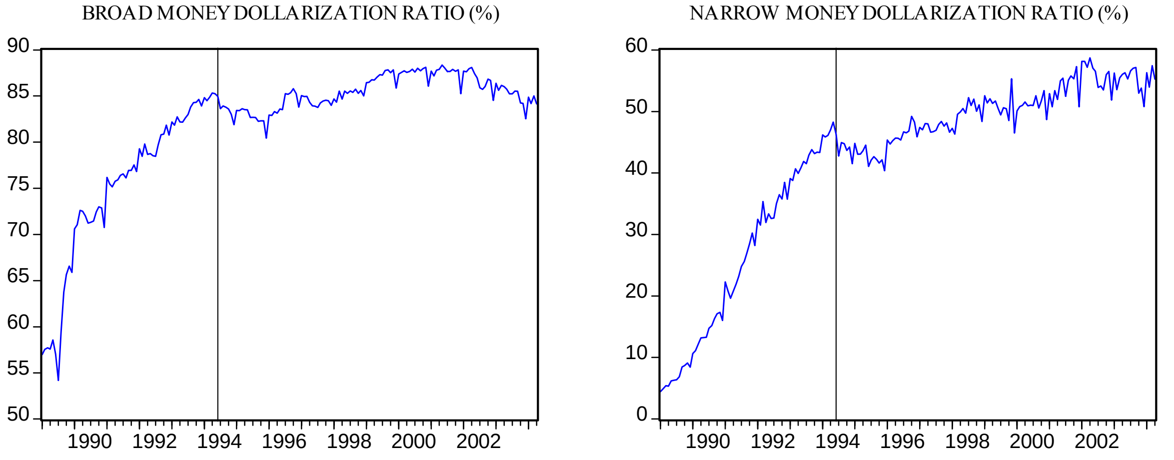

Figure 2. Explanatory Variables.

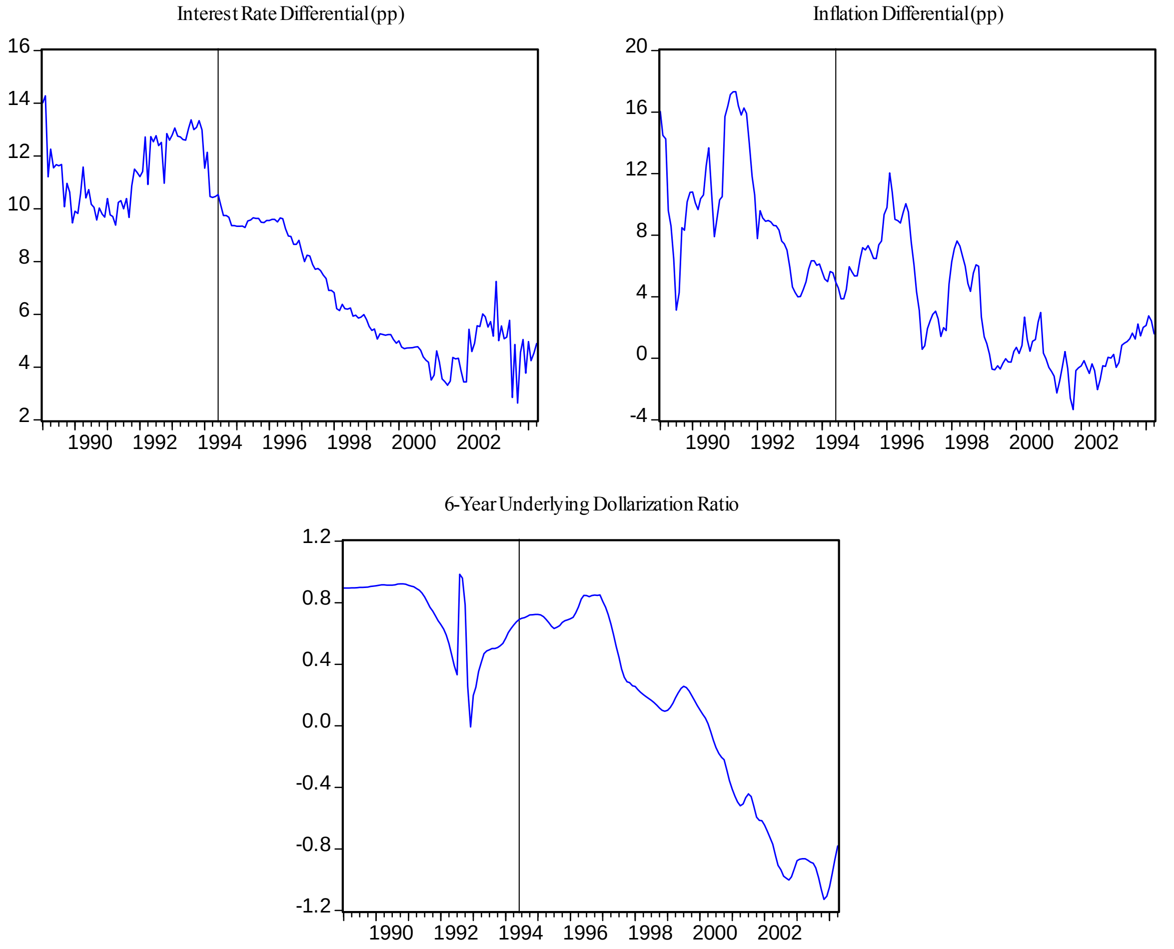

Table 1. Descriptive Statistics.

	BMDR	NMDR	IRSDIF	INFDIF
Mean	81.8	41.6	8.2	5.2
Median	84.3	46.6	9.0	5.0
Maximum	88.3	58.7	14.3	17.3
Minimum	54.2	4.4	2.6	-3.3
Std. Dev.	7.2	14.6	3.0	4.8
Skewness	-2.0	-1.2	0.0	0.6
Kurtosis	3.9	0.4	-1.3	-0.3
Obs	184	184	184	184

Table 2. Single Equation Estimation Results. BMDR.

Estimates of determinants of dollarization in Bolivia - Sample: 01-1989 to 06-1994

Equation		Constant	Interest rate differential	Inflation differential	Stock Adjustment	Underlying Dollarization	Trend	Adjusted R2	nR2
1	Coefficient	0.3428	-0.0009	-0.0009	0.9312				15.0994
	t-statistic	4.127*	-0.4379	-1.4466	50.5529*			0.9812	0.2360
2	Coefficient	0.6673	-0.0019	-0.0003	0.8505		0.0006		12.9283
	t-statistic	3.0038*	-0.9231	-0.3972	15.6104*		1.5713	0.9817	0.3743
3	Coefficient	0.2913	0.0006		0.9372				19.3949
	t-statistic	3.8417*	0.3851		51.7039*			0.9808	0.0794
4	Coefficient	0.6995	-0.0017		0.8409		0.0007		18.0950
	t-statistic	3.4093*	-0.8573		17.3437*		2.1305*	0.9820	0.1128
5	Coefficient	0.3344		-0.0008	0.9306				19.6614
	t-statistic	4.1701*		-1.4439	51.0628*			0.9815	0.0738
6	Coefficient	0.6266		-0.0001	0.8588		0.0005		17.1217
	t-statistic	3.1483*		-0.1752	16.9882*		1.4471	0.9830	0.1451
7	Coefficient	0.3688			0.9232	-0.0131			18.4859
	t-statistic	3.693*			42.0563*	-1.1732		0.9812	0.1017
8	Coefficient	0.3768			0.9176	-0.0058	0.0002		16.9602
	t-statistic	1.9550*			19.0188*	-0.4011	0.6629	0.9760	0.1511
9	Coefficient	0.2654	-0.0018	-0.0002	0.9471	-0.0091			16.4505
	t-statistic	1.7358**	-0.5844	-0.2850	31.984*	-0.4395		0.9662	0.1715
10	Coefficient	0.8536	-0.0035	-0.0002	0.8056	-0.0063	0.0009		14.9828
	t-statistic	3.1811*	-1.2707	-0.2067	12.6567*	-0.3542	1.9477**	0.9747	0.2424

Variables are estimated in levels for monthly data. The dependent variable is the natural logarithm of BMDR expresed in percentage points.
* Indicates significance of the variables at 5%. ** Indicates significance of the variables at 10%. nR2 is the Breusch-Godfrey serial correlation LM test statistic (order 12), p-value is below. Coefficients of seasonal and impulse dummies are not reported.

Estimates of determinants of dollarization in Bolivia - Sample: 07-1994 to 04-2004

Equation		Constant	Interest rate differential	Inflation differential	Stock Adjustment	Underlying Dollarization	Trend	Trend Squared	Adjusted R2	nR2
1	Coefficient	0.3204	0.0002	-0.0008	0.9333					14.1870
	t-statistic	1.5057	0.9733	-1.7778**	19.6006*				0.9312	0.2889
2	Coefficient	0.7951	-0.0011	-0.0002	0.8188		0.0006	0.0000		12.6703
	t-statistic	3.654*	-1.6186	-0.7939	16.4878*		2.7423*	-3.1132*		0.3935
3	Coefficient	0.3900	-0.0007		0.9176					18.5064
	t-statistic	2.1833*	-1.9336**		23.0155*				0.9421	0.1012
4	Coefficient	0.7086	-0.0011		0.8385		0.0005	0.0000		14.0331
	t-statistic	3.7682*	-1.6638**		19.4995*		2.6727*	-3.0295*	0.9484	0.2986
5	Coefficient	0.1455		-0.0001	0.9718					15.1177
	t-statistic	0.8745		-0.2886	25.9443*				0.9400	0.2351
6	Coefficient	0.6556		-0.0002	0.8457		0.0007	0.0000		12.5522
	t-statistic	3.2553*		-0.8697	17.9197*		4.0384*	-4.0539*	0.9474	0.4024
7	Coefficient	0.0917			0.9839	0.0002				15.1142
	t-statistic	0.7350			34.9231*	0.247			0.9400	0.2353
8	Coefficient	0.5584			0.8677	0.0007	0.0000	-0.0006		14.0650
	t-statistic	3.346*			21.8436*	3.9417*	-3.6308**	-0.1801	0.9470	0.2966
9	Coefficient	0.6182	-0.0019	-0.0001	0.8679	0.0037				12.1269
	t-statistic	2.8754*	-3.2887*	-0.5732	18.1181*	2.6457*			0.9449	0.4355
10	Coefficient	0.7978	-0.0011	-0.0002	0.8182	0.0005	0.0006	0.0000		12.8856
	t-statistic	3.6368*	-1.6178	-0.8047	16.3359*	0.1547	2.6674*	-2.7331*	0.9477	0.3774

Variables are estimated in levels for monthly data. The dependent variable is the natural logarithm of BMDR expresed in percentage points.
* Indicates significance of the variables at 5%. ** Indicates significance of the variables at 10%. nR2 is the Breusch-Godfrey serial correlation LM test statistic (order 12), p-value is below. Coefficients of seasonal and impulse dummies are not reported.

Table 3. Single Equation Estimation Eesults. NMDR.

Estimates of determinants of dollarization in Bolivia - Sample: 01-1989 to 06-1994

Equation		Constant	Interest rate differential	Inflation differential	Stock Adjustment	Underlying Dollarization	Trend	Adjusted R2	nR2
1	Coefficient	0.0935	0.0007	0.0051	0.9660				10.3843
	t-statistic	1.1228	0.3545	0.8327	98.6704*			0.9944	0.5823
2	Coefficient	0.1546	0.0020	0.0023	0.9165		0.0021		11.6557
	t-statistic	1.5648	0.7658	0.3520	22.0912*		1.2434	0.9935	0.4737
3	Coefficient	0.1062	0.0032		0.9661				12.7866
	t-statistic	1.6902**	0.5627		94.3414*			0.9936	0.3847
4	Coefficient	0.1760	0.0007		0.9319		0.0014		11.3881
	t-statistic	1.8626**	0.1135		25.7674*		0.9889	0.9936	0.4960
5	Coefficient	0.1420		-0.0003	0.9674				12.8659
	t-statistic	3.4509*		-0.1769	93.8826*			0.9936	0.3789
6	Coefficient	0.1841		0.0017	0.915		0.0022		10.6845
	t-statistic	3.5495*		0.6946	22.3329*		1.3201	0.9936	0.5561
7	Coefficient	0.1700			0.9627	-0.0235			12.1930
	t-statistic	2.6448*			72.7205*	-0.581		0.9936	0.4303
8	Coefficient	0.1581			0.9412	0.0087	0.001		12.0099
	t-statistic	2.4993*			30.6619*	0.2315	0.8762	0.9949	0.4449
9	Coefficient	0.1338	0.0022	0.0003	0.9636	-0.0166			13.2077
	t-statistic	0.9364	0.2826	0.1568	69.5294*	-0.3070		0.9934	0.3541
10	Coefficient	0.2063	0.0004	0.0022	0.9106	-0.0240	0.0022		11.5777
	t-statistic	1.3476	0.0466	0.8344	20.77*	-0.4442	1.2754	0.9934	0.4802

Variables are estimated in levels for monthly data. The dependent variable is the natural logarithm of NMDR expresed in percentage points.
* Indicates significance of the variables at 5%. ** Indicates significance of the variables at 10%. nR2 is the Breusch-Godfrey serial correlation LM test statistic (order 12), p-value is below. Coefficients of seasonal and impulse dummies are not reported.

Estimates of determinants of dollarization in Bolivia - Sample: 07-1994 to 04-2004

Equation		Constant	Interest rate differential	Inflation differential	Stock Adjustment	Underlying Dollarization	Trend	Trend Squared	AR(1)	Adjusted R2	nR2
1	Coefficient	0.8088	0.0008	-0.0089	0.8085				-0.4764		19.1782
	t-statistic	4.0501*	0.8372	-4.2741*	16.6916*				-5.396*	0.8867	0.0843
2	Coefficient	4.1901	-0.0016	-0.0008	-0.2659		0.0085	0.0000	0.6988		8.4556
	t-statistic	14.3003*	-0.3877	-0.3634	-3.7208*		3.211*	-2.2175*	10.1058*	0.9261	0.7486
3	Coefficient	0.8895	-0.0088		0.7883				-0.4877		16.3957
	t-statistic	4.5351*	-4.3754*		16.6897*				-5.5352*	0.8817	0.1738
4	Coefficient	4.1703	-0.0017		-0.2672		0.0088	0.0000	0.7020		8.2649
	t-statistic	14.4881*	-0.4238		-3.7888*		3.5057*	-2.3999*	10.7486	0.9267	0.7641
5	Coefficient	0.2378		-0.0009	0.9412				-0.5009		18.5472
	t-statistic	1.5867		-0.9103	24.9106*				-5.8473*	0.8612	0.1001
6	Coefficient	4.2151		-0.0015	-0.2775		0.0086	0.0000	0.6472		9.5746
	t-statistic	14.2823		-0.6476	-3.3569		3.7473	-2.5729	8.5484	0.9139	0.6532
7	Coefficient	4.8734			-0.2449	-0.1376			0.8550		9.8946
	t-statistic	17.9977*			-3.5441*	-4.9845*			15.8383*	0.9131	0.6252
8	Coefficient	4.1113			-0.2674	0.0077	0.0092	0.0000	0.7059		8.1423
	t-statistic	15.5506*			-3.7847*	0.1747	3.9107*	-2.537*	10.6649*	0.9266	0.7739
9	Coefficient	4.8876	-0.0061	-0.0026	-0.2370	-0.1232			0.8020		17.1139
	t-statistic	17.132*	-1.4536*	-0.9583	-3.2844*	-5.0865*			12.2232	0.9137	0.1454
10	Coefficient	4.1832	-0.0016	-0.0009	-0.2682	0.0094	0.0085	0.0000	0.7028		8.3192
	t-statistic	14.0802*	-0.3902	-0.3777	-3.7304*	0.2145	3.165*	-2.0628*	10.0648	0.9255	0.7597

Variables are estimated in levels for monthly data. The dependent variable is the natural logarithm of NMDR expresed in percentage points.
* Indicates significance of the variables at 5%. ** Indicates significance of the variables at 10%. nR2 is the Breusch-Godfrey serial correlation LM test statistic (order 12), p-value is below. Coefficients of seasonal and impulse dummies are not reported.

Table 4. Unit Root Tests.

Variable	Sample	Specification	ADF Statistic	P-value	PP Statistic	P-value	KPSS	5% statistic
BMDR	01.1989-06.1994	C,T	-2.0565	0.5597	-1.9228	0.6313	0.2001	0.1460
	07.1994-04.2004	C,T	-1.4608	0.8375	-2.4585	0.3481	0.2519	0.1460
NMDR	01.1989-06.1994	C,T	-1.4650	0.8310	-1.4174	0.8467	0.2683	0.1460
	07.1994-04.2004	C,T	-4.4915	0.0024	-8.8764	0.0000	0.1329	0.1460
INFDIF	01.1989-06.1994	C,T	-2.3750	0.3889	-2.2349	0.4627	0.1572	0.1460
	07.1994-04.2004	C,T	-2.9564	0.1491	-2.5077	0.3240	0.1264	0.1460
IRSDIF	01.1989-06.1994	C	-2.5525	0.1081	-2.9681	0.0432	0.3438	0.4630
	07.1994-04.2004	C,T	-1.3645	0.8663	-2.7147	0.2328	0.2494	0.1460
UDR	01.1989-06.1994	C	-1.5037	0.5256	-2.1077	0.2424	0.7748	0.4630
	07.1994-04.2004	C,T	-2.3258	0.4165	-2.2941	0.4335	0.1591	0.1460

Table 5. Cointegration Tests, Cointegrating Equations and Restriction Tests. NMDR (01-1989 to 06-1994).

Cointegration tests 1

Hypothesis	Eigenvalues	5% CV	L-Trace	Eigenvalues	5% CV	L-Max
r=0	0.4296	42.9153	57.6944	0.4296	25.8232	35.9278
r<1	0.2225	25.8721	21.7667	0.2225	19.3870	16.1109
r<2	0.0846	12.5180	5.6558	0.0846	12.5180	5.6558

Series: NMDR IRSDIF INFDIF

Lags interval: 1 to 1, Seasonal Monthly dummies included

Cointegrating parameter equation 1

Vector	NMDR	IRSDIF	INFDIF	C	Trend
β	1	-0.0839	-0.0562	**0.1725**	-0.0377
		-0.0117	-0.0408		
		[-2.0555]	[-4.8220]		

Standard errors () and t-statistics [] ; number of lags: 2

Adjustment parameter vector 1

Vector	NMDR	IRSDIF	INFDIF
α	-0.1148	4.3226	0.9977
	-0.0333	-1.2433	-0.5753
	[-3.4459]	[3.4766]	[1.7344]

Standard errors () and t-statistics [] ; number of lags: 2

Cointegration restrictions (IRSDIF=INFDIF) Model 1.2

	Vector	Coefficients		
LR test for binding	β	NMDR=1 IRSDIF=INFDIF	Chi-square(1)	0.5879
restrictions (rank = 1):	α		Probability	0.4898

Chi-square statistic is reported with one degree of freedom; number of lags: 2

Cointegrating parameter equation 1.2

Vector	NMDR	IRSDIF	INFDIF	C	Trend
β	1	-0.0488	-0.0488	-0.2679	-0.0382
		-0.0102	-0.0102		
		[-4.7867]	[-4.7867]		

Standard errors () and t-statistics [] ; number of lags: 2

Adjustment parameter vector 1.2

Vector	NMDR	IRSDIF	INFDIF
α	-0.1335	4.3702	1.1280
	-0.0361	-1.3984	-0.6320
	[-3.7015]	[3.1252]	[1.7848]

Standard errors () and t-statistics [] ; number of lags: 2

Table 6. Cointegration Tests, Cointegrating Equations and Restriction Tests. NMDR (07-1994 to 04-2004).

Cointegration tests 2

Hypothesis	Eigenvalues	5% CV	L-Trace	Eigenvalues	5% CV	L-Max
r=0	0.1784	29.7971	37.6180	0.1784	21.1316	23.1899
r<1	0.1016	15.4947	14.4281	0.1016	14.2646	12.6429
r<2	0.0150	3.8415	1.7852	0.0150	3.8415	1.7852

Series: NMDR IRSDIF INFDIF

Lags interval (in first differences): 1 to 1

Cointegrating parameter equation 2

Vector	NMDR	IRSDIF	INFDIF	Trend	C
β	1	-0.0681	0.0516	-0.0024	-3.2892
		-0.0244	-0.0105		
		[-2.7948]	[4.9299]		

Standard errors () and t-statistics [] ; number of lags: 2

Adjustment parameter vector 2

Vector	NMDR	IRSDIF	INFDIF
α	0.0499	-3.4865	0.5560
	-0.0262	-0.8759	-0.4948
	[1.9089]	[-3.9802]	**[1.1237]**

Standard errors () and t-statistics [] ; number of lags: 2

Cointegration restrictions Model 2

	Vector	Coefficients		
LR test for binding restrictions (rank = 1):	β	NMDR=1	Chi-square(1)	1.7967
	α	NMDR=0, IRSDIF=0	Probability	0.4454

Chi-square statistic is reported with one degree of freedom; number of lags: 2

Cointegrating parameter equation 2.1

Vector	NMDR	IRSDIF	INFDIF	Trend	C
β	1	-0.0178	0.0199	-0.0019	-3.5838
		-0.0103	-0.0044		
		[-1.7314]	[4.5130]		

Standard errors () and t-statistics [] ; number of lags: 2

Adjustment parameter vector 2.1

Vector	NMDR	IRSDIF	INFDIF
α	0.0000	0.0000	-9.6525
	0.0000	0.0000	-2.1038
	[NA]	[NA]	[-4.5882]

Standard errors () and t-statistics [] ; number of lags: 2

Table 7. Cointegration Tests, Cointegrating Equations and Restriction Tests. BMDR (01-1989 to 06-1994).

Cointegration tests 3

Hypothesis	Eigenvalues	5% CV	L-Trace	Eigenvalues	5% CV	L-Max
r=0	0.3429	45.5209	42.9153	0.3429	26.8775	25.8232
r<1	0.2141	18.6434	25.8721	0.2141	15.4168	19.3870
r<2	0.0492	3.2266	12.5180	0.0492	3.2266	12.5180

Series: BMDR IRSDIF INFDIF

Lags interval: 1 to 1, Seasonal Monthly dummies included

Cointegrating parameter equation 3

Vector	BMDR	IRSDIF	INFDIF	C	Trend
β	1	0.0774	0.0377	-5.4820	-0.0014
		0.0374	0.0109		-0.0022
		[2.0712]	[3.4522]		[-0.6176]

Standard errors () and t-statistics [] ; number of lags: 2

Adjustment parameter vector 3

Vector	BMDR	IRSDIF	INFDIF
α	-0.0578	0.6598	-4.8632
	-0.0179	-0.7194	-1.5597
	[-3.23590]	[0.91719]	[-3.11808]

Standard errors () and t-statistics [] ; number of lags: 2

Cointegration restrictions (IRSDIF=INFDIF) Model 3

	Vector	Coefficients		
LR test for binding restrictions (rank = 1):	β	BMDR(-1)=1 IRSDIF=INFDIF	Chi-square(1)	1.2717
	α		Probability	0.2594

Chi-square statistic is reported with one degree of freedom; number of lags: 2

Cointegration tests 4

Hypothesis	Eigenvalues	5% CV	L-Trace	Eigenvalues	5% CV	L-Max
r=0	0.5077	86.5464	63.8761	0.5077	45.3508	32.1183
r<1	0.2978	41.1956	42.9153	0.2978	22.6264	25.8232
r<2	0.2109	18.5693	25.8721	0.2109	15.1632	19.3870
r<3	0.0518	3.4061	12.5180	0.0518	3.4061	12.5180

Series: BMDR IRSDIF INFDIF UDR

Lags interval: 1 to 1, Seasonal Monthly dummies included

Cointegrating parameter equation 4

Vector	BMDR	IRSDIF	INFDIF	UDR	C	Trend
β	1	0.0402	-0.0106	0.5287	-4.9269	-0.0027
		0.0174	0.0040	0.1281		-0.0011
		[2.3122]	[-2.6475]	[4.1265]		[-2.4652]

Standard errors () and t-statistics [] ; number of lags: 2

Adjustment parameter vector 4

Vector	BMDR	IRSDIF	INFDIF	UDR
α	-0.0502	0.1597	6.8290	-0.8652
	-0.0514	-1.7457	-4.3611	-0.2979
	[-0.97661]	[0.09149]	[1.56588]	[-2.90461]

Standard errors () and t-statistics [] ; number of lags: 2

Cointegration restrictions Model 4

	Vector	Coefficients		
LR test for binding restrictions (rank = 1):	β	BMDR(-1)=1, INFDIF=0	Chi-square(1)	6.3634
	α	BMDR=0, IRSDIF=0, INFDIF=(	Probability	0.1736

Chi-square statistic is reported with one degree of freedom; number of lags: 2

Table 8. Cointegration Tests, Cointegrating Equations and Restriction Tests. BMDR (07-1994 to 04-2004).

Cointegration tests 5

Hypothesis	Eigenvalues	5% CV	L-Trace	Eigenvalues	5% CV	L-Max
r=0	0.2024	29.7971	32.7876	0.2024	21.1316	26.2383
r<1	0.0361	15.4947	6.5492	0.0361	14.2646	4.2655
r<2	0.0195	3.8415	2.2838	0.0195	3.8415	2.2838

Series: BMDR IRSDIF INFDIF

Lags interval: 1 to 1, Seasonal Monthly dummies included

Cointegrating parameter equation 5

Vector	BMDR	IRSDIF	INFDIF	C
β	1	-0.004747	0.009705	-4.445471
		-0.00308	-0.0019	
		[-1.54291]	[5.11058]	

Standard errors () and t-statistics [] ; number of lags: 2

Adjustment parameter vector 5

Vector	BMDR	IRSDIF	INFDIF
α	0.0327	1.0813	-22.6791
	-0.0288	-2.7701	-4.8106
	[1.13634]	[0.39034]	[-4.71439]

Standard errors () and t-statistics [] ; number of lags: 2

Cointegration restrictions (IRSDIF=0) Model 5

	Vector	Coefficients		
LR test for	β	BMDR(-1)=1 IRSDIF=0	Chi-square(1)	1.5427
binding	α		Probability	0.2142

Chi-square statistic is reported with one degree of freedom; number (

Cointegration tests 6

Hypothesis	Eigenvalues	5% CV	L-Trace	Eigenvalues	5% CV	L-Max
r=0	0.2116	47.8561	49.7863	0.2116	27.5843	27.5825
r<1	0.1094	29.7971	22.2038	0.1094	21.1316	13.4447
r<2	0.0588	15.4947	8.7590	0.0588	14.2646	7.0275
r<3	0.0148	3.8415	1.7315	0.0148	3.8415	1.7315

Series: BMDR IRSDIF INFDIF UDR

Lags interval: 1 to 2, Seasonal Monthly dummies included

Cointegrating parameter equation 6

Vector	BMDR	IRSDIF	INFDIF	UDR	C
β	1	-0.0028	0.0065	0.0078	-4.4486
		-0.0032	-0.0015	-0.00903	
		[-0.89720]	[4.22720]	[0.86499]	

Standard errors () and t-statistics [] ; number of lags: 3

Adjustment parameter vector 6

Vector	BMDR	IRSDIF	INFDIF	UDR
α	0.0385	-0.0810	-26.8350	-0.211923
	-0.0359	-3.4841	-6.1131	-0.10985
	[1.07181]	[-0.02325]	[-4.38980]	[-1.92929]

Standard errors () and t-statistics [] ; number of lags: 3

Cointegration restrictions Model 6

	Vector	Coefficients		
LR test for	β	BMDR=1 IRSDIF=INFDIF=0	Chi-square(5)	4.8410
binding	α	d(IRSDIF)=d(INFDIF)=d(BMDR)=0	Probability	0.4356

Chi-square statistic is reported with one degree of freedom; number of lags: 3

Cointegrating parameter equation 7

Vector	BMDR	IRSDIF	INFDIF	C	UDR
β	1	0.0000	0.0066	-4.4669	0.0000
			-0.0009		
			[7.45880]		

Standard errors () and t-statistics [] ; number of lags: 2

Adjustment parameter vector 7

Vector	BMDR	IRSDIF	INFDIF	UDR
α	0.0000	0.0000	-30.2518	0
			-6.7614	
			[-4.47422]	

Standard errors () and t-statistics [] ; number of lags: 3

Table 9. Estimation Results for the Peso Problem in Bolivia

Estimation results for Peso problem equation

	Coefficients	t-stat	Significance
C(1)	-0.0033	-0.4303	0.6675
C(2)	1.1265	9.0089	0.0000
C(3)	0.6282	9.5532	0.0000
Adj R^2	0.3824	DW	0.0647

Wald test

Test Statistic	Value	DF	Probability
F-statistic	22.59326	(3, 169)	0
Chi-square	67.77979	3	0

Null Hypothesis Summary

Normalized Restriction (= 0)	Value	Std. Err.
C(1)	-0.003319	0.007712
-1 + C(2)	0.1265	0.125043
-1 + C(3)	-0.371836	0.065755

Restrictions are linear in coefficients.