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Currency Substitution, Portfolio Diversification and Money Demand

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This paper extends the Thomas (1985) optimising model of money demand to a case in which the consumer is not allowed to use foreign bonds to hedge the currency risk. In this case, the demand for foreign currency has both a transactions and a portfolio component. It is shown that the demand for domestic currency may or may not depend on the expected exchange rate depreciation, depending on whether the two currencies are substitutes as means of payment. This result gives support to the traditional empirical procedure of considering a negative influence of an expected depreciation term in the demand for domestic money as evidence for CS. The results do not give support to the claim that the presence of CS does not constitute a qualitative difference relative to capital flight (Cuddington, 1983).

JEL Classification: E41, F41, G11.

Keywords: Money Demand, Currency Substitution, Dollarisation, Portfolio Choice.

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1. Introduction

During periods of macroeconomic and political uncertainty many developing countries experienced a partial replacement of the domestic currency by a foreign currency, either as store of value, unit of account or medium of exchange. This phenomenon is usually known as *currency substitution* (CS). CS results from the existence of substitutability between currencies (though it is not necessarily implied by it) and it may take place both at the domestic level and in the international arena (see Giovannini and Turtelboom, 1994, for a survey). This paper explores the implications of imperfect means of payment substitutability on the properties of the individual money demands, in a framework in which the consumer cannot use foreign bonds to hedge the currency risk. In this case, the demand for foreign currency gets both a portfolio and a transactions component. It is shown that the demand for domestic money may or may not depend on the expected exchange rate depreciation, depending on whether the domestic and foreign currencies are substitutes as means of payment. Contrary to what suggested by the PBM, the results obtained in

this paper suggests that the presence of CS constitutes a qualitative difference relative to capital mobility.

The Portfolio Balance Model of money demand (henceforth PBM) has been widely used in open economy macroeconomics. Typically, this approach postulates gross substitutability between money and all other assets, leading to empirical functional forms according to which the demand for money depends positively on a scale variable, such as wealth or income, and negatively on the return of each alternative asset. In case the available assets are domestic money, foreign money, bonds denominated in domestic currency and bonds denominated in foreign currency, the demand for domestic currency is assumed to depend negatively on the expected exchange rate depreciation by two different channels: substitutability vis-à-vis the foreign currency (currency substitution) and substitutability vis-à-vis the foreign bond (capital mobility). For this reason, followers of the PBM have been claiming that a negative influence of the expected exchange rate depreciation in the demand for domestic money does not provide evidence of currency substitution.

The PBM has two main shortcomings. First, as noted by Branson and Henderson (1985), gross substitutability is not always consistent with individual optimisation. Second, this model is not capable of explaining why money is held, despite being dominated by interest-bearing bonds. A closer scrutiny of the properties of the money demand in light of firmer microeconomic foundations was done by Thomas (1985) for the case with imperfect means of payment substitutability and complete bond markets (see Kareken and Wallace, 1981, for a deterministic model with perfect means of payment substitutability). Assuming that money reduces transaction costs, this author demonstrated that borrowing and lending opportunities separate ownership of currencies from portfolio decisions. That is, on one hand, an individual agent selects his currency holdings based on transaction services and opportunity costs. On the other hand, she borrows or lends to achieve the

desired overall portfolio composition. An optimal currency hedge is created and the denomination structure of the individual portfolio is independent of the currency holdings.

Although the Thomas' model may be appropriated to describe the phenomenon of substitution among international currencies, its usefulness to describe the phenomenon of "dollarisation" is rather limited[1]. As noted by Cuddington (1989), Thomas' separation result depends critically on the assumption of complete bond markets and this assumption may not hold in most developing countries. Following the author, "an extension of the Thomas' model to an environment where there are goods and capital market imperfections would be one way of yielding an appropriate empirical specification on which to base tests of the importance of CS in LDCs" (p. 269). Surprisingly, such extension has not been done yet. The Thomas' model was recently used by Sahay and Végh (1996) to discuss a case in which individual agents have no access to bonds denominated in foreign currency. However, since these authors assumed that agents may hold interest bearing deposits denominated in foreign currency, the model is basically the same. In this paper, we assume that individuals have no assets denominated in foreign currency other than foreign bank notes. This assumption prevents foreign currency holdings to be dominated as store of value.

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[1] CS may take place both in the international economy and at the domestic level. The first case (which may be referred to as "*international currency* substitution") occurs when an international currency displaces another international currency in functions performed by the former in the international economy (for the functions of international currencies, see Krugman, 1984). The second case (which we refer above as "dollarisation") occurs when a *local* currency is replaced by an *international* currency in functions traditionally performed by the former in the domestic economy. This phenomenon is common in high inflation countries, due to the rapid erosion of the value of domestic currency. While Thomas (1985) and Kareken and Wallace (1981) may be seen as applying to "international currency substitution", this paper deals with "dollarisation", for the case with imperfect means of payment

The results obtained in this paper have implications for the specification of the money demand in developing countries. In countries where citizens have no access to bonds denominated in foreign currency, the significance of an expected exchange rate depreciation term in the demand for domestic money is likely to provide a valid test for the CS hypothesis (see, for example Ramirez-Rojas, 1985, Rogers, 1992). If however a significant part of the population has access to bonds denominated in foreign currency, such specification may be too restrictive. In that case, a functional form combining elements of the money demand obtained in this paper and the one that results from Thomas (1985) model may provide a starting specification on which to base tests for the CS hypothesis.

The paper proceeds as follows. In section 2, we describe the theoretical model. In section 3 we discuss the implications of currency substitutability on the properties of the individual money demand when agents have no access to foreign capital markets. In Section 4, we discuss the implications for empirical work. Section 5 concludes.

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substitutability (for a deterministic model of dollarisation with perfect means of payment substitutability, see Freitas, 2000).

2. The model

Consider a small open economy, in which a foreign currency (called dollar, F) can be used along with the domestic currency (called peso, M) both as means of payment and store of value. Individuals have unrestricted access to bonds denominated in pesos (A) but are not allowed to hold bonds denominated in dollars. The individual' real wealth is defined as:

$$w = m + f + a\,, \tag{1}$$

where $m = M/P$, $f = EF/P$, $a = A/P$, P is the price level in the peso-area and E is the price of the dollar in peso-units[2].

Each consumer is endowed with a constant flow of a non-storable good, denoted by y, and maximises a lifetime utility function of the form:

$$\mathrm{E}\int_0^{\infty} e^{-\rho t}\,\frac{c^{1-\phi}}{\phi}\,dt\,, \qquad \text{with } \phi > 0 \tag{2}$$

In (2), c denotes real consumption and ϕ is the Arrow-Pratt measure of relative risk aversion.

Currency holdings earn zero nominal returns. Domestic securities have a certain nominal return, represented by i. There is uncertainty concerning real returns because the domestic price level and the exchange rate evolve stochastically, according to:

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[2] Since all assets are deflated by domestic prices, the corresponding demands will be neutral in respect to the domestic inflation rate. An alternative specification is to deflate foreign assets by foreign prices and to replace the exchange rate uncertainty by uncertainty in the foreign inflation rate (see Thomas, 1985). The approach followed in this paper looks, however, more appealing to describe the case of "dollarisation", in which a foreign currency is used along with a domestic currency as vehicle for transactions that take place in the domestic economy.

$$\frac{dP}{P} = \pi dt + \sigma dZ \tag{3}$$

$$\frac{dE}{E} = \varepsilon dt + \gamma dZ \tag{4}$$

$$dZdX = rdt \tag{5}$$

In (3)-(5), dZ and dX are standard Wiener processes and r denotes the respective instantaneous correlation. The covariance between the stochastic processes (3) and (4) will be denoted by ρ ($\rho = \sigma\gamma r$). Real returns to domestic bonds, domestic money and foreign money are obtained using the Ito' s lemma:

$$\left(i + \sigma^2 - \pi\right)dt - \sigma dZ \tag{6}$$

$$\left(\sigma^2 - \pi\right)dt - \sigma dZ \tag{7}$$

$$\left(\varepsilon + \sigma^2 - \pi - \rho\right)dt - \sigma dZ + \gamma dX \tag{8}$$

Money is distinguished from bonds by its means of payment role. In this paper, it is assumed that money reduces costs involved in transactions of goods[3]. The following transactions technology is borrowed from Végh (1989):

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[3] An alternative specification is to assume that money enters in the utility function. The two approaches become functionally equivalent when the utility function is weakly separable, as happens to be the case in most models used in the currency substitution literature. For a stochastic model with money in utility, currency substitution and complete bond markets, see Smith (1995).

$$\tau = cv\left[\frac{m}{c}, \frac{f}{c}\right], \tag{9}$$

with $v(.) \geq 0$, $v_1 \leq 0$, $v_2 \leq 0$, $v_{11} > 0$, $v_{22} > 0$, $v_{12} \geq 0$ and $\Delta = v_{11}v_{22} - v_{12}^2 > 0$. This transactions technology leads to well behaved money demand functions in the case with complete bond markets (see Sahay and Végh, 1996).

The flow budget constraint of the representative agent depends on the amount of saved wealth allocated to the available assets and on real returns. Using (1), (6)-(8) and (9), one obtains:

$$dw = \left[\left(\sigma^2 - \pi\right)m + \left(\varepsilon + \sigma^2 - \pi - \rho\right)f + \left(i + \sigma^2 - \pi\right)a + \left(y - c - \tau(.)\right)\right]dt + f\gamma dX - w\sigma dZ \tag{10}$$

The consumer problem is to maximise (2), subject to (1) and (10). The first order conditions in respect to *m* and *f*, lead to:

$$i + \tau_m = 0 \tag{11}$$

$$\frac{f}{w} = \left(1 - \frac{1}{\phi}\right)\left(\frac{\rho}{\gamma^2}\right) + \left(\frac{1}{\phi}\right)\left(\frac{-\tau_f + \varepsilon - i}{\gamma^2}\right) \tag{12}$$

Equation (11) states that the demand for domestic currency depends on its marginal productivity in the production of liquidity services and its user cost[4]. Equation (12) is a slight modification of the well known optimal portfolio rule in a world with two assets (references in Branson and Henderson, 1985). It states that the optimal share of foreign assets is a weighted average of two terms, the weights depending on the coefficient of relative risk aversion, ϕ. The term ρ/γ^2 gives the proportion of dollar bank notes that minimises the portfolio' s purchasing power risk.

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[4] In the case with complete bond markets, a condition similar to (11) holds for the foreign currency, instead of (12), leading to money demands that depend only on marginal productivities and interest rates (Thomas, 1985).

The second term captures the role of the expected return differential. Hence, according to (12), the consumer is induced to move away from the minimum risk portfolio by the expected return differential and the extend to which it moves depend on its degree of risk aversion. The only novelty here is that, as long as foreign money provides liquidity services (that is $\tau_f \neq 0$), its marginal contribution to the reduction of transaction costs is accounted for in the assessment of the expected return differential[5].

[5] Equation (12) implicitly assumes that individuals can borrow foreign bank notes at zero yield. The case of dollarisation corresponds, however, to positive values of *f*, in which case such assumption is not needed. For *f* to become negative, one should have either a very low coefficient of relative risk aversion or a negative expected return on foreign money holdings.

3. Money demands and currency substitution

In this section, we investigate how the money demand functions implied by (11-12) respond to changes in the domestic interest rate, the expected exchange rate depreciation and the exchange rate volatility, taking the consumption level as given[6]. In the following discussion, two cases will be distinguished: the case in which the marginal productivity of the peso-currency in the production of liquidity services depends on dollar currency holdings ($v_{12} > 0$) and the case in which it doesn't ($v_{12} = 0$).

Case 1: No means of payment substitutability ($v_{12} = 0$)

In this case, both the domestic currency and the foreign currency can be used as means of payment, but they do not compete in the same commodity domain. The optimal money demands implied by (11)-(12) are:

$$m = cL^m(i), \tag{13}$$

with $L_i^m = -\frac{c}{v_{11}} < 0$, and

$$f = cL^f(i, \varepsilon, \gamma), \tag{14}$$

with $L_i^f = -L_\varepsilon^f = \frac{-kc}{kv_{22} + \phi\gamma^2} < 0$, and $L_\gamma^f = \frac{-2f\gamma\phi}{kv_{22} + \phi\gamma^2} < 0$, where $k = c/w$.

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[6] Of course, changes in the interest rate impact on money demands also through changes in the optimal consumption path. The aim of the exercise, however, is to learn about money velocity, so as to obtain testable money demand functions.

Equation (13) is the same money demand that one obtains in a closed economy. The demand for foreign currency is described by (14). Dollars may be held both as means of payment and as store of value (as store of value only, in the sub-case $v_2 = v_{22} = 0$). A rise in the expected exchange rate depreciation - not embedded in the domestic interest rate - induces a portfolio shift from domestic bonds to foreign currency. In the same manner, a rise in the exchange rate volatility induces agents to shift from foreign currency to domestic bonds. Since the moneyness of the peso does not depend on the amount of dollar holdings, these developments do not impact on the domestic money demand.

Case 2. Means of payment substitutability ($v_{12} > 0$):

In this case, the two currencies compete in the same commodity domain. The demands for domestic and foreign money implicitly defined by (11) and (12) take the following form:

$$m = cL^m(i, \varepsilon, \gamma), \tag{13a}$$

with $L_i^m = \frac{kc(v_{22} - v_{12}) + c\phi\gamma^2}{\Omega}$, $L_\gamma^m = -\frac{2f\gamma\phi v_{12}}{\Omega} > 0$ and $L_\varepsilon^m = \frac{kcv_{12}}{\Omega} < 0$, and

$$f = cL^f(i, \varepsilon, \gamma), \tag{14a}$$

with $L_\varepsilon^f = \frac{-kcv_{11}}{\Omega} > 0$, $L_\gamma^f = \frac{2f\gamma\phi v_{11}}{\Omega} < 0$ and $L_i^f = \frac{kc(v_{11} - v_{21})}{\Omega}$, where $\Omega = -k\Delta - v_{11}\phi\gamma^2 < 0$.

Equation (13a) states that the demand for domestic currency depends negatively on the expected exchange rate depreciation. A rise in the expected exchange rate depreciation not accompanied by the domestic interest rate causes a portfolio shift from domestic bonds to foreign

currency. This in turns reduces the transactions value of the domestic currency, leading to currency substitution.

The signs of the partial derivatives in respect to the domestic interest rate are uncertain. To understand this, consider first the case in which the domestic interest rate and the expected exchange rate depreciation rise by the same amount. In that case, the demand for foreign currency does not change for speculative reasons. However, the rise in the user cost of the domestic currency leads agents to buy bonds and to substitute the domestic currency for the foreign currency as vehicle for consumption. In case the domestic interest rate raises alone, the decline in the demand for domestic money is accompanied by a portfolio shift from foreign currency to domestic bonds. As the demand for both currencies decline, currency substitution comes into operation, inducing movements in the opposite direction. To obtain sensible elasticities ($L_i^m < 0$ and $L_i^f < 0$), it is sufficient to assume that direct effects dominate over currency substitution effects ($v_{ii} > v_{ij}$ for $i \neq j$) (note that this is consistent with $\Delta > 0$, in (9)).

4. Implications for empirical work

The PBM postulates gross substitutability between money and all other assets. When both money and bonds denominated in both currencies are available, the demand for domestic money takes the form:

$$\frac{M}{P} = f\left(\overset{-}{i}, j + \overset{-}{\hat{e}^E}, \overset{-}{\hat{e}^E}, \overset{+}{y}, \overset{+}{w}\right) \tag{15}$$

Since in (15) the expected depreciation term influences the money demand both through CS and capital flight, it has been argued that the presence of currency substitution does not constitute a qualitative difference relative to a standard open economy portfolio model (see Cuddington, 1983)

The PBM was challenged by Thomas (1985), who showed that, if individuals can use foreign bonds to hedge the currency risk, there will be no portfolio demand for money. Using this result, Joines (1985) proposed the following specification:

$$\frac{M}{P} = f\left(\overset{-}{i}, \overset{+}{j}, \overset{+}{y},\right) \tag{16}$$

In (16), the CS hypothesis is tested by the significance of the foreign interest rate, *j*. As argued above, equation (16) does not provide a reasonable description of the money demand when individuals have no access to foreign bonds. In this case, the CS hypothesis shall be investigated by the significance of the expected depreciation term in:

$$\frac{M}{P} = f\left(\overset{-}{i}, \overset{-}{\hat{e}^E}, \overset{+}{y}\right) \tag{17}$$

Equations (16) and (17) apply to two extreme cases. One may think, however, that economies are composed by agents with different ability to buy foreign bonds. If a positive fraction of both types exist in a given economy, a possible test for the currency substitution hypothesis is to estimate a money demand function of the form:

$$\frac{M}{P} = f\left(\overset{-}{i}, \overset{+}{j}, \overset{-}{\hat{e}^E}, \overset{+}{y}\right) \tag{18}$$

Of course, when uncovered interest rate parity holds, these specifications are interchangeable. Still, since both the foreign interest rate and the expected exchange rate depreciation capture CS only, there is no ambiguity concerning the identification of the relevant effect.

5. Conclusions

In this paper, we investigate the properties of the money demand, when individuals have no access to bonds denominated in foreign currency. It is shown that the demand for domestic money may or may not depend on the expected exchange rate depreciation, depending on whether the CS hypothesis holds. This results gives support to the traditional empirical procedure of considering a negative influence of an expected exchange rate depreciation term on the demand for domestic money as evidence for CS.

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