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The Concept and Estimation of Direct, Indirect and "Total" Currency Substitution in Money Demand

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This paper reviews briefly the literature on currency substitution and presents two alternative specifications of money demand function which take into account different forms of currency substitution. It demonstrates that the money demand function which separates direct currency substitution from indirect currency substitution is mathematically equivalent to one that combines the two effects.

1. Introduction

This paper reviews briefly the literature on international currency substitution (CS hereafter) and develops a specification of money demand function which takes into account different forms of CS. A distinguishing characteristic of this paper is that it specifies a money demand function that separates direct currency substitution (DCS hereafter) from indirect currency substitution (ICS hereafter) induced by arbitrage in capital markets, and then demonstrates that this specification is mathematically equivalent to one that combines the two effects.

This paper is organized as follows. Section 2 reviews the theory, evidence and implications of CS. Section 3 presents and compares two alternative specifications of an open-economy model of general financial equilibrium and shows that these two specifications (and therefore those of the underlying money demand functions) yield quantitatively equivalent rate-of-return coefficients and that, with respect to the money demand functions, the only difference is that one takes into account DCS and ICS separately while the other takes into account "total" currency substitution (TCS hereafter) or the sum of DCS and ICS. The final section summarizes the conclusions.

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2. Brief Review of the Theory, Evidence and Implications of CS

2.1 Theory and Evidence

The major approaches to flexible exchange rates, namely the monetary approach and the portfolio balance (PB) approach, largely neglected the issue of CS by implicitly assuming that domestic residents do not hold foreign currencies or that such holdings are insignificant. On the other hand, the inclusion of foreign currency as an asset is more in line with the phenomenon of increasing openness among economies and, in addition, the same arguments of portfolio diversification and transactions costs which are used to justify the demand for domestic currency are also applicable to foreign currency.

That domestic residents of each country hold only their own respective currencies is not an implication of either the monetary approach or the PB approach. On the contrary, potential financial risk created by the instability of exchange rates can be reduced by currency diversification. This is the essence of the Tobin-Markowitz theory of portfolio choice. Levy and Sarnat (1979), for example, use a quadratic programming technique to derive the set of efficient portfolios (or portfolio frontier) for American investors for the period November 1970 to April 1973, where the set of portfolio assets consists of the currencies of eight industrialized countries excluding the US. Since the stronger currencies during this period were the Japanese yen and the German mark, they dominate the other six currencies in one of the efficient portfolios of a given expected risk and expected return. When they expand the set of asset inputs to also include the stocks of the US and those of the other eight industrialized countries, the efficient portfolio of the same expected risk has a higher expected return and still includes the Japanese yen as one of the "efficient" assets; this shows that for a given risk, expected return can be increased by further diversification and that an efficient portfolio may still include a foreign currency as an "efficient" asset.

However, the mere holding of foreign currency is not a sufficient condition for CS to occur. As clarified by Miles (1978), in order for CS to exist, not only must there be foreign currency holdings but the level of such holdings must change in response to changes in other economic variables. In his approach, there is CS if the elasticity of substitution (defined as the percent change in the relative holdings of domestic and foreign currencies resulting from a percent change in the relative opportunity costs or the interest rate differential) is positive.

There are two forms of CS that occur as a result of an increase in the expected rate of domestic currency depreciation. According to McKinnon (1982), these are: DCS which arises mainly due to transactors' desire to avoid direct losses and ICS which arises mainly due to capital mobility and works out through interest rate changes. To show how ICS could be possible, McKinnon (1982) assumes perfect capital mobility which, in equilibrium, implies the Fisher open condition: $i - i^* = x$, i.e., the short-term interest rate differential or the difference between domestic and foreign interest rates accurately reflects the expected rate of domestic currency depreciation. To describe the mechanism of ICS, he assumes initially that $x = i - i^*$. As the expected rate of domestic currency depreciation increases, then $x > i - i^*$ and such would create an incipient arbitrage pressure to move out of domestic bond *(B)* and into foreign bond *(B*)* ; this foreign-domestic bond arbitrage would cause i to rise and i^* to fall. But even if the interest rate differential becomes correctly aligned to reflect the expected rate of domestic currency depreciation, these interest rate changes would cause ICS and an additional capital outflow. Specifically, transactors in the home country would shift from domestic currency *(M)* into B as i increases while transactors in a foreign country would shift from B^* into their currency *(M*)* as i^* decreases; this money-bond arbitrage tends to decrease i and raise i^* so that, again, x exceeds $i - i^*$, thereby creating temporary pressure in the international bond market. International arbitragers would react to this by selling B and buying B^*, resulting in an additional capital outflow that is exactly equal to the sum of the decrease in the demand for M and the increase in the demand for M^*; this ICS, according to McKinnon, is likely to be more significant and dominant than DCS.[1]

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[1]Goldstein and Haynes (1984), on the other hand, argue that ICS is implausible because: (1) huge amounts of uncovered funds that move in response to very small differential in expected yields are unlikely for risk-averse investors and (2) making the Fisher open condition consistent with the observed interest differentials would require an implausibly small expected change in the exchange rate. They also argue that DCS is implausible because transactors would prefer to hold interest-bearing assets rather than money balances that yield either zero or small explicit returns. While it is true that the speculative demand for money balances vanishes when they earn zero nominal return while at the same time riskless bonds yield a given return, the transactions demand for money balances (whether domestic- or foreign-currency-denominated) would not vanish.

Levy and Sarnat (1979) show that the speculative demand for US dollars and other seven currencies by American investors vanishes when stocks are included as asset inputs to a portfolio. However, this does not mean that these currencies would not be assets in one's portfolio; rather , the demand for these currencies by American investors has to be explained by transactions motives.

The forms of CS, as distinguished by McKinnon, can be examined and tested using a money demand function that is derived from a model of general financial equilibrium. Cuddington (1983), based on an open-economy PB model, specifies money demand as a function of transactions variable (income) and rate-of-return variables *(i, i^* or $i^* + x$, and x)*. In a model with i, i^* and x as the rate-of-return variables, he interprets a negative x coefficient as an indicator of CS and a negative i^* coefficient as an indicator of high capital mobility. However, as shown in the next section, the x coefficient measures TCS while the i^* coefficient measures ICS, and the difference between the two measures DCS.

CS can also be incorporated in a model of exchange rate determination. Brillembourg and Schadler (1979), recognizing that the demands for different currencies are interdependent, develop a general portfolio-allocation model of exchange rate determination. They assume perfect capital mobility and substitutability, sequential portfolio choice, and symmetry conditions across countries. They assume that each of the exchange rates depends not on the real returns on non-money assets (bonds) but only on the real returns on different currencies, and then postulate that the currencies are substitutes (complements) in demand if the cross rate-of-return effect is negative (positive).

King, Putnam and Wilford (1978), on the other hand, use a currency-portfolio approach to develop a model of exchange rate determination that incorporates CS. They assume sequential portfolio choice, continuous purchasing-parity, and continuous interest-rate parity. With sequential portfolio choice, residents first decide how much of total (domestic and foreign) money balances to hold based on real domestic income and domestic interest rate, and then decide the ratio of domestic to total money balances based on the expected rate of change in and variance of the exchange rate. Based on this, they specify generalized domestic money demand as a function of scale variable (domestic real income), rate-of-return variable (domestic interest rate), and CS variables (the expected rate of change in and variance of the exchange rate). In this model, there is CS if the coefficients of the CS variables are negative. Given the generalized domestic money demand function and the assumptions of continuous monetary equilibrium, purchasing power parity and interest rate parity, they derive an exchange rate change equation.

As to the empirical evidence on CS, Miles (1978) uses the "elasticity of substitution" approach and finds that the US dollar and the

Canadian dollar are close substitutes in demand for Canadians during the float sub-periods 1960 (IV) to 1962 (II) and 1970 (III) to 1975 (IV). Miles (1981) also finds that the US dollar and the German mark are close substitutes from the point of view of either Americans or Germans during the float sub-period 1971 (I) to 1978 (III). However, he finds no evidence of CS in any of these countries during the fixed-rate sub-periods considered.

Cuddington (1983) furnishes only weak evidence for CS. In the estimation of the money demand function, he uses different subsets of the rate-of-return variables $(i, i^* + x, x)$. He concludes that, in general, there is CS only in the case of real *M3* and there is high capital mobility in the US and Canada.

Additional evidence on currency substitutability/complementarity is provided by Brillembourg and Schadler (1979). Their results show that most European currencies are complements but that the US dollar tended to be a substitute during the period March 1973 to June 1978. However, there is no evidence of either substitutability or complementarity between the US dollar and the Canadian dollar. The latter is in sharp contrast with Miles' results.

2.2 Implications

Other papers examine the implications of CS. One implication is on the volatility of the exchange rate. Girton and Roper (1981), in their asset model of CS, show that the exchange rate will be more volatile with CS because the exchange rate movements necessary to maintain monetary equilibrium become larger without limit as the degree of CS (in terms of the elasticity of substitution) increases, and that the exchange rate is indeterminate when CS is perfect (the elasticity of substitution is infinite).

Canto and Miles (1983) investigate the impact of CS on the exchange rate by introducing a second currency into a closed-economy monetary model where residents form expectations rationally. Like Girton and Roper, they also find that the variance of the exchange rate depends on the CS variable, elasticity of substitution. King, Putnam and Wilford (1978) also make the same point. In their currency-portfolio model of exchange rate determination, they show that the change in the exchange rate also depends on CS variables, the changes in the expected rate of change in the exchange rate and its variance.

Another implication is on monetary independence. With CS, flexible exchange rates no longer guarantee monetary independence. To show this, Miles (1978) considers a hypothetical case in which the home country increases its money supply *(M)* once and for all. For the additional amounts of home currency to be absorbed, the cost of borrowing currency *(i)* must fall. With money supply in a foreign country *(M*)*, *M**-denominated assets and *i** remaining the same, and since both countries face the same interest rates *(i = i*)*, holding *M* becomes more attractive in both countries. For monetary equilibrium to hold in each country, both the price levels in the home country and the foreign country must rise as *M* flows into the foreign country. Hence, the effect of monetary policy is no longer internalized in the home country.

McKinnon (1982) argues that even the US lacks monetary independence because of CS. He starts with the presumption that the US dollar and the currencies of other industrialized countries are highly substitutable in demand. In response to expected dollar depreciation, there would be CS (a decrease in demand for US dollars that is equal to an increase in demand for foreign currencies, implying that world money is stable) as well as unstable national money demands and exchange rates. To stabilize exchange rates, foreign central banks would then intervene, expanding money supplies abroad (in Europe and Japan). Because the US pursues a passive sterilization policy, this would result in an increase in world money supply which, with stable world money demand, would lead to world inflation. To prove his point, McKinnon argues that between 1971-72 and 1977-78, the US money supply remained almost the same, whereas abroad there were money supply explosions and world inflation. Based on this, he concludes that US inflation can be explained better by the growth of the world money supply than by changes in any monetary aggregate.[2] McKinnon also concludes that given events in 1971-72 and 1977-78 (when speculation against the US dollar was combined with foreign exchange interventions that directly expanded money supplies abroad), the US should have responded by decreasing its money supply. Brillembourg and Schadler, on the other hand, reach an opposite conclusion for US monetary independence. Based on their findings that the cross-real-rate-of-return effects on the demand for US dollar are small compared to its own-real-rate-of-return effect, they conclude that the US need not be as concerned as the Europeans (whose currencies are found to be complements) about the effects of foreign monetary shocks.

[2] However, Goldstein and Haynes (1984) show that US inflation is significantly affected by the growth in US money supply (M1) but not by the growth in world money supply.

To summarize, it is clear that when there is CS, exchange rates are more volatile and flexible exchange rates no longer guarantee monetary independence. If so, then countries should have policy coordination. There is no disagreement among authors with respect to the implications of CS. However, if one compares the results in Miles, Brillemboug and Schadler, Cuddington, and McKinnon, the fundamental question remains: is there significant CS?

3. Specification of an Open-Economy Money Demand Function

The objective of this section is two-fold: first, to come up with an open-economy money demand function which can be used to test for the presence of the two forms of CS hypothesized by McKinnon and to reinterpret Miles' and Cuddington's empirical estimates; and, second, to show, contrary to Cuddington's analysis (1983, pp. 112-114), that both PB models take into account CS and that these models and, therefore, the underlying money demand functions, yield qualitatively and quantitatively equivalent rate-of-return coefficients.

We consider an economy that is linked with the rest of the world through the markets for goods, financial capital, and foreign exchange. Being an open economy, its residents are allowed to hold their financial wealth in the form of four types of assets: domestic-currency-denominated money balances *(M)*, with nominal rate of return equalling zero; domestic-currency-denominated bond *(B)*, with nominal rate of return equalling the domestic interest rate *(i)*; foreign-currency-denominated bond *(F)*, with nominal rate of return equalling the foreign interest rate plus the expected rate of domestic currency depreciation $(i^* + x)$; and, foreign-currency-denominated money balances *(N)*, with nominal rate of return equalling the expected rate of domestic currency depreciation *(x)*.

The home demand for each asset then depends on, among others, all the returns on assets.[3] Financial equilibrium condition requires that, for each asset, desired demand equals supply and that these demands satisfy the wealth constraint. It is assumed that each asset demand is homogeneous in financial wealth.[4] Finally, it is assumed

[3]Theoretically, each asset demand should also depend on the variance and covariance of returns. It is assumed here that these variables are stationary.

[4]Even without the homogeneity assumption, the alternative specifications are quantitatively equivalent. Also see note 8 below.

that due to exchange risk, domestic and foreign bonds are imperfect substitutes, which implies that i is not equal to $i^* + x$.

3.1 Equivalence of the PB Models which Separates and Combines the Direct and Indirect Effects

We now present and compare two alternative open-economy PB models and their underlying money demand functions. The specifications are similar to those of Cuddington.

The PB model which distinguishes between the direct and the indirect effects of x is given by:

$$(1.1)\ M/P = M^d \equiv g_1(i, i^* + x, x, Y/W).\ W$$

$$(1.2)\ B/P = B^d \equiv g_2(i, i^* + x, x, Y/W).\ W$$

$$(1.3)\ SF/P = SF^d \equiv g_3(i, i^* + x, x, Y/W).\ W$$

$$(1.4)\ SN/P = SN^d \equiv g_4(i, i^* + x, x, Y/W).\ W$$

$$(1.5)\ W = MP + B/P + SF/P + SN/P$$

where M^d, B^d, SF^d, and SN^d are the desired stock demands; Y, the real domestic income; P, the domestic price level; W, real financial wealth; S, the exchange rate expressed in terms of domestic currency per unit of foreign currency; and, other notations are as defined before.

Eqs. 1.1 to 1.4, the asset market equilibrium conditions, shows that each asset demand is a function of rate-of-return variables *(i, i^* + x and x)* and transactions variable *(Y)*, and is homogeneous in scale variable *(W)*. Eq. 1.5, the balance sheet constraint, ensures that $\Sigma g_j = 1$ and $\Sigma dg_j / dr_k = 0$ ($j = 1, 2, 3, 4$ and r_k is the kth rate-of-return variable).

In contrast, the PB model which combines the direct and indirect effects of x is given by:

$$(2.1)\ M/P = M^d \equiv h_1(i, i^*, x, Y/W).\ W$$

$$(2.2)\ B/P = B^d \equiv h_2(i, i^*, x, Y/W).\ W$$

$$(2.3)\ SF/P = SF^d \equiv h_3(i, i^*, x, Y/W).\ W$$

$$(2.4)\ SN/P = SN^d \equiv h_4(i, i^*, x, Y/W).\ W$$

(2.5) $W = M/P + B/P + SF/P + SN/P$

where Eqs. 2.1 to 2.4 are the asset market equilibrium conditions and Eq. 2.5 is the balance sheet constraint which ensures that $\Sigma h_j = 1$ and $\Sigma dh_j / dr_k = 0$ ($j = 1, 2, 3, 4$ and r_k is the kth rate-of-return variable).

This PB model (Eqs. 2.1 to 2.5) is exactly the same as the first one (Eqs. 1.1 to 1.5) except for the specification of the rate-of return variables: now i, i^* and x are the rate-of-return variables. Since the return on foreign bond is not adjusted for x, this PB model does not take into account explicitly the indirect effects of x on asset demands.

Given the balance sheet constraint (Eq. 1.5 or 2.5) and the assumption of gross substitutability of the four assets, the constraint on the partial derivatives with respect to x in both PB models is:

(3) $dM^d / dx + dB^d / dx = -(dSF^d / dx + dSN^d / dx) < 0$

The sign of Eq. 3 follows from the PB theory which predicts a positive own-rate-of-return effect and a negative other-rate-of-return effect. Eq. 3 indicates that, for a given increase in x, the resulting decrease in the demand for domestic-currency-denominated assets, M and B, are exactly equal to the resulting increase in the demand for foreign-currency-denominated assets, F and N.[5]

Using Eqs. 1.1 to 1.4 and Eqs. 2.1 to 2.4, the effects of x on each asset demand are as follows:

(4.1) $(dg_1 / d(i^* + x))\,(d(i^* + x) / dx) + dg_1 / dx = (dM^d / dx) / W = dh_1 / dx < 0$

(4.2) $(dg_2 / d(i^* + x))\,(d(i^* + x) / dx) + dg_2 / dx = (dB^d / dx) / W = dh_2 / dx < 0$

(4.3) $(dg_3 / d(i^* + x))\,(d(i^* + x) / dx) + dg_3 / dx = (dSF^d / dx) / W = dh_3 / dx > 0$

(4.4) $(dg_4 / d(i^* + x))\,(d(i^* + x) / dx) + dg_4 / dx = (dSN^d / dx) / W = dh_4 / dx > 0$

[5]The balance sheet constraint itself does not ensure that Eq. 3 will hold unless $dW/dx = 0$. On the other hand, it is the assumption of homogeneity, together with the balance sheet constraint, which ensures that $\Sigma dg_j / dx = 0 = \Sigma dh_j / dx$. Thus given the balance sheet constraint and the assumptions of homogeneity and gross substitutability of the four assets, Eq. 3 will hold.

The signs of Eqs. 4.1 to 4.4 follow from, again, the PB prediction of a positive own-rate-of-return effect and a negative other-rate-of-return effect. Since domestic bond and domestic money balances are denominated in terms of domestic currency, asset holders tend to shift out from these assets as they attempt to avoid losses due to an increase in expected domestic currency depreciation. Eqs. 4.1 and 4.2, therefore, are both negative. With respect to the demand for foreign bond (currency), PB theory predicts a positive (negative) indirect effect of x via $i^* + x$ and a negative (positive) direct effect of x. However, given gross substitutability and the asset constraint, the net effect of an increase in x is to reduce both the demand for foreign currency and the demand for foreign bond and, therefore, Eqs. 4.3 and 4.4 are both positive.

As shown by Eqs. 4.1 to 4.2, the two PB models (Eqs. 1.1 to 1.5 and Eqs. 2.1 to 2.5) are equivalent in terms of the effects of x on asset demands. In particular, the right-hand sides of $(dM^d/dx) \,/\, W$, $(dB^d/dx) \,/\, W$, $(dSF^d/dx) \,/ W$ and $(dSN^d/ dx) \,/\, W$ show that under the first model the indirect effects of x via $i^* + x$ and the direct effects of x are separated while the left-hand sides show that under the second model these indirect and direct effects are combined. It can also be shown that they are equivalent in terms of the effects of other variables.

3.2 Comments on Cuddington's Analysis

Thus far, we have shown that the two PB models yield quantitatively equivalent x coefficients (see Eqs. 4.1 to 4.4). The only difference is that one model distinguishes between the direct and indirect effects of x on asset demands while the other model makes no such distinction. With respect to other variables, it can also be shown not only that the two PB models are qualitatively equivalent, as Cuddington (p. 114) points out, but quantitatively equivalent as well.

Cuddington (pp. 112-114), however, claims that one of these PB models ignores CS. In terms of the equation used here, this model is given by Eqs. 1.1 to 1.5. Simply by looking at Eqs. 4.1 and 4.4, it is very clear that Eqs. 1.1 to 1.5 also constitute a model which takes into account CS. Eqs. 4.1 and 4.4 clearly satisfy Miles' condition for the existence of CS: that the relative holdings of M and N respond to changes in an economic variable, in this case x. Therefore, both models take into account CS and the only difference is that in the former ICS is separated from DCS and in the latter these are combined, as shown by Eq. 4.1 and in the next sub-section.

Furthermore, Cuddington refers to Eqs. 1.1 to 1.5 as the basic equations of a "standard" PB model. On the other hand, the "standard" PB model wold have *M, B,* and *F* as assets and i, $i^* + x$ as rate-of-return variables and, therefore, would exclude x as a separate rate-of-return variable and N as an additional asset.[6] It is this "standard" model which ignores CS, not Eqs. 1.1 to 1.5 as claimed by Cuddington, because it implicitly assumes that domestic residents do not hold foreign currencies or that such holdings are insignificant. In fact, the basic characteristic of the so-called "standard" PB model (for instance, Branson, 1983) is that it does not explicitly take into account the domestic holdings of foreign-currency-denominated money balances and, therefore, ignores CS.

3.3 Specification of an Open-Economy Money Demand Function

Given the equivalence of Eqs. 1.1 and 2.1, an open-economy money demand function can then be specified in one of two ways:

(5.1) $m = m^d (\equiv g_1) \equiv a_o + a_1 p + a_2 y + a_3 i + a_4 (i^* + x) + a_5 x$

(5.2) $m = m^d (\equiv h_1) \equiv b_o + b_1 p + b_2 y + b_3 i + b_4 i^* + b_5 x$

where m^d, equal to both g_1 and h_1, is the log of domestic money demand (assuming monetary equilibrium), equals log of money supply, m; p, the log of domestic price level; y, the log of real domestic income; i, the domestic interest rate; i^*, the foreign interest rate; and x, the expected rate of change in the exchange rate.[7]

To see the mathematical equivalence of Eqs. 5.1 and 5.2, which are based on Eqs. 1.1 and 2.1, notice that:

(6.1) $dm^d / dp = dg_1 / dp = a_1 = dh_1 / dp = b_1$

(6.2) $dm^d / dy = dg_1 / dy = a_2 = dh_1 / dy = b_2$

(6.3) $dm^d / di = dg_1 / di = a_3 = dh_1 / di = b_3$

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[6]The signs of the rate-of-return coefficients in the "standard" PB model are the same as those of the PB models which account for CS (Eqs. 1.1 to 1.5 and Eqs. 2.1 to 2.5) but the sizes may be different because here there are only three assets adjusting to a given change in a particular rate-of-return variable.

[7]Notice that x is included in Eq. 5.1 twice; this may cause the t-values to be insignificant due to multicollinearity, but the coefficient estimates remain unbiased.

$$(6.4)\ dm^d / d(i^* + x) = dg_1 / d(i^* + x) = (dg_1 / (di^* + dx))\,(d(i^* + x) / di^*) = a_4 = dm^d / di^* = dh_1 / di = b_4$$

$$(6.5)\ dm^d / dx = (dg_1 / (di^* + dx))\,(d(i^* + x) / dx) + dg_1 / dx = a_4 + a_5 = dh_1 / dx = b_5$$

where g_1 and h_1, both equal to m^d, are used to distinguish between the two specifications.[8]

In both specifications of money demand, the coefficient of the domestic price level ($a_1 = b_1$, see Eq. 6.1) is expected to equal one because, in the long run, it is expected that money demand is stable so that a given percent change in money supply leads to the same percent change in the domestic price level. The coefficient of real domestic income ($a_2 = b_2$, see Eq. 6.2) is expected to be positive, based on the hypothesis that the transactions demand for money varies directly with income.

With respect to rate-of-return effects, the assumption of gross substitutability implies that the demand for domestic currency varies inversely with the return on other assets.[9] When domestic currency and domestic bond are gross substitutes in demand, the demand for domestic currency falls as the return on domestic bond increases; thus, the coefficient of i ($a_3 = b_3$, see Eq. 6.3) is negative.

While the effect of i can occur directly, the effect of i^* works through international capital mobility. When domestic currency and foreign bond are gross substitutes in demand, an increase in the return on foreign bond tends to decrease the demand for domestic currency, implying that the coefficient of either i^* or $i^* + x$ ($a_4 = b_4$, see Eq. 6.4) is negative.

International capital mobility can also lead to ICS. The indirect

[8]It can also be shown that Eqs. 5.1 and 5.2 are not only mathematically equivalent but also statistically equivalent in the sense that their estimation yields exactly the same estimates of auto-regressive parameter, coefficient of determination, parameters and t-values except for a_5 and b_5. However, both should be estimated to get separate t-values for the estimates of coefficients which measure DCS and TCS.

[9]Two assets are gross substitutes when the total effect, the sum of the cross-substitution and wealth effects, is negative. In general, the sign of the cross-substitution effects is unknown; they may be complements in terms of cross-substitution effect and yet they are gross substitutes (see Henderson and Quandt, 1980, pp. 32 and 273). Note that a_3, a_4, a_5 represent partial derivatives and therefore are not the correct theoretical measures of either gross-substitutability or cross-substitution effects.

effect of an increase in x via $i^* + x$ is to increase the demand for foreign bond, thereby reducing the demand for domestic currency. This is ICS. Thus, either a_4 or $b_4 < 0$ (since the measure of ICS, a_4, is equal to the direct effect of $i^* + x$ on m^d, also a_4, and both are equal to the direct effect of i^* on m^d, b_4) may be an indicator of the presence of high capital mobility and a measure of ICS.

While CS may occur indirectly through capital mobility, it can also occur directly. When domestic and foreign currencies are gross substitutes in demand, the demand for domestic currency falls as x rises, implying that $a_5 (= b_5 - a_4) < 0$. This is DCS.

The sum of ICS (the indirect effect of x via $i^* + x$ on m^d, a_4) and DCS (the direct effect of x on m^d, a_5) is equal to TCS (the "total" effect of x on m^a, b_5), as shown in E. 6.5. It is clear from Eqs. 6.1 to 6.5 that the only difference between Eqs. 5.1 and 5.2 is that the indirect effect (ICS) and direct effect (DCS) are separated in the former and that these effects are combined as TCS in the latter.

Eqs. 5.1 and 5.2 can be used to test for the presence of CS. McKinnon's presumption that ICS is likely to be more significant and dominant than DCS can be tested using Eq. 5.1, the money demand equation which separates ICS from DCS. Miles, in contrast, because he does not distinguish between ICS and DCS, is in a sense testing for the presence of TCS and, therefore, his findings may be compared to empirical results using Eq. 5.2, the money demand function which combines ICS and DCS.

Cuddington, on the other hand, estimates equations, among others, which are similar to Eqs. 5.1 and 5.2. He defines either $a_4 < 0$ or $b_4 < 0$ as the "high capital mobility" effect and alternatively uses either $a_5 < 0$ or $b_5 < 0$ as an indicator of CS. In the analysis above, this high capital mobility effect is the same as ICS and is also measured by either a_4 or b_4 since $a_4 = b_4$. In contrast, however, we differentiate between a_5 and b_5, and we show that a_5 measures DCS while b_5, the sum of a_4, and a_5, measures TCS or the sum of ICS and DCS. [10]

[10]It is possible that CS involves asset complementarities, as noted by Cuddington (1983). In this case, b_5, which measures TCS, will not necessarily be negative because a_4 and a_5 can be of either sign, positive when assets are complements or negative when they are substitutes.

4. Conclusions

This paper has attempted to give a brief review of the literature on CS. While authors share similar views that a high degree of CS would cause the exchange rate to be unstable and the domestic monetary policy to be no longer independent from foreign monetary policies even with a flexible exchange rate, some do not agree as to whether or not there is a significant evidence of CS.

This paper has also attempted to develop, within the context of a PB model, two alternative specifications of money demand function which take into account CS. Alternative specifications of an open-economy model of general financial equilibrium were first presented and compared, and then it was shown that the two specifications and therefore the underlying money demand functions yield quantitatively equivalent rate-of-return coefficients. With respect to the money demand functions, the only difference is that one distinguishes between DCS and ICS and the other combines the two effects.

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