DOLLARIZATION HYSTERESIS NETWORK EXTERNALITIES AND THE "PAST LEGACY" EFFECT: THE CASE OF BOLIVIA

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ABSTRACT

Dollarization in Bolivia rose rapidly immediately after the hyperinflation and currency crisis episode that took place between 1984 and 1985, but failed to reduce and, in fact, continued increasing the following years. In order to explain this dollarization hysteresis, this document proposes and estimates a model, based in the work of Oomes (2003), where network externalities can generate multiple steady-states for dollarization while a so-called past legacy effect increases the likelihood of ending up in a high-dollarization steady-state. The empirical procedure utilizes a more adequate measure of dollarization than the deposit-based ratio, by taking into account a direct estimate of the USD currency holdings in Bolivia thanks to a new source of data. While the empirical results tend to confirm a strong significance of the past legacy effect in this country, the evidence in favour of network externalities seems to rely heavily in the incidence of the past legacy effect over the agents´ formation of exchange rate expectations. Given these results, the document discusses some exchange rate policy implications.

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1. INTRODUCTION

Many researchers agree that dollarization – a phenomenon by which residents of a country extensively use foreign currency alongside or instead of the domestic currency – has become one of the leading theoretical and policy debate issues of the past years.[1] This debate has focused mostly on a number of Latin-American, where the main issue under discussion is whether these countries should fully dollarize or, instead, pursue zero-dollarization. Unfortunately, as both alternatives enjoy significant support by numerous economists, the debate is far from being resolved and, indeed its intensity has been increasing markedly the recent years.

What is still somewhat overlooked by this normative debate is the fact that most of the countries under analysis are already partially but highly dollarized principally as a result of severe high inflation and currency crisis experiences in the past (Calvo, 1999). The cases of Argentina, Peru, Uruguay and particularly Bolivia are the most visible ones (Savastano, 1996). More, even after several years of economic stability, low inflation and exchange moderate rate depreciation rates that followed, dollarization showed substantial levels of persistence, a phenomenon which is frequently called dollarization hysteresis.

Many authors[2] consider the current monetary systems in these countries as being prone to currency-mismatch-related risks whose prevention could eventually make extreme regimes (*i.e.* full dollarization or, conversely, zero dollarization) more preferable. At this juncture, dollarization hysteresis has decisive effects over a highly-dollarized nation's desire to shift to another monetary regime. For instance, if zero-dollarization is pursued, signs of hysteresis would imply the necessity of stronger and more costly measures to encourage de-dollarization. In fact, some authors point out that if such measures are excessively costly, dollarization may have to be seen as virtually irreversible (Feige *et al.*, 2003). Conversely, if full dollarization were the preferred regime, the presence of hysteresis would probably ease the remaining steps towards it. Knowledge of the causes and consequences of dollarization hysteresis is therefore a significant input into the normative dollarization debate.

[1] See, for example, Baliño *et. al.* (1999), Calvo (1999), Schuler (2005) and Salvatore (2003).
[2] See Baliño *et al.* (1999) and Gulde *et al.* (2004).

Early economic models on dollarization usually adopted a portfolio-balance approach where the interest rate differentials and the exchange risk are the main factors driving the currency-choice process among agents (Mizen and Pentecost, 1996). While possibly explaining why dollarization may have started, these models have not been able to explain cases where dollarization persists even if the domestic inflation is low and the interest rate differentials have been favouring domestic assets for several years (Oomes, 2003). In other words, they fail in explaining dollarization hysteresis.

This document proposes two alternative phenomena to explain dollarization hysteresis*:* network externalities and the so-called past legacy effect. The former implies that the benefits for a given agent of holding a certain currency increase with the use of the same currency by other agents. If, for some reason, this phenomenon favours a foreign currency such as the US dollar and becomes strong enough, a high degree of dollarization may persist after macroeconomic stabilization and despite a low return on foreign assets. In turn, the past legacy effect is defined as a particular investment behaviour caused by a long memory of violent episodes of inflation and currency crisis caused by past monetary and fiscal mismanagement (Baliño *et al*., 1999).

This study rests in a theoretical model developed by Oomes (2003), which takes into account these phenomena to explain the dynamics of dollarization and examine the main features of dollarization hysteresis. In short, the model shows that: a) network externalities in the demand for currency can generate multiple equilibria for dollarization but only the extreme cases (those consistent with high or low dollarization) are stable steady-states; c) the high-dollarization steady-state can be reached with sufficiently large levels of currency depreciation; and d) the past legacy effect increases the likelihood of reaching such high-dollarization steady-state, so the reversion of dollarization becomes more difficult.

The network externalities and past legacy effect hypotheses will be tested for the case of Bolivia, one of Latin America's most severe cases of dollarization (Feige *et al.*, 2003). The hyperinflation and currency crisis of Bolivia in the 1980s and the relatively quiet years that have followed offer an interesting opportunity to observe how dollarization evolves under such contrasting circumstances. The estimations of the model will benefit greatly from a new source of data on US dollar currency holdings in Bolivia

(a variable whose estimation has constantly been elusive in the empirical work on dollarization) collected by the US Custom Service over the last 28 years.

The document proceeds as follows. Section 2 discusses the multiple forms of dollarization and the main benefits and costs often attributed to it. Dollarization hysteresis and its causes are discussed in Section 3 using a sample of four Latin-American economies. Section 4 presents the model in its structural form and also derives a linear reduced-form of it so standard econometric techniques can be utilized next. The results of the empirical work using Bolivian data are presented in Section 5. These are then interpreted and used to analyse some exchange rate policy implications related to the potential desire to change the current dollarization levels in Bolivia. Section 6 summarizes and concludes.

2. CONCEPTUAL ISSUES ON DOLLARIZATION

2.1 DEFINITIONS

In the most general sense, dollarization could be defined as a phenomenon by which residents of a country extensively use a foreign currency alongside or instead of the domestic currency (Schuler, 2005). Many authors[3] stress the little consensus that has characterized the search for more insightful definitions of dollarization in the past decades, provided that it is possible to study this phenomenon from diverse perspectives. This section tries to present a set of definitions that might possibly meet the widest agreement today.

The multiple forms dollarization may take will be examined in accordance with two major criteria. The first one is a theoretical approach associated with the monetary services provided by a currency. The second criterion considers the legal tender status of a currency in line with a country's existing laws.

a) The monetary services criterion

According to this criterion, which considers the services provided by a currency, dollarization is the result of two related phenomena: currency

[3] See, for example, McKinnon (1996), Mizen and Pentecost (1996) and Savastano (1996).

substitution and asset substitution. Currency substitution (CS) occurs when foreign-currency-denominated assets are used as a medium of exchange and unit of account while asset substitution (AS) occurs when foreign-currency-denominated assets are mainly used as store of value (interest bearing assets or cash). This distinction is consistent with most of the relevant literature.[4] McKinnon (1996) labelled this two terms "direct currency substitution" and "indirect currency substitution" while Gulde *et al*. (2004) renamed them as "payments dollarization" and "financial dollarization", respectively.

Some authors[5] consider important to introduce another phenomenon which usually accompanies AS, known as liability dollarization (LD). LD refers to a situation where domestic residents tend to borrow funds denominated in foreign currency. It is particularly relevant in many less developed countries where foreign loans, normally denominated in foreign currency, represent a key source of funding for their financial systems (Calvo, 1999). In these cases, banks generally try to balance their large foreign-currency-denominated liabilities by encouraging foreign-currency lending (*e.g.* by offering better financial conditions for it when compared to domestic-currency lending) and extending it to domestic-currency earners. Thus, LD generates a number of currency-mismatch-related risks which tend to weaken the solvency of the financial systems, particularly in episodes of significant exchange rate depreciation (Calvo *et al.* 2004). Given their importance, these financial risks are discussed later on this section.

b) The legal tender status criterion

Legal tender is defined as currency that cannot legally be refused in payment of debt, unless an explicit agreement to pay in a different currency had previously existed.[6] Thus, according to this criterion, dollarization may take three different forms. The first one is commonly known as full or Official Dollarization (OD), by which the foreign currency is adopted as the unique legal tender and the domestic currency is abandoned on a permanent basis. Panama adopted the US dollar as full legal tender since its independence in 1904 and until 2000 was considered

[4] See, for example, Calvo and Végh (1992), Baliño *et al.* (1999) and Feige *et al.* (2003).
[5] See Calvo (1999) and Calvo *et al.* (2004).
[6] See the Concise Oxford English Dictionary (2004).

the only independent and sizeable country under such regime. Recently, Ecuador (2000), El Salvador (2001) and Guatemala (2001) have also become fully-dollarized.

The second form is known as Partial Official Dollarization (PD), where both the domestic and the foreign currency are full legal tender and are let to freely compete for the public's currency preferences. According to the International Monetary Fund (IMF) only a dozen of countries including Bahamas, Cambodia and Haiti are included under this classification.[7]

The third and last form is frequently labelled Unofficial Dollarization (UD), whereby the domestic currency is the only legal tender and the use of the foreign currency, although authorized for some purposes, is restricted for many others (Schuler, 2005). For example, the *boliviano* is the only legal tender in Bolivia. Holding deposits and cash in USD is permitted in this country and even private legal contracts can be denominated and settled in USD if the parties decide so. However, unless previously agreed, USD can be rejected in payment of a debt. Moreover, the use of USD has many other relevant restrictions related to transactions with the public sector. That is, any transfer of resources from the private sector to the public sector (taxes, payments for public services and social security) must be denominated and settled in *bolivianos*.[8] The same is also obligatory for any transfer of resources from the public sector to the private sector (wages of public workers, payments for private services and subsidies). Furthermore, private wages are virtually denominated and settled in *bolivianos*.

This definition of UD will be constantly used throughout this study and especially when the particular case of Bolivia is addressed, as it is consistent with most of the literature on this topic.[9] In effect, according to the current IMF´s exchange rate regime classification,[10] UD is known to be

[7] Also known as semi-official dollarization. See IMF (2000).
[8] Except for the Tax for Flying Abroad, periodically adjusted to the *boliviano* - USD exchange rate. See www.impuestos.gov.bo
[9] See for example Schuler (2005), Feige *et al.* (2003), Kamin and Ericsson (2003) and Feige and Dean (2004).
[10] The classification given by IMF excludes many highly-dollarized countries from the list of countries under PD since in these the foreign currency is not legal tender. See, for example, IMF (2000) and Fisher (2001).

present in different degrees in a number of Latin-American countries such as Argentina, Bolivia, Costa Rica, Nicaragua, Peru and Uruguay.

Before concluding this section, it is important to stress the fact that only under PD or UD the domestic monetary authority can still have some degree of monetary policy independence as long as agents voluntarily choose the domestic currency to provide them with monetary services. As said before, under OD this possibility is abandoned on a permanent basis. In the same way, the definitions of dollarization given by the monetary services criterion are relevant only under PD or UD, since in both regimes the agents´ preference for one currency or another will tend to affect the degree of dollarization in a country. Again, when OD is the prevailing regime, dollarization in any of its multiple forms is complete regardless of currency-preference considerations.

2.2 THE BENEFITS AND COSTS OF OFFICIAL AND UNOFFICIAL DOLLARIZATION

Latin-American economies are always under scrutiny in the dollarization debate, where some consider Bolivia as one of the strongest candidates to adopt an OD regime in the near future (Salvatore, 2003). Such debate naturally ends up looking at the expected benefits and costs that OD would imply for a given country.

Supporters of OD[11] often cite poor monetary and fiscal performances which generated or exacerbated a large record of hyperinflations and currency crisis in many underdeveloped countries as the main motivations for full dollarization. In other words, OD would involve importing a superior foreign monetary policy as well as a lower and stable foreign inflation rate (Mundell, 2003). Thus, in general, three main benefits are often related to OD: a) macroeconomic stability, b) elimination of currency depreciation risk and c) financial integration. Conversely, OD opponents[12] cite a number of related costs such as: a) the loss of seignorage revenues, b) a higher dependency and vulnerability against the foreign currency issuer's monetary policy, and c) the weakening of the central bank's capacity as lender of last resort.[13]

[11] See, for example, Mundell (2003), Calvo (1999) and Schuler (2005).
[12] See, for example, Cohen (2003), Edwards (2003) and Rojas-Suarez (2003).
[13] Fischer (1999) suggests that the government can still deal with potential banking sector problems even under OD, via other standard revenue sources, such as taxes.

This debate has continued with a number of counter-arguments from both sides,[14] where the narrow range of historical experiences of OD accounts as the main reason why it is far from been resolved. While Panama appears to be the only independent sizeable country that can be used to study the insights of OD, the country's close historical, political and economic links to the US implies that any examination of this economy should be taken with care. Perhaps the recent experiences with OD in Ecuador, El Salvador and Guatemala will provide richer information to the debate, although more time is required.

Nevertheless, it is important to note that, from a positive point of view, the current high levels of UD many Latin - American countries already face also imply benefits and costs that must be taken into account in the dollarization debate. UD can be considered as a less drastic alternative than OD that governments can motivate in first place in order to stop and reverse capital flights in countries that have experienced large periods of macroeconomic instability and high inflation. This was indeed the case of several Latin-American countries (such as Argentina, Bolivia, Peru and Uruguay) where Foreign Currency Deposits (FCD) were allowed since the mid-1970s to stop the fall of deposits in domestic banks and to reverse the sharp increase in Cross Border Deposits (CBD) that took place under the episodes of high inflation and large devaluation in that decade.[15] In that sense, three main benefits can be regarded to UD:

- *Re-intermediation.* Availability of FCD in a country can stop and reverse capital flights, since agents may be willing to return to domestic intermediaries (attracted by higher returns) only if they can hold foreign-currency-denominated assets and avoid large depreciation and hyperinflation risks.

- *Financial Deepening*. In a UD scenario, domestic banks can still expand their financial services supply to compete for FCD held abroad, given that agents are less willing to bear domestic-currency-related risks but could be attracted by higher interest rates. FCD can also facilitate integration to the international market and reduce international financial transaction costs.

[14] See Berg and Borennzstein (2003).
[15] See Baliño *et al.* (1999).

- *Credibility*. If FCD are allowed then the credibility of the future domestic monetary policy in the residents' eyes could increase, as the costs of monetary indiscipline will be higher. That is, under any suspicion of mismanagement agents can rapidly abandon the domestic currency and shift their investment portfolios towards FCD or Foreign Currency Cash (FCC), in which case the control of the money supply is seriously hindered. Note that while FCD do not cover agents from confiscation risk, FCC (cash "under the mattress") can be used for this purpose, especially when CBD are not attractive due to low international interest rates or if investing abroad is either restricted or too costly.

As said before, much of these benefits were present when the episodes of financial crisis and macroeconomic instability were experienced by Argentina, Bolivia, Peru and Uruguay in the 1970s and 1980s. Yet the levels of UD in these countries kept firmly increasing the following years despite the evident improvement of the economic conditions[16] and, consequently, introduced new challenges to their financial sectors. More specifically, high levels of UD involve two specific types of financial risk:

- *Liquidity risk*. Systemic liquidity risk exists if the demand for FCD falls, due to an increase in the perceived country risk (political instability) or bank risk, and depositors convert their deposits in foreign-currency-denominated cash or transfer them abroad. Then, unless FCD in domestic banks are backed by sufficient liquid foreign-currency-denominated assets, banks may run out of reserves and fail to honour their liabilities. The monetary authority's lender of last resort function is indeed designed to moderate this kind of circumstances. However, if the extent of the bank run is large enough the authority may also run out of international reserves. In such case, the agents' fears that motivated the run in first place become self-validated.

- *Solvency risk*. Partially-dollarized economies usually exhibit high levels of LD in both the private and the public sectors. In the case of the latter, even though public revenues are generally denominated in domestic currency, governments usually attempt to attract private

[16] Except for short periods of compulsory de-dollarization in Bolivia, Peru and Argentina, which are discussed later.

domestic and foreign savings to finance their fiscal deficits by issuing foreign-currency-denominated public bonds.

In such context, a large depreciation of the exchange rate will undermine the domestic-currency-earners´ ability to pay-off their dollarized debts, including those issued by the governments. The default levels in the domestic banking sector will tend to rise and, with it, the risk of insolvency in the future. Therefore, the country's international creditworthiness could be seriously damaged and lead international lending to a "sudden stop",[17] thus reducing the country's sources of funding and aggravating its fiscal and financial crisis. In addition, the negative effects of a sharp depreciation will tend to be more intense if the share of tradable goods output (which can be rapidly transformed into exports to supply extra foreign currency) is small.

Note that besides the mentioned risks, UD also implies a set of costs that are similar but logically less pronounced than those cited in the case of OD. In other words, the greater the degree of UD in a country, the less will be the monetary authority's ability to earn *segnoriage* revenues as well as its degree of control over the effective money supply in the economy. Significant levels of UD imply that the effective money supply is larger than the domestic money supply and thus it acquires an endogenous behaviour.

Overall, the UD benefits appear to have been quite relevant for a set of countries aiming to overcome large macroeconomic disorders and re-intermediate their economies over the past decades. Yet, its costs and in particular its related risks are widely present nowadays, leaving these countries in a rather uncomfortable situation of high vulnerability against shocks and speculative behaviours. This is perhaps one of the main reasons why Latin-America has been at the centre of the dollarization debate over the last years.

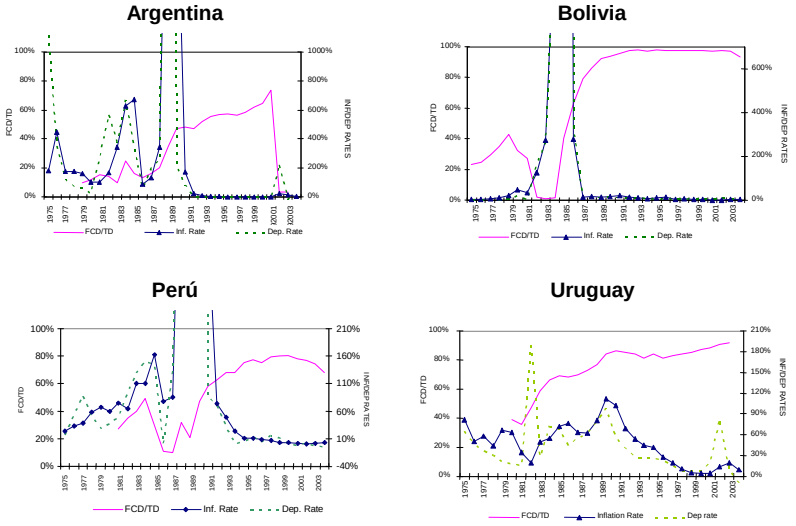
[17] See Calvo *et al.* (2004).

3. DOLLARIZATION HYSTERESIS

3.1 DEFINITION AND PRESENCE IN LATIN-AMERICA

Dollarization hysteresis can be defined as a phenomenon that occurs when dollarization (in the form of currency and/or asset substitution) rises as a result of a significant increase in inflation or the exchange rate but does not decrease when these variables fall (Oomes, 2003). Many authors have recognized or at least warned about this sort of "stylised fact" in the Latin-American dollarization processes.[18] To see this, Figure 1 presents the evolution of the FCD to total deposits (TD) ratio and the inflation and exchange rate depreciation rates for Argentina, Bolivia, Peru and Uruguay, which are known to be experiencing the highest levels of dollarization in the region (Feige *et al.* 2003).

FIGURE 1: FOREIGN CURRENCY DEPOSITS TO TOTAL DEPOSITS, INFLATION RATE AND DEPRECIATION RATE IN SELECTED LATIN-AMERICAN COUNTRIES[19]



[18] See for example, Savastano (1996) and Feige *et al.* (2003).

[19] The data on the FCD/TD ratio were collected from the IMF International Financial Statistics (IFS) for Bolivia, the IMF Country Report 04/195 for Argentina, the Central Bank of Peru and De la Rocha (1996) for Peru and the Central Bank of Uruguay for Uruguay. Data on inflation and exchange rate depreciation against the US Dollar were collected from the IFS.

The typical symptoms of dollarization hysteresis can be easily identified in the cases of Argentina and Uruguay. As their domestic currencies were rapidly losing value due to high inflation and depreciation rates over the 1980s, domestic depositors in these countries shifted their savings into FCD. Indeed, FCD rose sharply between 1981 and 1983 and again in 1989 in Uruguay and between 1989 and 1991 in Argentina, as their inflation and depreciation rates reached maximum levels. Nevertheless, when stability was recuperated the following years and both rates were low and under control during most of the 1990s, the FCD/TD ratios kept increasing and seemed to stabilize only at very high levels of over 80% in Uruguay and less than 60% in Argentina. In fact, due to the severe financial and fiscal crisis that affected both countries in 1999, the ratios regained some of their rising trends, especially in Argentina.

Only the compulsory *pesofication* of FCD in 2002 disrupted the upward trend of the mentioned ratio for Argentina, although not without costly consequences (Perry and Serven, 2004).[20] Moreover, one might expect that, despite *pesofication*, dollarization in Argentina has remained high over the last years, although most in the form of CS (Feige *et al.* 2003), which can not be captured by the FCD/TD ratio.

Bolivia and Peru also experienced episodes of compulsory reductions in FDC that explain the sharp drop in their ratios during the 80s. In Bolivia, FCD were not allowed between 1982 and 1985, in the midst of a severe economic and political crisis that led the country to a record hyperinflation, unsustainable rates of exchange rate depreciation, the default of the public debt and an early call for presidential elections (Antelo, 2000). Yet, it is known that USD currency was still circulating in Bolivia during this period, representing a sizable amount in real terms (Melvin, 1988). Again, as the FCD/TD ratio is unable to capture this phenomenon, a more appropriate measure of dollarization will be introduced in Section 5.

Once FCD were authorized again in 1985, along with other policy measures which helped to stop hyperinflation and the rigorous depreciation of the Bolivian currency against the USD almost immediately, the FCD/TD ratio easily surpassed its pre-1982 levels and kept rising until 1993 where it stabilised around 96% for several years. Since 2003, it

[20] As *pesofication* was forced using an overvalued (fixed) official exchange rate, commercial banks were left with severe imbalances in their foreign exchange positions and depositors had to absorb significant capital losses on their savings. See Perry & Serven (2003) for further details.

showed a slight decreasing trend, possibly encouraged by the introduction of a tax on financial transactions (July-2004), which has a larger effect on transactions settled in USD than in those settled in *bolivianos*.[21]

A similar succession of events took place in Peru. FCD were banned in 1985, causing significant capital outflows while the country was facing a severe economic crisis characterised by hyperinflation, a sharp depreciation of the exchange rate and the default of the public debt (De la Rocha, 1996). Once the prohibition was lifted in 1990 in an attempt to re-monetize the economy, FCD rose sharply and the FCD/TD ratio reached its maximum in 1999 before showing slight signs of decrease the following years.

The evident presence of dollarization hysteresis in many Latin-American and other partially-dollarized countries represents a significant drawback for traditional models of dollarization (mainly based in return rates and portfolio balance considerations), as they predict an instantaneous fall in dollarization once the domestic inflation and the exchange rates are also low and under control (Oomes, 2003). New advances on this field have thus focused on two phenomena which have proved very helpful to explain the evolution of dollarization and particularly its persistence at very high levels. These two phenomena are the so-called past legacy effect and network externalities.

3.2 THE PAST LEGACY EFFECT

The past legacy effect can be defined as an atypical investment behaviour caused by a long memory of several important and violent episodes of high inflation and currency and financial crises mainly caused by monetary and fiscal mismanagement. Such hocking policy record leads citizens' expectations to be pessimistically about the future stability and sustainability of the domestic monetary and fiscal regimes biased.[22] Therefore, UD is the result of firms and individuals voluntarily choosing to use a stronger foreign currency in order to avoid the highly probable negative outcomes that will affect to domestic-currency users.

[21] Until July 2005, all financial transactions settled in USD had to pay a 0.3% tax (currently the tax is 0.15%), including FCD withdrawals and deposits of over USD1.000 (currently the amount is USD2.000). Domestic currency deposits are not affected by this tax.

[22] A similar definition was given by Peiers and Wrase (1997).

However, such biased beliefs should not be perennial. One may expect that if macroeconomic stability has been present for a reasonable period of time, then agents should correct their pessimistic expectations when making investment decisions. Nevertheless, the lengthier and more severe the record of bad economic policy in a country, the longer their citizens´ adjustment period will be and, accordingly, the stronger the past legacy effect that encourages persistence of dollarization.

Although not many studies are available on this topic, there is some strong evidence suggesting that the past legacy effect has been common in many Latin-American countries.[23] Usually, this effect has been modelled by means of a so-called ratchet effect, defined as phenomenon where a dependent variable reacts asymmetrically to changes in a key explanatory variable.[24] Such concept is clearly consistent with the notion of dollarization hysteresis if the dollarization ratio is taken as the variable that reacts to changes in the inflation rate or, alternatively, the exchange rate depreciation rate.[25] As the cases in Figure 1 show, the FCD/TD ratios increased sharply when these two rates rose to unprecedented levels, thus showing a high degree of sensitivity to them. However, such sensitivity reduced noticeably once the rates started to fall and returned to low levels.

Empirically, a ratchet effect is usually captured through the inclusion in the estimated model of a ratchet variable, defined as the maximum value over the last *n* years of a key independent variable such as the inflation rate or the depreciation rate. As Peiers and Wrase (1997) propose, if the ratchet variable is found to be statistically significant for a country, it might be in fact capturing the extent to which agents´ long-term pessimistic expectations are contributing in keeping the level of dollarization high even after macroeconomic stabilization, regardless of depreciation or return considerations.

[23] See for example Peiers and Wrase (1997), Uribe (1997) and Feige *et al.* (2003).
[24] See Mongardini and Mueller (2000) and Kamin and Ericsson (2003).
[25] Many studies include *ratchet* variables based on these two rates almost interchangeably (Mongardini and Mueller, 2000; Oomes, 2003; and Feige *et al.*, 2003). Both rates have exhibited a high degree of co-movement during episodes of crisis (See Figure 1) as they reflect the same phenomenon: the loss of relative value of the domestic currency.

3.3. NETWORK EXTERNALITIES

Given its effect over the investors´ return expectations, the past legacy effect seems to be a relevant factor in explaining hysteresis mostly from a financial and precautionary point of view (*i.e.* the as-store-of-value function of money). However, it seems to have no apparent relation to the use of foreign currency for transactional purposes where the network externalities approach can provide a realistic explanation. According to this approach, network externalities occur when the benefits for a given agent of holding a certain currency increase with the use of the same currency by other agents (Oomes and Shinkevich, 2002).

An intuitive way to explain this phenomenon is by introducing the formally equivalent example of the telephone network. The well-known benefits of the use of the telephone service exist only if there is someone else using the same service. Thus, every time a new participant arrives, the value of the network increases for the rest of the users as well as for the newcomer.

A currency network works in a similar fashion. If initially an economy is not dollarized the domestic currency is the only well-built currency network. Consequently, it will be more costly for any agent to perform transactions in foreign currency as almost no-one uses it to purchase or sell goods. Here, a number of discouraging transaction or switching costs become relevant for the (few) foreign currency holders, namely, the opportunity costs of walking to an exchange office (shoe-leather cost), the costs of learning how to use the new currency and the losses related to the bid-offer differential as well as the commissions often involved in money exchange.[26]

However, if some severe shock (*i.e.* a hyperinflation or a large depreciation) substantially undermines the domestic currency's ability to provide services as medium of exchange, a foreign-currency trade network may emerge among domestic residents. Moreover, if the shock over the domestic currency has been strong and lengthy enough, the alternative foreign-currency network may in response grow continuously, implying that the value of holding foreign currency for each member of the network will increase as more agents participate of it (network externalities). In other

[26] See Dowd and Greenway (1993).

words, an increasing aggregate level of dollarization in the economy tends to reduce a given agent's marginal cost of performing transaction in foreign currency.

Consequently, one might expect that there exists some high level of UD from which returning to the domestic currency becomes costly and, therefore, agents will have no incentive to de-dollarize irrespective of depreciation or return rate considerations and even after long periods of macroeconomic stability (Oomes and Shinkevich, 2002). Here, the effects of network externalities tend to favour the recently adopted foreign-currency network and work against the recuperation of domestic-currency network even in the absence of a past legacy effect.

Yet the domestic currency will not be necessarily abandoned. Just as some degree of CS is known to exist in many countries,[27] the existence of a bi-network system within an economy is perfectly feasible for many reasons: the domestic-currency network still exists and is widely-known so can be used whenever necessary; convertibility between currencies allows plenty access to both currency networks; and typically there are legal restrictions imposed by governments to (partially) restrict the use of foreign currency.[28]

Along with this intuition, supporters of this approach emphasize three main features regarding the incidence network externalities may have over the dynamics of UD (which also can be identified in the selected cases shown in Figure 1 above):

- The functional relationship between UD and inflation or, alternatively, the exchange rate depreciation appears to be non-linear. First, dollarization does not seem to monotonically increase with any of these two variables: only drastic increases in these variables seem necessary to incite a rise in UD. But then, when at very high levels, dollarization does not decrease even if inflation (or depreciation) has returned to low levels (Oomes, 2003). Note that this approach provides a different but fully coherent intuition in order to explain dollarization hysteresis.

[27] Several estimations suggest that 40%-60% of the US currency is outside US. See Feige and Dean (2004).
[28] See Dowd and Greenway (1993) and also Costa and De Grauwe (2004).

- Given the above considerations, some authors suggest that network externalities may lead to two different steady-state in the evolution of UD (Oomes, 2003): one where UD is low and the domestic currency has predominance over the foreign currency; and other (reached only due to some severe shock) where UD is high and the foreign currency has substantially usurped the domestic currency's functions in the economy. Note that such intuition is consistent with the low FCD/TD ratios observed during the 70s and early 80s in the selected countries of Figure 1, which then changed dramatically to very high levels after the severe crisis of the mid-80s and showed high degree of persistence ever since.

- A critical implication of the existence of an steady-state-equilibrium where UD is high, is that once such state has been reached in a country there is some risk that the effect of network externalities may lead the equilibrium to become irreversible for practical purposes,[29] Dollarization irreversibility is defined as a situation where the policy measures required to promote the shift from a high-dollarization to a low-dollarization equilibrium in a given economy are extremely drastic, such as sharp currency appreciations that could severely undermine the traded sector's competitiveness, or further legal restrictions related to the use of foreign currency, known to be highly unpopular and threatening to financial-intermediation.

Studies making a clear connection between network externalities and dollarization hysteresis are relatively recent and few in the empirical field. Uribe (1997) presented a model where introduces the idea of "getting used" to USD where purchases in this currency are subject to transaction costs that are negatively related to what he defines as dollarization capital or the accumulated knowledge about using USD. However, no direct estimation of the model was carried out. Peieres and Wrase (1997) presented a similar model, where the experience with dollar-denominated transactions reduces the marginal costs of lending and borrowing in dollars. Although they only estimated their model indirectly and used a rather narrow definition of dollarization,[30] they were able to find some

[29] See Oomes (2003), Feige *et al*. (2003) and Feige and Dean (2004).

[30] Their model is based on a general equilibrium setup where choice between informal loans (their proxy for the dollarization ratio) in foreign or domestic currency is done in a continuous way. However, their estimations are based on a probit model where choices are made in a binary fashion, thus implying the estimation of a different model.

evidence of dollarization hysteresis in Bolivia due to network externalities. These findings tend to be confirmed by Reding and Morales (2004), who also present and estimate a similar model for this country. Yet, they also warn about the poor quality of the dollarization ratio (*i.e.* the FCD/TD ratio) used in their estimations, a widely-known and critical concern that will be discussed in Section 5.

In an attempt to address all the major drawbacks found in these studies, Oomes (2003) presented a novel approach which brings together the effects of network externalities and the past legacy to model dollarization using a non-linear theoretical framework. He also derived a linear reduced-form of this model which is then estimated using newly available direct estimates of FCC in Russia, derived from the Currency and Monetary Instruments Reports (CMIR)[31] collected by US Custom Office and complementary data from the Central Bank of Russia. His estimations give supportive evidence of network externalities as a key explanation of dollarization hysteresis in this country, without any relevant signs of irreversibility. A similar approach, but based on a broader definition of dollarization (*i.e.* including FCC and FCD), was used by Feige *et al.* (2003) to study UD in Argentina. They also find supportive evidence of network externalities to explaining dollarization hysteresis in this country but, unlike the Russian case, they suggest that Argentina's post-1990 levels of UD have become virtually irreversible.

4. A MODEL OF DOLLARIZATION

As said before, the past legacy effect and network externalities explain dollarization hysteresis from two different perspectives. The former drives the agents´ expectations on the future monetary policy and is more related to return rates and risk considerations where AS is the main concern. The latter focuses on the use of currency for transactional purposes and, therefore, deals largely with CS considerations. The empirical estimation to be presented later for the case of UD in Bolivia is based on a novel theoretical approach developed by Oomes (2003)[32] where both phenomena are gathered within a non-linear framework which depicts

[31] The CMIR data will be discussed in more detail in Section 5.

[32] Inspired in the work of Brock and Durlauf (2001) and probably in the earlier work of Dowd and Greenway (1993).

more suitably the dynamics of dollarization[33] observed in practice. This model is described next.

4.1 GENERAL CONSIDERATIONS AND MAIN ASSUMPTIONS

Consider an economy inhabited by many agents. Time is discrete and at $t = 0$, each agent is randomly assigned to be either a buyer or a seller of a good, whose price is normalized to unity. Each agent who is a buyer in one period becomes a seller in the next. At each time, a buyer is matched with a seller of the good. Buyers are subject to a cash-in-advance constraint according to which, before being matched with a random seller they need to hold currency equal to the price of the good. Buyers and sellers can choose between conducting their transactions in USD (m^*) or in *bolivianos* (m). Each payment is made fully in USD or fully in *bolivianos*.

Consider an agent i who is a seller in time *t* and a buyer at $t+1$. The decision problem he faces is which currency to hold after receiving currency from a random buyer at t but before being matched with a random seller j at $t+1$. Thus, the currency choice of agent i during "period t" (hereafter defined as the interval between times t and $t+1$), denoted by $m_{t,i} \in [m, m^*]$, will depend on the costs associated with each currency choice, which in turn are conditional on the currency choice of seller *j* for at time $t+1$ (see Table 1).

TABLE 1: COST MATRIX FOR AGENT *i* [34]

	$m_{j,t+1} = m$	$m_{j,t+1} = m^*$
$m_{i,t} = m$	e	$e + \theta$
$m_{i,t} = m^*$	θ	ψ

[33] For the reasons exposed in Section 2, the terms unofficial dollarization and dollarization will be used interchangeably during the rest of the document, unless otherwise specified.

[34] These costs are net of the price of the good itself which, as said before, is normalized to unity.

If agent i decides to hold *bolivianos* and j prefers to be paid in that currency in order to hold *bolivianos* in the next period (upper left cell of the matrix), then the only cost *i* faces is the rate of *boliviano* depreciation against the USD, e. But, if j prefers to hold dollars in the next period (upper right cell), then i will face the cost e and also the transaction costs associated with exchanging *bolivianos* for USD or shoe-leather cost, θ.[35]

Consider now the case where agent i prefers to hold dollars. In that case, if *j* prefers to hold *bolivianos* in the next period (lower left cell of the matrix), then *i* will only face the transaction cost of exchanging dollars for *bolivianos*, θ as the depreciation cost only affects *boliviano* holdings. Conversely, if j prefers to hold USD in the next period, then the match of preferences for this currency eliminates all the previous costs (lower right cell of the matrix). Yet, transactions made fully in USD entail a new potential cost associated with the probability of confiscation of USD by the country's authorities, denoted by ψ.

The probability of confiscation of USD is not irrelevant in many underdeveloped countries. The banning of FCD in Bolivia and other Latin-American countries during the 80s is a good example of that. One may expect, though, that ψ is generally low and becomes more relevant in episodes of severe economic or political distortions. In fact, the model assumes that ψ is sufficiently low to satisfy $\psi < 2\theta$, which ensures that it will be optimal to conduct the transaction in USD in this case, given that 2θ represents the shoe-leather costs involved in the alternative case where i and j decide to exchange currencies twice and perform the transaction in *bolivianos* to avoid the risk of confiscation.[36]

Overall, *i*´s returns of holding a given currency during period t increase with the probability that j will want to hold the same currency in

[35] The Oomes (2003) model also included a tax on foreign currency purchases as observed in Russia between 1997 and 2000, which is omitted here as it does not apply for the Bolivian case.

[36] The assumption here is that USD can be confiscated only when the transaction is taking place. Therefore, in order to avoid confiscation the buyer who holds USD will exchange them for *bolivianos* to perform the payment. The seller will receive *bolivianos* and then exchange them back for USD. The total transaction costs are thus given by 2θ.

period $t+1$, thus implying the existence of network externalities. More specifically, network externalities in an economy with two coexisting currencies are present when: a) agent i is better of holding *bolivianos* when j prefers to hold *bolivianos* as well, and b) agent i is better of holding USD when j prefers to hold USD. These two criteria are equivalent to the following conditions, respectively:

$$e < \theta \qquad ; \qquad \psi < e + \theta \qquad (1)$$

4.2 THE LAW OF MOTION OF UNOFFICIAL DOLLARIZATION

In reality, agent *i*´s currency decision for period t must be based on the expected *boliviano* depreciation during that period ($\hat{e}_t$), the expected shoe-leather cost at time $t+1$ ($\hat{\theta}_{t+1}$) and the expected confiscation risk at time $t+1$ ($\hat{\psi}_{t+1}$). Moreover, *i*´s currency decision will also depend on his expectations of seller *j*'s preferences. The probability, expected by i, that any random seller j will prefer to hold USD in period $t+1$ (*i.e.* he prefers to be paid in USD at time $t+1$) can be interpreted as the expected proportion of agents holding USD during period $t+1$ or, alternatively, as the expected (unofficial) dollarization ratio in the economy in period $t+1$, denoted by $\hat{p}_{t+1}$.

Consequently, using the information in Table 1 and the expected dollarization ratio, it is possible then to express the expected cost of holding *bolivianos* during period t as:

$$c(m_t) = (1-\hat{p}_{t+1})\hat{e}_t + \hat{p}_{t+1}(\hat{e}_t + \hat{\theta}_{t+1}) \quad (2)$$

At this point, $(1-\hat{p}_{t+1})$ clearly represents the proportion of agents holding *bolivianos* in period $t+1$. Similarly, the expected cost of holding USD during period t is:

$$c(m^*_t) = (1-\hat{p}_{t+1})\hat{\theta}_{t+1} + \hat{p}_{t+1}(\hat{\psi}_{t+1}) \quad (3)$$

From these conditions it is simple to predict that any cost-minimizing agent will choose to hold USD if the expected cost of holding *bolivianos* is larger than the expected cost of holding USD or $c(m_t) > c(m_t^*)$, and will choose to hold *bolivianos* in the opposite case.

Note that the model so far may be unable to capture some other factors that also affect currency preferences among agents, such as the confidence in the Bolivian economy, nationalistic issues[37] or others which are unobservable in practice. Two variables, denoted by ε_t and ε_t^*, will be used to represent these other unobserved (to the modeller, but observable to agent i) factors involved in holding bolivianos and USD, respectively. Consequently, the probability $p_{i,t}$ that any agent i will hold USD during period t will be given by:

$$p_{i,t} = \Pr\left\{c(m_t^*) + \varphi\varepsilon_t^* < c(m_t) + \varphi\varepsilon_t\right\} \quad (4)$$

Where φ represents the measure of the effect that ε_t and ε_t^* have over the expected cost of holding each currency. According to (4), the probability that any agent will hold USD during period t increases if the probability that the total expected cost of holding bolivianos is larger than the total expected cost of holding USD increases too. From (2) and (3) and reordering terms, equation (4) can be written as:

$$p_{i,t} = \Pr\left\{\varepsilon_t^* - \varepsilon_t < \frac{1}{\varphi}\left[\hat{e}_t - \hat{\theta}_{t+1} + (2\hat{\theta}_{t+1} - \hat{\psi}_{t+1})\hat{p}_{t+1}\right]\right\} \quad (5)$$

A standard approach to make this kind of models econometrically estimable, is to make an assumption concerning the distribution of the unobservable terms ε_t and ε_t^*. A common assumption in the discrete choice theory[38] is that these two are independent and extreme value distributed both within and across individuals. This implies that the

[37] Some authors point the loss of economic sovereignty or the loss of a national symbol (the domestic currency) as factors that could affect preferences or generate some actions to affect those preferences. See Schuler (2005).

[38] See Brock and Durlauf (2001) and Oomes (2003).

difference between the unobservable components ($\varepsilon_t^* - \varepsilon_t$) is logistically distributed. Hence, from equation (5):

$$p_{i,t} = \left(1 + \exp\left\{-\frac{1}{\varphi}\left[\hat{e}_t - \hat{\theta}_{t+1} + (2\hat{\theta}_{t+1} - \hat{\psi}_{t+1})\hat{p}_{t+1}\right]\right\}\right)^{-1} \quad (6)$$

Equation (6) can be defined as a given agent *i*´s best response function regarding his currency choice given the social interactions (*i.e.* the decision of others) involved in holding a currency, imbedded in $\hat{p}_{t+1}$. According to (6), the probability (conditional on $\hat{p}_{t+1}$) that agent i will hold USD increases when the expected depreciation rate increases too. In contrast, the conditional probability decreases when the expected risk of confiscation $(\hat{\psi}_{t+1})$ increases.

The effect of the expected shoe-leather cost $(\hat{\theta}_{t+1})$ is ambiguous and depends on $\hat{p}_{t+1}$. If the expected dollarization ratio is low (if $\hat{p}_{t+1} < 0{,}5$) then an increase in this cost will lead to a decrease in $p_{i,t}$, thus reducing the demand for USD. Equally, if the expected dollarization ratio is high ($\hat{p}_{t+1} > 0{,}5$) then a raise in $\hat{\theta}_{t+1}$ will increase $p_{i,t}$ and encourage the demand for USD.

Next, note that given the assumption $\hat{\psi}_{t+1} < 2\hat{\theta}_{t+1}$ made earlier, equation (6) implies that $p_{i,t}$ is increasing in $\hat{p}_{t+1}$: the probability that any agent *i* will hold USD on t increases with the expected overall dollarization ratio (*i.e.* the best response function is upward-sloping). In order to find an expression that determines the actual overall dollarization ratio, p_t, it can be assumed that the number of agents in the economy is large enough for the law of large numbers to hold. In that case, the overall dollarization ratio must equal the probability that a random agent holds USD. That is $p_t = p_{i,t}$, for all i and t.

Finally, in order to close the model, an assumption regarding the formation of expectations must be made. A first alternative is to assume perfect foresight, where agents completely understand the underlying model and forecast the future values of the relevant variables. Hence, in order to predict p_t agents need to know p_{t+1} but, to predict the latter, they also need to know p_{t+2} and so on. Such assumption appears to be quite unrealistic in this case, as in reality agents may find problematic to forecast future dollarization ratios with certainty.

A second and more plausible alternative is to assume that agents have static expectations: they predict that each variable will remain at its previous value. Such assumption seems fairly reasonable for the cases of the dollarization ratio, the shoe-leather cost and the confiscation risk, as in reality agents may find helpful to use previous values of these variables as benchmarks for their decisions. Static expectations imply $\hat{x}_{t+1} = x_t$ for all variables except for the dollarization ratio where the relevant condition is $\hat{p}_{t+1} = p_{t-1}$ as agents that are sellers at time $t+1$ are expected to behave in the same way they did when they were sellers before, at time $t-1$.[39]

However, this assumption seems less reasonable for $\hat{e}_t$, as its prediction seems to involve a more complex set of information.[40] Moreover, in countries with large records of miserable economic performance due to discretionary monetary policy (which are of the most interest in this study), the past legacy effect described in Section 3.1 may also have great incidence over agents´ expectations. Thus, in order to keep the model simple but able to depict the main insights of the dollarization process, no attempt of explicitly modelling the exchange rate evolution will be made. Instead, it will be assumed that agents believe the depreciation rate will be the actual rate (e_t) with probability α but that it may reach its maximum value of the recent past, a ratchet effect reflecting fears of new policy mismanagement or other related economic distortions given by $e_t^{\max}$, with probability $(1-\alpha)$.

[39] Recall that an agent that is a seller at a given time becomes a buyer in the next.

[40] Including, for example, the domestic money supply growth, the interest rate differential between domestic and foreign assets and the current account position.

Therefore, applying all the previous considerations into equation (6) yields an expression defined as the law of motion for UD:

$$p_t = \left(1 + \exp\left\{-\frac{1}{\varphi}\left[\alpha e_t + (1-\alpha)e_t^{\max} - \theta_t + (2\theta_t - \psi_t)\, p_{t-1}\right]\right\}\right)^{-1} \quad (7)$$

This then describes how UD evolves over time, given the values of the fundamental variables: $\hat{e}_t$, θ_t and ψ_t.[41]

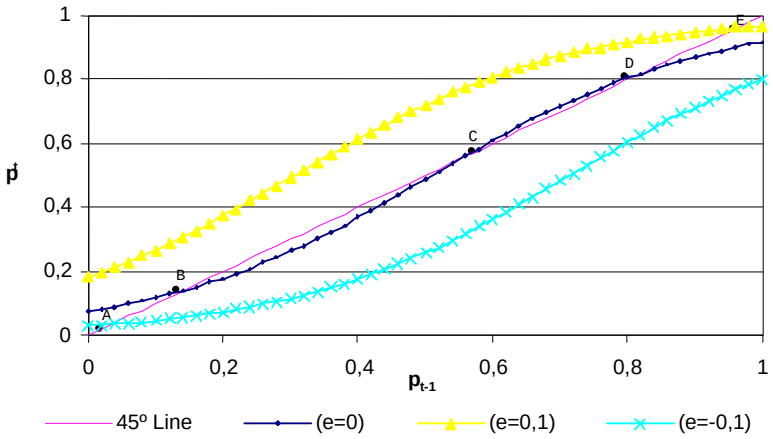
4.3 EQUILIBRIA, STEADY-STATES AND DYNAMICS

If the fundamental variables remain fixed, it follows from (7) that the dollarization ratio will converge to a steady state level p_t^* which solves $p_t = p_{t-1}$ for all t. If any of the fundamental variables change, the steady state level will change too. The analysis will now focus in the relationship between the dollarization ratio and the depreciation rate which is expected to be non-linear: the ratio increases sharply with high depreciation rates but it does not fall when depreciation falls. Moreover, the model will show that, for a given depreciation rate, multiple steady-state ratios may exist, a feature that provides an explanation for dollarization hysteresis.

The best way to illustrate this relationship is by plotting equation (7) under three different alternatives: a depreciation rate of 10% $(e_t = 0{,}1)$, no variation of the exchange rate $(e_t = 0)$, and an appreciation of 10% $(e_t = -0{,}1)$. In order to focus in the effect of network externalities over dollarization, it will be assumed for now that $\alpha = 1$ so $\hat{e}_t = e_t$ and there is no ratchet effect. The rest of the variables will be fixed at $\theta_t = 0{,}25$, $\psi_t = 0{,}01$ and $\varphi = 0{,}1$, arbitrary values selected in order to satisfy the conditions for network externalities given by (1). Figure 2 presents the resulting law of motion of the dollarization ratio for each one of the three cases.

[41] Note, incidentally, that equation (7) has the same form as a non-linear Logistic Smooth Transition (LSTAR) model, an specific case of the regime switching econometric models which allows autoregressive parameters to change slowly over time (Enders, 2004).

FIGURE 2: DOLLARIZATION RATIO DYNAMICS, EQUILIBRIA AND STEADY-STATES



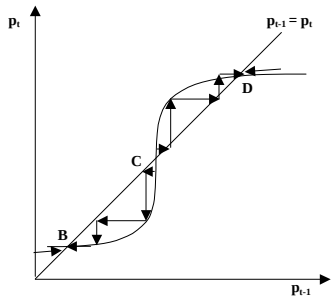
The 45-degree line shows all the cases where $p_t = p_{t-1}$ which represents the structural dependence of this period's dollarization ratio on the dollarization ratio of the last period. Consider first the lower curve describing the evolution of dollarization when $e_t = -0{,}1$. This curve intersects the 45-degree only at point A, which depicts an initial situation where the set of parameter values provide a stable equilibrium point or steady-state corresponding to a low degree of unofficial dollarization.[42]

Suppose now a gradual increase in the depreciation rate represented by an upward shift of the curve to the case where $e_t = 0$ (intermediate curve in Figure 2). According to the intersections with the 45-degree line, three equilibria emerge, denoted by points *B, C* and *D*. However, only the lower and upper equilibria (points *B* and *D*) are stable or steady-states while the intermediate one (point *C*) is unstable. This is shown more clearly in the phase diagram presented in Figure 3, which corresponds only to the situation when $e_t = 0$. In this case, when the dollarization ratio is slightly

[42] Oomes (2003) defines all points in Figure 2 as steady states, which can be stable or unstable. However, a more accurate use of the relevant definitions in this case would regard these points as stable or unstable equilibria. Thus, only stable equilibria such as points A, B, D and E (*i.e*. excluding point C, which is an unstable equilibrium) should be considered as authentic steady-states.

below point *C* it will fall in the next period and will continue to fall until *B* is reached, where $p_t = p_{t-1}$ is satisfied again. Conversely, when the ratio is slightly above *C*, it will continuously increase until the upper steady state *D* is reached.[43]

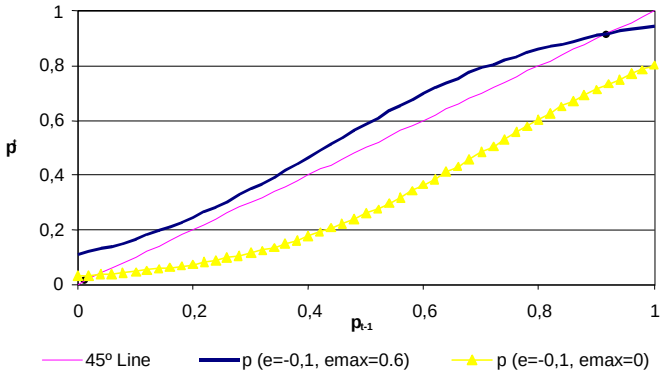
FIGURE 3: PHASE DIAGRAM FOR THE DOLLARIZATION RATIO WHEN $e_t = 0$



Given that the economy started out in point *A* in Figure 2, the only possible stable equilibrium or steady-state to be selected when the rate of depreciation increases is the one given by point *B*, where dollarization is still low. Now, consider the case when the depreciation rate continues to increase and the curve reflecting the evolution of dollarization keeps shifting upwards. In this case, illustrated by the upper curve where $e_t = 0{,}1$, the lower and intermediate equilibria disappear and the economy ends up in a unique high-dollarization steady state at point *E*. More interestingly, though, when the depreciation rate falls back to $e_t = 0$ again, dollarization hardly falls and, in fact, it stabilizes at the nearest high-dollarization steady state, which in this case is given by point *D*.

[43] Note also that when the dollarization ratio in *t-1* is below point B, it will increase in order to return to B; and when it is above point D it will fall back to B. This contributes to the notion that only the outer equilibria are stable or steady-states.

FIGURE 4. THE INCIDENCE OF THE "RATCHET EFFECT" IN THE DYNAMICS



Next, to illustrate the incidence of a ratchet or past legacy effect in the dynamics consider the previous example where $e = -0{,}1$ and $\alpha = 1$ and another where $e_t = -0{,}1$, $e_t^{\max} = 0{,}6$ and $\alpha = 0{,}9$ so agents expect that a peak past depreciation rate of 60% may occur again with a 10% probability. The rest of the variables will take their previous values. Both cases are plotted in Figure 4. Clearly the presence of the ratchet effect encourages an upward shift of the curve even though the domestic currency is currently appreciating. In general, since $\hat{e}_t$ is increasing in $e_t^{\max}$, it should be expected that the latter will increase the likelihood of reaching the high-dollarization steady states, the higher the past peak depreciation and/or the probability $(1-\alpha)$.

This is how network externalities and the past legacy effect may cause dollarization hysteresis as, even though high depreciation rates are temporary, the increase in the dollarization ratio can become permanent. Recall, however, that only as long as the conditions for network externalities given by (1) are satisfied in practice, the curves depicting the evolution of dollarization will be upward-sloping so the described dynamics can take place.

4.4 THE LINEAR REDUCED-FORM EQUATION OF THE MODEL

The next section will try to empirically test the above hypotheses for the Bolivian case. As said before, the structural-form equation of the model given by (7) is non-linear as the relationship between the dollarization ratio and the depreciation rate is suspected to be. This, in turn, implies a much more complex procedure for empirical purposes. However, Oomes (2003) and others[44] propose to apply a very convenient logistic transformation on equation (7) so it can be linearized as follows (see Appendix 1):

$$\ln\left(\frac{1-p_t}{p_t}\right) = -\frac{1}{\varphi}\left[\alpha e_t + (1-\alpha)e^{\max} - \theta_t + 2(\theta_t - \psi_t)\, p_{t-1}\right] \qquad (8)$$

Next, in order to make equation (8) estimable, some final assumptions are required. First, it will be assumed that the confiscation risk is fixed over the entire sample period so $\psi_t = \psi$; the reasons being the lack of data on this variable and the possibility of getting a fair approximation of it via the estimation of the model.

Second, as the data on the shoe-leather cost is not available either, it will be realistically assumed that this cost decreases with the dollarization ratio. That is, as more people use USD, holding this currency becomes less costly (*i.e.* the network externalities hypothesis). The shoe-leather cost will then have the following form:

$$\theta_t = 1 - \lambda p_{t-1} \qquad (9)$$

where λ is a parameter that satisfies $0 \leq \lambda \leq 1$, thus ensuring that the shoe-leather cost can not be negative and allowing the possibility that it can be positive even under full dollarization. Finally, an error term, denoted by u_t, will be included in the equation in order to capture unobservable variables that also affect dollarization as well as any possible measurement error in the data. Taking into account all these assumptions in the model, it is possible to obtain an estimable reduced-form equation given by:

[44] Mongardini and Mueller (2000) and Feige *et al,* (2003) also use a similar transformation.

$$\ln\left(\frac{1-p_t}{p_t}\right) = -\frac{1}{\varphi}\left[\alpha e_t + (1-\alpha)e^{\max} - 1 + \lambda p_{t-1} + (2 - 2\lambda p_{t-1} - \psi)\, p_{t-1}\right] + u_t \quad (10)$$

or:

$$\ln\left(\frac{1-p_t}{p_t}\right) = -\frac{1}{\varphi}\alpha e_t - \frac{1}{\varphi}(1-\alpha)e^{\max} + \frac{1}{\varphi} - \frac{1}{\varphi}(2+\lambda-\psi)\, p_{t-1} + \frac{1}{\varphi}2\lambda p_{t-1}^2 + u_t \quad (11)$$

which, finally, can be written as:

$$\ln\left(\frac{1-p_t}{p_t}\right) = \beta_0 + \beta_1(e_t - e_t^{\max}) + \beta_2 e_t^{\max} + \beta_3 p_{t-1} + \beta_4 p_{t-1}^2 + u_t \quad (12)$$

where:

$$\beta_0 = \frac{1}{\varphi}; \qquad \beta_1 = -\frac{1}{\varphi}\alpha; \qquad \beta_2 = -\frac{1}{\varphi}; \qquad \beta_3 = -\frac{1}{\varphi}(2+\lambda-\psi); \qquad \beta_4 = \frac{1}{\varphi}2\lambda$$

A number of authors have carried out estimations of equations similar to (12) to study dollarization in many countries but without presenting any theoretical justification of the chosen functional form and the included explanatory variables.[45] The main contribution of the model presented in this study is that it provides such justification and also shows that this functional form is consistent with the existence of multiple stable equilibria or steady-states in the dynamics of dollarization which, in turn, can explain dollarization hysteresis. Also, the structural-form parameters from (7) can be easily recovered from the reduced-form parameter estimates so further inference on the former can be made.

[45] See, for example, Clements and Schwartz (1993), Mueller (1994) and Mongardini and Mueller (2000).

5. EMPIRICAL EVIDENCE OF DOLLARIZATION HYSTERESIS IN BOLIVIA

5.1 THE DOLLARIZATION RATIO FOR BOLIVIA

Bolivia provides an interesting case of UD under different episodes of economic performance over the last 30 years. The early incentives for dollarization in this country took place when the restrictions over USD usage were eased after 1973 (Reding and Morales, 2004) and also with the significant amount of USD-denominated international commercial credits (often referred to as *petrodollars*) arriving to Latin America since 1975 (SELA, 1997). An increasing inflation in the late 1970s, which culminated in the 1984-1985 hyperinflation and currency crisis, gave rise a strong trend in AS and CS which until now has revealed little signs of reversion. Even when FCD were outlawed and partly confiscated between 1982 and 1985, it is known that significant amounts of USD currency were held by residents. Estimates from Melvin and Afcha (1989) suggest that when hyperinflation reached its peak in the second quarter of 1985, almost 80% of the total cash holdings were USD.

Once FCD were allowed again in September of 1985 a rapid catch-up occurred and their importance continued to increase the following years. Presently, after 20 years of economic stability characterized by low inflation rates, a controlled exchange rate and a monetary policy largely independent from political pressures,[46] more than 90% of the domestic deposits are denominated in USD while some estimations sustain that USD currency represents 35% to 50% of the residents´ total cash holdings.[47]

In this sense, it seems little advisable to ignore the large role USD currency has had in Bolivia over the last 30 years not only as a store of value but also as medium of exchange. Hence, the FCD/TD ratio presented in Figure 1 is not an adequate measure of dollarization because it neglects the existence of USD cash holdings among residents, thus misjudging the real extent of dollarization within the country. A more appropriate UD ratio should then take into account both the evolution of AS and CS over time.

[46] Title 1 of Law Nº 1670, passed the 31st of October of 1995. See www.bcb.gov.bo.
[47] See Orellana (1999) and Central Bank of Bolivia (2005).

An overall measure of foreign currency in its capacity to produce all types of monetary services within a country has been proposed by Feige and Dean (2004) and is given by:

$$UDR = \frac{FCC + FCD}{FCC + DCC + FCD + DCD} \qquad (13)$$

where FCC denotes the foreign currency in circulation, FCD the foreign-currency deposits, DCC the domestic currency in circulation and DCD the domestic-currency deposits. UDR denotes the overall UD ratio and represents the fraction of a country's broad effective money supply that is composed of foreign monetary assets.[48]

Theoretically, the UDR should be easy to estimate using real data. However, while FCD, LCD and LCC are all observable in practice, countries usually have no data available on FCC (Calvo and Vegh, 1992). In Bolivia, for example, the Central Bank of Bolivia (CBB) has no precise estimates regarding the amount of USD circulating in the economy due to a number of factors such as the existence of a large informal economy and the important flows derived from contraband and from the traffic of illegal drugs. Occasional empirical evidence on the evolution FCC in Bolivia has been presented in a few studies but these often followed different approaches and focused on short periods of time, thus making difficult to collect a large span of FCC data for analytical purposes.

This study will utilise a direct estimate of FCC in Bolivia which could help to circumvent this major drawback. The estimate is based on recorded flows of USD between Bolivia and the US. By US law, persons or institutions importing or exporting currency in amounts exceeding $10.000 are required to file a Currency and Monetary Instruments Report (CMIR).[49] These records have been aggregated and collected by the US Custom Service since 1977 in what is known as the CMIR data. Although confidential, aggregate series of these data are occasionally available for academic purposes only.

Some factors might affect the accuracy of these data for use in empirical work. For instance, all unrecorded under-$10.000 shipments may

[48] All the components in equation (13) must be expressed in the same currency.
[49] The reporting threshold was raised from $ 5.000 to $ 10.000 in 1980. See Murray and Powell (2002).

represent an important share of the total USD shipped over time. Also, part of the currency sent to a country might end up unrecorded in third countries via capital outflows or tourism expenditures. Despite these deficiencies, the CMIR data are the best long-span direct estimation of FCC currently available for many countries where USD usage is significant and a growing body of empirical work has been using the data to study dollarization in several countries.[50] Even though the estimates derived from the CMIR data are surely subject to large errors, they are likely to capture the movements in the holdings of US currency to some extent.

In order to estimate the FCC in Bolivia, the net USD currency flows to this country given by the CMIR data were cumulated over time. Melvin and Afcha (1989) placed the USD currency stock at about $65 million in 1982. Taking this as a reference and employing the CMIR[51] data flows backwards implies that in 1976 the FCC should have been around $350 million. Pre-1976 estimates were obtained due to Melvin (1988) who suggests that the USD/*peso* deposits ratio was growing at an annual average of 33% between 1973 and 1976 and that this should have been indicative of the USD/peso cash holdings ratio as well. Taking this notion and given that data on DCC are available for this period, allows to infer that in 1973 the FCC should have been around $48 million. Figure 5 presents the evolution of the estimated FCC for the period 1973 to 2003.

The FCC estimates seem moderately consistent with the major economic and political events that took place in the country during this period. The increasing trend during the early-1970s might have been related to the international credit boom in Latin-America in those years (commonly known as *petrodollars*), which stopped after a violent military takeover in 1979 (Melvin, 1988). Then, the country's poor economic performance and political instability along with the financial restrictions imposed over USD usage seem to fairly explain the important reduction of FCC in the early 1980s. Immediately after the economic and political recovery in 1985, FCC rose sharply, suggesting that agents gradually recovered confidence in the economy but kept large holdings of USD cash "under the mattress" as the domestic financial system was probably not fully trusted yet.

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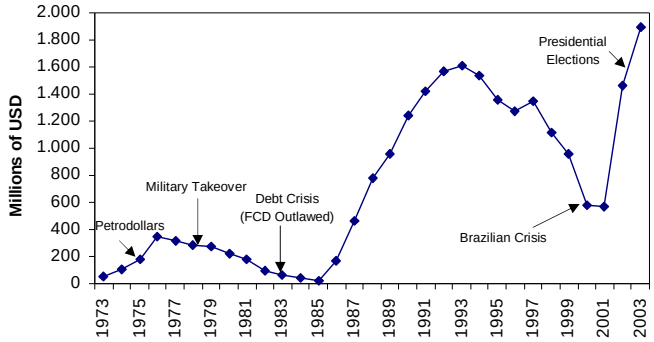
[50] Murray and Powell (2002) used the CMIR data to study dollarization in Canada. Kamin and Ericsson (2003) and Feige *et al.* (2003) used the data for Argentina and Oomes (2003) for Russia. See also Baliño *et al.* (1999).

[51] The CMIR data for Bolivia were shared by the Economic and Social Analysis Department of the Bolivian Government.

FIGURE 5: ESTIMATED FCC IN BOLIVIA



What seems somewhat puzzling is the sharp downturn observed after the peak in 1993. An increasing number of agents shifting their USD-denominated wealth from FCC to FCD, as confidence in the financial system was gradually improving, might partly explain this behaviour but one may suspect that potential errors in the data could also be affecting the accuracy of the estimates. More reasonable is the large fall in FCC in the late 1990s, as the severe economic crisis that affected Brazil had a significant contagion effect over Bolivia, where the economic activity slowed down notably since 1999.

Finally, the political uncertainty related to the 2002 presidential elections, which also affected the confidence in the financial sector, led FCC to rise remarkably. In effect, during this period the deposits in general were reducing rapidly (demanding an intensive financial support from the CBB as lender of last resort) but capital outflows were not as significant mostly due to the record-low international interest rates observed over that year which discouraged international lending.[52] These circumstances might have led residents to keep most of their wealth in the country but in the form of USD cash holdings "under the mattress".

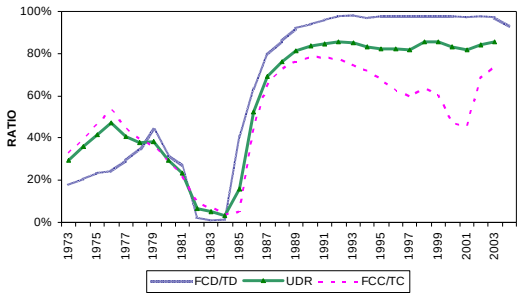
The estimates of FCC based on the CMIR data can be used to examine its incidence in the overall extent of dollarization in Bolivia. Thus, utilising

[52] The Fed Rate was placed at record-low 1,25% while the 6-month LIBOR rate reached 1,8% (CBB, 2002).

1973-2004 annual data of FCD, DCD and DCC along with the FCC estimates,[53] allows calculating the UDR for a similar period according to equation (13). The estimated UDR as well as the FCD/TD ratio are presented in Figure 6. In addition, from (13) it follows too that the differences between these two ratios would be explained by the evolution of the FCC/TC ratio, where TC $(TC = FCC + DCC)$ represents the resident's total cash holdings. Hence, this ratio is also presented in Figure 6.

The Figure shows that, although in general the UDR and the FCD/TD ratio present a similar evolution over time, some relevant differences must be mentioned. First, the FCD/TD ratio seems to underestimate the extent of dollarization for most of the 70s, when the development in the financial sector was at its lower stages, as well as in the early-80s, when restrictions on FCD were imposed; the reason being that this ratio neglects the public's USD currency holdings which were quite relevant (as shown by the FCC/TC ratio, specially in the 70s). Moreover, the evidence also indicates that over the last 20 years the FCD/TD has slightly overestimated the extent of dollarization in Bolivia as the UDR (and more notably the FCC/TC ratio) has been consistently below the FCD/TD ratio. This, in turn, suggests that the dollarization process in Bolivia after 1985 has taken place principally due to the public's need for a reliable store of value rather than for a more efficient medium of exchange.[54]

FIGURE 6: DOLLARIZATION RATIOS FOR BOLIVIA



[53] Data obtained from the IFS. All series were converted to USD using the respective end-of–the-year exchange rate.
[54] Orellana (1999) gives a similar conclusion.

Therefore, given the likely relevance of both the FCC estimates based on the CMIR and the FCD in measuring the evolution and extent of dollarization in Bolivia, the more general UDR will be used as the relevant overall unofficial dollarization ratio in the estimation of the model.

5.2. EMPIRICAL PROCEDURE AND RESULTS

For practical purposes, equation (12) can also be written as:

$$LNUDR = \beta_0 + \beta_1 Dif_t + \beta_2 e_t^{\max} + \beta_3 UDR_{t-1} + \beta_4 UDR_{t-1}^2 + u_t \quad (14)$$

Where:

$$UDR_t = p_t; \qquad LNUDR = \left[(1 - UDR_t)/UDR_t\right]; \qquad Dif_t = e_t - e_t^{\max}$$

The Bolivian 1973-2003 annual data sources used in the estimation of the model were the following:

- The UDR_t was estimated in the previous section.
- The depreciation rate (e_t), measured as the growth rate in the nominal end-of the-year boliviano/USD exchange rate, was obtained from the IFS.
- The ratchet variable $(e_t^{\max})$ is defined as the maximum boliviano depreciation rate over the past years. The maximum and most relevant rate took place during the 1984-1985 currency crisis, reaching a remarkable 13.900%.

The first concern at this stage is to discern whether the series that will be used in the estimation are stationary.[55] Standard Augmented Dickey Fuller (ADF) tests have been carried out for each one of them and the results are presented in the left panel of Table 2.[56] According to these tests, apparently only LNUDR is stationary. However, it is essential to recognise the effect Aberrant Observations (AO) may have over standard unit root

[55] This analysis is not performed for UDR_{t-1}^2 as its evolution is identical to the one of UDR_t, and for $e_t^{\max}$ as it has been roughly defined to be a constant value with a level shift since *t=1986*.

[56] The number of lags in each test was determined using the Akaike and Schwartz criteria minimization approach.

tests. As Franses (1998) notes, neglecting outliers (*e.g.* a 13,900% depreciation rate) leads to spurious findings of stationarity while neglecting level shifts (*e.g.* a shift from a low-dollarization to a high-dollarization level) leads to spurious unit roots. The failure to finding normal residuals in the performed ADF tests (see the Jarque-Bera test in Table 2) as well as the visual inspection of the data (see Appendix 2) lead to strongly believe the series suffer from AO.

Consequently, two remedial measures suggested by Franses (1998) were included in the auxiliary regressions of the ADF test for each variable: a) single dummy variables for each identified major outlier and, b) a dummy variable to capture the level shift, defined as being 1 for all $t > \tau$, where τ is the date of shift,[57] and 0 otherwise. The asymptotic distribution of the *t-statistic* in this case is proved to depend only on $\lambda = \tau / n$ where n is the number of observations (Perron, 1990). The adjusted ADF test results are presented in the right panel of Table 2.

TABLE 2: UNIT ROOT TESTS

Variables	Standard ADF-test		ADF-test Considering AO[a]		
	lags	Test Statistics	lags	Test Statistics	
				Test 1	Test 2
LNUDR (NI, NT)	0	**-2.27***	1	**-27.67***	**2,69**
LM (2) test - Prob(n*R^2)		0,86		0,00	0,08
Normality - Prob (JB)		0,00		0,01	0,13
DIF (I,NT)	0	**-1,94**	1	**-21,89***	
LM (2) test - Prob(n*R^2)		0,22		0,16	
Normality - Prob (JB)		0,00		0,01	
UDR (I,T)	1	**-2,82**	1	**-3,45***	
LM (2) test - Prob(n*R^2)		0,33		0,99	
Normality - Prob (JB)		0,01		0,45	

Parenthesis indicate the use of deterministic components (T = Trend, I = Intercept).

* Indicates rejection of null hypothesis of a unit root at 5% significance level.

[a] The 5% Critical Value calcualted by Perron (1990) for 0,4 (12/30) is 3,35.

According to these tests, the null hypothesis of a unit root can be strongly rejected in the cases of DIF and UDR, while the findings are ambiguous

[57] Placed at $t = 1985$ for most variables. In the case of *DIF* it was placed at $t = 1986$.

for LNUDR. Treating the major outliers $(t = 1982 - 1984)$ in the latter, along with the level shift in 1985 in Test 1, gives an *ADF-t* equal to 27,7, implying stationarity but still with non-normal and heteroscedastic residuals in the auxiliary regression. Treating less significant outliers $(t = 1985)$ in Test 2 corrects these problems but yields a positive *ADF-t*, which means that LNUDR would be explosive. In the need of a more definite approach, standard ADF tests were performed for two sub-samples, the break date being 1985.[58]

This procedure shows that LNUDR seems stationary for the 1985-2003 sub-sample (*ADF-t* = -5,4, higher than the 5% critical value of –2,96), but shows signs of a unit root for the 1973-1984 sub-sample (*ADF-t* = -0,1), although it must be noted that it is well-known that a low number of observations reduces the test's power to reject the null hypothesis of a unit root, so some doubts regarding the latter result may exist. Overall, seems reasonable to consider that the evidence in favour of a unit root in LNUDR is rather weak.

In the light of these results, an estimation procedure based on Ordinary Least Squares (OLS) seems adequate for the purposes of this analysis as the risk of finding spurious results is low.[59] To ensure this, equation (14) must to include a set of dummy variables in order to capture all the potential distortions in the data which may adversely affect the accuracy of the estimates. These dummy variables are:

- $D_{1,t}$, which captures the period were FCD were outlawed:

$$D_{1,t} = \begin{cases} 1 \text{ for } t = 1982 - 1985 \\ 0 \text{ otherwise} \end{cases}$$

- $D_{2,t}$, which captures the peak of the economic and financial crisis in the country:

$$D_{2,t} = \begin{cases} 1 \text{ for } t = 1984 - 1985 \\ 0 \text{ otherwise} \end{cases}$$

[58] As suggested by Enders (2004). The identified outliers were treated with dummy variables.
[59] The unit root analysis was surprisingly overlooked by Oomes (2003) and Feige *et al.* (2003). Despite this fact, both used OLS to estimate the model.

The results of the OLS estimation of equation (14) are presented in Table 3. As the lower panel of the Table shows, no problems of non-normality or serial correlation in the residuals were found. However, there is some evidence of heteroscedasticity, which implies that the parameter estimates are inefficient for econometric inference although still unbiased and consistent.[60] Hence, p-values based on White's-heteroscedasticity-consistent-standard-errors are reported in order to properly analyse the significance of the variables. The results show that all the variables are statistically significant at a 95% of confidence level and are correctly signed so as to recover the structural-form parameters.

TABLE 3: OLS ESTIMATION RESULTS

Parameter	Estimates Prob(t-stat)[a]
β_0	**5,745** (0,00)**
β_1	**-0,197** (0,00)**
β_2	**-0,207** (0,00)**
β_3	**-15,036** (0,01)*
β_4	**12,053** (0,03)*
D_1	**13,152** (0,00)**
D_2	**14,555** (0,00)**
Fitness - Adj-R^2	0,985
JB Normality Test - Prob(JB)	0,65
Autocorrelation LM (2) Test - Prob($n*R^2$)	0,43
Heterosced. White Test - Prob($n*R^2$)	0,001

[a] T-stat calculated using White´s Heteroscedasticity Consistent S.E.
* (**) Indicates significance at 5% (1%).

[60] See Greene (1997).

First, $\alpha = \beta_1 / \beta_2 = 0{,}95$ suggests that agents believe there is a 95% chance that the exchange rate will replicate its last year value. Consequently, there is a 5% probability that the *boliviano* will depreciate at a rate equal to its maximum past rate $(e_t^{\max})$. Even though no detailed modelling of the exchange rate behaviour was intended with this model,[61] this finding could be taken as indicative evidence on the existence of a past legacy effect in the formation of exchange rate expectations among agents. Second, $\lambda = \beta_4 / 2\beta_0 = 1$ implies that the rate at which the shoe-leather cost of using USD reduces when the dollarization ratio increases is the highest possible and that such cost would be zero in the extreme case of full-dollarization. Finally, the estimated confiscation risk is $\psi = (2\beta_0 + \beta_3 + 0{,}5\beta_4)/\beta_0 = 0{,}43$. That is, agents who accept USD estimate a 43% chance of having them confiscated. While such estimate seems too high, it may be justified by the appalling events occurred between 1982 and 1985, where FCD were banned and partially confiscated by the government, leaving USD depositors with considerable capital losses.[62]

The structural-form parameter estimates seem moderately consistent with the hypothesis of network externalities for USD usage in Bolivia. As the upper panel in Figure 7 shows, only when the ratchet effect $(e^{\max})$ is taken into account, the condition for USD network externalities $\hat{\psi}_{t+1} < \hat{e}_t + \hat{\theta}_{t+1}$, which would then translate to:

$$0{,}43 < 0{,}95e_t + 0{,}05e_t^{\max} + 1 - p_{t-1} \qquad (15)$$

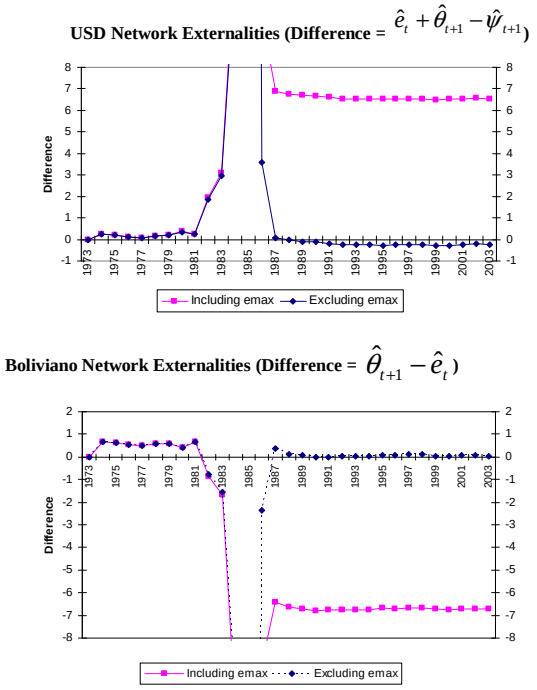
is satisfied over the entire sample. This implies that an expected preference for USD by sellers has induced a demand for USD by buyers at all times, a decision which seems to be heavily influenced by the agents´ fears of a new extreme depreciation of the *boliviano*. In the absence of the ratchet effect (*i.e.* assuming that agents have short memory), the condition for USD network externalities is only satisfied for the first half of the

[61] In reality, agents might consider a wider range of probable outcomes rather than only the peak past depreciation rate.

[62] FCD had to be exchanged into *bolivianos* at an extremely overvalued exchange rate (Reding and Morales, 2004). In the Russian and Argentinean cases, even though no USD confiscation occurred during the analysed periods, the estimated ψ´s were 3% and 9%, respectively. See Oomes (2003) and Feige *et al.* (2003).

sample and notably between 1982 and 1986, where the actual depreciation rate was so high that holding dollars was considered a dominant strategy by all agents.

FIGURE 7: CONDITIONS FOR NETWORK EXTERNALITIES



In turn, the lower panel in Figure 7 shows that the condition for *Bolivian* network externalities, $\hat{e}_t < \hat{\theta}_t$ which translates to:

$$0{,}95e_t + 0{,}05e_t^{\max} < 1 - p_{t-1} \qquad (16)$$

is satisfied only for the 1973-1981 period if the ratchet effect is considered. It is not satisfied for the rest of the sample because of the high depreciation rates observed the following five years which made it optimal for buyers to hold USD regardless of the sellers´ currency preferences

and, later, because of the incidence of a very high $e_t^{\max}$. When the ratchet effect is not considered the condition holds for all *t* except for the high-depreciation period.

Overall, the empirical estimates confirm the existence of network externalities to explain dollarization hysteresis in Bolivia although heavily relying on the incidence the past legacy effect has had on the agents' exchange rate expectations in the last 20 years. That is, in the hypothetical absence of the ratchet effect, the network externalities related to USD usage would tend to vanish with time. These findings are consistent with the notion that dollarization in Bolivia is founded mainly on the agents' need of a reliable store of value and a practical hedge against high inflation and depreciation rates, rather than on pure transactional motives.[63] Therefore, while holding USD cash for transactional purposes seems to be motivated by the agents keeping USD-denominated interest-bearing assets for hedging purposes, the inverse is probably not true.

To conclude this section, note that when a similar estimation procedure is performed using the FCD/TD ratio instead of the UDR as the relevant dollarization measure the empirical results are not as convincing as in the previous case.[64] First, the general robustness of the model and the significance of the estimated coefficients are lower but, even more important, the unexpected sizes of the latter imply dubious values for the structural-model parameters: a negative confiscation risk, a far larger than one shoe-leather cost and a probability α which also exceeds one. These findings would indicate that the use of a broader measure of dollarization such as the UDR seems to provide a more adequate way to capture the agents´ currency-choice process whenever both transactional and store-of-value motives are involved.

[63] Similar conclusions are given by Orellana (1999) and Arguedas and Requena (2002).

[64] No problems of autocorrelation or non-normality in the residuals were found. Using OLS, the estimated model is:

$$LDEPR = 43{,}12 - 0{,}59DIF - 0{,}46e^{\max} - 180{,}94DEPR_{-1} - 122{,}58DEPR_{-1}^2 + 60{,}89D1 - 19{,}65D2$$

Where DEPR denotes the FCD/TD ratio and LDEPR = ((1-DEPR)/DEPR). The heteroscedasticity-consistent t-statistics show that all the coefficients, except for the one of D2, are significant at a 5% of significance level. The adjusted R^2 is 0,92.

5.3. INTERPRETATION OF THE DYNAMICS

Once more, the best way to illustrate the dynamics of the dollarization ratio in Bolivia is by plotting the estimated structural-form equation given by equation (7):

$$p_t = \left(1+\exp\left\{-\frac{1}{0{,}18}(0.95e_t + 0{,}05e_t^{\max} - (1-p_{t-1}) + (2*(1-p_{t-1}) - 0{,}43)\right\}\right)^{-1} \quad (17)$$

for several key time periods (*i.e.* several combinations of e_t and $e_t^{\max}$). Actual data points (p_t, p_{t-1}) are also shown so the evolution of dollarization can be tracked over time. First, consider the period between 1973 and 1986, depicted in Figure 8.

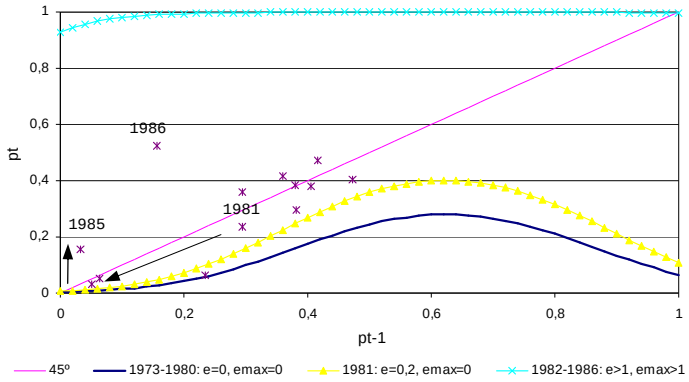
The estimated curves suggest that the dollarization levels between 1973 and 1980 were part of a mid-dollarization unstable equilibrium mostly founded on large relative levels of FCC as FCD were not too significant yet (see Figure 5), but which was probably heading to a low-dollarization steady-state, the only achievable in the existing conditions as the curve crosses the 45-degree line only at a near-zero level (bottom left of the graph). A first shock on the dynamics was given by the 20% depreciation rate in 1981 which shifted the curve upwards although with no serious implications. However, the 161% depreciation rate observed in 1982, followed by the whooping 1,200%, 2,600% and 13,900% rates the next 3 years caused radical shifts in the curve which led the low steady-state to disappear. Thus the high-dollarization steady-state (top right of the graph) became the only feasible steady-state for the dollarization ratio as holding USD became a dominant strategy for any agent.

The fact that the actual data behaved oppositely as expected (*i.e.* the ratio is decreasing between 1982 and 1985 in Figure 6) can be explained by a) the severe financial restrictions imposed by the government including the prohibition of FCD and, b) the continuous capital outflows in the form of USD-denominated cross-border deposits motivated by the poor economic conditions in the country,[65] both of which also had a negative effect over FCC (see Figure 5). Immediately after the financial restrictions over USD

[65] See Antelo (2000) and Baliño *et al.* (1999)

usage were removed in September 1985 along with several other fiscal and monetary measures which helped to restore the economic and political stability in the country, dollarization equally in the form of FCD and FCC initiated its increasing trend.

FIGURE 8: THE DOLLARIZATION RATIO DYNAMICS (1973 – 1985)

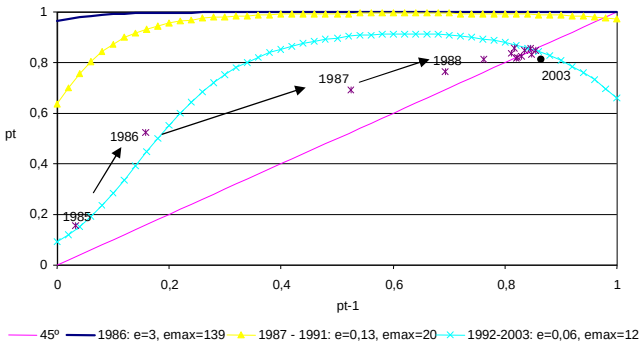


In order to stabilize the exchange rate and its expectations, a crawling peg regime was introduced at the end of 1985. After a 300% depreciation rate in 1986, the regime succeeded in bringing the depreciation rate down to less than 20% the following years. However, it seems that the regime did not succeed in eradicating the past legacy effect on the agents' exchange rate expectations formation.

As Figure 9 shows, the dollarization ratio increased sharply between 1986 and 1991 despite a 13% average depreciation rate. Then, even though the average depreciation fell to only 6% since 1991 the UDR kept rising until it apparently reached a high-dollarization steady-state in 1998 at about 85%, where continues until today. In fact, the UDR kept increasing even though the FCC holdings reduced remarkably after 1993 (see Figure 5); thus reinforcing the notion that agents probably were gradually shifting their USD-denominated wealth from cash to deposits as the confidence in the domestic banking system (although not in the domestic currency) was recovering during the 90s.[66]

[66] A similar conclusion was proposed by Baliño *et al.* (1999).

FIGURE 9: THE DOLLARIZATION RATIO DYNAMICS (1986 – 2003)



Such behaviour should not be surprising since the 1982 to 1986 shocking depreciation rates, caused by poor monetary and fiscal policies carried out by the bolivian government, may not be easy to forget by the public. Consequently, the agents' reasonable fears that such episodes could reiterate in the future will necessarily affect their investment decisions as well as their currency preferences in favour of USD-denominated assets as a hedge against domestic distortions (*i.e.* domestic inflation and *boliviano* depreciation).

Figure 9 also suggests, however, that while the past legacy effect has not been completely eradicated it might have been considerably reduced thanks to more than 20 years of low depreciation rates, thus leading the curve to continuously shift downwards. In fact, the 85% steady-state dollarization ratio seems consistent with the lower curve in the Figure, where $e_t^{\max} = 12$ (*i.e.* an expected maximum depreciation rate of 1.200%). Nevertheless, given the current circumstances, this steady-state still represents the only achievable stable steady-state, a feature with critical implications for the efficacy of the policies used in order to modify the current dollarization levels in Bolivia, an issue which is discussed next.

5.4. EXCHANGE RATE POLICY IMPLICATIONS

Whether Bolivia should fully dollarize or pursue zero-dollarization is part of a very intense debate which was examined in Section 2. Given the many

pros and cons often associated with dollarization and so little evidence, it is difficult to determine with certainty which of these alternatives is better.[67] Where there is some unanimity, though, is that the current Bolivian situation (*i.e.* a high-dollarization steady-state) is not optimal as it intensifies the financial system's vulnerability to exchange rate movements in a context of excessive currency-mismatches, high levels of liability dollarization and the central bank's limited capacity as lender of last resort.[68]

The analysis in the previous section suggests that the remaining steps towards OD in Bolivia seem to be quite straightforward. The economy has already reached a high-dollarization steady-state which could be used as the groundwork to achieve full-dollarization in the sense that a potential government's official decision to adopt such regime might not be greatly contested by the public. However, this does not necessarily imply that OD is the best regime for Bolivia.

In fact, a clear-cut cost-benefit analysis derived from the proposed model, which consists in comparing the costs associated with zero-dollarization to those associated with full-dollarization (see Table 1), indicates that a high-dollarization steady-state is suboptimal for agents whenever $e_t < \psi$ (or $e_t < 0{,}43$), a condition that has held true in Bolivia for the last 20 years if the past legacy effect is not considered. In the same line, the CBB has declared its full commitment to reduce the current level of dollarization in Bolivia (CBB, 2005), citing the costs often attributed to dollarization as the main reasons driving this endeavour.

In this sense, it is worthwhile to examine what the bolivian monetary authority could do to reduce dollarization. Only exchange rate policy issues will be discussed here as other coercion-based approaches such as imposing taxes on USD holdings (Russia) or prohibiting FCD (Bolivia and Peru) have proved to work not only against de-dollarization but also against the stability of the entire financial system.[69]

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[67] See Berg and Borenztein (2003).

[68] See Baliño *et al.* (1999) and Gulde *et al.* (2004).

[69] See Oomes (2003) and Antelo (2000). Other opportunity-cost-related measures designed to encourage de-dollarization (*i.e.* reducing reserve requirements for *boliviano*-deposits, increasing the ask-bid spread in the regulated exchange rate market or increasing the supply of inflation-indexed *boliviano*-denominated assets) are not discussed here as they go beyond the intended scope of this study.

FIGURE 10: REDUCING UNOFFICIAL DOLLARIZATION IN BOLIVIA

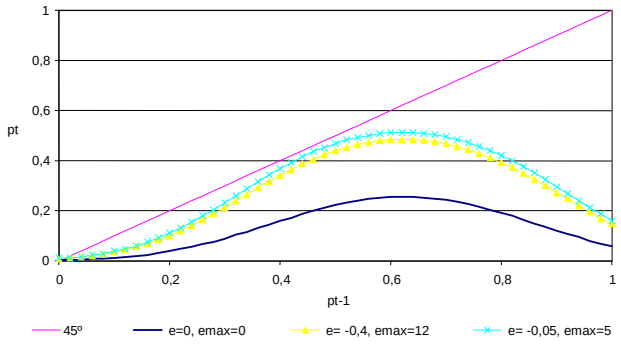


Figure 10 shows that, in the hypothetical case where $e_t^{\max} = 0$ and $e_t = 0$ (represented by the lower curve), the only possible stable steady-state is the low-dollarization one. This important finding suggests that, despite its high levels, dollarization in Bolivia has not become irreversible in a strict sense. If stabilization is maintained long enough so $e_t^{\max} = 0$ and the current depreciation rate is also low and under control, the Bolivian economy can spontaneously initiate a reverse phase transition by which it gradually moves from the high-dollarization steady-state to the low-dollarization one. Nevertheless, one may expect this process to be painfully slow (a sort of soft irreversibility of dollarization) as, according to the evidence presented earlier, $e_t^{\max}$ seems to decrease very slowly over time and still today is suspected to be quite considerable.

Consequently, the CBB could have a leading role in order to accelerate the reverse phase transition. In effect, assuming that $e_t^{\max} = 12$ as suggested by the estimates of the previous section, and assuming too that stabilization is firmly sustained over time, the CBB could: a) directly induce de-dollarization via temporary exchange rate appreciations; or b) induce a faster reduction of $e_t^{\max}$, via some efforts to recuperate the public's confidence in the domestic economic policy.

According to the first alternative, which is operatively feasible as the CBB daily and directly administers the country's current crawling peg exchange

rate system,[70] a temporary appreciation of about 40% would be necessary in order to offset the effect of $e_t^{\max}$ and induce de-dollarization (intermediate curve in the Figure). However, note that the effects of such measure over the country's competitiveness in the international trade could be important and, thus, seems quite impractical.

Alternatively, the second option could involve a continuous strengthen of the CBB´s reputation, mainly associated with its independence from political pressures and a responsible management of the country's monetary policy, so the public's confidence in the financial system can be fully restored and, thus, $e_t^{\max}$ can be gradually reduced.[71] Yet, applying this approach alone will probably represent a much slower progress towards low-dollarization and also will be difficult to measure given the high degree of subjectivity involved.

Given these considerations, a combination of both approaches may then be more feasible in order to reach a low-dollarization steady-state. For example, assuming an hypothetical case where $e_t^{\max} = 5$ (due to an increase in the public's confidence) it would require an initial appreciation of 5% (upper curve in the Figure), which needs to be maintained until the actual UDR is below the intermediate, unstable equilibrium level (not shown in the Figure but probably placed at about 40% as in the 1976-1981 period) so it can spontaneously decrease towards the low-dollarization steady-state. Hence, a combination of moderate temporary exchange rate appreciations, which do not affect the country's competitiveness, and a continuous strengthen of the CBB´s reputation appears to be the most feasible approach in order to accelerate de-dollarization.

6. SUMMARY AND FINAL REMARKS

The results obtained from the empirical work presented in this paper in order to explain dollarization hysteresis in Bolivia give strong evidence of the relevance of the so-called past legacy effect while the importance of network externalities seems to rely deeply on the presence of the latter. This would imply that, while dollarization in Bolivia has been highly persistent, there is some evidence suggesting that it has not become

[70] See www.bcb.gov.bo

[71] Pro-*boliviano* media campaigns may also be helpful for this purpose.

strictly irreversible. Indeed, the condition that ensures the existence of USD network externalities is found to be strongly rooted in the incidence the past legacy effect has on the formation of exchange rate expectations. This also seems to support the notion that dollarization in Bolivia is more associated with the agents´ need for a reliable store of value rather than a medium of exchange, in which the *boliviano* still has a primary role.

The use of the UDR as the relevant dollarization ratio in the estimation procedure proved to be adequate given the general robustness of the estimation, the reasonable sizes and expected signs of the estimated coefficients, which led to find realistic values for the structural-model parameters. These results contrasted with the unconvincing and rather unrealistic values found when the commonly used FCD/TD ratio was included. This would suggest that the use of a broader measure of dollarization such as the UDR seems more adequate in reflecting the agents´ currency-choice process associated with both transactional and store-of-value purposes.

The empirical results also suggested that, whereas the remaining steps towards and OD regime appear to be somewhat straightforward, a fully-committed de-dollarization process will probably be very slow as it is necessary to consistently reduce the incidence of the past legacy effect over the public's exchange rate expectations. In fact, the evidence indicated that this effect has been gradually fading out, possibly due to 20 years of relative economic stability, but still seems to be quite significant, implying that agents continue to "remember" the shock despite such a long time.

Finally, this study showed that if reaching a low-dollarization steady-state represents the main objective (as recently stated by the CBB and also as suggested by the benefit-cost analysis derived from the estimated model), combining moderate temporary exchange rate appreciations which do not affect the country's competitiveness in trade with a continuous strengthen of the CBB´s reputation regarding its independence from political pressures and a responsible management of the monetary policy, can help to accelerate de-dollarization and thus achieve a low-dollarization steady-state in a faster and less costly way.

APPENDIX 1: LOGISTIC TRANSFORMATION OF EQUATION (7)

Consider equation (7):

$$p_t = \frac{1}{1+\exp\left\{-\frac{1}{\varphi}(\alpha e_t + (1-\alpha)e_t^{\max} - \theta_t + (2\theta_t - \psi_t)\,p_{t-1})\right\}}$$

Which can be written as:

$$p_t = \frac{1}{1+\exp\{\beta\}}$$

Where:

$$\beta = -\frac{1}{\varphi}(\alpha e_t + (1-\alpha)e_t^{\max} - \theta_t + (2\theta_t - \psi_t)\,p_{t-1})$$

Now, subtracting (-1) from both sides of the equation, multiplying them by (-1) and reordering terms:

$$1 - p_t = \frac{\exp(\beta)}{1+\exp(\beta)}$$

Dividing both sides by p_t and recalling equation (7):

$$\frac{1-p_t}{p_t} = \frac{\exp(\beta)}{(1+\exp(\beta))^{-1}(1+\exp(\beta))} = \exp(\beta)$$

Finally, applying natural logarithms to both sides of the equation and recalling the following logarithm properties: a) $\ln a^x = x \ln a$; and b) $\ln e = 1$, yields:

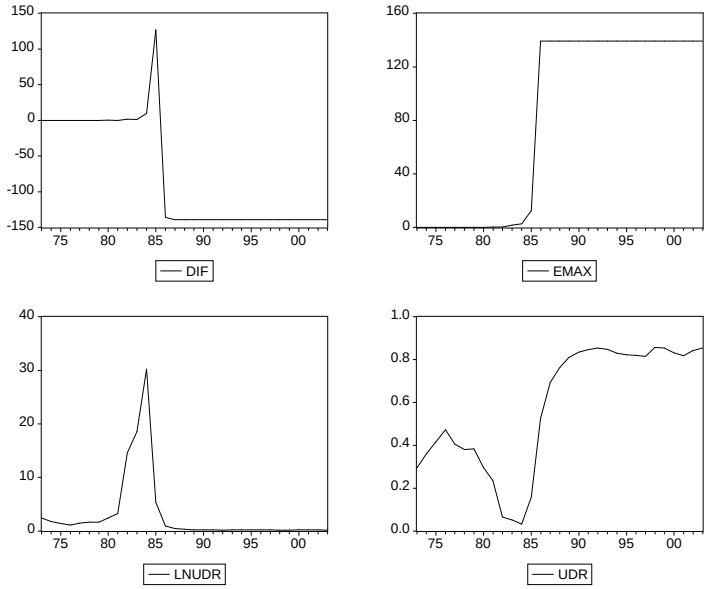
$$\ln\left(\frac{1-p_t}{p_t}\right) = \beta$$

Or:

$$\ln\left(\frac{1-p_t}{p_t}\right) = -\frac{1}{\varphi}(\alpha e_t + (1-\alpha)e_t^{\max} - \theta_t + (2\theta_t - \psi_t)\,p_{t-1})$$

Which is the log-linear representation of equation (7), as presented in equation (11).

APPENDIX 2: VARIABLES INCLUDED IN THE EMPIRICAL PROCEDURE



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