Bolivia: Drivers of De-Dollarization

Evidence from Macroeconomic Aggregates and Microeconomic Data

Thesis submitted in partial fulfillment of the requirements for the Degree of Master of Science in Economics for Development at the University of Oxford

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Abstract

The essay assesses the validity of the portfolio model developed by Ize and Levy-Yeyati (2003) and of other macroeconomic factors to explain the process of de-dollarization of savings in Bolivia during the last decade. The identification strategy is derived from a specification of the portfolio model where the risk premium in the uncovered interested rate parity condition is a function of the fiscal deficit and the level of international reserves relative to the deposits in the banking system. A Vector Error Correction Model (VECM) is used on monthly data of aggregated savings in foreign currency and macroeconomic indicators from 2000 to 2012. The interactions between the macro variables and the level of savings are also studied on a dynamic panel of savers from a Bolivian financial institution from 2004 to 2012, using a first difference Generalized Method of Moments model. Although the macroeconomic model does not fit the data perfectly, it does produce some significant results. The minimum variance portfolio hypothesis is partially valid in this context, which means that a decrease in the correlation between the inflation rate and the nominal depreciation rate relative to the variance of the latter fosters de-dollarization. At the same time, we find evidence that expected nominal appreciations, improvements in the fiscal position and accumulation of reserves are associated with less dollarization. The microeconomic panel fails to detect significant interaction effects between these variables and the level of savings. However, it allows us to see that dollarization is less persistent than at the macro level and that de-dollarization has been more pronounced for individuals with higher savings.

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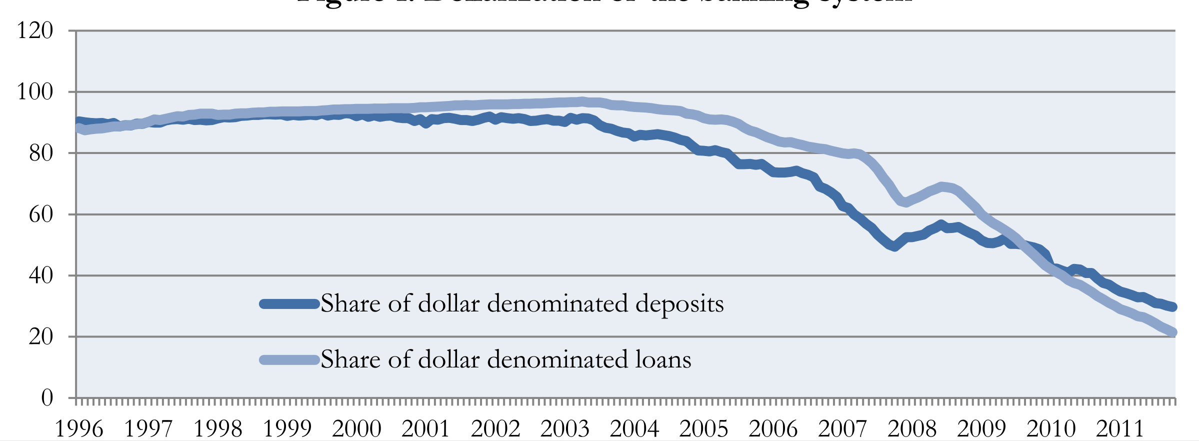
1. Introduction

"Bolivia is probably the most highly dollarized economy among those that have stopped short of full dollarization", is the introductory line of the selected issues report prepared by the International Monetary Fund (IMF) in 2003. At that time, financial dollarization, defined as the foreign currency denomination of financial assets, reached its peak in Bolivia affecting 95 percent of all domestic deposits in the banking system. Today, ten years after that peak, Bolivia is still a dollarized country but the days when full dollarization was one of the possible recommendations are far behind. The last available data suggests that only a fifth of the deposits in the banking system are denominated in U.S. dollars. Bolivia is not by all means the only country that has achieved to de-dollarize its financial sector through market driven policies and without incurring a financial crisis, but is certainly one of the poorest to have done it. Other frequently cited examples are Israel, Chile and Peru, all of them classified as high or high-middle income countries. Another important difference with these economies is the fact that Bolivia did not have an inflation targeting regime nor a flexible exchange rate arrangement when the de-dollarization process took place.

Figure 1: Dollarization of the banking system



The purpose of this essay is to identify the macroeconomic drivers that can explain this process using both macro and microeconomic data. The first part of the paper gives a qualitative description of the Bolivian context so that the reader can understand the data generating process that motivates the empirical strategy adopted in the subsequent parts. The empirical estimations of section 3 use a vector error correction model (VECM) to identify the role of different macroeconomic variables. A second, much shorter empirical section, studies the persistence of dollarization and the effects of the levels of savings in a panel of savers. Interactions effects between this latter variable and the main macroeconomic factors are also studied.

Although the main theoretical model is not entirely consistent and accepted by the data, there is sufficient evidence to say that the appreciation of the exchange rate, the improvements of the fiscal position and the accumulation of foreign reserves are partially responsible for the de-dollarization. Our microeconomic data detects a significant but small persistence of individual dollarization and finds empirical evidence suggesting that individuals with higher savings may have de-dollarized their assets more. However, it fails to explain this differential effect of wealth through interaction with the macroeconomic variables.

2. Dollarization of the banking sector in Bolivia

2.1 Hyperinflation and the exchange rate regime

As in other places of Latin America, the historical origins of financial and real dollarization in Bolivia can be attributed to the dependency of the economy on foreign savings, received in the form of development loans, foreign direct investment or export revenues. During the seventies, time deposits in foreign currency were introduced as an attempt to repatriate part of the national savings hold abroad. The share of domestic dollarization increased alongside a rapid accumulation of public external debt. In the words of Sachs and Morales (1988), in a context of intense political instability, from 1979 to 1982 Bolivia changed president 9 times, the government was borrowing time through foreign debt while keeping a high level of public expenditure and an overvalued exchange rate without raising taxes. In 1982, Bolivia suffered two major adverse shocks to its external position: as the interest rates on its foreign debt rose, the international prices of its leading mining exports fell. The international debt crisis eventually lead to the cut-off in lending and the government decided to finance its deficit by forcing the conversion of all dollars denominated deposits into domestic currency using a rate lower than the free-market exchange rate.

This attempted forced de-dollarization lead to the emergence of a large black market of foreign exchange. It also caused a massive retreat of financial intermediation and large capital outflows. That being said, as Sachs (1987) and Sachs and Morales (1988) explain, this measure was only one of the strategies adopted by the government to maintain its high level of expenditure and its direct effects were insignificant compared with those of the inflation financing of the public deficit. From April 1984 to August 1985, prices were multiplied by 625, creating the seventh highest inflation of the XXth century and the only one not directly linked to a war.

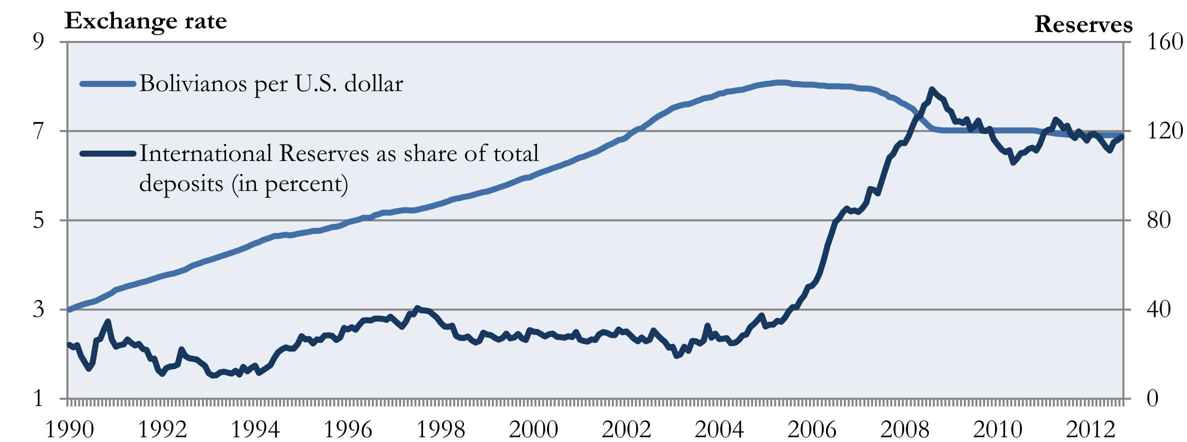
By the end of 1985, the authorities finally came up with a stabilization plan that put an end to the hyperinflation and established a new exchange rate regime. Bolivia moved to what IMF classified at that time as a floating exchange rate arrangement. Although the arrangement has not changed until this day, the regime was gradually classified first as a managed float and finally as a crawling peg by the IMF, mostly to adapt itself to the *de facto* arrangement. We will briefly discuss its main characteristics[1] because it can help us understand how agents build their expectations in Bolivia and the data generating process of the nominal exchange rate. Every day, a Dutch auction of foreign exchange determines the exchange rate of the day. The central bank sets both a floor price and the quantity to be auctioned in each session. Each bidder whose bid exceeds the floor price must pay his bid price. The official exchange rate of the day is the weighted average of all accepted bids. Bidders know neither the floor price nor the quantity of foreign exchange supplied by the central bank before entering the auction.

As we can see, although the system was built to move towards a market driven exchange rate, the Central Bank still has an important discretionary power over the rate. However, its power is asymmetric with respect of depreciation and appreciation pressures. Since the central bank sets a floor price, in the event of appreciation pressures, the appreciation rate is under its control and the market adjusts through quantities. By contrast, whenever the public bid is larger than the reservation price (devaluation pressure), the Bank increases the amount supplied in the auction in order to smooth the devaluation rate, however its actions are constrained by the availability of international reserves. I believe that these internal pressures, combined with the asymmetric power of the central bank, determine the daily exchange rate in Bolivia. Indeed, public securities have been absent from international capital markets and international financial integration is very low, which means that the role of the capital account in the determination of the exchange rate is weak. For all these reasons, in the Bolivian context, the availability of international reserves is critical to the stability of the exchange rate in the long run. In figure 2, we can see how the stagnation of reserves is associated with a period of continuous depreciation while the rapid

[1] For a more complete description of how the exchange rate is set in practice the readers can refer to Morales (1991)

accumulation of reserves coincides with stabilization and an appreciation. In the following parts we will discuss additional issues that can justify these trends.

Figure 2: Exchange rate and international reserves



2.2 Stabilization and dollarization peak

With a fragile external position and an almost non-existent banking sector in the aftermath of hyperinflation, dollar denominated deposits and loans were not only allowed but politically embraced in the late 1980's. During this period, inflation rates decreased sharply and debt sustainability was achieved. However dollarized financial assets were by far the rule rather than the exception in the nascent banking sector. The level reached not only exceeded the pre-crisis situation, it was also close to a 100 percent for both assets and liabilities. By the end of the 1990's, Bolivia was the second most *de facto* dollarized country in the World.

It must be noted however that real dollarization remained marginal. This fact suggests that the dollarization process in Bolivia took place principally to satisfy the public's need for a reliable store of value rather than a more efficient medium of exchange. In fact, most of the real dollarization that took place actually concerned real state, vehicles and other expensive goods that can also be seen as stored capital. It is for this reason that we follow a *portfolio approach* in this study, as opposed to a currency substitution approach.

At this point it is worth exploring some of the most cited causes of dollarization in the Bolivian context. The *traumatism of the hyperinflation*, high skepticism about the *sustainability of the monetary regime* and the *loose regulation* on dollarized financial assets seem to be the most cited causes. As De Nicolo, Honohan and Ize(2003) explain, dollarization tends to appear in countries that have suffered from high inflation in the past as a rational response to the bad monetary policies. Orellana (1999), Balino et al. (1999) and Fernandez Telleria (2011) also suggest something similar for the Bolivian case. They argue that the emergence and persistence of financial dollarization was due to "past legacy" effects, meaning that the traumatic experience of the past have influenced the expected depreciation rates even long time after the dramatic events occurred. In the same sense, Morales(2003) argues that the leading cause of dollarization in Bolivia was a "peso problem". The public attributes a small probability to a catastrophic devaluation event that suffices to impose a very high risk premium to the accumulation of assets in national currency. This weak monetary policy leads agents to label their assets and liabilities in foreign currency.

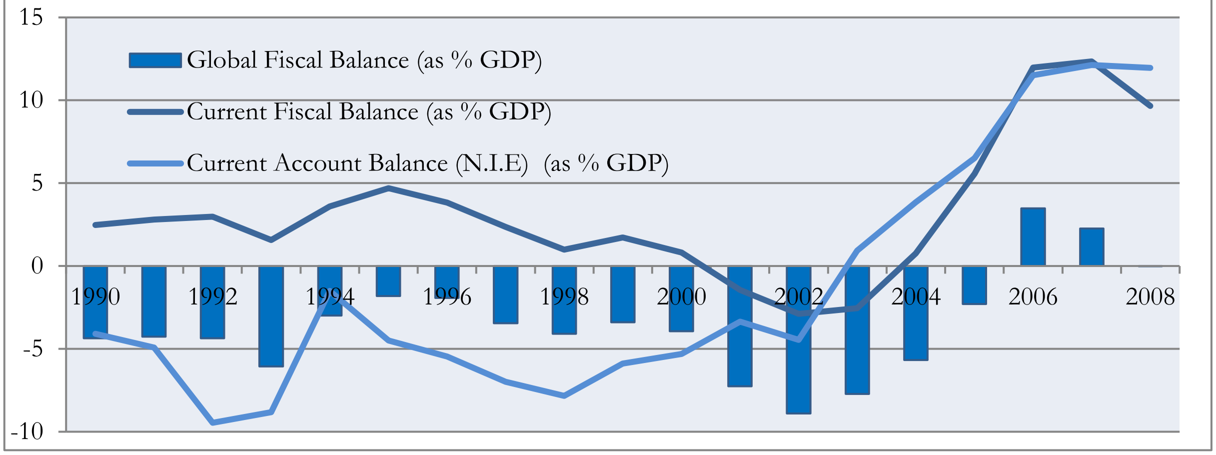
More generally, in the context of unreliable monetary policies, Ize and Levy Yeyayi (1998) and Parrado and Ize (2002) argue that savers and lenders may be unwilling to bear the risk involved in holding financial assets in domestic currency at an acceptable rate for borrowers. At the same time, by introducing probabilities of default, Jeanne (2003) and Ize and Powell (2005) explain that the demand for foreign currency denominated liabilities can be high even when large but unlikely devaluations can have catastrophic consequences. Foreign currency denominated liabilities can maximize expected returns if the projects revenues are positively correlated with devaluation rate and the risk premium of assets in domestic currency is high enough.

In addition, the Bolivian authorities decided to promote the expansion of the financial sector that had almost disappeared after the hyperinflation by imposing very little and currency blind prudential regulations. For Broda and Levy-Yeyati (2003), this legal framework does foster growth of the financial sector but also promotes the accumulation of dollarized assets and liabilities. As a matter of fact, traditional banks and microfinance institution both expanded greatly during the 1990's by receiving and lending in U.S. dollars. At the same time, the government ensured a sustainable risk premium on its securities issued in dollars. These government notes, as well as the real state, were the main collaterals that allowed the expansion of the dollarized portfolio of financial institutions.

Finally, we need to ask ourselves why agents still distrusted the monetary regime once stability was achieved. Although inflation and the depreciation rate stayed in single digits during the 1990's, the economy still suffered from chronic problems of fiscal and current account deficits. These twin deficits, which we can see in figure 3, were the result of low international prices of

Bolivia's traditional commodity exports combined with a public foreign debt whose service was above the government's capacity.

Figure 3: Twin deficits



Additionally, privatization and liberalization did not have significantly increased growth nor promoted high levels of foreign direct investments in labor intensive sectors as it was predicted. When the Brazilian and Argentinean crisis hit Bolivia from 1999 to 2002, real output shrank, the depreciation rate increased and political instability reappeared. In this fragile macroeconomic environment combined with an extremely low level of foreign reserves, the public's distrust in the stability of the exchange rate regime is easier to understand.

2.3 De-dollarization: fiscal consolidation and reserves accumulation

In June 2005, Bolivia benefited from the Multilateral Debt Relief Initiative (MDRI). Although Bolivia had already benefited from the Highly Indebted Poor Countries (HIPIC) initiative in 2001, the size of this second debt relief was significantly higher. The external debt went down from more than 60% of the GDP in 2003 to less than 20% in 2006. An important external pressure had been taken from the central government. From that point on Bolivia entered in a more stable debt path, increasing only marginally its external debt.

The path from twin deficits to twin surplus certainly started with the MDRI, but it took a very large step when Bolivia's recently elected president renegotiated the gas export contracts in May 2006. The government took control of a higher share of the gas industry, just a few weeks before the international prices started to increase sharply. Finally the international price increase of other traditional exports of the Bolivian economy, mostly minerals and soy beans, brought the macroeconomic stability so desperately needed for the de-dollarization process. With mineral and hydrocarbons taxes accounting now for over 40 percent of the revenues and 12 percent of the GDP, the fiscal position improved drastically. The government started a rapid accumulation of international reserves. From January 1995 to December 2003, the net inflow of foreign currency from both the public and private sector was only 99 million USD. By contrast, from January 2004 to September 2012, the net balance was slightly above 10 billion USD. Where did these new inflows come from? Looking at the data more carefully, comparing the 1995-2003 period to the 2004-2012 period, 7 additional billions USD entered the country through government sales of goods and services, mostly because of the additional tax revenues from commodities exports. At the same time, the private sector balance was 3 billion USD above the balance of the previous period. Although some of this new inflow to the private sector can be attributed to capital repatriation and foreign direct investments in the commodity sector, it should also be noted that stricter capital controls were put in place during this period.

It is undeniable that the currency inflow, the transition from twin deficit to surplus and the accumulation of foreign reserves played an important role in the improvement of the credibility of the exchange rate regime and the anchorage of inflation expectations. In fact, during the short period of macroeconomic instability in the eve of the international financial crisis, when the commodity prices plumbed, a sudden return to dollarization can be observed in the data. Fortunately, the important amount of international reserves that had been accumulated during the boom years, around 41% of the GDP at that time, and the good creditor record of the public sector in the internal capital market allowed the government to support the sharp decline in its revenues. More importantly, the fast recovery of the Brazilian economy and the second price increase brought the macroeconomic environment back to its pre-crisis state and de-dollarization resumed. This qualitative finding seems to support the findings of Reinhart et al. (2003) and Vieira et al. (2012) who argue that high levels of public indebtedness combined with large fiscal deficits in speculative-grade economies explain more accurately the expected future inflation, and therefore the dollarization rates, than the present and past levels of the inflation rate.

As many authors have pointed out, achieving macroeconomic stability is only the first step in the long road to de-dollarization, other fiscal, monetary and prudential measures are often recommended in the literature. Some of these financial and especially prudential measures, supported by Kokenyne(2010), Garcia Escribano (2012) and Erasmus et al (2009), have indeed being used in Bolivia to promote de-dollarization. The introduction of a financial tax on dollar denominated transactions and the differential reserve requirements applied to deposits in national and foreign currency were probably the most binding new regulations that went in that sense.[2] Additionally, the expansion of the internal public debt market in national currency was greatly reinforced. Not only the traded volumes increased, also longer maturities[3] were progressively introduced. This expansion of the financial market in national currency certainly did not solve all the problems related to the underdevelopment of the market but provided the collateral that was needed to develop a credit market in national currency with a stable interest rate.

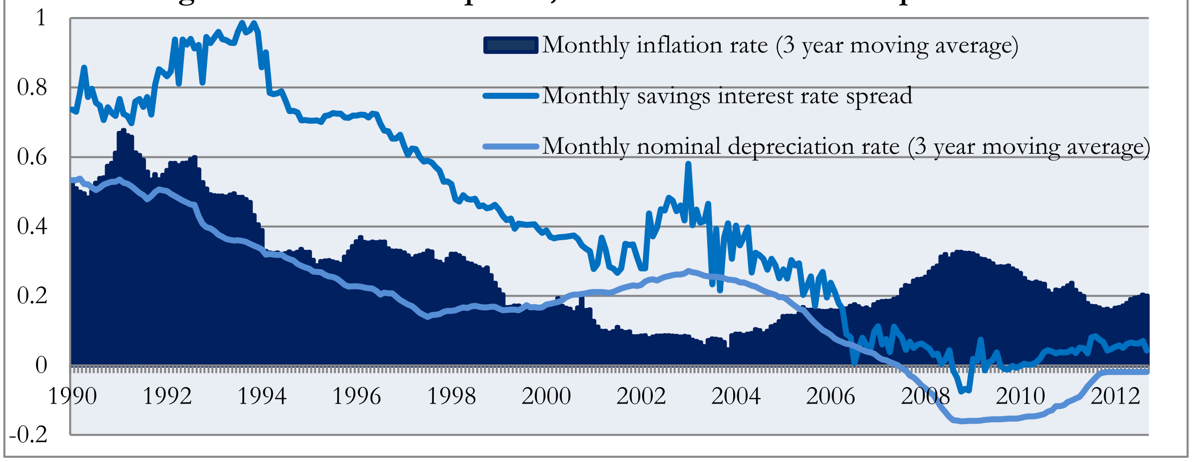
In this different macroeconomic context, monetary policy was also conducted differently. As Morales (2003) explains, in a financially dollarized economy with underdeveloped financial markets, the monetary authorities know that their only monetary tool is the exchange rate. At the same time, the author recognizes that the "Fear of Floating" (Calvo and Reinhart (2002)) may be exacerbated because financial stability can be endangered by large devaluations. During the 1990's, when the inflationary pressures were very low and dollarization extremely high, the depreciation rate was used to stabilize the real exchange rate when the international prices of traditional exports suffered adverse shocks, with the authorities trying to smooth the changes as much as they could. Starting in late 2005, the external position improved and the capital inflows created an appreciation pressure on the nominal exchange rate. However, the authorities refused to appreciate the currency. The resilience of the central bank to apply contractionary policies in the boom years is consistent with what Levy-Yeyati et al. (2012) call "Fear of Appreciation". However, while overall the external position improved, inflationary pressures also reappeared, mostly because of the price increase in imported fuel and food, which in turn forced the authorities to allow a slow appreciation. When the international financial crisis hit the region; Bolivia was one of the few countries that did not had to devaluate its currency. Instead a slow appreciation reappeared during the recovery and eventually a de facto pegged was put in place. These very smooth changes in the nominal depreciation rate and the more favorable macroeconomic conditions have fostered an expansion of the financial sector in the past decade.

In figure 4, we can see how gradually the domestic interest rate spread (the difference between the returns of domestic savings in national currency and in foreign currency) and the nominal

[2] The complete list of prudential measures that were put in place during this period can be found in Garcia Escribano (2012)
[3] D-dollarization of public debt in Bolivia is analyzed in great details in Vesperoni and Orellana (2008)

depreciation rates have converged to zero, while inflationary pressures have slowly reappeared after having reached their minimum in 2004. It is in this context that we will build our theoretical model of dollarization.

Figure 4: Interest rate spread , inflation and nominal depriciation



3.1 Theoretical framework

In this section we will briefly present the underlying model used in our empirical estimations. Our model is very close to the portfolio model of Ize and Levy-Yeyati (2003), however for simplification we only focus on one side of the balance sheet and we do not consider cross border deposits. This latter assumption is theoretically justified by the weak financial integration of the Bolivian economy and for more practical reasons by the lack of available data.

The initial assumption in this portfolio model is always the internal uncovered interest rate parity (UIP) condition. That is, the domestic nominal spread between dollar denominated and local currency deposits is equal to the expected nominal depreciation rate.

$$i_t^{DC} - i_t^{\$} = \ln\left(\frac{\mathbb{E}_t[S_{t+1}]}{S_t}\right) \tag{1}$$

Where i_t^{DC} and $i_t^{\$}$ are the nominal interest rates for domestic deposits in national currency and U.S. dollars and S_t is the value in national currency of one U.S. dollar in time *t*. We will make the simplifying assumption that the right hand side of this equality is equal to the expected depreciation rate. In the rest of this paper, the time unit and the maturity of these variables are fixed to one month; we therefore use monthly nominal interests and depreciation rates. The relationship shown in (1) has frequently been extended to include a time varying risk premium factor that can explain persistent deviations from the UIP condition. I argue that in the case of the Bolivian financial system, this risk premium is a function of the level of international reserves as a share of total deposits and the fiscal surplus. Indeed, the share of the international reserves is crucial to assess the capacity of the central bank to avoid large devaluations and therefore the risk involved in holding financial assets in domestic currency. At the same time, we have seen that in the Bolivian context high fiscal deficits have been associated with periods of continuous depreciation of the national currency and large current account deficits. Additionally, Vieira et al. (2012) argue that when the tax system capacity is extremely limited, as in the Bolivian case, high current fiscal deficits and debt tend to be associated with high expected future inflation and therefore more risk in domestic currency assets. The uncovered interest rate parity condition can now be rewritten as:

$$i_t^{DC} - i_t^{\$} = \delta_0 * \mathbb{E}_t[n_t] - \delta_1 * R_t - \delta_2 * FS_t \tag{2}$$

Where $\mathrm{R_t}$ is the level of international reserves and $\mathrm{FS_t}$ is the de-seasonalized value of the fiscal surplus in national currency at time *t*, both of them expressed as a share to total deposits in the banking system. $\mathbb{E}_t[n_t]$ is the expected depreciation rate. The parameter δ_0 should still be in principle equal to one, but we will explore the consequences of deviations from this value. These two different specifications of the UIP conditions will help us build the portfolio model of dollarization.

In the following model, a risk-averse saver chooses the level of dollarization of its portfolio that maximizes its utility function. The framework is the following:

$$r_t = i_t^{DC} - \pi_t \tag{3}$$

$$r_t^{\$} = i_t^{\$} - \pi_t + n_t \tag{4}$$

$$RR_t = d_t * \left(1 + r_t^{\$}\right) + (1 - d_t) * (1 + r_t) \tag{5}$$

$$\max_{d_t} U\left(RR_t\right) = \max_{d_t} \mathbb{E}_t[RR_t] - \frac{\mathbb{V}[RR_t]}{2 * c} \tag{6}$$

Where r_t and $r_t^{\$}$ are the real returns from domestic deposits in national currency and U.S. dollars respectively and π_t and n_t are the inflation and nominal depreciation rates. In this context, RR_t are the real returns from a portfolio where a share d_t of the deposits is held in foreign currency. The real returns are defined assuming that the agents take the U.S. inflation as given and evaluate their gains in terms of their purchasing power in Bolivia. The only random variables in this model are the domestic inflation and nominal depreciation rates. The agent maximizes the expected returns of such portfolio conditional on minimizing its variance, the parameter c represents risk aversion. The optimal level of dollarization can then easily be derived from this optimization problem:

$$d_t = \frac{Cov(\pi_t, n_t)}{\mathbb{V}(n_t)} - \frac{i_t^{DC} - i_t^{\$}}{c * \mathbb{V}(n_t)} + \frac{\mathbb{E}_t[n_t]}{c * \mathbb{V}(n_t)} \tag{7}$$

The first term is frequently called the Minimum Variance Portfolio (MVP_t) and it should be exactly equal to the dollarization ratio if the UIP in (1) holds at all times. In the rest of the paper we will ignore the fact that the coefficients in front of the deviations from the UIP depend on the expected variance of the depreciation rate and we will simply model them as a positive constant. Having done these simplifying assumptions, equations (7) can be rewritten as:

$$d_t = \frac{Cov(\pi_t, n_t)}{\mathbb{V}(n_t)} - \alpha * \left(i_t^{DC} - i_t^{\$}\right) + \alpha * \mathbb{E}_t[n_t] \tag{8}$$

Deviations from this specification can partially be explained by deviations from the UIP. For instance, if we model the risk premium as in (2), then equation (7) can be re written as:

$$d_t = \frac{Cov(\pi_t, n_t)}{\mathbb{V}(n_t)} + \alpha\delta_1 * R_t + \alpha\delta_2 * FS_t + \alpha * (1 - \delta_0) * \mathbb{E}_t[n_t] \tag{9}$$

This means that the level of reserves and the fiscal surplus should have an indirect effect in the level of dollarization as well. More formally we will test the empirical validity of the following system of structural equations:

$$d_t = \frac{Cov(\pi_t, n_t)}{\mathbb{V}(n_t)} + \alpha\delta_1 * R_t + \alpha\delta_2 * FS_t + \alpha * (1 - \delta_0) * \mathbb{E}_t[n_t] \tag{10}$$

$$i_t^{DC} - i_t^{\$} = \delta_0 * \mathbb{E}_t[n_t] - \delta_1 * R_t - \delta_2 * FS_t \tag{11}$$

3.2 Empirical strategy

These relationships can be tested using a Vector Error Correction Model (VECM). This framework is appropriate in this context because all the macroeconomic variables posses a unit root[4] and are therefore unsuitable for OLS estimations or unrestricted VAR models. In addition, the theoretical existence of two long run relationships between some of these variables, the UIP and the dollarization equation, brings more support to the vector approach in favor of simple cointegrations. Nevertheless, we will start by trying to identify the two structural relations separately before aggregating them in a full VECM.

3.2.1 Data and variables

The Bolivian Central Bank stores monthly data from aggregated savings in both national currency and foreign currency since January 1990. In this paper we will however restrain ourselves to the latter part of that data to put the emphasis in the de-dollarization and not the dollarization era. Because of data availability for the fiscal revenues and expenditures, all our models of dollarization will start in January 2000 and will end in September 2012.

The nominal interest rates, exchange rate and consumer price index used to build the macroeconomic variables, come from the monthly tables of the International Finance and Statistics (IFS) survey of the IMF. The monthly depreciation and inflation rates are calculated using logarithms and not percentage changes. In addition, the annual savings rates have been transformed to their monthly equivalents so that the maturities are the same for all our variables.

The foreign international reserves of the Central Bank are also from the IFS tables, and their values in national currency have been calculated using the average nominal exchange rate of that month. The monthly fiscal surplus has been deseasonalized by using a moving average centered on the current value and covering twelve months of data. In what follows, both of these variables are expressed as a share of the total deposits in the banking system.

There are multiple empirical challenges with evaluating the MVP as a time series. Computing a monthly value of the variance of a time series requires the use of past data in somehow arbitrary proportions. For this reasons the MVP has been evaluated using five different techniques. The

[4] Univariate test for unit root for each of these variables can be found in Appendix I.

dollarization model has then been applied to each of these specifications and there are some variations in the results obtained with each method; although overall, significant results are similar. The first approach uses 10-year backward looking rolling windows of the inflation and nominal depreciation rates to compute their variances and covariance. This technique has been applied by Rennhack and Nozaki (2006) in their panel study using quarterly data. In this paper we apply it on monthly data. The method does not require any additional assumption, but its simplicity may also cause some confusing results. Small changes from one month to another can have very large consequences on the value of the MVP from one month to the other, something that is clearly not observable in the dollarization series. The next three techniques will also apply 10-year backward looking rolling windows to smoothed versions of the inflation and nominal depreciation series to estimate the variance and covariance.

The second technique uses a non parametric simplification that smoothes the time series. More precisely, we apply a 3-year backward looking moving average to the inflation and depreciation series. This enables us to have smoother time series, but relies in this somehow *ad hoc* assumption of forecast. Rennhack and Nozaki (2006) also use 3-year backward looking moving average instead of the observed values of their depreciation and inflation series.

The third approach uses a more parametric technique. A time series analysis of the inflation and depreciation rates series, over the period from January 1987 to September 2012, during which the same monetary policy was in place, shows that they can be modeled as autoregressive integrated moving averages (ARIMA) (1,1,1) series. The coefficients of these ARIMA process are extracted from the data and the obtained time series are used as the support of the 10-year backward looking rolling windows.

The fourth technique applies a Hodrick-Prescott (1997) filter to our time series before applying the rolling windows. This filtered series is less influenced by short term fluctuation of the depreciation and inflation rates while keeps the long-term evolution, which is the relevant part for the dollarization rate. The smoothing parameter we apply is the standard coefficient applied on monthly data with HP filters.

Finally, the last technique does not rely on the rolling windows technique. Instead it makes assumptions about the form of the expected variance of the time series over the period from January 1987 to September 2012. We find that a multivariate generalized autoregressive conditionally heteroskedastic (M-GARCH)[5] model can be fitted to these two time series. The mean of these series are jointly represented as a vector autoregressive (VAR) (1) model but the conditional variances and covariance follow a GARCH(1) process. To evaluate the time series we estimate a dynamic conditional correlation (DCC) multivariate GARCH model introduced by Engle (2002). In these types of models both the conditional variances and covariance of the series follow a GARCH process, whose parameters are estimated in a two-step procedure. The essence of this technique is that the predicted variances represent the current inflation and current depreciation "uncertainty" and not the historical volatility of the series. In fact many authors have used them to study the relationship between inflation and inflation uncertainty (Fountas(2001), Wilson (2006), Karanasos et al. (2006)) in a time series context. Considering that we are mainly interested in the evolution in time of the second moment variables, variances and covariance, and that this last technique explicitly models those moments, the results obtained with this approach are an important point of reference to our previous techniques where only historical volatilities mattered.

3.2.2 The uncovered interest rate parity

The relationship between the nominal spread and the monthly depreciation rate is tested assuming rational expectations. In other words we test for cointegration between the monthly interest rate spread and the actual forward looking monthly depreciation rate. The empirical methodology applied to this first simple model will be replicated in all our subsequent models.

We use information criteria and likelihood ratios in pre-estimation tests to determine the number of additional lags that need to be added to explain the short run dynamics and avoid serial correlation. In this case the tests suggest that 5 lags should be added to jointly explain their relationship. We then test for granger causality between our variables, in this case, we conclude that at the five percent level, the nominal depreciation rate Granger-causes changes in the interest rate spread and not the other way around. We then conduct a Johansen tests for cointegration (trace and eigenvalues), in this case it fails to reject the null of one cointegration vector between these two variables.

Once the existence of a cointegration relationship has been determined we estimate the long run dynamics, these results are summarized in the first column of Table 1.

[5] The explicit vector form that is assumed can be found in Annex 2.

Table 11: Long run dynamics of the uncovered interest rate parity condition

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Basic model	Restricted model	Complete model	Restricted model	Restricted model	Restricted model	Restricted model
Interest rate spread	1	0	1	0	1	1	1
	.	*Omitted*	.	*Omitted*	.	.	.
Depreciation rate	-.61***	-.20**	-.36***	1	0	-.63***	-.34***
	(.12)	(.094)	(.063)	.	*Omitted*	(.076)	(.082)
Fiscal surplus			.094***	.24***	.19***	0	0.11***
			(.022)	(.090)	(.030)	*Omitted*	(.029)
International Reserves			-.00052**	-.00039*	.000094	-.00058	0
			(0.00022)	(.0013)	(.00043)	(.00038)	*Omitted*
p-value : LR test of identifying restrictions	.	.001	.	.000	.001	.006	.043
Observations	152	152	152	152	152	152	152

Standard errors in parentheses*** p<0.01, ** p<0.05, * p<0.1

For the uncovered interest rate parity relationship the estimated value of δ_0 is (.61) and it is significant at the one percent level. We then conduct over-identification restrictions to check the robustness of the results. In this case, we conclude that δ_0 is not null but is also different than the predicted value of one. The specification is also validated by the fact that the additional eigenvalues are different from 1 and that there is no evidence of autocorrelation in the residuals at the five percent level. The residuals from the cointegrating vector are not statically different from a white noise and the stationarity of the deviations from the long run equilibrium is not rejected by the Augmented Dickey-Fuller (ADF), Kwiatkowski, Phillips, Schmidt, and Shin test (KPSS), the Phillips and Perron (PP) tests and the modified Dicky Fuller test (DFGLS). The adjustment parameters also suggest that only the interest rate spread responds significantly to deviations from long run equilibrium.

Concerning the value and the sign of the long run relationship, the data rejects the validity of a strict UIP in the Bolivian economy. The result is however in line with the evidence from developing countries, where large deviations from the uncovered interest rate condition can be persistent. However, our values are close to those obtained for the Bolivian UIP in Morales (2003) and Melander (2009), although both studies used much shorter series and specified the maturities of the interest rate in a different manner. Nevertheless, the fact that a cointegrating relation exists and that the adjustments have the correct sign encourages us to continue.

Concerning the adjustment mechanism, showed by the Granger causality tests and the adjustment parameters, the results are consistent with our qualitative observations in the previous part. From the 2005-2012 the nominal exchange rate was confronted to appreciating pressures but the rate of appreciation was exogenously fixed by the monetary authorities. Interestingly, when we test for co integration over a longer period (1990-2012) we obtain similar values for the long run relationship but we find evidence that the nominal exchange rate also adjusts to deviations from the long run relationship. A plausible explanation for this is the asymmetric discretionary power of the central bank that we mentioned before. Indeed during the 1990's the nominal exchange rate was more responsive to market forces driving its depreciation than in the late 2000's when the central bank managed to fully control the appreciation process.

The next step is to add the risk premium factors to our uncovered interest rate parity condition to test the validity of equation (2). This can only be done in the shorter series because of lack of data capturing monthly government surplus before the year 2000. Pre-estimation analysis suggests the existence of only one cointegrating relationship between these variables. The long run dynamics and the over-identification tests (using a likelihood ratio test to see if we can drop a variable) are shown in Table 1. We conclude that none of the four variables can be dropped out of the VECM.

We can see that the relationship between the nominal depreciation rate and the interest rate spread is further away from the predicted unitary value. Nevertheless this variable and the government surplus have a significant effect of the predicted sign. In contrast the parameter determining the influence of international reserves has an unpredicted positive sign. A deeper analysis of this long run relationship and the adjustment parameters can help us understand this result. Indeed, in the above model only the interest rate spread and the level of reserves adjust to deviations from the steady state. For instance, we realize that a positive shock causing an appreciation of the exchange rate will be absorbed by two mechanisms. The interest rate spread will increase as the UIP equation predicts but this is not a one to one relation. Additionally the level of international reserves will decrease, representing the fact that the authorities will intervene to smooth the effects of the shock and this reaction is expected by the agents. This intuitive response of our model seems consistent with the behavior of the monetary authorities in Bolivia and with the "Fear of Floating" behavior of a dollarized economy.

3.2.2 Baseline model of dollarization

For each of our different specification of the MVP we test for a cointegrating relationship over the period (Jan 2000-Sept 2012) in the form of equation (7). That is, a relationship between the share of dollarized deposits, the MVP, the interest rate spread and the nominal depreciation. It must be noted at this point that if the UIP holds strictly as in (1), then we should be able to identify two cointegrating relationships between these variables, one capturing the UIP and the other the dollarization share. In fact, once we test this hypothesis with the different forms of the MVP, we never find evidence of two relationships. We only find evidence of one cointegration relationship with the M-GARCH specification and the moving average adjustment. However, with the latter one, over identification tests signal us that the only cointegration relationship between these variables is the UIP. In the former case, we find evidence that the MVP and the dollarization terms cannot be excluded from the cointegration relationship. We have therefore estimated this model and the results are shown in Table 2.

Table 22: Long run dynamics of the baseline model of dollarization

	(1)	(2)	(3)	(4)	(5)	(6)
	Basic model	Restricted model	Restricted model	Restricted model	Restricted model	Opposite effects
Dollarization	1	0	1	1	1	1
	.	*Omitted*	.	.	.	.
MVP	-.240***	1	0	.011	0.097	-.210***
	(.072)	.	*Omitted*	(.14)	(.19)	(.045)
Depreciation rate	-111***	-51000***	-4800***	0	-181***	-89.5***
	(14.9)	(7900)	(741)	*Omitted*	(30)	(10.1)
Interest rate spread	141***	98000***	9230***	-217***	0	89.5***
	(43.9)	(20000)	(1850)	(39)	*Omitted*	(10.1)
p-value : LR test of identifying restrictions	.	.041	.031	.000	.000	.69
Observations	152	152	152	152	152	152

Standard errors in parentheses*** p<0.01, ** p<0.05, * p<0.1

Figure 53: Deviation from the steady state

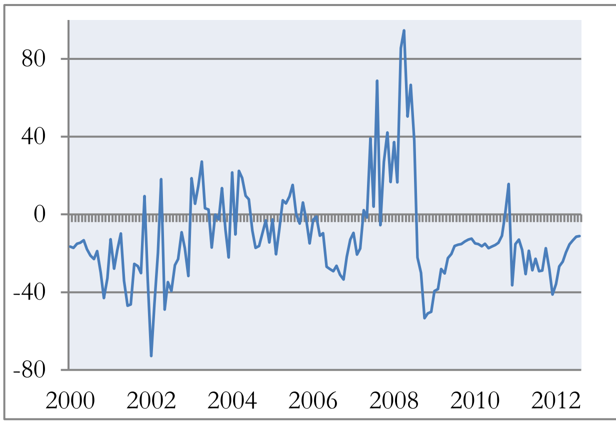
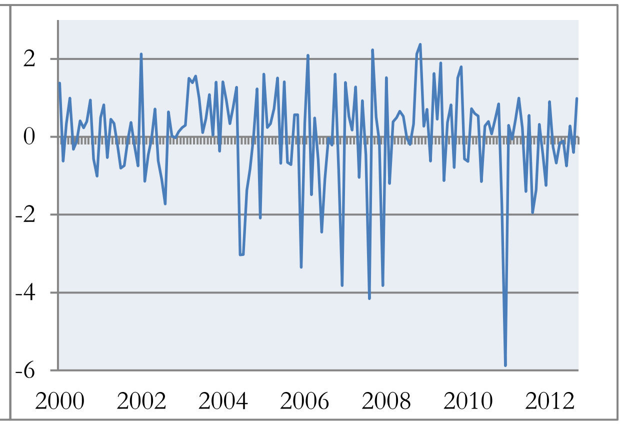


Figure 64: Residuals



In the long run relationship, all terms are significant and with the expected signs. However, the effect of the MVP is different from the predicted value of one. The existence of the relationship is once again validated by the over identification test (column 2-5). According to equation (7), the effect of the nominal spread should be exactly the opposite of the effect of the nominal depreciation rate; a likelihood ratio test fails to reject this hypothesis (column 6).

The deviations from the steady state look stationary in the first half of the sample and at the very end. In contrast, stationarity during the years 2007 and 2008 seems very unlikely. The residuals however appear to be close to a white noise, what they should be if the model is well specified. The Portemanteau test fails to reject the null of white noise residuals. Additionally, all four unit root test conclude that the deviations from the steady state follow a stationary process. The adjustment parameters give some plausible results. The dollarization ratio and the interest rate spread adjust most of the deviations from the steady state, and there are small adjustments in the depreciation rate and the MVP. These results are plausible because one would expect the interest rate spreads and the allocation of savings to adjust more to changes in the macroeconomic environment (depreciation rate and inflation) than the other way around.

Figure 75: OIRF of the dollarization ratio

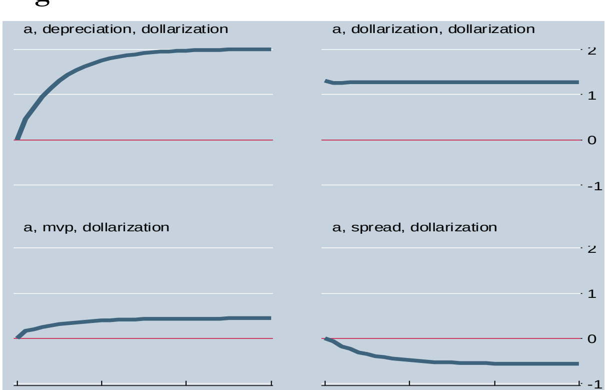
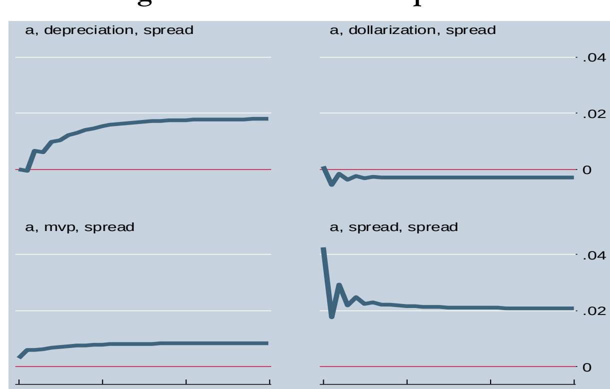


Figure 86: OIRF of the spread rate



The reaction functions of the dollarization ratio and the interest rate spread to orthogonalized exogenous shocks in the other variables are presented in figures 7 and 8. Results are once again partially consistent with the theory. Changes in the MVP, the expected depreciation and the interest rate spread have effects with the predicted sign. However, the magnitudes of these effects are far away from our theory. The effect of a change in the MVP is permanent but much smaller than the predicted unitary effect. At the same time, a one standard deviation change in the interest rate spread and the expected depreciation rate have not the opposite effect, with the exchange rate having a predominant role. The interest rate spread (figure 8) seems to respond mainly to changes in the depreciation rate and its past values, which is consistent with the results of the previous part. In contrast, a positive shock to dollarization should only have temporary effects since this variable is unlikely to cause changes in the other structural variables, something inconsistent with the permanent effects of such shock in our empirical model. This permanent effect arises because the model predicts the MVP will adjust to changes in the dollarization ratio, something incompatible with the theory.

3.2.3 Multidimensional model of dollarization

Once we add the two risk variables into the model, pre-estimation tests always indicate one or two cointegrating relationships. The challenge when we have multiple variables and two cointegrating equation is to correctly identify the relationships that are meaningful. However, in order to achieve identification of the steady state relationships one needs to impose constraints to the model. It is mainly at this point that our theoretical framework becomes essential. However, since some aspects of the theory will have to be assumed to identify the model, those assumptions cannot be tested by our model, even though the validity of the subsequent tests relies on them. Using Juseliuis (2006) notations, the unrestricted framework is:

$$Reduced-form\ \ equation: \Delta\boldsymbol{x}_t = \alpha * \beta' * \boldsymbol{x}_{t-1} + \sum_{i=1}^{p} A_i \Delta\boldsymbol{x}_{t-i} + \varepsilon_t, \qquad \varepsilon_t \sim \mathrm{N}(0,\Omega)$$

$$\boldsymbol{x}_t = \begin{pmatrix} d_t \\ i_t^{DC} - i_t^{\$} \\ MVP_t \\ \mathbb{E}_t[n_t] \\ FS_t \\ R_t \end{pmatrix}, \quad \beta = Unrestricted\ long-run\ structure = \begin{pmatrix} \beta_{11} & \beta_{12} \\ \beta_{21} & \beta_{12} \\ \beta_{31} & \beta_{13} \\ \beta_{41} & \beta_{14} \\ \beta_{51} & \beta_{15} \\ \beta_{61} & \beta_{16} \end{pmatrix}$$

Additionally, α is the vector of adjustment parameters and the A_i matrices are the short run dynamics. In order to identify the steady state equations, we need to impose constraints to at least four terms in the long run structure. For doing that we use what the theoretical framework and the unitary cointegration relationships above have shown us so far. First, both the theory and the data seem to suggest that there is one cointegrating relationship that does not contain the share of dollarized deposits. This relationship is close to the UIP, although the relationship is not exact. Additionally, the dollarization variable is also related to the macroeconomic variables through another equation, close to the portfolio optimization problem where the effect of all these variables is unknown. Unfortunately these mild assumptions are not sufficient to identify the model. One additional assumption concerning the second equation is needed. The stronger assumption that we will make has also both theoretical and empirical justifications. We will assume that dollarization equation does not contain the interest rate spread. More formally:

$$\mathcal{H}_{S,1}: Just - identified\ model\ (1): \beta = \begin{pmatrix} 1 & 0 \\ 0 & 1 \\ \beta_{31} & \beta_{13} \\ \beta_{41} & \beta_{14} \\ \beta_{51} & \beta_{15} \\ \beta_{61} & \beta_{16} \end{pmatrix}$$

From a theoretical point of view this assumption is based on the fact that in the portfolio optimization problem we can replace the interest rate spread using the UIP in order to obtain equation (9). It should be noted that this does not rely on δ_0 being equal to one. From an empirical point of view this hypothesis gives us a normalized identified symmetric model. Subsequent additional constraints will lead us to models approached with mathematical optimization where convergence may not be achieved.

Having made this two assumptions we can estimate the VECM for all our specifications of the MVP. Pre-estimation tests suggest that three specifications of the MVP have two cointegrating relationships: The ARMA models, the moving average and the M-GARCH model. We will only present the results for the latter one to see the evolution from our previous part. Very similar results are obtained when we use the ARMA models and the moving average to build the MVP. The two other techniques do not pass the stability post estimation tests.

Table 37: Long run dynamics of the multidimensional model of dollarization

	Just- indentified model (1)		**Semi restricted model (2)**		**Fully restricted model (3)**	
	Portfolio equation	UIP equation	Portfolio equation	UIP equation	Portfolio equation	UIP equation
Dollarization	1	0	1	0	1	0
	.	*Omitted*	.	*Omitted*	.	*Omitted*
Interest rate spread	0	1	0	1	0	1
	Omitted	.	*Omitted*	.	*Omitted*	.
MVP	-.377***	.000595	-.348***	0	-.341***	0
	(.051)	(.00053)	(.045)	*Omitted*	(.070)	*Omitted*
Depreciation rate	-88.3***	-.258**	-84.9***	-.317***	0	-1
	(9.6)	(.10)	(9.0)	(.071)	*Omitted*	.
Fiscal surplus	11.0***	.151***	13.1***	.113***	42.5***	-.127**
	(3.4)	(.035)	(3.2)	(.025)	(6.2)	(.050)
International reserves	-.718***	.00044	-.693***	-.00038	-.561***	-.000149**
	(.042)	(6.8)	(.039)	(.00027)	(.098)	(.00075)
p-value : LR test of identifying restrictions	.		.807		.072	
Observations	152		152		152	

Standard errors in parentheses*** p<0.01, ** p<0.05, * p<0.1

In table 3, the first estimated model gives us the long run relationships when we impose only our indentifying constraints. Since the model is exactly identified there is no test for identifying restrictions. The results obtained have in general the expected sign and similar magnitudes than the simple cointegrations. The MVP has the expected sign but it is statically different than one. The depreciation rate still has a very significant effect on the dollarization ratio and has not a unitary effect on the interest rate spread. The fiscal surplus has a significant and unpredicted negative effect on the dollarization equation while keeping its expected negative sign in the UIP. The international reserves only affect the dollarization ratio in the predicted way.

In order to evaluate the empirical relevance of our theoretical model we then impose over-indentifying restrictions to the data and evaluate their stability. More formally in columns (2) and (3) we replace our identifying assumptions by the following hypothesis.

$$\mathcal{H}_{S,2} Semi\ restricted\ model: \beta = \begin{pmatrix} 1 & 0 \\ 0 & 1 \\ \beta_{31} & 0 \\ \beta_{41} & \beta_{14} \\ \beta_{51} & \beta_{15} \\ \beta_{61} & \beta_{16} \end{pmatrix}, \mathcal{H}_{S,3}\ Restricted\ model: \beta = \begin{pmatrix} 1 & 0 \\ 0 & 1 \\ \beta_{31} & 0 \\ 0 & -1 \\ \beta_{51} & \beta_{15} \\ \beta_{61} & \beta_{16} \end{pmatrix}$$

The semi restricted model of column (2) is not only closer to our theory and accepted by the likelihood ratio tests it also gives us stationary deviations from the steady state and white noise residuals. In contrast the fully restricted model (3) makes the additional assumption of a unitary effect of the depreciation rate on the interest rate spread, which also implies dropping it from the first equation (see equation (9)). Although barely accepted by the LR test, these additional restrictions do not give stationary residuals. The fact that this model is rejected is evidence against a full compliance with the UIP hypothesis in the Bolivian data. We therefore decide to focus on the results obtained with the semi restricted model, but similar conclusions apply to model (1).

Figure 98: Steady state deviations, portfolio model (2)

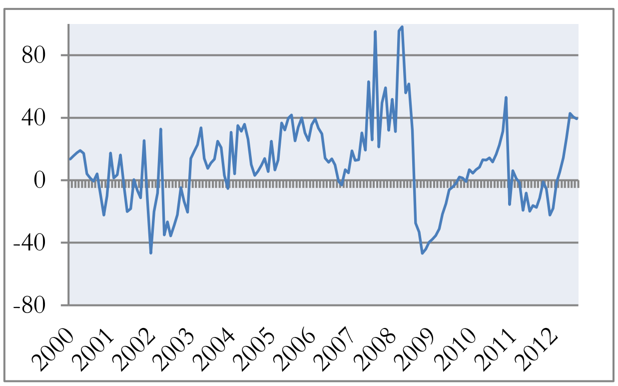
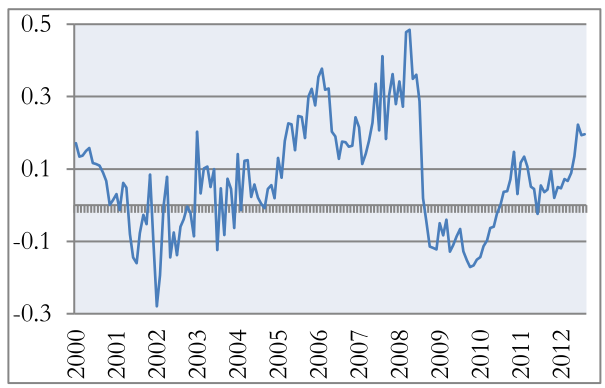


Figure 109: Steady state deviations, UIP model



The stationarity of the deviations from the steady state is not transparent from the above figures. However it is possible to say that we are closer to have stationary series in the first and final parts of the sample. In both cases, three out of four unit root tests conclude in favor of the stationary hypothesis. In addition, the Portemanteau test fails to reject the null of white noise residuals and there is no evidence of serial correlation. It is therefore valid to estimate the adjustment parameters. The fiscal surplus and the depreciation rate are the only variables that do not adjust to changes in the other variables. As predicted the dollarization ratio adjust to changes only in the portfolio equation and the interest rate spread to changes in the UIP. More surprisingly, the international reserves and the MVP adjust to changes in both equations.

We conclude by looking at the orthogonalized impulse response functions. In figure 11, we can see how our variable of interest, the dollarization ratio, responds to changes in the other variables. We find evidence that the expected depreciation has the most significant effects. However, we also find that the MVP and the interest rate spread have a permanent effect in the expected way. By contrast, only a positive shock to the fiscal surplus seems to matter for the de-dollarization process while shocks in the reserves have insignificant direct effects. As in the previous part, shocks to the dollarization ratio have permanent effects, something inconsistent with the theory.

Figure 1110: OIRF of the dollarization ratio shock

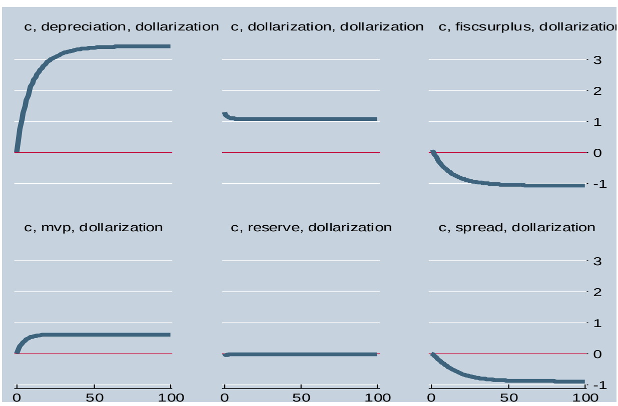
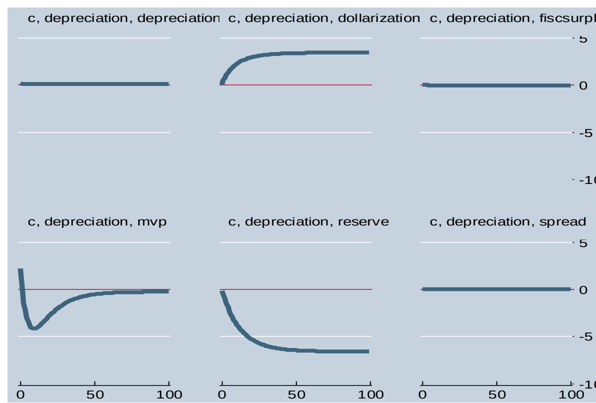


Figure 1211: Response to a depreciation



We then try to assess how our model is predicting the response of the system to a positive shock in the main drivers of the dollarization process. It is encouraging to see that a shock to the deprecation rate will only have a temporary effect in the MVP and that the model predicts a very strong response from the monetary authorities to a depreciation shock. Similarly, a positive fiscal shock will increase the level of reserves and will have a permanent negative effect on the MVP and the dollarization ratio. This seems to highlight the importance of fiscal consolidation to achieve macroeconomic stability and de-dollarization. More surprisingly, reserves seem also to have an important impact on the MVP ratio, which is consistent with the idea that a more powerful central bank will limit the pass trough between nominal exchange rate and inflation. This indirect channel may also give a more important role to international reserves in the de-dollarization process, which the simple OIRF of the dollarization ratio does not allow us to see.

Figure 1312: Response to a fiscal surplus shock

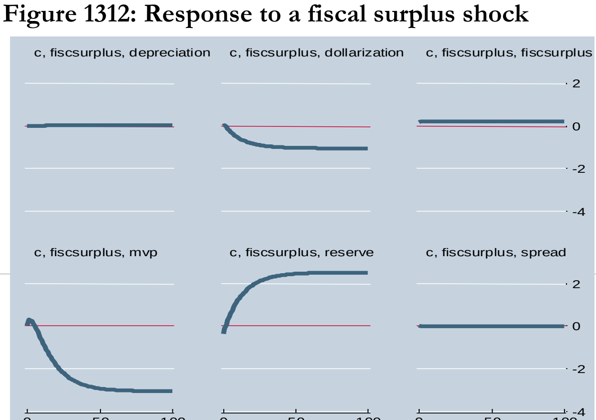
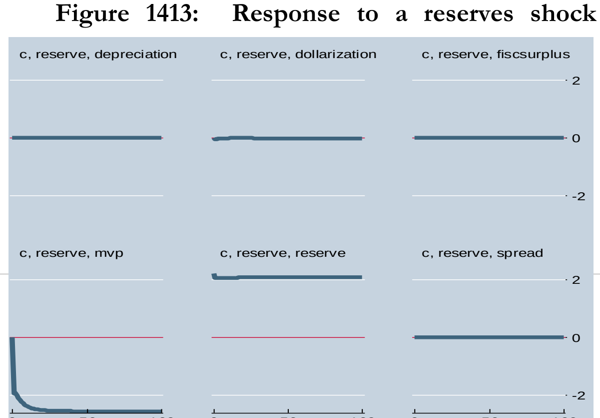


Figure 1413: Response to a reserves shock



4. Microeconomic evidence

Now that we have analyzed the macroeconomic context in which the de-dollarization process took place and identified some of the macroeconomic drivers of this process we will try to see if the effect of these variables is observable in a microeconomic panel. However, since these variables will equally affect all the individuals in every period, their separate effects cannot be distinguished from the time effects. To infer at least partially their effect we will use their interaction with a microeconomic variable affecting the level of individual dollarization.

4.1 Data and variables

I analyze a panel of 151 savers from a Bolivian financial institution, using yearly data from 2004 to 2012 of their individual savings in U.S. dollars and national currency. All our observations correspond to savings from an individual agent or household and not to a firm or a producer. In addition all our agents saved in two bank accounts, one in national currency and the other in U. S dollars. Our panel is strongly balanced with only 10 individuals lacking values for the first year of the study. The dependent variable in this study will be the individual ratio of dollar denominated savings as a percent of total savings in the financial institution. The average nominal exchange rate of the year was used to convert all savings to national currency.

In addition to annual values of the macroeconomic variables presented above (MVP, deprecation rate, interest rate spread, fiscal surplus and international reserves), we will have two microeconomic control variables in all our estimations. These variables are the lagged value of the individual dollarization ratio and a dummy variable equal to one when the individual total savings are higher than the sample median and zero otherwise, this variable is called the wealth dummy (WD). The first variable is relevant because our macroeconomic study show us that dollarization is a very persistent process and this may still be the case at the individual level. The second control is relevant because it is frequently assumed that relative risk aversion is a decreasing function of wealth. Assuming this, we should find that richer individuals will be more prone to invest in the riskier asset, which in the Bolivian context corresponds to savings in national currency. The effect of this control can also be interpreted as the income elasticity of substitution between savings in national and foreign currencies. The descriptive statics of this variable and its relevance for our purpose are presented in figures 15 and 16.

Figure 1514: Dollarization in the sample r

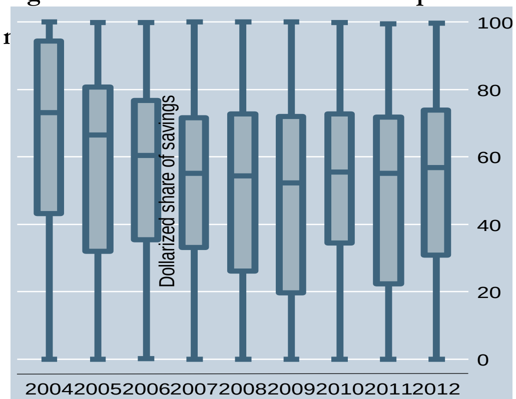
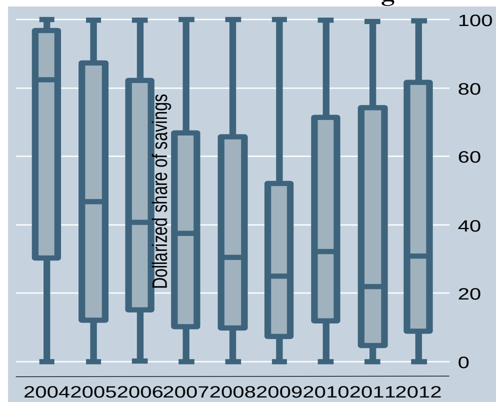


Figure 1615: Dollarization if savings are above the



We can see that the de-dollarization trend is not as visible in the aggregated sample as it is in the sub-sample of high savings. The average dollarization rate decreases only from 78 percent in 2004 to 59 percent in 2012 in the general sample. In contrast, when we look to individuals with high savings the average dollarization ratio decreases from 82 percent in 2004 to 33 percent in 2012. At the same time, the first and third quartiles are much closer to the mean in the general sample than in the sub sample of individuals with higher savings.

4.2 Empirical results

We use three estimation techniques (Ordinary Least Squares (OLS), Fixed Effects (FE) and First difference Generalized Method of Moments (GMM)) to assess the effects of the lagged value of individual dollarization, the level of total savings and different combinations of the interaction term between our macroeconomic variable and our control dummy.

For each technique, three models were estimated: A simple model containing only the microeconomic controls, a baseline model containing the interactions with the MVP, the interest spread and depreciation rates and finally a complete version with all the macroeconomic interactions. Because of the presence of the lagged dependent variable in the estimated equation, the first two techniques give us biased estimators. However, the sign of the observed bias seems to be consistent with econometric theory, indeed the coefficient of the lagged dependent variable in the unbiased GMM estimation is in between FE and OLS counterparts. Aside from this issue the results from one technique to the other are broadly consistent. The GMM identifying assumptions (absence of serial correlation and predetermined dependent variable) also seem to hold as the Arrellano and Bond and over-identification test suggest. A fourth estimation technique (System GMM) dealing with the weak instrument problem was also applied but the additional assumptions required to validate it were rejected by a difference in Hansen test.

Table 416: Microeconomic drivers of individual dollarization

	(OLS)	(OLS)	(OLS)	(FE)	(FE)	(FE)	(GMM)	(GMM)	(GMM)
L .Dollarization	.474***	.473***	.475***	.0885***	.0879***	.0901***	.0987*	.0944*	.100**
	(.42)	(.43)	(.42)	(.032)	(.032)	(.032)	(.053)	(.050)	(.48)
Wealth dummy	-14.3***	-14.3***	9.73	-24.3***	-23.9***	-10.4	-28.9***	-33.3***	-50.4**
	(2.4)	(4.7)	(28)	(3.4)	(4.9)	(27.9)	(7.9)	(7.8)	(22)
MVP * WD		.0134	-.102		.0320	-.0336		.0739	.0434
		(.070)	(.12)		(.068)	(.12)		(.086)	(.10)
Spread * WD		.772	.38		.200	.0277		3.72	4.26
		(3.7)	(4.2)		(3.4)	(4.1)		(3.7)	(4.0)
Depreciation * WD		22.1	29.5		11.8	16.7		-81.3	-30.7
		(49)	(79)		(43)	(70)		(58)	(68)
Fiscal surplus * WD			.463**			.262			.225
			(.22)			(.19)			(.19)
Reserves * WD			-.226			-.127			.127
			(.25)			(.24)			(.19)
m1							0.001	0.001	0.001
m2							0.486	0.579	0.534
Hansen							0.442	0.601	0.569
Diff Hansen doll							0.452	0.309	0.608
Diff Hansen WD							0.285	0.682	0.739
Diff Hansen macro								0.616	0.766
Observations	1208	1208	1208	1208	1208	1208	1208	1208	1208

Note: *, **, and *** denote significance at 10, 5 and 1%, respectively. All standard errors are clustered at the individual level and are robust to heteroskedasticity. In the two-step difference GMM estimator the instrument matrix is collapsed. All regressions include time dummies. m1 and m2 show p-values for Arellano and Bond's (1991) tests of first- and second-order serial correlation in the differenced residuals. Hansen is the p-value for Hansen's (1982) J-test of instrument validity. P-values for difference-in-Hansen tests of the following subsets of instruments are reported: the lagged dependent variable (Diff Hansen doll), the endogenous wealth dummy (Diff Hansen doll) and the endogenous interaction variables (Diff Hansen macro).

The results in table 4, confirm that there is evidence of persistence in the dollarization process. However, the obtained value is far away from the unit root process that we had in the macroeconomic aggregates. The persistence coefficient is closer to 10 percent and statistically different than to one. In addition, there seems to be strong evidence in support of a negative link between individual wealth and dollarization of savings. This result is also obtained when the wealth dummy is replaced by the natural logarithm of total savings. Considering the fact that in the 1990's and early 2000's most of the Bolivian financial assets and liabilities were labeled in dollars it could be argued that saving in national currency was probably the riskier bet. If this is the case then this result is consistent with decreasing relative risk aversion at higher levels of income. However, this result is incompatible with the argument that wealthier individuals have a higher propensity to save in foreign currency because they benefit from a privileged access to international financial markets where only this currency is traded.

Finally the above results fail to detect significant effects of the interaction terms between the macroeconomic variables we analyzed in the previous section and the wealth dummy. This result is also observable when we use the natural logarithm of total savings instead of the binary wealth variable. We can therefore say that there is no evidence of differential effects of the macroeconomic drivers of the de-dollarization by income groups. An important caveat of our estimation is the fact that it relies only on individuals who had two savings accounts during our period of interest. Although there is no reason to believe this sub-sample of the population should behave differently than individuals with a single type of bank account, it completely ignores a potential driver of the de-dollarization process, the arrival of new depositors in the banking system. For this reason we should be careful about the significance of the result from this section for the population as whole.

5. Final remarks

This paper has tried to explore some of the mechanisms that explain the de-dollarization process of domestic savings in Bolivia. The lessons from our main empirical macroeconomic study are that a simple application of the Ize and Levy-Yeyati model of portfolio dollarization does not completely explain the process. Indeed, the empirical model has produced some results that are not consistent with the theoretical predictions. However, there is also empirical evidence in favor of the approach adopted in this paper. The fact that the statistical tests detect the presence of two cointegrating relations between our variables and the realistic values we obtain for our long run relations are encouraging. These positive empirical results allow us to conclude that the capital inflows that improved the fiscal position and also lead to appreciation pressures and to the accumulation of international reserves helped to deliver a more credible monetary regime. When risk averse agents internalized this process they gradually adjusted their domestic portfolios by increasing their share of national currency denominated assets. This paper also contributes to the scarce microeconomic empirical literature in dollarization, by showing that the persistence of individual dollarization may not be as large as in the macroeconomic data. It also allows us to see that in the Bolivian context the de-dollarization process was more visible for wealthier savers. However, we fail to detect the differential effect of macroeconomic variables that could explain this result. Indeed, our paper has completely ignored in its empirical estimation two main issues that could have an important role in explaining the de-dollarization process. The first one is the policy reforms that were put in place during this decade to promote de-dollarization. In particular the financial tax applied only to dollar transactions above a certain limit could be a plausible explanation for our second microeconomic result. The second one is the important expansion of the banking sector during the decade, driven mainly by the entrance of new depositors to the system. Using empirical methods to evaluate the effects of these two issues could be a logical extension for this work.

The dollarization of bank deposits was certainly not the most binding constraint on the development of the poorest country in South America, although it entailed some important problems of its own (financial fragility and diminish role of the monetary policy). However it was one of the most visible signs of a general distrust of the population in the long run stability of the system. In a more general sense the retreat of dollarization may in fact be signaling that the agents believe that recent improvement of the economic conditions will allow sustainable growth, signaling the belief that this time is different. We can only hope that their expectations are rational.

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Annex 1: Unit root tests, test statistics

Variable\Test	ADF	DFGLS	KPSS	PP
Levels				
Dollarization	-2.244*	-0.532*	.477*	0.311*
Nominal depreciation	-2.628*	-2.671*	.102	-41.686*
Interest rate spread	-2.588*	-2.682*	.505*	-3.068*
Reserves/Total deposits	-1.527*	-1.071*	1.19*	0.316*
Fiscal Surplus/Total deposits	-1.967*	-1.247*	.598*	-1.412*
First Difference				
Dollarization	-4.126	-3.972	.114	-253.802
Nominal depreciation	-16.204	-2.601*	.0376	-348.422
Interest rate spread	-16.086	-1.621*	.0396	-423.257
Reserves/Total deposits	-3.517	-3.306	.102	-258.055
Fiscal Surplus/Total deposits	-3.403*	-3.305	.094	-154.930

(*)= Unit root at the five percent level

Annex 2: ARIMA and M-GARCH process

All reported values are significant at the five percent level

ARIMA (1,1,1) process :

$$\Delta\pi_t = First\ difference\ of the\ inflation\ rate = .25 * \Delta\pi_{t-1} + \varepsilon_t^1 - 0.95 * \varepsilon_{t-1}^1$$

$$\Delta n_t = First\ difference\ of the\ depreciation\ rate = .46 * \Delta n_{t-1} + \varepsilon_t^2 - 0.89 * \varepsilon_{t-1}^2$$

$$\varepsilon_t^1\ and\ \varepsilon_t^2\ are\ white\ noise\ process$$

Multivariate GARCH specification (Dynamic Conditional Correlations, Engle (2002)):

$$\Delta\pi_t = .002 + 0.35\Delta\pi_{t-1} + \varepsilon_t^1 \quad ; \quad \Delta n_t = .8\Delta n_{t-1} + \varepsilon_t^2$$

$$\varepsilon_t^1 = v_t^1\sqrt{h_t^{11}} \quad ; \quad \varepsilon_t^2 = v_t^2\sqrt{h_t^{22}}\ ; \quad v_t^1\ and\ v_t^2\ are\ white\ noise\ process$$

$$Conditional\ covariance\ matrix : H_t = \begin{pmatrix} h_t^{11} & h_t^{12} \\ h_t^{12} & h_t^{22} \end{pmatrix} = \begin{pmatrix} h_t^{11} & \rho_t^{12}\sqrt{h_t^{22}h_t^{11}} \\ \rho_t^{12}\sqrt{h_t^{22}h_t^{11}} & h_t^{22} \end{pmatrix}$$

$$h_t^{11} = 5.5 * 10^{-6} + .23(\varepsilon_{t-1}^1)^2 + .69h_{t-1}^{11}\ ; \ h_t^{22} = 7.1 * 10^{-8} + .86(\varepsilon_{t-1}^2)^2 + .53h_{t-1}^{22}$$

$$\rho_t^{12}\ is\ estimated\ using\ the\ non\ linear\ \ two\ step\ approach\ described\ in\ Engle\ (2002)$$