DOLLARIZATION IN LATIN AMERICA:

A Survey of Empirical Literature

Regula R. Schaub

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Supervisor: Professor Louis Corriveau

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1 Introduction

"Dolares, dolares, cambio dolares", "Dollars, I change dollars" is heard in the streets of several major cities or tourist centres in different countries in Latin America. Money traders, more or less tolerated by local people, look for persons, primarily tourists, who are willing to exchange U.S. dollars for local currency. Although unofficial exchange offices are camouflaged, everyone knows where they are. The exchange rate is often negotiated, but as is obvious, does not fall below the official exchange rate. Money traders who buy U.S. dollars generally resell them for local currency at a higher price. This allows the money trader to continue trading to earn an income.

In general, tourists are expected to exchange their money at the official exchange rate in banks. However, effective controls against unofficial money trading is very difficult. When a country is experiencing a lack of foreign reserves, individuals who want hard currency are more or less forced to purchase them in the black-market. During the most difficult times, only dollar deposit certificates are available.

In this paper, dollarization is defined as the substitution of domestic money for U.S. dollars. Dollarization is a particular case of currency substitution whereas the expression currency substitution refers to substitution between any two currencies. Substitution can vary from a very limited use of foreign currency

to a significant replacement of domestic currency. In Latin America, dollarization and currency substitution are often used as synonyms.

Currency substitution may be either symmetric or asymmetric. Symmetric currency substitution occurs when the involved parties hold each others national currency. An often cited and studied example is the United States and Canada[1]. Two primary reasons for currency substitution between the United States and Canada are the contiguous areas and strong economic ties. Asymmetric currency substitution occurs when residents of one country hold a foreign currency without reciprocity. Dollarization is a particular case of asymmetric currency substitution.

People hold U.S. dollars instead of their national currency for a number of, sometimes country specific reasons. Most often, they hold U.S. dollars rather than other currencies due to the U.S. dollar's role as an international reserve currency and because of the dollar standard for the exchange rate in many countries. Moreover, international trade generally involves foreign currency. Another reason for holding U.S. dollars is to minimize the real value loss of assets. Saving is difficult in countries with high inflation rates. Real interest rates can easily become negative.

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[1] For these two countries, see for example: Bana and Handa (1987, 1990), Bordo and Choudhri (1982), Daniel and Fried (1983), De Vries (1988), Ghosh (1989), Miles (1978).

For other industrialized countries, including Canada, see: Batten and Hafer (1984, 1985), Brillembourg and Schadler (1979), Browne (1986), Cuddington (1983), Melvin (1985), Miles and Stewart (1980), and Miles (1981).

The uncertainty regarding the trend in the inflation rate is another reason for holding U.S. dollars. If the domestic inflation rate increases and the interest rate remains for some assets fixed, investors realize a decrease in the real value of their assets. In general, people will avoid medium or long term investments except where interest rates are indexed to the inflation rate. Moreover, if confidence in the national banking system is weak, people may be unwilling to block their money in accounts for long periods. Many have experienced government interventions in the financial sector, including blocking of accounts for a specified period of time and forced conversion of foreign currency holdings at a government set exchange rate[2].

The uncertainty regarding the exchange rate trend is another factor influencing people to hold U.S. dollars. If the national currency is expected to devaluate, people will endeavour to protect themselves against a loss by holding foreign currencies[3]. Finally, many people in Latin America, want to accumulate U.S. dollars because they hope to have one day enough U.S. currency to go abroad.

People in Latin America who want to hold U.S. dollars create the demand for foreign currency. The supply of dollars comes from

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[2] For example, when the new Brazilian President Collor de Mello took office in March 1990, a temporary seizure of 80 percent of private savings was implemented. (The Economist, (Dec. 7, 1991), Brazil Survey, p. 9).

[3] This situation arises when interest rates are not freely determined by market forces. Otherwise the interest rates would adjust to compensate for increased exchange rate uncertainty.

a number of channels, including tourists as mentioned above. Another way dollars are supplied is through remittances from nationals working abroad. Legal and illegal workers in the United States send part of their income home through either official or unofficial channels. In addition, foreign currency can be obtained through trade. Some regulations covering export earnings allow exporters to keep a certain portion of their earnings in foreign currency and stipulate that they convert the remainder of their foreign currency holdings at an official exchange rate. A final important source of dollars is illegal trade or smuggling. As Melvin and Ladman (1991, p. 752) note:

> Since illicit activities like smuggling are financed with currency rather than bank deposits, many people believe that much of the U.S. dollar currency circulating in Bolivia, Colombia and Peru is earned from illegal drug sales.

The role of the government is an important consideration in any discussion of dollarization. Does the government have an active or passive influence on dollarization? Is the government affected by dollarization? In general, governments in developing countries face budget deficits and experience difficulties in collecting their revenues. Often the tax system is not well developed and the most common taxes being excise or sales taxes. When inflation is high, much of the real value of the taxes is eroded before the tax revenue arrives at the state coffers. The lag between tax assessment and effective tax collection is a critical factor. Because of the lag, governments must find supplementary revenue sources. One possible source is the issuing of government bonds.

However, it is generally difficult to find buyers and the interest rates have to be quite high[4]. Internal financial markets are often not well developed in Latin American countries. Consequently, the government has very restricted and insufficient sources of income or financing and the only remaining alternative of the government is to issue currency.

Dollarization has important consequences in the countries where it occurs. One general effect is that a country's freedom to follow an independent monetary policy, under a flexible exchange rate regime, is reduced[5]. To a certain extent, the monetary policies of different countries become interdependent. A country cannot follow a monetary policy that is substantially diverging from other countries. Otherwise, the residents of that country will adapt their behaviour to this different monetary policy. If the incentives are significant enough and the opportunity exists to substitute away from their national currency, residents may do so; thereby modifying the money demand.

Fischer (1982) analyzes the benefits of using a national currency. Countries that use foreign currency pay seigniorage to

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[4] "In Brazil, in the last years of high or even hyperinflation, the government cannot sell 28-day paper at all and is having trouble finding takers for seven-day debt. Almost the entire government debt is being rolled over daily." (The Economist, (Dec. 7, 1991), Brazil Survey, p. 15).

[5] See for example: Brillembourg and Schadler (1979), Miles (1978) or McKinnon (1982). Other studies relate to the apparent instability of the exchange rate with currency substitution. However, the opinions on this aspect are very divergent. For example Girton and Roper (1981) find that exchange rates can be indeterminate if transaction costs are abstracted. Other studies are: Bordo and Choudhri (1982), Calvo and Rodriguez (1977), Daniel (1986), Isaac (1989) and Zervoyianni (1988).

the foreign country. Fischer (1982) calculates the proportion of seigniorage in total government revenue (including seigniorage) for various countries. He finds an unweighted average of 13.3 percent (Fischer, 1982, p. 303) for Argentina, Brazil, Chile, Peru and Uruguay. This represents an important income loss, especially for countries with limited resources. Moreover, additional welfare costs arise from the loss of control over the domestic rate of high-powered money creation.

Another measure of the cost of using a foreign currency is the loss due to inflation tax. In the World Development Report (1989), the inflation tax for Mexico in 1987 is estimated at 3.7 percent of GDP. For 1987, Mexico's inflation rate was 159.2 percent and the monetary base was 6 percent of GDP.

1.1 An Illustration: Dollarization in Argentina

The phenomenon of dollarization in Argentina is illustrated in this section. Although precise quantification of the extent of the use of U.S. dollars is not possible because of the lack of data, the behaviour of the exchange rate provides indirect evidence of dollarization.

Argentina suffered from high inflation from 1985 to 1991. The consumer price index indicated inflation rates of 385.4 percent in 1985; 81.9 percent in 1986; 174.8 percent in 1987; 387.5 percent in 1988; 4,923.8 percent in 1989[6]; and over 20,000 percent in 1990[7].

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[6] ECLAC, (February 8, 1990) and (February 7, 1991).

[7] The Economist, (April 18, 1992), p.17.

The exchange rate increased from 0.801 Australes per U.S. dollar in 1985 to 1.257 in 1986; 3.750 in 1987; 13.370 in 1988; 1,795.0 in 1989; 5,585.0 in 1990; and 9,985.0 in 1991[8].

This series of inflation rates and exchange rates illustrate the progressive economic decline in Argentina. From 1989 on, dollarization became a serious problem and the government had to act with economic measures. The inflation rate was below 10 percent in early 1989. However, after February 1989 the austral[9] came under pressure because of the unease about the possible outcome of the mid-May presidential election. The new government, under Carlos Menem, adopted an economic stabilization programme which included two devaluations of the austral, by 53.6 percent in July 1989 and 34.6 percent in December 1989[10]. The immediate result was a sharp rise in the inflation rate. However, rather than narrowing, the gap between the official exchange rate and the one on the parallel market continued to widen while expectations of a further devaluation fuelled new inflationary pressures. In December 1989, the economy minister announced that the exchange rate would be allowed to float freely and that price controls would be lifted in combination with other measures.

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[8] The exchange rates are end of period market rates. (IMF, January 1992 and July 1992).

[9] The austral was the Argentine currency up to January 1992. It is now the peso.

[10] Latin American Regional Reports - Southern Cone, (February 8, 1990), p. 6-7.

> The dollar at first eased slightly, but resumed its upward trend when analysts predicted that the monthly rate of inflation would come close to 50% in December 1989. By December 28, the last banking day in 1989, the exchange rate had climbed to 2,000 austral per dollar, and rumours were rife of an outright 'dollarization' of the economy in early January, with a projected exchange rate above 4,000 austral. On January 1, Menem formally denied the reports on the 'dollarization' of the economy. The economy minister confirmed that the dollar would be allowed to float freely, without reaching 'extravagant' levels, and that the supply of austral would be contained to a bare minimum. This, he said, would make it advisable for people to start releasing their dollar holdings, and would soon lead to a fall in the exchange rate from what he described as artificially high. (Latin American Regional Reports Southern Cone, (February 8, 1990), p. 3).

By January 5, 1990, the exchange rate fell to 1,350 austral per U.S. dollar and the restrictive monetary policy led to a fall in the price of some basic goods.

Throughout 1990, Argentina continued to suffer from high inflation, albeit substantially lower than the previous year. Tough fiscal and monetary policies, in the context of a rigorous economic stabilization programme, showed their intended effects.

After a surge of the U.S. dollar against the austral near the end of January 1991, Argentina's minister of the economy resigned with his entire team. The surge in the exchange rate was interpreted as a sign of increasing concern over the country's economic and political stability. The government seemed to lose control of inflation when it increased from 4.7 percent in December 1990 to 7.7 percent in January 1991. When the exchange rate stood at 5,850 austral per U.S. dollar on January 5, 1991, and climbed to 7,980 austral by the end of January 1991, the minister of the economy resigned. A two-day banking holiday was declared to prevent

the exchange rate from increasing further, but in spite of the banking holiday, the exchange rate shot up to 10,000 austral. Cavallo, the new economy minister, announced a 8,000 to 10,000 range for the exchange rate, to be supported by central bank intervention. The exchange rate dropped, but climbed again and ended up close to the limit of the range.

> Prices responded immediately to the steep rise in the rate of the US dollar in late January, even though many of the products are not affected by the exchange rate. (Latin American Regional Reports Southern Cone, (March 14, 1991), p. 3).

The explanation was that shopkeepers sought to protect their margins because, with no sure value for the dollar, business people were uncertain how much it would cost to replenish their stock.

In April 1991, the *Convertibility Act*, in conjunction with the toughest economic adjustment programme since Menem took office, were implemented. Indexation was banned and money printing to cover the government's budget deficit was forbidden.

> The Convertibility Act made the austral fully convertible at a fixed rate of 10,000 austral to the dollar, and by law the monetary base must now be 100% backed by gold and foreign currency reserves. [...] This gold-standard-like link imposes a straitjacket on monetary policy [...] the authorities can no longer print money to finance a budget deficit. [...] The Convertibility Act has had remarkable success in restoring confidence in money and providing an anchor for inflationary expectations. People are again willing to hold cash. (The Economist, (April 18, 1992), p. 17).

Although pegging of the austral to the U.S. dollar was termed "dollarization" by the government, members of the economy minister's team preferred to call the exchange rate regime "australization".

1.2 Outline of the paper

Having introduced dollarization using Argentina as an example, the remaining parts of the paper are as follows. In part 2, some elements of monetary theory are introduced to cover the theoretical background of dollarization. Three models, belonging either to the money service production function or to the portfolio balance model, will be examined. This theoretical framework helps us to understand the empirical studies in part 3. There, we review five empirical studies with different econometric models to test on the existence and extent of dollarization in Latin America. In part 4, the criticism on the empirical studies of dollarization will focus on the existence and extent of dollar bills in circulation. The conclusion in part 5 not only underlines the importance of studying dollarization, but also gives some ideas for further research.

2 Theoretical framework for currency substitution

In this section, elements of monetary theory are presented to provide the reader with some theoretical background on the most frequently used models in empirical studies of dollarization. Although the discussion is not exhaustive, it is illustrative. Two approaches are discussed; the money service production function; and the portfolio balance model. The production function approach is presented in a rigorous fashion, while the portfolio balance model is described intuitively.

Three purposes for holding money, which are normally fulfilled by holding domestic money, are as follows:

i) Money is used as a **medium of exchange**, instead of barter between goods and services. It is universally acceptable.

ii) Money is a **store of value and standard of differed payment** because it can be held without perishing, occupies a small space and accommodates payment in time without changing nature.

iii) The value of goods and services can be quantified by using money as a **unit of account** to simplify the comparison between different goods and services which would otherwise have to be expressed in quantities of other commodities.

In countries with high inflation rates, domestic money is to some extent replaced. Balances denominated in foreign currency can

better fulfil the store of value function than balances denominated in domestic currency because real value loss is reduced by holding foreign currency. Foreign currency is also better able than domestic currency to satisfy the other functions of money when inflation rates become unbearable to the public.

Different theoretical frameworks are used to model money demand with currency substitution. These include[11] the transaction motive[12], the precautionary demand for money[13], the money service production function[14], the portfolio balance approach[15], the asset demand model[16], and the marginal utility theory of money demand[17]. The criteria for classification may be the focus of the study on the relative return for holding one currency rather than another; substitution between currencies and other assets; and financial and transaction motives.

The money service production function as illustrated by Miles

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[11] There are different classifications proposed. See for example S.H. Thomas and M. R. Wickens (1989).

[12] Poloz (1984) and Saurman (1986)

[13] Poloz (1986)

[14] Miles (1978). His approach was called the pure substitution theory by S.H. Thomas and M.R. Wickens (1989).

[15] Calvo and Rodriguez (1977), Kouri and Macedo (1978), Brillembourg and Schadler (1979), Miles and Stewart (1980), Cuddington (1983), and King, Putnam and Wilford (1986).

[16] Girton and Roper (1981)

[17] Bordo and Choudhri (1982)

(1978) is presented first. This approach may easily be linked to money as a medium of exchange since money facilitates the production process. Next, the portfolio balance model, as discussed in Kouri and Macedo (1978) and King, Putnam and Wilford (1986), is presented. Money as a store of value and standard of differed payment is modeled through the portfolio balance framework. In this approach, the two criteria of asset allocation are return and risk, that means the economic agent decides on how to preserve and/or augment the real value of an asset in order to make use of the asset at a later time.

The remaining theoretical frameworks mentioned above are generally used for theoretical conclusions on currency substitution as well as for empirical studies of industrialized countries. However, because these models are not used in the empirical studies on Latin America discussed in part 3, they are not analyzed in this paper.

2.1 The money service production function and currency substitution

Money is considered as both a consumer and producer good in the money service production function. For the consumer, money is an element of his indirect utility function. Money facilitates the payment and expenditure process and thereby helps the consumer to satisfy his needs. As an element of the production function, money renders similar services to producers. Money serves to smooth the

process of production by facilitating the purchase and sale of goods and services. However, holding money has opportunity costs as measured by the forgone interest payments. Consumers and producers therefore hold only a certain amount of money as determined by the solution of an optimization problem. The solution to the optimization problem states that the marginal utility of the last unit of money held must equal its marginal cost. Miles (1978) develops a two currency model to address this optimization problem.

2.1.1 Miles (1978)

Miles (1978) presents one of the earliest models of currency substitution[18]. His model was widely used in empirical studies of dollarization[19]. Miles (1978) assumes a money service production function which models the relationship between the level of money services and the quantities of real domestic money and real foreign money. A constant elasticity of substitution function (CES) is used. The exchange rate is defined from the purchasing power parity as $e = P_d/P_f$ where $P_d = 1$. The money service production function is thus:

(2.0) $$MS = (\alpha_1 M_d^{-\rho} + \alpha_2 e M_f^{-\rho})^{-(1/\rho)}$$

where:

MS = the level of money services

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[18] According to S.H. Thomas and M.R. Wickens (1989), Miles' (1978) model is a development of McKinnon (1969) and Chen (1973).

[19] See, for instance, Marquez (1987).

M_d, M_f = domestic and foreign real currency-denominated cash balances held by the economic agent

P_d, P_f = domestic and foreign currency price indices

α_1, α_2 = weights reflecting the efficiency of domestic and foreign real balances in producing money services

i_d, i_f = interest rates on domestic and foreign currency balances

Now, the private sector is assumed to select its portfolio by choosing among different types of real assets, including real money. Once this distribution is decided, the agents determine the allocation of real cash balances (M_0) between domestic and foreign currencies. We thus have the asset constraint:

(2.1) $$M_0 = M_d(1+i_d) + eM_f(1+i_f)$$

The private sector's problem is then to maximize the level of monetary services, given by equation (2.0), subject to the asset constraint (2.1).

The first order conditions are as follows:

(2.2) $$\partial MS/\partial M_d = -\lambda(1+i_d)$$

(2.3) $$\partial MS/\partial eM_f = -\lambda(1+i_f)$$

(2.4) $$M_0 = M_d(1+i_d) + eM_f(1+i_f)$$

where λ is the Lagrange multiplier. More explicitly, equations (2.2) and (2.3) can be written as:

(2.5) $$\partial MS/\partial M_d = -(1/\rho)(\alpha_1 M_d^{-\rho} + \alpha_2 eM_f^{-\rho})^{-((1+\rho)/\rho)}(\alpha_1 M_d^{-(1+\rho)})$$

(2.6) $$\partial MS/\partial eM_f = -(1/\rho)(\alpha_1 M_d^{-\rho} + \alpha_2 eM_f^{-\rho})^{-((1+\rho)/\rho)}(\alpha_2 eM_f^{-(1+\rho)})$$

The first-order conditions of the firms' constrained optimization problem indicate that in equilibrium, the marginal

productivity of each type of money must equal its opportunity cost. Replacing the left hand sides of (2.5) and (2.6) with equations (2.2) and (2.3) respectively and forming their ratio, we can express the relative marginal productivity of the two types of balances as a function of their relative prices. After rearranging and adding a disturbance term (u) Miles (1978) obtains:

$$(2.7) \qquad \log(M_d/eM_f) = (1/1+\rho)\log(\alpha_1/\alpha_2) + (1/1+\rho)\log[(1+i_f)/(1+i_d)] + u$$

The elasticity of currency substitution (σ) is defined as the percentage change in the use of domestic money divided by the percentage change of the use in foreign money and is expressed as:

$$(2.8) \qquad \sigma = (\partial\log(M_d/P_d)/\partial\log(eM_f/P_f))$$

Calculating the elasticity of currency substitution (σ) in this model, we obtain:

$$(2.9) \qquad \sigma = 1/(1+\rho)$$ [20]

When $\sigma \to 0$, the currencies are perfect complements and their portfolio mix is independent of changes in relative financing costs. When $\sigma \to \infty$, the currencies become perfect substitutes. In that case, the portfolio mix is dependent on small changes in relative costs. When $0 < \sigma < \infty$, domestic and foreign currencies are substitutes to some extent. In this case, the portfolio mix will be affected by the relative efficiency of domestic money to foreign money in producing money services, and by the relative cost of holding domestic and foreign currency balances.

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[20] For details of the calculations, see for example Chiang (1988), p. 426-428.

As we will see in the empirical part, (discussing Marquez (1987)), the elasticity of currency substitution (σ) is estimated in the studies on dollarization using a money service production function approach. If σ is different from zero and significant, then the hypothesis of currency substitution, i.e. dollarization cannot be rejected.

2.2 The portfolio balance approach and currency substitution

The portfolio balance approach has been widely used to study dollarization. However, it gives rise to several problems. First, currency substitution is only one aspect of the studies involving portfolio balance models and the models are not specifically designed to test for currency substitution[21]. Furthermore, the models have in general been designed for industrialized countries and thus for a different economic and institutional framework than that prevailing in developing countries.

Despite these restrictions, simplified versions of the portfolio model are used to study dollarization in Latin America. Kouri and Macedo's (1978) adaptation of a portfolio balance model to test for currency substitution is discussed below. In addition, the work of King, Putnam and Wilford (1986) is highlighted to illustrate some additional variables which may be included in a

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[21] The article of Calvo and Rodriguez (1977) became one of the most referred articles on currency substitution. However, the emphasis is on how currency substitution affects exchange rates.

portfolio model.[22]

In the portfolio balance approach, an individual is faced with a choice among several assets of differing return and risk[23]. These assets may be grouped as money and other financial assets. A probability is attached to every return in order to be able to calculate the average return and variance. The individual chooses among assets with higher return and higher risk or with lower return and lower risk. This choice is dependent on the individual's preference for and behaviour towards uncertainty. It is generally assumed that for a rational individual, an increase in the interest rate, or a perception of decreased risk with respect to a specific asset would cause demand for that asset to increase. In order to determine the actual portfolio choice, the individual's wealth function and his return/risk preference trade-off must be compared.

2.2.1 Kouri and Macedo (1978)[24]

Kouri and Macedo's (1978) model belongs to the portfolio balance theory. Foreign exchange market participants hold different currencies depending on their risk and expected return. The implications of currency substitution are studied using a reduced model formed by four behavioural equations as presented below.

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[22] For other studies on currency substitution using a portfolio balance model, see for example: Brillembourg and Schadler (1979), Miles and Stewart (1980). For criticism: Cuddington (1983), Saurman (1986), Thomas (1985) and Zervoyianni (1988).

[23] For a detailed description of the model, see Tobin (1965) or Branson (1989).

[24] Presented in Baillie and McMahon (1989), p. 85-86.

$$(2.10) \quad m_t - p_t = \theta(w'_t) + E_{t-1}[\alpha(i_t - i'_t) + \sigma(i_t - i_t^*)]$$

$$(2.11) \quad m_t^* - p_t^* = \theta^*(w'_t) + E_{t-1}[\alpha^*(i_t^* - i'_t) + \sigma^*(i_t^* - i_t)]$$

$$(2.12) \quad E_{t-1}(i_t - i_t^*) \equiv (r_t - r_{t*}) - E_{t-1}(\pi_t - \pi_t^*)$$

$$(2.13) \quad E_t(\Delta)s_{t+1} = E_{t-1}(\pi_t - \pi_t^*)$$

where:

m_t = logarithmic deviation of the domestic money stock from its trend value

p_t = logarithm of price level

i_t = real yield on domestic currency

i_t' = real yield for a unique non-monetary asset

r_t = nominal interest rate

w_t' = stock of world wealth or production

s_t = exchange rate, price of foreign currency

π_t = inflation rate

* = foreign equivalent of denoted variable

σ = coefficient of currency substitution

The demand for real domestic money (2.10) is a function of the stock of world wealth or production, the expectation of real yield differentials between domestic currencies and a unique non-monetary asset as well as the expectation of real yield differentials between domestic and foreign currencies. The demand for foreign money (2.11) is dependant upon the same variables as the demand for real domestic currency (2.10), except that domestic and foreign yields are interchanged. The assumption of the Fisher parity (2.12) indicates that the nominal interest rate differential plus the expected inflation rate differential equal the expected real

interest rate differential. Equation (2.13) is the condition of purchasing power parity.

In this model, arbitrage occurs with money, not commodities. Subtracting equation (2.11) from equation (2.10) and replacing two terms, leads to the currency substitution model (2.14) proposed by Kouri and Macedo (1978):

$$(2.14) \qquad s_t = m_t - m_t^* + \theta^* - \theta - (\alpha+2\sigma)[r_t - r_t^* - (Es_{t+1} - s_t)]$$

Equation (2.14) explains the exchange rate as a function of the difference in the logarithmic deviation of the domestic and foreign money stock from their trend rate; the logarithmic differences in the importance of the stock of world production on the domestic and foreign money demand; the logarithmic differences in the domestic and foreign nominal interest rate and the logarithmic change in exchange rate expectations. The higher the coefficient of currency substitution, the higher the exchange rate variation given $(Es_{t+1} - s_t)$. If the coefficient of currency substitution tends towards infinity, then the currencies are perfect substitutes and the exchange rate is undefined, or extremely unstable.

2.2.2 King, Putnam and Wilford (1986)

The basic framework of Kouri and Macedo (1978) can be augmented with the addition of supplementary exogenous variables. For instance, King, Putnam and Wilford (1986) assume the demand for domestic and foreign money to be affected by the degree of world market integration. The intensity of market integration is influenced by institutional factors such as barriers to trade, controls on international capital movements, transaction costs, and the availability of information. King, Putnam and Wilford (1986) expect that a high degree of market integration, (i.e few restrictions to trade), will lead to increased currency substitution. In this case, economic agents are able to meet their demand for goods and services among various substitutable sources.

3 Empirical studies of Latin America

Section 2 provided the theoretical background of the empirical studies to be discussed in this chapter. The studies are grouped by author in chronological order. The countries studied are Argentina, Bolivia, Ecuador, Mexico, Uruguay and Venezuela. One approach applies a money service production function model. All other studies use a portfolio balance model. The general objective of the studies is the search for evidence on the existence and magnitude of the dollarization phenomena. The papers to be examined are Ortiz (1983), Ramirez-Rojas (1985), Fasano-Filho (1986), Marquez (1987) and Melvin (1988).

3.1 Ortiz (1983), Mexico

Ortiz (1983) estimates a money demand function for Mexico from 1933 to 1980. He studies the effects of devaluation[25] expectations on dollarization. Devaluation expectations are influenced by political and other factors related to foreign exchange risks. For example, whether exchange rates are fixed or floating. In view of the currency substitution literature, the risk of exclusively holding domestic currency increases under floating exchange rates. Therefore, under a floating exchange rate regime, economic agents have more incentive for portfolio diversification. However, Ortiz

[25] Ortiz uses devaluation and depreciation depending on the exchange rate regime in use. This can lead to some confusion, because the period he analyzes is long and the exchange rate regime changed several times.

argues that the fixed/floating exchange rate distinction is not very relevant for Mexico. Floating exchange rate regimes have been of relatively short duration (about 30 quarters in total from 1933 to 1980) in Mexico. The Banco de México constantly intervened in the foreign exchange market when the Peso was allowed to float. For Mexico, the crucial variables for the study of dollarization are the perception of political risk and devaluation expectations.

Ortiz's model is comprised of two money demand functions; a demand for domestic money function, and a demand for foreign money function.

(3.0) $M_d/P = L_d$ (ER, ED, PRD, r, w)

(3.1) $M_f/P = L_f$ (ER, ED, PRD, r, w)

(3.2) $ED = \pi_f - \pi_d$

where:

M_d/P = real domestic desired money balances

M_f/P = real foreign desired money balances

r = real return on an alternative asset

ER = measure of foreign exchange risk, defined as deviations of the real exchange rate from the trend[26]

ED = expected devaluation[27]

PRD = dummy variable for political risk factors, introduced for the years with a change in government

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[26] Ortiz (1983) defines ER as: "[...] generated from the residuals of a regression between the real exchange rate and a trend variable." (Ortiz, 1983, p. 179, footnote 10). However he does not precise how he defined the trend.

[27] Ortiz (1983) takes the absolute value of the expected devaluation. Although this definition is not explicit in his paper it can be inferred from the estimations.

w = real wealth

π_d = real return on domestic currency approximated by the rate of inflation in Mexico

π_f = real return on foreign currency which is π_d plus the expected depreciation of the exchange rate

An individual's demand for domestic money (3.0) is dependant upon the perception of foreign exchange risk; the expected devaluation; the perception of political risk; the real return on alternative assets and real wealth. These variables also determine the demand for foreign money (3.1). Expected devaluation, equation (3.2), is proxied by the difference between foreign and domestic inflation rates.

Ortiz expresses equations (3.0) and (3.1) in exponential form and provides the expected signs of the partial derivatives. The real demand for domestic money and the real demand for foreign money may now be determined as follows:

$$(3.3) \qquad M_d/P = \alpha_0(w)\exp[\alpha_1(-ED)+\alpha_2(\pi_d-r)+\alpha_3 ER+\alpha_4 PRD]$$

$$(+) \qquad (+) \qquad (+) \qquad (-) \quad (-)$$

$$(3.4) \qquad M_f/P = \beta_0(w)\exp[\beta_1(ED)+\beta_2(\pi_f-r)+\beta_3 ER+\beta_4 PRD]$$

$$(+) \qquad (+) \qquad (+) \qquad (+) \quad (+)$$

Ortiz proceeds by subtracting equation (3.3) from equation (3.4) and writes the resulting equation in logarithmic form. After imposing symmetry conditions on the parameters dealing with the same exogenous variables in equation (3.3) and (3.4), he adds a random term u_t and a lagged term for the endogenous variable. The real interest rate and real wealth variables drop out of the equation. The estimating equation for the ratio of foreign money

balances to domestic money balances now becomes:

(3.5) $\ln (M_f/M_d) = \gamma_1 ED + \gamma_2 ER + \gamma_3 PRD + \gamma_4 \ln (M_f/M_d)_{t-1} + \epsilon_t$

The parameters are expected to be positive. The results of the estimations are presented in Table (3.0).

Table (3.0): CS in Mexico, 1933.I - 1980.IV

(3.6) $\ln(M_f/M_d) = 0.059\ ED_{t-1} + 0.053\ ED_{t-2} + 0.006\ ER_{t-1}$

$(1.70) \qquad (1.83) \qquad (2.23)$

$+ 0.045\ ER_{t-2} + 0.079\ PRD + 0.932\ \ln(M_f/M_d)_{t-1}$

$(1.32) \qquad (2.75) \qquad (17.3)$

$R^2 = 0.907$ D.-W.= 2.20 SEE = 0.157

(t-statistics in parentheses)

Source: Ortiz (1983, p. 179)

The equation is estimated with an ordinary least squares estimation procedure and quarterly data from 1933.I to 1980.IV. (M_d) and (M_f) are defined as the peso and dollar demand deposits held by the public in private Mexican financial institutions. The difference between the official and the real exchange rate is used as a proxy for the expected rate of devaluation (ED).

Except for (ER_{t-2}), the coefficients are different from zero at the five percent level of confidence. All the coefficients have the expected signs. Given these results, Ortiz concludes that dollarization has occurred in Mexico.

In this study, the magnitude of dollarization is probably underestimated. Ortiz points out that only some of the monetary

aggregates (namely the demand deposits) are included in M_f and M_d. The variations of the ratio of currency and deposits affecting the dollarization coefficient is not considered. Good measures of devaluation expectations are also difficult to obtain for such a long period in the absence of a forward market.

3.2 Ramirez-Rojas (1985), Argentina, Mexico and Uruguay

Ramirez-Rojas (1985) discusses and estimates models for Argentina, Mexico and Uruguay. He uses the same reduced model for the money demand in each of the countries. The model consists of the following four equations:

(3.7) $M_d = P_d L_d (w, E^*)$

(3.8) $M_f = P_f L_f (w, E^*)$

(3.9) $P_d = EP_f$

(3.10) $w = (M_d + EM_f)(1/P_d)$

where:

M_d = nominal holdings of domestic money by domestic residents

M_f = nominal holdings of foreign money by domestic residents

w = real liquid wealth

E = nominal exchange rate expressed in units of domestic currency

E^* = expected rate of depreciation of the home country's currency

P_d = domestic price level

P_f = foreign price level

The demand for domestic nominal money (3.7) is a function of the domestic price level, real liquid wealth and the expected rate of depreciation of the exchange rate. Equation (3.8) gives the demand for foreign nominal money balances which depends on the foreign price level, real wealth and the expected rate of depreciation of the exchange rate. Equation (3.9) shows that purchasing power parity is assumed. Equation (3.10) indicates that real wealth is composed of real nominal domestic and foreign money balances held by domestic residents.

The ratio of domestic to foreign money balances (3.11) can be obtained from equation (3.7) to (3.9). Thus, we get:

(3.11) $M_d/EM_f = [L_d(w, E^*)]/[L_f(w, E^*)]$

Assuming that the demand for each type of money is homogeneous of degree zero in wealth, (3.11) can be expressed as:

(3.12) $M_d/EM_f = \alpha (E^*) \qquad \alpha' < 0$

The first order condition indicates that an expected change in the ratio of domestic to foreign money balances is negatively related to a change in the expected exchange rate. The dynamics of this model depend on the assumptions about the exchange rate regime and on the model of expectations. Ramirez-Rojas does not include interest bearing assets in the model as there were no available empirical data for such assets.

Ramirez-Rojas puts two warnings in the interpretation of the data which could lead to miss-specifications. First, the major part of foreign currency deposits in the domestic financial market are held by domestic residents. However, foreigners could hold them as

well. Secondly, it is impossible to measure the amount of foreign currency notes held by the public in the country[28].

Ramirez-Rojas measures currency substitution by the ratio of M/F, where M = C + D + S + T

C = currency in the hands of the domestic public

D = demand deposits

S = saving deposits

T = time deposits

F = foreign currency deposits in the domestic financial system expressed in units of domestic currency.

We now have the basic model used by Ramirez-Rojas and can continue with the empirical results. We will start with Argentina.

Empirical results for Argentina

Ramirez-Rojas uses quarterly data for his estimation from 1980 to 1984. The proxy (e_t) used for the expected change in the exchange rate is the current differential between inflation rates in Argentina and the United States, with both rates measured in terms of WPI. The interest rate differential cannot be used because of interest rate controls. Equation (3.12) is modified to allow for the lag of the dependent variable as an explanatory variable. A short-run stock adjustment model seems justified because of quarterly data. Another reason is more ad hoc in nature as the examination of the (M/F) series indicates that a lagged term plays

[28] However, Melvin and Parra (1989) try to measure the detention of foreign currency notes in circulation in the case of Bolivia. We look at this study in part 4.

an important role in explaining the current behaviour of (M/F). Furthermore, two dummies were added, one for the South Atlantic conflict in 1982 (D_1) and the other for the political uncertainty surrounding the elections in 1983 (D_2). We get the following equation for estimation:

$$(3.13) \qquad \ln (M/F)_t = \alpha_0 + \alpha_1 e_t + \alpha_2 \ln (M/F)_{t-1} + \alpha_3 D_1 + \alpha_4 D_2$$

$$\alpha_1 < 0, \qquad 0 < \alpha_2 < 1$$

The coefficient of the expected exchange rate is negative as dollarization is expected to become more important with increasing expected changes in the exchange rate. The influence of the lagged ratio of domestic money to foreign currency deposits is expected to be positive. Ramirez-Rojas does not specify the expected signs of the two dummy variables[29].

The estimation results of (3.13) are reported in table (3.1):

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[29] We might think of two possible explanations for the resulting negative signs of the coefficients of the dummies (See table 3.1). The first explanation is that dollarization would apparently decrease as the Argentineans would try to withdraw dollars from their foreign currency deposits due to lack of confidence in the banking system in times of uncertainty. This would reduce (F), and therefore increase the ratio of (M/F). The second explanation would be that the government imposes restrictions on the banking system during uncertain times and makes it more difficult to hold foreign currency deposits.

Table (3.1): Estimates of currency substitution in Argentina, 1980.II - 1984.I

Regression	α_0	α_1	α_2	α_3	α_4
a) ln(M/F)	2.49	-1.99	0.36	-	-
	(0.70)	(0.81)	(0.17)		
b) ln(M/F)	2.02	-1.53	0.45	0.80	-
	(0.62)	(0.71)	(0.15)	(0.33)	
c) ln(M/F)	1.83	-2.05	0.52	0.88	0.68
	(0.42)	(0.49)	(0.10)	(0.22)	(0.18)

R^2: a) 0.67 b) 0.79 c) 0.91 SEE: a) 0.36 b) 0.30 c) 0.20 H: a) -0.32 b) 0.18 c) 1.38

Note: Standard errors are in parentheses. R^2 is the coefficient of determination; SEE is the standard error of the regression; H is the Durbin statistic for serial correlation in a model with a lagged dependent variable.

Source: Ramirez-Rojas (1985, p. 648)

The results presented in table (3.1) show that all the coefficients are statistically significant and have the expected sign. The calculated semi-elasticity of $\ln(M/F)_t$ with respect to (e_t) is around -3.5 for the average of the three presented regressions.

However, some restrictions on the results should be mentioned. The small sample size indicates that the results should be considered suggestive. Furthermore, it is expected that an

important amount of foreign currency notes are circulating in Argentina which would lead to an underestimation of currency substitution. The amount of foreign currency deposits held in Uruguay by foreigners can give additional insight into the magnitude of currency substitution in Argentina because it is assumed that Argentineans hold most of these deposits in Uruguay.

Empirical results for Mexico

Until the mid 1970s Mexico had a fixed exchange rate system and no capital controls. Currency substitution became a problem to the monetary authorities during the period from 1975 until the devaluation of the peso in August 1976. During that period the foreign currency deposits (F), mainly in U.S. dollars, increased substantially. The public did not move out of dollars during the years following the devaluation. The sample period ends in 1982 when the private banking system was expropriated. The proxy for the expectations of the change in the exchange rate (e_t) is the current differential between inflation rates in Mexico and in the U.S. The interest rate differential cannot be used because of interest rate controls. The presence of the lagged term can be justified by the same reasons as those given in the case of Argentina. Ramirez-Rojas uses the following equation (3.14) for estimation:

(3.14) $$\ln (M/F)_t = \beta_0 + \beta_1 e_t + \beta_2 \ln (M/F)_{t-1}$$

$$\beta_1 < 0, \qquad 0 < \beta_2 < 1$$

For the same reasons as in the case of Argentina, we expect the coefficient of the expected exchange rate to be negative and

the coefficient of the lagged dependent variable to be positive. Ramirez-Rojas estimates for different periods, but we present just the first and most significant results in table (3.2). The other results do not provide more insight.

Table (3.2): Estimates of CS in Mexico, 1970 - 1982

(3.14) $\ln(M/F)_t = 0.06 - 1.96e_t + 0.98\ln(M/F)_{t-1}$

(0.08) (0.57) (0.02)

R^2: 0.98 SEE: 0.14 H: 0.55 Note: See table for Argentina

Source: Ramirez-Rojas (1985, p. 653)

The estimation of equation (3.14) provides high explanatory power (R^2: 0.98). The coefficients have the expected signs and are significant. The statistical results therefore, give evidence in favour of currency substitution in Mexico.

Empirical results for Uruguay

Two regression models were estimated using quarterly data from 1970 to 1982 for Uruguay.

In the first model, the proxy for the expected change in the exchange rate (e_t) was defined as the differential between the domestic interest rate (i_d) paid on domestic currency deposits and the domestic interest rate (i_f) paid on foreign currency deposits. The estimated equation (3.15) is:

(3.15) $\ln(M/F)_t = \gamma_0 + \gamma_1 \ln e_t + \gamma_2 \ln(M/F)_{t-1}$

We expect: $\gamma_1 < 0$ and $0 < \gamma_2 < 1$, (see explanations for Argentina

and Mexico). The results are reported in table (3.3).

Table (3.3): Estimates of CS in Uruguay, 1970.I to 1982.II

(3.15) $\ln(M/F)_t = 1.63 - 0.42\ln e_t + 0.75\ln(M/F)_{t-1}$

(0.67) (0.17) (0.10)

R^2: 0.95 SEE: 0.24 H: -0.90 Note: See table for Argentina

Source: Ramirez-Rojas (1985, p. 653)

The coefficients are significant and have the expected sign. The high value of (R^2: 0.95) indicates the high explanatory power of the results.

However, some restrictions should be kept in mind. Ramirez-Rojas does not distinguish between two effects which influence the interest rate differentials. On the one hand, there is the expected rate of depreciation of the domestic currency and, on the other hand, there is the risk premium. Only the expected rate of depreciation is relevant for dollarization, therefore the empirical results may be biased. A further problem is that the interest rate regime changed. The interest rates were fixed by the government for some periods, they were managed at other times, and for other periods they were determined by market forces. These events are also likely to affect the performance of (3.15).

In the second model, equation (3.16), the proxy ($\overline{e}_t$) denotes the current differential between inflation rates, given as the difference of the WPIs in Uruguay and the U.S.

(3.16) $\ln(M/F)_t = \delta_0 + \delta_1\bar{e}_t + \delta_2\ln(M/F)_{t-1}$

We expect: $\delta_1 < 0$ and $0 < \delta_2 < 1$ for the same reasons as before. The empirical results of (3.16) are presented in table (3.4):

Table (3.4): Estimates of CS in Uruguay, 1970.I to 1982.II

(3.16) $\ln(M/F)_t = 0.00 - 0.13\bar{e}_t + 0.98\ln(M/F)_{t-1}$

(0.00) (0.60) (0.04)

R^2: 0.94 SEE: 0.26 H: -1.53 Note: See table for Argentina

Source: Ramirez-Rojas (1985, p. 653)

The coefficients have the expected signs, however the coefficient for ($\bar{e}_t$) is not significant and the intercept is zero. These results may be explained by the definition of the proxy. From the end of 1978 on, a declining path of the inflation rate was observed due to the introduction of the preannounced exchange rate several months in advance. Therefore, the use of the WPI differentials as proxy for the expected depreciation of the exchange rate may lead to biased results.

Overall, the proxy formed by the interest rates perform better than the WPI differentials. Still, some further restrictions affecting both models should be mentioned. In 1975, a far-reaching financial reform was initiated in Uruguay. In that time, foreign currency deposits increased in Uruguay, which might be explained by the fact that foreign money previously held abroad (and consequently not recorded) was now entering the domestic financial

system. So, the observed change in the ratio of (F/(M+F)) might not have been the result of an increase in the demand for foreign fiat money. Ramirez-Rojas (1985, p. 658) concludes:

> Given the series of profound reforms that this country has undertaken during the past ten years, it is difficult to estimate with precision the timing and the type of structural changes that have occurred. Consequently, the results given by the regressions should be considered only as suggestive. Nevertheless, the available evidence indicates that currency substitution is empirically important in Uruguay [...] .

To conclude with the article of Ramirez-Rojas, we have to remember the crucial assumption that foreign currency deposits in the domestic financial system can be used as substitutes for foreign currency deposits held abroad. This assumption might be fragile as the evidence (i.e. foreign currency deposits of Argentineans in Uruguay) in the Ramirez-Rojas article shows. Furthermore, the general trend from 1970 to 1982 shows that the amount of foreign currency deposits was increasing for Argentina, Mexico and Uruguay except for some short periods. The findings are only partial estimates of worldwide foreign currency deposits for these countries and show clearly the limitations of existing empirical measures of currency substitution.

3.3 Fasano-Filho (1986), Argentina

Fasano-Filho (1986) uses data from 1960 to 1976 to test for dollarization in Argentina. He attempts to verify whether a flexible exchange rate regime is more likely to induce dollarization than a fixed exchange rate regime. A flexible exchange rate regime theoretically allows every country to choose its own monetary policy. This fact is assumed to create more uncertainty on inflation and exchange rate behaviour.

Fasano-Filho estimates four different money demand equations for different time periods. He uses four different definitions of money (M). The money demand equations have the following specification:

(3.17) $\ln (M)_t = a_0 + a_1 \ln y_t + a_2\pi_t + a_3x_t + u_t$

Where $(M)_t$ stands for (1) currency, (2) demand deposits, (3) currency plus demand deposits (M1) and (4) quasi-money (time and savings deposits). The other variables are:

P_t = domestic price level as measured by the general wholesale price index (WPI)

y_t = real income (measured by GDP at factor cost in 1960 constant prices)

π_t = domestic inflation rate calculated as $\ln (P_t/P_{t-1})$[30]

x_t = expected rate of depreciation

a_1 = income elasticity coefficient

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[30] This definition of inflation rates is acceptable for periods with low inflation. However, in times with high inflation rates this measure is not precise.

a_2 = price inflation elasticity coefficient

a_3 = expected rate of depreciation coefficient

The money demand specification of Fasano-Filho's model includes real income, the expected rate of inflation and the expected rate of depreciation as explanatory variables. We expect $a_1 > 0$, because increased income should lead to an increased demand for money. Furthermore, we expect $a_2 < 0$ because higher rates of domestic inflation generally lead to a decrease in the demand for money. The currency substitution effect in Fasano-Filho's model will be captured by the expected rate of devaluation, i.e. (a_3). If the economic agents anticipate a devaluation, they are expected to move out of domestic money into foreign money holdings, therefore we expect $a_3 < 0$.

Exchange rate controls and a fixed exchange rate or a passive crawling peg make the black-market exchange rate the relevant variable for the expected rate of devaluation (x). Thus, assuming that purchasing power parity holds, Fasano-Filho uses equation (3.18) to estimate the expected rate of devaluation.

(3.18) $x_t = \ln P_t - \ln P_t^* - \ln e_{tb}$

where:

P_t^* = US wholesale price index as a proxy for world prices

e_{tb} = black market exchange rate from Pick's Currency Yearbook

Fasano-Filho did not use interest rates as explanatory variables in his estimations because interest rate ceilings were imposed during the period. At the same time, asset-holders did not

hold foreign assets but only foreign currency. It seems that the expected annual rate of devaluation, which is at least equal to the high inflation rate, overwhelmed any change in the foreign interest rate. Fasano-Filho assumes that the foreign currency balances are insensitive to foreign interest rate changes.

Fasano-Filho uses an OLS estimation procedure with annual data. The average rate of inflation, measured by the general wholesale price index, was 46 percent in the sample period (1960-1976). The sample ends in 1976 because of the beginning of the liberalization of the financial sector in 1977. Fasano-Filho presents 16 regressions. We will report a representative one in table (3.5). The dependent variable is M1.

Table (3.5): Estimates for currency substitution in Argentina, 1960-1976

(3.17)* $\ln(M1/P_t) = -0.0997 + 0.7857 \ln y_t - 0.2529\ \pi_t - 0.2565\ x_t$

$\qquad\qquad\qquad\qquad\qquad\quad (-0.6302)\quad (17.3075)\qquad (-3.1799)\qquad (-3.4819)$

$\bar{R}^2$: 0.95 D.-W.: 1.71 RHO: 0.55

Note: The t-statistics are in parentheses. The Cochrane-Orcutt method was used to correct the auto-correlation in the disturbances.

Source: Fasano-Filho (1986, p. 334)

Fasano-Filho finds the coefficient of the expected rate of depreciation to be negative and statistically significant for all

definitions of money he used, except for quasi-money where the coefficient is statistically insignificant. He explains this particular case with the generally negative real rate of return on quasi-money. Therefore quasi-money was never held in significant amounts. All the other parameters have the expected signs.

Fasano-Filho then analyzes two different periods. During the first period 1966 to 1977, there were single digit inflation rates, no exchange controls, fixed exchange rates, positive ex-post real interest rates, and higher than average GDP growth. As expected, currency substitution was an insignificant phenomenon. In the second period, 1960-65 and 1971-76, there was high inflation, exchange and capital movement controls, negative real interest rates, and a passive crawling peg regime. As expected, dollarization occurred during that period.

3.4 Marquez (1987), Venezuela

Marquez (1987) presents a micro-oriented model inspired by Miles (1978) to test for currency substitution in Venezuela. He uses a money service production function model due to the specific institutional banking structure. In Venezuela, no onshore holdings of monetary balances denominated in foreign currency were allowed. Marquez expects currency substitution to arise from the relative importance of firms with international transactions and from the absence of capital controls.

We will not outline the development of the model here because it was done under section (2.1.1) with equation (2.0) to (2.7). The differences from Miles' (1978) model are that: a) Marquez minimizes the cost of holding money instead of maximizing the level of money services[31] and b) he defines certain variables in a slightly different manner. We therefore reproduce Marquez's version of equation (2.6) in equation (3.18) which gives the optimal domestic money balances. As Venezuela is a small open economy the domestic price level follows the foreign price level: $P_d = eP_f$.

$$(3.18)\quad M_d^* = \left\{1+[(1-\delta)/\delta]^{\sigma} * [(1+i_d)(1+E(\Delta lne))/(1+i_f)]^{\sigma-1}\right\}^{\sigma/(1-\sigma)} * \delta^{\sigma/(1-\sigma)} * (M^*/A)$$

The partial derivatives are:

$$\partial M_d^*/\partial i_d < 0 \qquad \partial M_d^*/\partial [E\Delta lne] < 0$$

$$\partial M_d^*/\partial i_f > 0 \qquad \partial M_d^*/\partial M^* > 0$$

where:

i_d, i_f = domestic and foreign nominal interest rates

M_d = holdings of domestic money by domestic residents

M_f = holdings of foreign money by domestic residents

M^* = amount of total money needed

P_d, P_f = domestic and foreign price levels

e = exchange rate (domestic currency/foreign currency)

$E(\Delta lne)$ = expected depreciation of the domestic currency

δ = distribution parameter

ρ = substitution parameter, $\rho = (1 - \sigma)/\sigma$, $\sigma > 0$

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[31] i.e. he minimizes equation (2.1) subject to (2.0).

σ = elasticity of currency substitution

A = (money) efficiency parameter as an indicator of the state of technology

These results correspond to portfolio balance models on currency substitution except for the effect of foreign interest rates on domestic money balances. In Marquez's model, to the extent that domestic and foreign money can be substitutes, an increase in the cost of foreign money services leads to an increase in domestic money holdings. In other models[32], where domestic money is a riskless asset with zero nominal return, higher foreign interest rates increase the opportunity cost of any money balances, so a decline in optimal domestic money should result in that case.

A notable feature of Marquez (1987) is that he estimates the elasticity of currency substitution directly. Marquez (1987, p. 171 and footnote 11) criticises the use of cross-partial interest elasticities of money demand specifications to estimate the elasticity of currency substitution. As he illustrates, the estimates from such a procedure may lead to the conclusion that currency substitution does not exist when it is false.

However, equation (3.18) cannot be directly estimated because σ is not known a priori and we would need it to estimate M^*. Therefore, Marquez uses equation (3.20), assuming that the level of aggregate monetary services is a function of nominal income (Y).

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[32] See, for instance, Melvin (1988).

This equation is a particular form of the quantity theory[33]. We thus have:

(3.20) $M^* = f(Y) = \alpha * Y^{1/\rho}$

where:

α = liquidity preference

ρ = inverse of the income elasticity of aggregate monetary services M^*, (i.e., in equation (2.8) $\sigma = 1/(1+\rho)$)

To take account of dynamic adjustments, a partial adjustment model is used:

(3.21) $M_{dt} = [M_{dt}^*]^{\psi} [M_{d,t-1}]^{1-\psi}$

Substituting (3.18) into (3.21) and adding an error term u_t, leads to:

(3.22) $$M_{dt} = \{1+[(1-\delta)/\delta]^{\sigma} * [(1+i_{dt})(1+E\Delta lne))/ (1+i_{ft})]^{\sigma}\}^{\psi\sigma/(1-\sigma)} * K\delta^{\psi\sigma/(1-\sigma)} * [Y_t^{\psi/\mu}] [M_{d,t-1}]^{1-\psi} + u_t$$

where u_t follows $N(0,\sigma_u)$, $E(u_t, u_{t-j}) = 0$, for $j > 0$, and $K=(\alpha/A)\psi$.

To estimate (3.22) an expectation model for the exchange rate is needed. Marquez assumes that the expected exchange rate follows a random walk, i.e.

(3.23) $e_{t+1} = e_t + v_t$

where v_t follows $N(0,\sigma_v)$, $E(v_t.v_{t-j}) = 0$ for $j > 0$.

Marquez refers to Meese and Rogoff (1983)[34] as an empirical

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[33] Note that the stability of the money demand is then assumed implicitly. This assumption can be very restrictive for a developing country with high inflation.

[34] Meese R. and K. Rogoff, (1983) "Empirical Exchange Rate Models of the Seventies: Do They Fit Out of Sample?", Journal of International Economics, 14, p. 3-24.

justification of the assumption. For the estimation annual data are used. The sample period starts in 1961 and ends in 1980 because later data could already have been influenced by the coming financial crisis in 1983. We will report only the estimates for (3.22) using M1 and M2 but not M3 because these results do not provide more insight. The empirical results are reported in table (3.6).

Table (3.6) Parameter estimates for conditional money demand (M1) and (M2) in Venezuela 1961-1980:

	(M1)	(M2)
Elasticity of currency substitution: (σ)	6.038 (2.1)	8.521 (3.9)
(Inverse of) income elasticity: (μ)	0.956 (5.4)	0.763 (15.4)
Speed of adjustment: (ψ)	0.279 (1.7)	0.446 (3.9)
Intercept: (K)	1.109 (20.1)	1.095 (29.5)
$\bar{R}^2$:	0.99	0.99
D.-W.:	1.56	1.83
Durbin's H:	0.668	0.442

(The numbers in parentheses are t-statistics)

Source: Marquez (1987, p. 172)

The elasticity of currency substitution for M1 is 6.04 and 8.5 for M2, so Marquez concludes that the currencies are good substitutes and that the absence of onshore balances denominated in foreign currency is not a necessary condition for the existence of currency substitution.

3.5 Melvin (1988), Bolivia and Mexico

Melvin (1988) studies dollarization in Bolivia and Mexico as an optimum portfolio choice between domestic currency and U.S. dollars. In his article, Melvin introduces "quality" variables related to the confidence on future exchange values of domestic and foreign money. As we will see, this study using "quality" variables does not depend on the significance and the sign of the foreign interest rate coefficients to yield information about currency substitution.[35]

The choice between the two currencies depends on different non-pecuniary services and different pecuniary returns. The money demand function is (3.24):

(3.24) $m = g(y, r, r_f, Q, Q_f)$

where

m = domestic real money balances

y = real income

r = nominal yield on domestic bonds

r_f = nominal yield on foreign bonds denominated in dollars

Q = measure of confidence with regard to the future exchange value of domestic money, (a "quality" variable)

Q_f = measure of confidence with regard to the future exchange value of dollars, (a "quality" variable)

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[35] In other studies, where currency substitution relates to foreign interest rate effects on the demand for domestic money, the effects of substitution between money and interest bearing assets are mixed with the effects of substitution between domestic and foreign money. See the criticisms of Thomas (1985).

The demand for real money, (equation 3.24), is a function of: real income, nominal yield on domestic bonds, nominal yield on foreign bonds denominated in dollars, and the two quality variables related to the confidence of the future exchange value of domestic money or of dollars. It is assumed that $\partial m/\partial y > 0$, as higher income would lead to an increased demand for money. Melvin expects $\partial m/\partial r < 0$ and $\partial m/\partial r_f < 0$, i.e. the demand for domestic money would decrease with increased domestic or foreign opportunity costs. Therefore, higher interest rates would reduce the demand for money balances in general, independent of domestic or foreign interest rates. The last assumption differs from the hypothesis made by Marquez where $\partial m/\partial r_f$ is expected to be positive. In that case, foreign interest rates are assumed to represent only the opportunity cost of holding foreign money, so an increase in (r_f) would cause substitution from (m_f) to (m).

The sign of the derivative $\partial m/\partial Q < 0$, shows that an increase in Q is associated with greater uncertainty of future values or a lower quality of domestic money. On the other hand, $\partial m/\partial Q_f > 0$ is related to greater uncertainty of future values or a lower quality of dollars, therefore the demand for domestic money is supposed to increase.

To estimate (3.24) Melvin employed a log-linear demand function with nominal money supply (currency plus demand deposits) as the dependent variable. He chose Bolivia and Mexico because dollar-denominated deposits were allowed in these countries and data were available. To measure the confidence in the future

exchange value of domestic money (Q), a proxy had to be used. The procedure of construction was the following: first, an ARIMA (1,1,0) process was estimated for the domestic price levels (P). That is, we have equation (3.25):

(3.25) $\Delta \ln P_t = a + b\Delta \ln P_{t-1} + \epsilon_t$

Then, the residuals ϵ_t of the regression were used as the proxy for inflation uncertainty.

The same process was applied to find a measure of confidence in the future value of dollars. Obviously the domestic price level was replaced by the foreign price level in a modified equation (3.25).

Table (3.7) presents the empirical results obtained by Melvin.

Table (3.7): Money demand in Bolivia 1973.I - 1982.III

(3.24)* $m = 3.60 + 0.184y + 0.941P - 0.138r - 0.148Q/Q_f$

(4.74) (2.09) (12.31) (-1.91) (4.69)

$\bar{R}^2$: 0.972 S.E.: 0.081 D.-W.: 1.87 ρ: 0.27 (1.51)

Money demand in Mexico 1973.I - 1982.II

(3.24)** $m = -0.256 + 0.284y + 1.15P - 0.104r - 0.055Q/Q_f$

(0.31) (1.11) (10.36) (-1.09) (2.35)

$\bar{R}^2$: 0.995 S.E.: 0.066 D.-W.: 2.05 ρ: -0.22 (1.25)

Note: t-statistics in parentheses. All variables are logs. S.E. = standard error. D.-W. = Durbin-Watson statistic. In the fourth quarter of 1977, Mexico changed the definition of money. Therefore, a dummy variable was incorporated to allow the intercept to shift with the break in the series. The dummy has a value of one from 1973.I to 1977.III, and then becomes zero for the remainder of the sample. The coefficient on the dummy is estimated as -0.172 with a t-statistic of -4.10.

Source: Melvin (1988, p.547)

The justification for the last term (Q/Q_f) in the regression is that quality is typically thought of in a relative sense. The

money demand functions appear to fit the data quite well and the coefficients show the expected signs. The negative and significative coefficient of (Q/Q_f) indicate that the dollarization hypotheses cannot be rejected.

Melvin uses only one interest rate to capture the opportunity cost of holding money substitutes instead of money. He justifies this simplification by two reasons: a) interest rates were not, either in Bolivia or Mexico, freely determined by market forces but by regulation, b) the returns on peso- as well as dollar-denominated deposits move closely together and tend to be constant for long periods.

3.6 Conclusion of the chapter

In all the empirical studies we have presented in this chapter, the authors found evidence of dollarization. However, there are some technical and empirical problems remaining. Some authors mention that dollarization is more likely to be underestimated than overestimated because of the missing data on dollar bills in circulation. In the next section we will look at two studies trying to give a rough approximation of dollar notes in circulation.

4 Criticism on the models for currency substitution

4.1 Measuring dollar deposits instead of dollar currency

To study dollarization fully, data on dollar bills in circulation and data on dollar deposits are required. However, the empirical studies discussed in part 3, only use dollar deposits held abroad or in the country. None of the studies uses estimates of dollars in cash. All are based on the assumption that dollar deposits are a good approximation for cash balances in analysing the dollarization phenomenon.

Anecdotal evidence on dollar cash in circulation in Latin America is available, but it is more difficult to confirm and measure these balances using economic models. However, Melvin and Ladman (1991) provide evidence of the existence of dollar bills in circulation. They developed a model based on the linkages of the coca industry and the use of dollar loans in Bolivia.

Melvin and Parra (1989) go a step further by estimating the magnitude of dollar bills in circulation in Bolivia. Their approach is based on the observed and expected velocity of money.

The models developed in these studies are discussed and their conclusions are presented in the following paragraph.

4.1.1 Melvin and Ladman (1991)

Melvin and Ladman (1991) endeavour to determine whether or not dollarization in some Latin American countries may be linked to the illicit drug trade. The article is intended to address one of the major problems of the empirical studies on dollarization by providing some information on the supply side of dollarization. Melvin and Ladman use data based on the informal loan market in an agricultural region adjacent to a major coca leaf producing area of Bolivia. The idea underlying the study is the following:

> Since illicit drug transactions are largely in dollars, the coca industry has increased the local supply of U.S. currency. As these dollars are earned, we expect to see them reflected in a greater fraction of informal loans being denominated in dollars rather than domestic Bolivian currency. (Melvin and Ladman, 1991, p. 753)

A Probit regression method is used to test the hypothesis that during the major coca harvest season the probability of a loan being denominated in U.S. dollars is higher. The results indicate that the shorter the duration and the larger the amount of a loan, the more likely the loan is denominated in dollars. This comes from the fact that the credit needs of the coca industry can best be covered by short term but large loans. Therefore, Melvin and Ladman (1991) conclude that their hypothesis on the link between the coca industry and the dollar supply cannot be rejected.

The evidence on dollars in circulation in Melvin and Ladman (1991) is indirect in nature. While the study does not directly measure the supply or demand of dollar bills, the likeliness of their reappearance in the informal loan market is measured. The

study allows to confirm that findings with respect to dollar bills in circulation go beyond anecdotal evidence.

4.1.2 Melvin and Parra (1989)

Melvin and Parra (1989) estimate two models on the use of dollars in Bolivia. The authors believe that if the use of dollar currency in Bolivia fluctuates over time, the official velocity estimates fluctuate as well. This occurs because the official velocity is influenced by the hidden dollar currency in circulation. Therefore, the official velocity appears to be more unstable than it would be if it was correctly measured using a broader base.

In the first method, Melvin and Parra use data on cheque-clearing activities under the assumption that the data are a good indicator of spending behaviour. These data are combined with the data used for the official money velocity in order to calculate a new velocity. The new velocity appears much more stable than the official one.

To interfere the quantity of dollars circulating in Bolivia, the authors use a quantity theory of money equation. They divide the Gross Domestic Product (GDP) by the estimated velocity to determine a new measure of M2. The difference between the official and the calculated M2 is attributed to U.S. dollars in circulation. The estimate of dollar currency in Bolivia is 19.31 million U.S. dollars in 1986.IV.

In the second approach, a currency demand function is estimated for the period 1973.I to 1982.III. With this demand function, Melvin and Parra predict the change in currency demand for the period 1982.IV to 1986.IV. The difference in the two money demand functions is attributed to the change in the stock of dollar currency held. Using this approach, Melvin and Parra calculated an approximate dollar currency of 338 million U.S. dollars in 1986.IV.

When we compare the two methods and their results, one important problem arises. The second method gives substantially larger estimates of dollar currency in circulation than the first method. Melvin and Parra conclude that without knowing the actual stock of dollar currency held, it is not possible to determine which method is better.

4.1.3 Conclusion of the Critics

Both studies indicate that a considerable amount of dollars is in circulation in Bolivia. These results may suggest that dollarization in Latin America is underestimated in empirical studies which use only dollar deposits. However, the studies on dollar currency in circulation also show that it is not yet possible to report precise results. The methodologies require improvement and application to other countries to obtain more accurate estimations on dollar bills in circulation.

5 Conclusion

> It is common in many developing and even in some developed countries for individuals to hold large amounts of, and actually make transactions in, foreign currency. This indicates that, in those countries, foreign currency can satisfy, to some degree, a portion of domestic transactors' demand for monetary services. (Tanzi and Blejer, 1982, p. 782)

In this paper, the attempts of many authors to model dollarization in Latin America were discussed. The models contain augmented money demands to allow for foreign money balances using either a portfolio balance approach or a money service production function. Many factors, some of which are difficult to model, influence the agents decisions to substitute foreign for domestic currency. One of the main determinants is actual or expected reduction in the value of domestic money holdings. The value of domestic money may be altered due to increases in domestic inflation pressure; expectations of exchange rate depreciation; and/or lower interest rates on domestic currency holdings. A shift in the pace of currency substitution is induced by a change in the relative yield of domestic to foreign currency denominated money balances. Consequently, currency substitution becomes a particularly significant phenomena during periods of rapid inflation.

The empirical studies we discussed provide evidence on the existence and magnitude of dollarization in Latin America. However, as addressed in section 4, the empirical studies which use only dollar deposits as the representative variable, are likely to underestimate the existence of currency substitution.

It is necessary to go beyond the first approximations of the extent of dollarization and focus on the effects. The broadly recognized macroeconomic effects are reduced independence in the use of monetary instruments for economic policy making; increased exchange rate volatility; loss in seigniorage and inflation tax. Fischer (1982) calculates the loss due to inflation tax income forgone for some countries in Latin America. However, it does not appear that the empirical results on dollarization of any Latin American country have been used directly to quantify the resulting loss in welfare. Although the technical difficulties of the empirical studies are apparent and the results have to be used with caution, attempts to quantify the effects of dollarization may be useful. It is expected that the effect of quantitative measures would be greater than qualitative impact statements. With the effects quantified, dollarization may be considered as a more serious phenomenon and can then be integrated in the economic policy making process.

In conclusion, there are two directions for further research. The first is to find improved methods for empirical studies on dollarization. Most important is to measure data regarding dollar bills in circulation, and to combine the data with that on dollar deposits. The second step is to quantify the effects of dollarization and to use the results in making future economic policy decisions.

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