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Theory and Empirical Analysis**

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Yasuyuki Sawada

University of Tokyo and Economic and Social Research Institute

and

Pan A. Yotopoulos

Stanford University

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Economic and Social Research Institute
Cabinet Office
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Yasuyuki Sawada

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Please address correspondence to:

Professor Pan A. Yotopoulos
FRI – Encina West
Stanford University
Stanford, CA 94305-6084

Phone: (650) 723-3129; Fax (650) 329-8159

E-mail: yotopoulos@stanford.edu

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Abstract:

We extend the “fundamentals model” of currency crisis by incorporating the currency substitution effects explicitly. In a regime of free foreign exchange markets and free capital movements the reserve (hard) currencies are likely to substitute for the local soft currency in agents’ portfolios that include currency as an asset. Our model shows that, controlling for the fundamentals of an economy, the more pronounced the currency substitution is in a country, the earlier and the stronger is the tendency for the local currency to devalue. The model is implemented by constructing a currency-softness index. Two empirical findings emerge. First, there is a negative relationship between the currency-softness index and the degree of nominal-exchange-rate devaluation. Second, there is a systematic negative relationship between the softness of a currency and the level of economic development. The empirical and policy implications of the model can prove germane in approaching “speculative attacks” on currencies and in evaluating proposed dioramas of the “new architecture” of the international financial system.

JEL Classification: F31, F41, G15

Key words: Financial crises, incomplete markets, the new architecture of the international financial order, currency substitution, free currency markets

1. Introduction

Money enters agents' intertemporal budget constraint as an asset. A subset of money, currency, is the monetary asset *par excellence* because of its liquidity characteristics. Moreover, when it is transacted freely in an open economy, a country's currency can be readily converted into "consumable" internationally tradable goods and into other currencies as well. Besides its attributes as a store of value and a medium of exchange, the characteristics of liquidity and convertibility make currency into a super-asset that finds a prominent place in agents' portfolios. But not all currencies were created equal. From the point of view of asset value currencies occupy a continuum from the reserve, to the hard, the soft, and the downright worthless. Reserve/ hard currencies are treated as store of value internationally, and they are held by central banks in their reserves. This asset-value quality of a reserve currency is based on reputation, which in the specific case means that there is a credible commitment to stability of reserve-currency prices relative to some other prices that matter.¹ Soft currencies, on the other hand, lack this implicit warrantee of relative price stability.

A basic premise of this paper is that there is an ordinal preference-ranking for currencies that becomes important when one uses a currency for asset-holding purposes. Moreover, in a free currency market agents can implement this ranking by moving to higher-ranking monetary assets at small transaction cost. In a free currency market where an agent has the choice of holding any currency as an asset, why not hold the best currency there is – the reserve currency that Central Banks also hold in their reserves? A free currency market, therefore, sets off a systematic process of currency substitution: the substitution of the reserve/hard currency for the soft.² Currency substitution is the outcome of asymmetric reputation between, e.g., the dollar and the peso in the positional continuum of currencies.³

¹ Reputation in this context is different from credibility that entered the literature on foreign exchange management following the seminal article of Barro and Gordon (1983). In that literature reputation is related to time inconsistency when policy-makers renege on their commitment to target one of the two alternative targets, the inflation rate or the balance of payments. For examples of this literature see Agenor (1994) and references therein.

² Our definition of currency substitution is not the only one employed in the literature. In fact the concept of currency substitution is rather ambiguous in economics. For a survey of different definitions, see Giovannini and Turtelboom (1994).

³ In this formulation of the reputation-based continuum between reserve/hard and soft currencies, a free

It results in an asymmetric demand from Mexicans to hold dollars as a store of value, a demand that is not reciprocated by Americans holding pesos as a hedge against the devaluation of the dollar!⁴ This can lead to a systematic change in exchange rate parities. Girton and Roper (1981), for example, emphasized that currency substitution can magnify small swings in expected money growth differentials into large changes in exchange rates. Kareken and Wallace (1981) also showed that the free-market international economy generates the multiplicity of equilibrium exchange rates which highlight the potential instabilities caused by currency substitution. Our specific focus is the substitution of the hard currency for the soft and the ensuing systematic devaluation of the latter. Capital flight constitutes a form of this currency substitution. A complete flight from a currency, in the form of dollarization, represents the extreme case where any or all of the three functions of a currency - unit of account, means of exchange, and, in particular, store of value – are discharged in a foreign currency (Calvo and Végh, 1996).

We extend the “fundamentals model” (or the “first-generation model”) of currency crisis by incorporating the endogenous currency substitution effects explicitly. Recently, several papers have tried to extend this “first-generation model” by introducing an endogenous risk premium or an endogenous regime-switching of economic policy (Flood and Marion, 2000; Cavallari and Corsetti, 2000). By focusing on an optimal dynamic response of domestic agents our model is distinguished within this genre of recent literature by its generality. We show that the more pronounced the currency substitution is in a country the earlier and the stronger is the tendency for the local currency to devalue. This tendency holds whether the origins of currency substitution lie in a risk premium or simply in a "taste" for ratcheting up liquid asset holdings to a harder currency. The intuition behind our theory is straightforward. With strong currency substitution the demand for the domestic currency, relative to the foreign (hard) currency, declines. Given the stream of domestic money-supply growth, a decline in domestic money demand will

currency market makes foreign exchange into a “positional good” (Hirsch, 1976; Frank and Cook, 1976; Frank, 1985; Pagano, 1999). Following that literature, in a shared system of social status, e.g., it becomes possible for an individual (a good) to have a positive amount of prestige (reputation) such as a feeling of superiority, only because the other individuals (other goods) have a symmetrical feeling of inferiority, i.e., negative reputation (Pagano, 1999). In a free currency market, the simple fact that reserve currencies exist, implies that there are soft currencies that are shunned.

⁴ Keynes (1923) called “precautionary” this new slice added on the demand for foreign exchange that impinges asymmetrically on the conventional demand-and-supply model for determining exchange rate

increase the equilibrium domestic price level. This increased domestic price level will lead to devaluation through arbitrage among tradable goods - or simply according to purchasing power parity. A novel feature of this paper is to show empirically that, controlling for the fundamentals, the reputation-asymmetry vis-a-vis the reserve currencies triggers systematic devaluations of the soft currencies of emerging economies and developing countries.⁵

The paper is organized as follows. Section 2 sets the main thrust of this paper in the context of the literature. Section 3 extends the fundamentals model of the currency crisis by incorporating the currency substitution effect. The empirical model and results are presented in Section 4. Section 5 presents the policy implications of the currency substitution hypothesis of devaluation, emphasizing specifically the departures from the conventional treatment of financial crises. It turns out, for example, that the simple extension of incorporating in the extant models currency substitution becomes germane for modeling "speculative attacks" on a currency and for designing the "new architecture" of the international financial system. The concluding Section 6 follows.

2. The Predecessors

This paper builds on two strands of the literature. Krugman (1979) first developed a model of the balance of payment crisis due to speculative attacks on the fixed-exchange-rate regime. Flood and Garber (1984) presented the linear version of Krugman's model. This crop of the "first generation" models fingers the deteriorating "fundamentals" of an economy as the trigger to the currency crisis (Eichengreen, Rose, and Wyplosz, 1994).

It seems that this literature implicitly assumes that the important role of money is as a medium of exchange, since the model introduces the arbitrage equation of tradable goods prices or the purchasing power parity equation. The idea of money as the medium of exchange was expanded in two alternative directions that formalized the micro-foundation of the money demand function: the cash-in-advance

parity.

⁵ In a two-country general equilibrium model one could show the impact of asymmetric reputation as a zero-sum game (Pagano, 1999). For simplicity, we consider only one-sided reputation in this paper.

model (Clower, 1967; Lucas and Stokey, 1987) and the transaction model (Baumol, 1952; Tobin, 1956). In either model, money is held for transaction purposes. However, money also serves a store of value, and enters as such the utility function. Sidrauski (1967) first formulated the Ramsey optimal growth model with both consumption and real money balances in the utility function subject to an intertemporal budget constraint with money.

From the technical perspective, in order to examine whether putting money in the utility function is appropriate, we can ask whether it is possible to rewrite the maximization problem of an agent with transaction costs of money holdings. Feenstra (1986) showed that maximization subject to a Baumol-Tobin transaction technology can be approximately rewritten as maximization with money in the utility function. Moreover, the simple cash-in-advance model of money can be written as a maximization problem by ignoring the cash-in-advance constraint but introducing money in the utility function (Blanchard and Fischer, 1989: 192). Also Obstfeld and Rogoff (1996: 530-532) showed that the money-in-utility-function formula can be viewed as a derived utility function that includes real balances because agents economize on time spent in transacting. Therefore, the money-in-utility-function formula can be regarded as a general formulation of the micro-foundations of the money demand function.

The novelty in our model lies in fusing and expanding both strands of this literature into a micro-fundamentals model in which optimizing agents engage in currency substitution thus setting-off endogenously serial devaluations that can culminate in a currency crisis. In the process, we expand Krugman's model by introducing money not only as a medium of exchange but also in its role as an asset. Moreover, the utility function in our model contains both domestic and foreign currency, with possibilities of substituting one for the other, especially for asset-holding purposes. Flood and Marion (2000) and Cavallari and Corsetti (2000) extended the first-generation model of currency crises by incorporating an endogenous risk premium and by introducing an endogenous policy, respectively. Our contribution lies in constructing and testing a general model that extends the first-generation model by introducing endogenous currency substitution by optimizing agents.

3. The Fundamentals Model of Balance-of-Payments Crisis under Currency Substitution

If a country with a soft currency fixed its exchange rate initially, an expansionary fiscal and/or

monetary policy will render the fixed exchange rate regime untenable, sooner or later. In this section, we will construct a simple model of currency crisis that is triggered by currency substitution. The model portrays a situation where speculation-led crises can occur in a completely rational environment under the basic principles of efficient asset-price arbitrage.

In what follows we first derive the optimal condition of currency substitution in a dynamic model of optimizing agents. Then we extend the Obstfeld and Rogoff (1996) log-linear version of Krugman's (1979) model by introducing currency substitution effects while controlling for the fundamentals.

3.1 The Micro-fundamentals of Currency Substitution

Our focus is to model the role of money as an asset and a store of value. However in the real world, money as a store of value is dominated by several assets. To account for this we construct a dynamic optimization model of currency substitution, applying the basic setup of Obstfeld and Rogoff (1996: 551-553). By definition, a domestic representative agent's total money for asset-holding purposes, M , is composed of domestic currency, M_1 and foreign currency, M_F :

$$M_t = M_{1t} + eM_{Ft}$$

where e is the nominal exchange rate. Then the optimal allocation of money-holding (of two different currencies in our case) can be solved as a dynamic optimization problem of a household with money-in-the-utility-function in a model with log-linear utility components of real balance.

Assuming a small open economy, a representative household maximizes the following lifetime utility:

$$(1) \quad U_t = \sum_{s=t}^{\infty} \mathbf{r}^{s-t} \left\{ \mathbf{q}u(C_s) + (1-\mathbf{q}) \left[\mathbf{g} \log \left(\frac{M_{1s}}{P_s} \right) + (1-\mathbf{g}) \log \left(\frac{eM_{Fs}}{P_s} \right) \right] \right\},$$

where $u(C)$ represents instantaneous utility from consumption and \mathbf{r} is a discount factor. The parameters \mathbf{q} and \mathbf{g} are utility parameters and P_t represents the price level. The household can accumulate foreign bonds and two kinds of monetary assets. The optimal consumption and money

demand are determined by maximizing (1) subject to the following intertemporal budget constraint:

$$(B_{t+1} - B_t) + \frac{(M_{1t} - M_{1t})}{P_t} + \frac{e_t(M_{Ft} - M_{Ft-1})}{P_t} = rB_t + Y_t - C_t - T_t,$$

where B is the stock of foreign bonds or assets. Y and T represent the exogenously given income and lump-sum tax, respectively. Note that the left-hand side of the budget constraint represents three different devices to accumulate assets, i.e., bonds, real domestic money and real foreign money, all converted in the local currency, and by definition equal to the real surplus during the period t on the right-hand side. In order to derive a tractable analytical solution, we assume that there is no consumption-titling effect, i.e., $(1+r)r = 1$. Then we obtain the following first-order conditions with regard to C , M_1 , and M_F , respectively (see Appendix A):

$$(2) \quad u'(C_t) = u'(C_{t+1}),$$

$$(3a) \quad \frac{(1-q)g}{M_{1t}} + \frac{rqu'(C_{t+1})}{P_{t+1}} - \frac{qu'(C_t)}{P_t} = 0,$$

$$(3b) \quad \frac{(1-q)(1-g)}{M_{Ft}} + \frac{rqu'(C_{t+1})e_{t+1}}{P_{t+1}} - \frac{qu'(C_t)e_t}{P_t} = 0.$$

For the purpose of deriving the optimal allocation condition of two different currencies in a regime of currency substitution, let us define the foreign-currency-preference variable, \mathbf{a} , as follows:

$$(4a) \quad M_{1t} = (1-\mathbf{a}_t) M_t$$

$$(4b) \quad eM_{Ft} = \mathbf{a}_t M_t$$

This foreign-currency preference, \mathbf{a} , is the key variable since its value, as it rises from 0 to 1, activates progressively greater currency substitution. If $\mathbf{a} = 0$, there is no currency substitution effect and a consumer holds only the domestic currency as an asset. The condition $\mathbf{a} = 0$ is also satisfied in the case of non-convertibility of the domestic currency and strict capital control. In either case, foreign money-holding is forced to zero. On the other hand, the case of $\mathbf{a} = 1$ indicates that domestic residents hold

monetary assets exclusively in the form of foreign currency. This is the case of complete dollarization. Hence, the variable \mathbf{a} reflects the degree of softness of a currency, defined as the proclivity for currency substitution for asset-holding purposes. The value of \mathbf{a} then represents an inverse transformation of Gresham's law since, as it ranges from 0 to 1, it is the good (hard) currency that progressively drives out the bad.

Denote that $\mathbf{e}_{t+1}/\mathbf{e}_t = 1 + z_{t+1}$, where z_{t+1} is (future) devaluation rate. Then, combining equations (2), (3a), and (3b) yields (see Appendix B):

$$(5) \quad \mathbf{a}_t = \frac{(1-\mathbf{g})i_{t+1}}{i_{t+1} - \mathbf{g}_{t+1}},$$

where i_{t+1} is the nominal interest rate, which is defined by the following expression: $i_{t+1} = (1+r)(P_{t+1}/P_t) - 1$. We can easily show that $\partial \mathbf{a}_t / \partial z_{t+1} > 0$, indicating that exchange rate devaluation will induce currency substitution under the assumption of sticky prices. What happens when the prices adjust instantaneously? To see this, we assume that the purchasing power parity (PPP) condition holds given instantaneous and complete price adjustments. In this case, we have $P_t = \mathbf{e}_t P^*$, where P^* is the foreign price level which is assumed to be constant to avoid unnecessary complications.⁶ Then equation (5) becomes:

$$(5a) \quad \mathbf{a}_t = \frac{(1-\mathbf{g})[r + (1 + z_{t+1})]}{r + (1 + r - \mathbf{g})z_{t+1}}$$

As shown in Appendix B, the following property is satisfied:

$$(5b) \quad \frac{\partial \mathbf{a}_t}{\partial z_{t+1}} = \frac{(1-\mathbf{g})r\mathbf{g}}{[r + (1 + r - \mathbf{g})z_{t+1}]^2} > 0$$

⁶ Our qualitative results remain unchanged in the argument that follows even if we assume that P^* is not

This comparative statics result indicates that currency substitution is induced by (future) devaluation. Facing depreciation of the foreign exchange rate, households optimally switch their holdings of domestic currency to foreign currency, in order to maximize their intertemporal utility. This result holds in general, regardless of the speed of price adjustment. It is summarized by the following proposition:

Proposition 1 (Devaluation-induced Currency Substitution): *Regardless of the adjustment speed of goods prices, a (future) devaluation induces currency substitution unambiguously.*

Proof: See Appendix C.

Also, from equations (5), (5a) and (5b), it is straightforward to show that $\partial \mathbf{a}_t / \partial \gamma < 0$ and $\partial(\partial \mathbf{a}_t / \partial z_{t+1}) / \partial \gamma < 0$, indicating that strong utility preference towards the domestic currency decreases the effects of currency substitution by lowering its level and muffling the response toward devaluations. Alternatively, a particular utility preference toward foreign currency induces strong currency substitution as a behavioral consequence. These results are intuitively straightforward. Basically, equation (5b) captures the substitution effect of the money demand function: a decrease in the relative price of domestic currency induces substitution of the foreign currency for the domestic.

3.2 The Monetary Model of Currency Crisis

Now, utilizing the definition of total real balance of a representative household given by (4a) and (4b), we can rewrite the household's objective function (1) as follows:

$$U_t = \sum_{s=t}^{\infty} \mathbf{r}^{s-t} \left\{ \mathbf{q}u(C_s) + (1 - \mathbf{q}) \left[\log \frac{M_t}{P_t} + \mathbf{g} \log \mathbf{a}_t + (1 - \mathbf{g}) \log(1 - \mathbf{a}_t) \right] \right\},$$

In order to obtain a tractable formulation, examine the case of a symmetric preference between domestic real money balance and foreign real money balance in local currency., i.e., $\gamma = (1 - \gamma)$. Then with an

constant.

approximated objective function, we can rewrite the household optimization problem as follows:⁷

$$(1a) \quad \text{Max } U_t = \sum_{s=t}^{\infty} \mathbf{r}^{s-t} \left\{ \mathbf{q}u(C_s) + (1-\mathbf{q}) \left[\log \frac{M_t}{P_t} - \frac{1}{2} \right] \right\},$$

$$\text{s.t. } B_{t+1} + \frac{M_t}{P_t} = (1+r)B_t + \frac{M_{t-1}}{P_t} + Y_t - C_t.$$

From the first order condition of this modified formulation, we have the conventional money demand function:⁸

$$(6) \quad \frac{M_t}{P_t} = \left(\frac{1-\mathbf{q}}{\mathbf{q}} \right) \left(\frac{1+i_{t+1}}{i_{t+1}} \right) [u'(C_t)]^{-1},$$

Combining Equations (4a) and (6), we have the following domestic money demand function:

$$(6b) \quad \frac{M_{1t}}{P_t} = (1-\mathbf{a}_t) \left(\frac{1-\mathbf{q}}{\mathbf{q}} \right) \left(\frac{1+i_{t+1}}{i_{t+1}} \right) [u'(C_t)]^{-1}$$

For the sake of expositional simplicity suppose for the time being that \mathbf{a}_t is exogenously given – an issue that we will revisit later in section 3.4. We thus set aside the endogenous structure of equation (5a). Now we draw on the first-generation models of Krugman (1979), as log-linearized by Obstfeld and Rogoff (1996), to model a small open economy with a foreign exchange rate that

complies with purchasing power parity (PPP) and uncovered interest parity (UIP). This model assumes perfect goods market adjustment and perfect capital mobility:⁹

⁷ We utilized that $\log \mathbf{a}_t \approx \mathbf{a}_t - 1$ and $\log(1-\mathbf{a}_t) \approx -\mathbf{a}_t$.

⁸ Note that a similar real money demand function can be derived from a different dynamic optimization model of a household (Sidrauski, 1967; Lucas and Stokey, 1987; Feenstra, 1986).

⁹ This strong assumption will be released in the empirical implementation of the model below.

$$(7a) \quad p_t = e_t + p_t^*$$

$$(7b) \quad i_{t+1} = i_{t+1}^* + E_t e_{t+1} - e_t,$$

where e is the logarithm of the nominal exchange rate of this economy. The log of the price level, P_t , is denoted by p , and the interest rate is denoted by i . Then, log-linearizing Equation (6b), the money market equilibrium condition, becomes:¹⁰

$$(8) \quad m_{1t} - p_t = \log(1 - \mathbf{a}_t) + \mathbf{f}c_t - \mathbf{h}i_{t+1},$$

where m and c are the log of the money supply and the consumption, respectively. The parameters, \mathbf{f} and \mathbf{h} , are income elasticity and semi-interest elasticity of money demand, respectively.

Combining (7a), (7b), and (8), we have a dynamic equation of the exchange rate which satisfies PPP, UIP, and money market equilibrium:

$$(9) \quad m_{1t} - \mathbf{f}c_t - e_t + \mathbf{h}i_{t+1}^* - p_t^* = \log(1 - \mathbf{a}_t) - \mathbf{h}(E_t e_{t+1} - e_t),$$

Under the assumption of the small open economy, foreign variables are exogenously given. In order to simplify the argument, we assume that $-\mathbf{f}c_t + \mathbf{h}i_{t+1}^* - p_t^* = 0$. Then we have a continuous version of the exchange rate dynamics under perfect foresight as follows:

$$(9a) \quad m_t - e_t = \log(1 - \mathbf{a}_t) - \mathbf{h}\dot{e}_t$$

3.3 The Role of the Central Bank

The balance sheet of the Central Bank is represented as

¹⁰ Alternatively, equation (8) is justified by an assumption of a continuous-time Cagan-type money demand function.

$$(10) \quad B_H + eA_F = M$$

where B_H represents the domestic government bond ownership of the Central Bank and A_F is its total foreign asset holdings, i.e., foreign bonds and reserve currency. The Central Bank's monetary base is $M_1 = mMB$, where $m > 1$ represents the money multiplier. Hence, Equation (10) gives

$$(11) \quad M_1 = m(B_H + eA_F).$$

3.4 The Collapse of the Fixed Exchange Rate Regime

From Equation (9a), we can see that a fixed exchange rate regime generates

$$(12) \quad m_{1t} - \bar{e} = \log(1 - \mathbf{a}_t).$$

Suppose that the Central Bank is required to finance an ever-increasing fiscal deficit by buying government bonds thus expanding its nominal holdings of domestic government debt, B_H . If the growth rate of domestic bond stock is constant at \mathbf{I} , we have

$$(13) \quad \dot{B}_H = B_H \mathbf{I}.$$

Following Krugman (1979), we can calculate the shadow exchange rate under the flexible exchange rate assumption and no foreign reserves, i.e., $A_F = 0$. In this situation, the Central Bank's balance sheet equation (11) implies that

$$(14) \quad m_{1t} = \log \mathbf{m} + b_{Ht},$$

where b_{Ht} indicates the log of the Central Bank's bond holding. By combining Equations (13) and (14),

it becomes obvious that the money supply increases at the constant rate I after the collapse of the fixed exchange rate regime, i.e., $\dot{m}_t = I$. Moreover, from Equation (9a), we can easily see that $\dot{m}_t = \dot{e}_t = I$ along the balanced growth path. Therefore, inserting Equation (14) into Equation (9a), we obtain

$$(15) \quad b_{Ht} - e_t = -\log \mathbf{m} + \log(1 - \mathbf{a}_t) - \mathbf{h}I$$

Finally, we can derive the log of the shadow exchange rate, which is defined as the floating exchange rate that would prevail if the fixed exchange rate regime collapsed, as follows:

$$(16) \quad e_t = b_{Ht} + \log \mathbf{m} - \log(1 - \mathbf{a}_t) + \mathbf{h}I.$$

We can see that $\partial e_t / \partial \mathbf{a} > 0$. This indicates that the currency substitution effects due to agents' preference toward foreign currency will induce potential devaluation of the exchange rate over time. As a result, controlling for the fundamentals, the collapse of the fixed exchange rate would occur earlier. We can formally derive the time path to the collapse as follows. From Equation (12), we have

$$(17) \quad b_{Ht} = b_{H0} + I t,$$

where b_{H0} is the initial value of the Central Bank's government bond holding. Combining Equations (16) and (17), together with $e_T = \bar{e}$, we can derive the time elapsed to the collapse of the fixed exchange rate regime as follows:

$$T = \frac{\bar{e} - b_{H0} - \log \mathbf{m} + \log(1 - \mathbf{a}_t)}{I} - \mathbf{h}.$$

Hence, we can easily inspect that $\partial T / \partial \mathbf{a} < 0$. Again, the softness of a currency is negatively related to

the timing of the currency crisis. As indicated in Figure 1, e_T is the cross-over point from fixed to flexible exchange rate, the onset of devaluation. The equation and figure denote that currency substitution, totally independently of the fundamentals and induced by a shift in the preference parameters, will lead to an early collapse of the stable exchange rate regime (Figure 1).¹¹ For example, such a change in the substitution parameter, \mathbf{a} , can be induced by a preference shift from domestic currency to foreign currency, i.e., a decrease in \mathbf{g} (equation 5a). It is important to note that even with a modest expansion in the level of government indebtedness, \mathbf{I} , a large currency substitution effect, \mathbf{a} , can accelerate the onset of the crisis. This is applicable to the recent Asian crises where the government account was in balance and otherwise the fundamentals were solid (Yotopoulos and Sawada, 1999).

The intuition behind this result should be straightforward. A high degree of currency substitution results in shrinking the demand for the domestic currency (Equation 6b). Given the flow of money supply, a decline in money demand will increase the equilibrium price level. According to the PPP, Equation (7a), this increased price level will lead to devaluation. Although the devaluation rate itself will be the growth rate of the money supply, it is the currency substitution that shifts the locus of the shadow exchange rate toward the devaluation.

So far, for the sake of tractability, we have assumed that the currency substitution variable, \mathbf{a} , is exogenously given. Yet, equation (5b) and Proposition 1 indicate that this variable is endogenously determined by a household's dynamic optimization behavior. The true equilibrium exchange rate behavior should take into account this endogeneity of the currency substitution variable. Although we have imposed the perfect foresight assumption of the model so far, the future devaluation rate, z_{t+1} , should be treated as an expected variable in reality. For convenience, we denote an expected devaluation rate as z_{t+1}^e . A correct interpretation of Proposition 1 is that the foreign-currency-preference variable will increase in response to an *expected* devaluation, i.e., make the collapse of the fixed exchange rate regime in $\mathbf{a}_t = \mathbf{a}(z_{t+1}^e)$ with $\partial \mathbf{a}_t / \partial z_{t+1}^e > 0$, because of endogeneity of the currency substitution variable, \mathbf{a}_t . Then once a country's currency behaves as a soft currency with an expected devaluation, the dynamic locus of the shadow exchange rate line, represented by Equation (16), will shift toward further devaluation (Figure 1). In this case, even if a country is initially at the point A', where the

¹¹ Note that the first-generation currency-crisis model *a la* Krugman (1979) is the special case of our

speculative attacks are not profitable without currency substitution, a currency substitution due to an expected devaluation can cause the immediate collapse of a fixed exchange rate regime. Hence, the expectation of devaluation can become a self-fulfilling prophecy. Note that this story does not depend on the usual assumption of the second generation model of currency crisis where the existence of speculative bubbles itself generates multiple-equilibria and a self-fulfilling expectation of speculative attacks (Obstfeld, 1996). Rather, in our model, the expectations of devaluation of optimizing domestic residents are evitable.

Moreover, as is often pointed theoretically and empirically, there is a habit-formation of currency substitution (Uribe, 1997). The self-fulfilling expectation of devaluation is likely to have hysteresis on currency substitution. This mechanism creates the possibility of self-validating devaluation spirals. An expected devaluation generates currency substitution of agents [equation (5b)]. Currency substitution, in turn, leads to a further expected devaluation [equation (16)]. Soft currencies depreciate systematically because of the currency substitution effect and crises occur more frequently. This is a formal representation of the Y-Proposition elaborated by Yotopoulos (1996, 1997).

4. Empirical Implementation

The previous sections have generalized the treatment of currency crises by introducing currency substitution as a trigger for devaluation while controlling for the fundamentals of an economy. We can examine this process intuitively by constructing an imperfect proxy of the currency substitution variable, \mathbf{a} , and observing its behavior over time and especially during a crisis. Lacking data on foreign currency deposits, we define the proxy as the ratio of time, savings, and foreign-currency deposits in the deposit money banks to a broader measure of money, $M2$, which also includes time, savings, and foreign currency deposits.¹² Monthly data of these variables from January 1991 to September 2000 are extracted from *International Financial Statistics* of the International Monetary Fund. This measure of currency

model with no currency substitution effects, i.e., $\mathbf{a} = 0$.
financial institutions that accept transfer¹² Note that the deposit banks comprise commercial banks and other able deposits.

substitution can be regarded as the upper-bound of \mathbf{a}_t , since the data commingle in the numerator foreign currency deposits with other time and savings deposits.

Figure 2 represents the above ratio-proxy estimate of monthly currency substitution for for Indonesia, Korea, Malaysia, and Thailand. Over the period from January 1991 to September 2000, there was no trend except a slight upward trend in Indonesia until July 1997 when there was a renounced increase in the proxy variable. Casual observation suggests a synchronicity between the increase in the proxy variable and the currency devaluations of 1997 and 1998. This is consistent with our theoretical framework: switching behavior from domestic to foreign currency ratchets up to devaluation. In Korea particularly, gradual currency substitution preceded the massive devaluation of November 1997.

Actually, in our model currency substitution is no longer an issue of fundamentals. As long as currency used for asset-holding purposes is a positional good and a free currency market provides for currency switching at negligible transaction costs, it pays for agents to ratchet up by substituting the reserve/ hard currency for the soft. Agents' expectations for devaluation generate self-fulfilling outcomes. Expectations thus become important determinants of devaluation.

4.1 The Empirical Model

The formal cross-country empirical implementation of the model rests on Equation (16) above which represents a modified version of Krugman's collapse of the fixed exchange rate regime, with e_T indicating the cross-over point from fixed to flexible exchange rate, denoting devaluation. The modifications consist of introducing currency substitution that impacts on the timing of the collapse of the exchange rate regime (Figure 1) and of releasing the strong assumption of perfect international capital mobility. We therefore rewrite Equation (16) to represent a hypothetical exchange rate under PPP and UIP:

$$(16a) \quad e_t = b_{Ht} + \log \mathbf{m} + \mathbf{a}_t + \mathbf{h}l + \mathbf{b}_2$$

where \mathbf{b} is a parameter which represents the degree of capital mobility.

In estimating Equation (16a) the following four components need be distinguished: First, recall that the first two terms of the RHS are equal to nominal money holdings, m_{1t} , that determine e_t when foreign exchange is used for transactions purposes. In other words, these two terms represent the fundamental PPP components of exchange rate due to trade in goods (and services), combined with the money market equilibrium condition. This part reflects the role of money as the medium of exchange, i.e., for transaction purposes. Figure 3-a represents the implicit mechanism that determines the PPP exchange rate by clearing the market for tradables, PPP_{Tt} .

Second, the third and fourth terms of Equation (16) modify the PPP-determination of the exchange rate to reflect the impact of other endogenous components. The latter term reflects the impact of the domestic money supply, while the third term represents the additional splice on the demand for foreign exchange that serves for asset-holding purposes. Figure 3-b shows the “equilibrium” exchange rate that accounts also for currency substitution, \mathbf{a} .

Third, if there is effective capital control and foreign exchange allocation is limited, then the last term in Equation (16a) $\mathbf{b} > 0$ (Figure 3-c). In this case the “equilibrium” exchange rate is overridden at a level higher than in Figure 3-b.¹³ The resulting foreign exchange rate is the black market exchange rate, BM , which is higher than the equilibrium nominal exchange rate under perfect capital mobility in Figure 3-c:

$$(16b) \quad BM_t = \ln PPP_{Tt} + \mathbf{a}_t + \mathbf{b},$$

where PPP_{Tt} is the fundamental PPP part and \mathbf{b} represents the degree of capital control.

Finally, the official nominal exchange rate (NER) is often managed by the government, especially in soft-currency countries. There is a certain degree of discretion in setting the NER, and in any event it

¹³ Note that Figure 3-c is drawn to depict the special case where the foreign exchange allocation is limited by excluding the precautionary demand of holding foreign exchange for asset purposes. At the level of allocation shown in the figure all transactions demand for imports of goods and services, including servicing foreign investment, is satisfied.

is lower than the BM which is regarded as the logarithm of the black market exchange rate that reflects the existence of currency substitution by the domestic residents and foreign exchange market interventions of the governments.

We can now subtract NER from both sides of (16b) in order to have the empirical model that yields currency substitution, or else an operational index of the softness of the currency, \mathbf{a}_{it} , as a residual:

$$(18) \quad BM_{it} - \ln NER_{it} = \ln PPP_{Tit} - \ln NER_{it} + \mathbf{b} D_{it} + \mathbf{a}_{it},$$

where D is a dummy for the extent of capital control that is in effect.

For estimation purposes, let BP denote the black market premium relative to the nominal exchange rate. Then, by applying a first-order Taylor expansion to equation (18), we have

$$(19) \quad BP_{it} = \ln DNER_{it} + \mathbf{b} D_{it} + \mathbf{a}_{it2}$$

where $\ln DNER_{it} = \ln PPP_{Tit} - \ln NER_{it}$. If data sets are available, the currency softness index, \mathbf{a}_{it} , can be derived as the residual of this empirical model, by regressing black market premium, BP_{it} , on the NER distortion index, $\ln PPP_{Tit} - \ln NER_{it}$, and the capital control indicator variable, D_{it} , which takes value of one if there are any foreign exchange controls and zero otherwise.

Equation (19) calls for imposing coefficient restrictions. We thus estimate Equation (19) with coefficient restriction on the NER distortion index, $\ln DNER$, by using OLS with the Huber-White robust standard error. Finally, we obtain the currency softness index, \mathbf{a}_{it} , as the estimated residuals of Equation (19) with the coefficient restriction.¹⁴

4.2 The Data Set

¹⁴ We also add time effects in this regression.

In order to estimate the regression equation (19), we need three variables: the exchange-rate black-market premium, *BP*; the nominal exchange rate, *NER*; the *NER* distortion index, $1n DNER$; and qualitative information about foreign capital control.

First, the data for the black market premium on the foreign exchange rate are widely available from different sources. We utilized a comprehensive annual cross-country panel data set of black market premium, which is compiled by Adrian Wood (1999). This data set covers 42 countries over a period of ten years (Table A2).

Second, consistent annual panel information on exchange rate restrictions is reported in Ernst & Whinney (various years)¹⁵. The data denote restrictions on equity capital; debt capital; interest; dividends and branch profits; and royalties, technical service fees, etc. Based on this information we construct a binary variable of foreign capital control (Table A2).

Obtaining the appropriate *NER* distortion index that the theory requires is more difficult. The empirical version of the *NER* distortion index that is broadly used for gauging a currency's tendency to appreciate or depreciate is supposed to measure the deviation of the nominal exchange rate (*NER*) from the ideal world where *PPP* holds and the prices of tradables tend to converge internationally (McKinnon, 1979). The empirical application of the index, however, whether it relies on the differential rate of inflation or other shortcut methods, reflects the prices of both tradables and nontradables. Measuring the deviation of the *NER*, which is formed exclusively in the world of tradables, by using a (*PPP*-deflated) general price index introduces a distortion that makes the resulting index of questionable value. This shortcoming is remedied by utilizing the unique set of data on the prices of tradables alone that Yotopoulos (1996) has developed.

Yotopoulos' point of departure is the *PPP* exchange rate that is constructed from the price-parity (micro-*ICP*) data of the Penn World Tables (Summers and Heston, 1991). The familiar expression that gives purchasing power parity, *PPP*, for country *I* as the geometric average of the *k* *GDP*-exhaustive commodity categories, is

¹⁵ Ernst and Young since 1989.

$$(20) \quad PPP_I = \prod_{i=1}^k \left(\frac{P_i^I}{P_i^W} \right)^{Q_i^I / \sum_{i=1}^k Q_i^I}$$

where P_i^I and P_i^W are the prices of i homogeneous commodity for country I and for the numeraire country (world), and Q are the quantity weights.

Different aggregations of Equation (20) can lead to alternative price indexes, such as the national price level of consumption or of government expenditure. For the Yotopoulos application the normalized index of the prices of tradables is constructed as:

$$(21) \quad PPP_I^T = \prod_{i=N+1}^T \left(\frac{P_i^I}{P_i^W} \right)^{Q_i^I / \sum_{i=N+1}^T Q_i^I}$$

where $i = N + 1, \dots, T$ is defined for commodities that are tradable in country I , (and symmetrically for $i = 1, \dots, N$ for the nontradables). The PPP indexes in equation (21) are expressed in local currency per US (numeraire country) dollar.

It still remains to be determined how to delineate the two subsets of commodities, $i = 1, \dots, N$ and $i = N+1, \dots, T$. Tradability is certainly related to tradedness. It could therefore be defined based on the empirical-positivist rule of whether a good enters (international) trade or not. One could then define two mutually exclusive categories of traded and nontraded goods. This heuristic approach, however, fails to address some important issues. Is any participation in international trade sufficient to make a good tradable? If so few nontradable goods would probably remain. Empirically Yotopoulos (1996: 112) addresses the issue by adopting the standard definition of openness in an economy (the ratio of imports and exports to GDP) and designating as tradable any commodity group that has exports plus imports valued at more than 20 percent of the total share of that commodity's expenditure in GDP . By distinguishing a large number of commodity groups and by weighting both prices and the participation of each individual commodity into tradability by actual expenditure weights, the arbitrariness of the criterion has been blunted.

Implementation of the definition of the real exchange rate (RER) relies on the micro- PPP data of

the *ICP* (Kravis, Heston, and Summers, 1982; Penn World Tables). For the "basic classification" prices and nominal and real per capita expenditures (expressed in domestic currency per U.S. dollar) are available for 152 *GDP*-exhausting commodities for the "benchmark" countries and years. They were used in a flexible aggregation form to derive prices of tradables and nontradables. The data for the definition of tradability come from the United Nations *Yearbook of International Trade Statistics* which provides in 5-digit *SITC* classification for each country the value of exports (f.o.b.) and imports (c.i.f.) in U.S. dollars. The 5-digit classification was re-aggregated to achieve concordance with the *ICP* data. Appendix Table A1 presents the value of the index for prices of tradables for the benchmark countries that were included in at least one of the phases II, III, IV, and V of the *ICP* for 1970, 1975, 1980, and 1985, respectively.

Let a variable NER represent a country's nominal exchange rate (NER) expressed in local currency/US dollar. A country i 's tradable goods price at time t is represented by PPP_{it}^T . Let PPP^T denote the PPP level of tradable goods, as in equation (21). Then, as we have discussed already, we can define a NER distortion index, $DNER$, as follows:

$$(22) \quad DNER_{it} \equiv \frac{PPP_{it}^T}{NER_{it}},$$

where T is a superscript for tradables. The ratio of tradable prices in the parentheses represents an implicit long-run equilibrium purchasing power parity of tradable prices. Therefore, $DNER_{it}$ represents the nominal exchange rate distortion, which is defined as the deviation of NER from the PPP for tradable goods, i.e., the long-run equilibrium exchange rate. We can then formulate formally:

Proposition 2 (NER Misalignment): *If $DNER_{it} > 1$ or $\ln DNER_{it} > 0$, then the NER is overvalued relative to the purchasing power parity level; and if $DNER_{it} < 1$ or $\ln DNER_{it} < 0$, then it is undervalued. If there are no time-specific and country-specific distortions, then absolute PPP holds among tradables.*

Proof: From Equation (22), if $DNER_{it} > 1 \Leftrightarrow NER_{it} < PPP_{it}^T$, NER is overvalued, and if $DNER_{it} < 1 \Leftrightarrow NER_{it} > PPP_{it}^T$, NER is undervalued. Moreover, if $DNER_{it} = 1 \Leftrightarrow NER_{it} = PPP_{it}^T$. *Q.E.D.*

Therefore, we can simply estimate this *NER* distortion index from Equation (22) by taking the ratio of the relative price level of tradables to the *NER*, i.e.,

$$(22a) \quad \ln DNER_{it} = \ln \left(\frac{PPP_{it}^T}{NER_{it}} \right).$$

Note that the index takes the value of zero if there is no *NER* distortion. In order to quantify this measure of distortion, we take advantage of Yotopoulos' (1996) estimates of PPP^T/e that rely on the price parities (micro-*ICP*) data set. The resulting estimates of *NER* distortions are also presented in Appendix Table A1.

4.3 Estimation Results of the Currency Softness Index.

The summary statistics of the empirical estimation are presented in Table 1. The values of the black market premium and of the Yotopoulos exchange rate distortion index indicate that, on the average, the countries in the sample had exchange rates that were relatively high by the standards of Figure 3-c, meaning that the components of *a* and *b* had come into play. The indication from both sets of variables is the same, despite the fact that the variables are different and so are their origins. The statistic on the currency softness index is the resulting residual of the estimating equation. Its value indicates that the sample of countries, on the average, had soft currencies. This is consistent with the other statistics described in the table.

As we can see, the exchange control has a positive and significant coefficient. This is consistent with the theoretical prediction that foreign capital controls will increase a country's foreign exchange black market premium (Figure 3-c). Another finding is that the dummy for 1985 has a positive and significant coefficient. This year-specific positive effect probably represents the impact of the significant appreciation of US dollar in the early 1980s and the resultant systematic depreciation of other countries' currency toward the US dollar.

The immediate objective of Equation (19) is the derivation of the currency softness index, the

values of which are summarized in Table A2. This statistic, besides revealing important country- and time-specific information could also be used for investigating causality in various episodes of currency crisis. Unfortunately the data set and the episodes of currency crises are not rich enough to rigorously investigate causality hypotheses. However, we can still examine empirically the relevance of the currency softness index to financial crises by other methods. In order to characterize empirically the currency softness, we employ two different approaches.

First, the relationship between the softness measure and the currency distortion index is represented in Figure 4. The Figure clearly indicates a negative relationship between the constructed currency softness index and the degree of *NER* overvaluation. The fact that soft currencies are more likely to be undervalued (i.e., too many pesos to the dollar) is consistent with the theoretical expectation of the model. The operational difference between a hard and soft currency is that the exchange rate for the latter reflects not only the demand and supply of foreign exchange for transaction (balance-of-payments) purposes, but includes also an additional splice of “precautionary” demand for foreign exchange to be held as an asset. To the extent that hard-currency-country residents do not need to hedge their domestic-money-asset holdings by accumulating soft currency, the latter is bound to devalue. This asymmetry in demand for the “other” currency for asset-holding purposes is rooted in asymmetric reputation between the reserve/hard and the soft currency in free currency markets. It is precisely this asymmetry that characterizes serial devaluations and financial crises as predominantly soft-currency phenomena. The tendency then for soft currencies to have “high” nominal exchange rates in Equation (22) drives the *DNER* values below 1 (and to negative territory) thus indicating a perennially undervalued domestic currency. This is consistent with the finding of Yotopoulos (1996: Chapter 6) in the original study of exchange rate parity relying on *micro-PPP* data. Also, we can easily see that capital control is negatively related with the currency substitution/softness indicator, α , which is fully consistent with our theoretical framework in Section 2.1. Controls imposed on domestic agents engaging in capital flight, on the other hand, tend to moderate the degree of the currency substitution, and therefore of the undervaluation of the soft currency.

The second empirical finding relates to the negative relationship between the currency softness index and

per capita real *GDP* as is verified in Figure 5.¹⁶ To examine this relationship statistically, we regressed the estimated currency softness index on the per capita *GDP*. We also included the year dummy variables in order to control for a potential bias due to year-specific systematic effects. The estimation results are presented in Table 3. The coefficient of per capita *GDP* is negative and highly significant. This result confirms that there is a systematic relationship between the credibility of a currency and the level of economic development. This argument is consistent with the story that a less-developed country is more likely to be subjected to systematic devaluations due to its reputation-challenged currency. In fact, there might be a circular causation between a currency's softness and a country's low level of economic development. Unconstrained by controls, residents in a poor economy prefer holding the dollar because the domestic currency lacks in its credibility. A poor country, in turn, finds it difficult to establish its currency's reputation because of the low level of economic development. This two-way causality could conceivably turn into a poverty trap for a country at a low stage of economic development.

The obverse side of this finding holds that the best way for a soft currency to acquire reputation and therefore to act with impunity like a hard currency, e.g., by removing all controls, is for development to succeed. In other words, liberalizing the currency market as a policy (dis)intervention for promoting development amounts to putting the cart in front of the horse. A currency cannot become hard by behaving like a hard currency, i.e., by trading freely in the world's exchange markets. There is an appropriate sequence in the process of economic liberalization. Freeing the foreign exchange market comes towards the end of this process when the main business of development has been done (Yotopoulos, 1996: Chapter 11).

5. Speculative Attacks and Policy Implications

The first-generation models of financial crises have focused on balance-of-payments disequilibria and the collapse of the fundamentals of an economy. Our model, on the other hand, predicts that even under a prudent fiscal policy and with pristine economic fundamentals, strong currency substitution

¹⁶ Data on per capita real *GDP* is extracted from Summers and Heston (1991) Penn World Tables.

precipitates a devaluation that may turn into a financial crisis. The analytical distinction between the two approaches lies in the economic function of money that has been incorporated in each. By focusing on the balance of payments, the extant models of financial crises consider the function of money as a medium of exchange in the (international) market for goods and services. The currency substitution hypothesis considers also the role of money as a store of value. While all currencies can do service, better or worse, for transaction purposes, when used as store of value they are ranked in a definite pecking order from the reserve/hard, to the soft, and to the worthless currency in a decreasing order of usefulness. There is a positional continuum in holding currency as an asset based on its reputation. Reputation in this specific case means that there is a credible commitment to stability of currency prices relative to some other prices that matter – and this commitment is more credible, the closer a currency is to the reserve currency. Their inherent asset value places reserve currencies in central banks' reserves, and also makes them safe havens for international capital movements. By the same token, the demand for foreign exchange – and especially for reserve and hard currencies - becomes an important component in a representative agent's utility function regardless of the motivation for holding such assets, whether it is for portfolio diversification, speculation or hedging.

The underlying asymmetry in reputation between soft and hard currency implies a corresponding asymmetry in the determination of their respective exchange parities in a free currency market. While transactions demand for foreign exchange is the principal determining factor of the price of both hard and soft currencies, in the case of the latter the demand for foreign exchange for asset-holding purposes plays an important role in decreasing the price of the currency (devaluation) and in exacerbating exchange rate instability. Asymmetrically, the same demand by a soft-currency country drives the price of the hard currency to appreciation – and appreciation, if it becomes problematic, is easier to combat than depreciation. Soft currencies, as a result, are likely to be more “undervalued” (and more difficult to remedy) than hard currencies that may tend to become “overvalued.”. Herein lies the emblematic difference between the currency substitution hypothesis and the extant interpretations of currency crises. In the mainstream view devaluation always retains its salutary healing effects by matching supply and demand and storing up the current account, thus eventually improving the fundamentals. In the currency substitution alternative, on the other hand, devaluation will increase the value of the parameter $\frac{a_t}{z_{t+1}} > 0$ (in Section 3.4) thus leading to an increased demand of foreign exchange for asset holding

purposes. In this view, competitive price-setting of foreign exchange for a soft currency represents “bad competition” and can lead to “a race for the bottom,” i.e., to further serial devaluations. It becomes intuitively clear that this interpretation of the foreign exchange market for a soft currency amounts to a market incompleteness because of asymmetric reputation. This case corresponds fully to the parallel literature of incomplete credit markets for reasons of asymmetric information (Stiglitz and Weiss, 1981). The empirical implications of the two types of market incompleteness are also concordant. The policy implication of rationing foreign exchange and imposing a mildly repressed exchange rate replicates the need for credit controls for circumventing the “bad competition” and the “race for the bottom” that competitive price-setting implies for the credit market. Capital controls become expedient in the case of an incomplete foreign exchange market only to the extent that the inflow of financial capital contributes to fanning (cheap) currency substitution of the soft local currency. Otherwise, there is no need for imposing restrictions on direct foreign investment inflows or on outflows for the purpose of settling current account imbalances, or of repatriation of capital and profits (Yotopoulos, 1996, 1997; Yotopoulos and Sawada, 1999).

The case of speculative attacks on a currency, as made in the literature, is related to financial capital flows in the form of “hot money.” This is a special case of the currency-substitution-induced devaluation in the model where unregulated inflows of financial capital can increase the value of the parameter α . In a free currency market, where devaluation may happen, or it may not, the holder of the soft currency is offered a one-way-option: by substituting the hard currency for the soft, there is a capital gain to be reaped if devaluation happens, while there is not an equivalent loss if it does not. This one-way bet is also offered to the “speculator” who can sell short the soft currency. It is especially attractive to foreign fund managers who can borrow the soft currency locally by leveraging a few million dollars’ deposit into a peso loan with the proceeds, in turn, converted into dollars. This play of draining the Central Bank’s reserves makes the devaluation of the peso a self-fulfilling prophecy. And when devaluation comes, the international investor can pay back the loan in cents on the dollar and take his hot money across the Rio Grande.¹⁷ The entire process is initiated by taking advantage of the free currency

¹⁷ A variant of this approach, fine-tuned for the existence of a Monetary Board, was used by fund managers in Hong Kong in September 1998. By selling short the Hang Seng stock market and at the same time converting HK dollars into US dollars they helped deplete the Monetary Board’s reserves thus forcing

market to convert a soft-currency monetary asset into hard currency, thus asymmetrically increasing the asset-demand for the latter and leading to the depreciation of the former.

The testable implication of this view of the role that financial capital can play in devaluations and financial crises relates to the timing of capital outflow. The currency substitution hypothesis would predict that the outflow of capital takes place after the devaluation happens and once the capital gains from selling the soft currency short have been captured. This expectation is confirmed from IMF data indicating that in the case of the East Asian crises the outflow of capital happened in the fourth quarter of 1997, instead of the third quarter when the crises were being staged. In the final quarter of 1997 the flight of capital from Korea amounted to \$89 billion, or 18.9 percent of GDP, compared to a net inflow of capital of 0.7 percent of GDP for the third quarter. The same pattern held for the other crisis-countries also (in percent of GDP, with the third quarter figures in parentheses): Indonesia, -15.8 (3.3); Thailand -22.1 (-15.1); the Philippines -6.1 (9.0) – with Malaysian data lacking due to the exchange and capital controls that were imposed in August 1997 (Cho and Rhee, 1999; Yotopoulos and Sawada, 1999).

The literature advocating capital controls has emphasized the unpredictability of international financial flows that consist largely of short-term bank deposits where a sudden reversal of the inflows may quickly result in bank insolvencies and failures (e.g., Calvo, Leiderman, Reinhart, 1993). The policy recommended for controlling financial capital inflows envisions ratcheting the reserve requirements up to 100 percent for the shortest-maturity capital flows. The cost of dis-intermediation in capital flows that this intervention entails is more than offset by decreasing banks' exposure. In the currency-substitution view such intervention prevents the formation of an avalanche of one-way-options against the soft currency that is bound to lead to a financial crisis. Thus the cost of disintermediation in capital flows is further decreased.

Financial capital flows notwithstanding, the use of reserve requirements as an appropriate financial-sector reform has been widely discussed in the literature (Cole and Slade, 1998; Calvo,

a monetary contraction. The increase in interest rates that followed fuelled a shift in assets from stocks to bonds, and a sharp decline in the stock market that rewarded the speculators with profits on their shorts. The scheme came to an abrupt end when the Hong Kong authorities intervened in support of the stock market (Yotopoulos and Sawada, 1999).

Leiderman, and Reinhart, 1993). Inappropriately low reserve requirements encourage domestic banks to undertake risky projects that ultimately may result in bank insolvencies. On the other hand, prudent reserve requirements contribute to reducing the risks of private banks through imposing high capital-to-risk-asset ratios and thus inducing banks to hold low-risk assets. Moreover, the central bank can use the rent created by reserve requirements to cover capital deficiencies in the event that banks became insolvent and need arises to have them be merged, sold, or liquidated. Such policy recommendations are consonant with the model of currency substitution that champions a conservative fiscal and monetary policy for avoiding a currency-substitution-led devaluation. To verify the importance of this intervention note that a lower money multiplier will put off the timing of the collapse of the fixed exchange rate regime since $\partial T / \partial m < 0$. Recall that the money multiplier is defined as $m = (c+1)/(c+r_D+d)$, where c , r_D , and d represent the currency-deposit ratio, the required reserve ratio, and the excess reserve-deposits ratio, respectively. Therefore, we can easily see that increasing the required reserve ratio will postpone the BOP crisis.

6. Conclusions

Since 1980 three-quarters of member-countries of the IMF, developed, developing, and emerging alike, have been hit by financial crises. In the 1990s financial crises became especially virulent occurrences. The “fundamentals” models of financial crises can still do service in explaining financial crises only with an increasing dose of willing suspension of disbelief.

This paper extends the first-generation models of financial crises to allow for a systematic devaluation of soft currencies that is independent of the fundamentals of an economy. In a globalized world of free foreign exchange rates and free capital movements, the demand for ratcheting up the quality of a currency used as an asset increases. Currency substitution in favor of the reserve currency (currencies) becomes an exogenous factor relating to currency as a positional good, and leads to systematic devaluation of the soft currency – and eventually to crises.

The seemingly simple extension that we introduce into the “fundamentals model” of financial crises has empirical and policy implications that can prove germane in approaching “speculative attacks” on currencies and in assessing the dioramas for the “new architecture” of the international financial

system. In the fundamentals approach to financial crises devaluation has remedial effects on the balance of payments and a transfusion of foreign capital helps shore up the reserves of the central bank and restore confidence in the currency. Devaluation and fresh capital inflows are the remedies to financial crises. In our extension of the fundamentals model, on the other hand, devaluation can be the validation of systematically substituting in liquid asset-holdings the foreign currency for the domestic. Should this be the case, devaluation will further increase the tendency for currency substitution; and emergency lending for shoring up the currency is likely to end up in portfolios of maximizing agents, whether under the mattress or in foreign tax havens. In the latter case abrogating the free currency market for asset-holding purposes is an orthodox macroeconomic tool that can stymie the tendency of “speculators”, let alone of local kleptocrats, to funnel emergency loans of foreign exchange into their offshore bank accounts.

Appendix A: derivation of the first-order conditions

We can solve the maximization problem of (1) subject to the intertemporal budget constraint by setting up the following Lagrange function:

$$(A1) \quad L_t = \sum_{s=t}^{\infty} \mathbf{r}^{s-t} \left\{ \mathbf{q}u(C_s) + (1-\mathbf{q}) \left[\mathbf{g} \log\left(\frac{M_{1s}}{P_s}\right) + (1-\mathbf{g}) \log\left(\frac{\mathbf{e}_s M_{Fs}}{P_s}\right) \right] \right\} \\ + \sum_{s=t}^{\infty} \mathbf{l}_s \left[(1+r)B_s + \frac{M_{1s-1}}{P_t} + \frac{\mathbf{e}_s M_{Fs-1}}{P_s} + Y_t - C_t - B_{s+1} - \frac{M_{1s}}{P_t} - \frac{\mathbf{e}_s M_{Fs}}{P_s} \right],$$

where \mathbf{l} 's denote Lagrange multiplier. Then we obtain the following first-order conditions with respect to C_t , C_{t+1} , B_{t+1} , M_{1t} , and M_{Ft} , respectively:

$$(A2) \quad \mathbf{q}u'(C_t) = \mathbf{l}_t,$$

$$(A3) \quad \mathbf{r}\mathbf{q}u'(C_{t+1}) = \mathbf{l}_{t+1},$$

$$(A4) \quad (1+r)\mathbf{l}_{t+1} = \mathbf{l}_t,$$

$$(A5) \quad \frac{(1-\mathbf{q})\mathbf{g}}{M_{1t}} + \frac{\mathbf{l}_{t+1}}{P_{t+1}} - \frac{\mathbf{l}_t}{P_t} = 0,$$

$$(A6) \quad \frac{(1-\mathbf{q})(1-\mathbf{g})}{M_{Ft}} + \frac{\mathbf{l}_{t+1}\mathbf{e}_{t+1}}{P_{t+1}} - \frac{\mathbf{l}_t\mathbf{e}_t}{P_t} = 0.$$

Combining (A2), (A3), and (A4), together with no-consumption tilting condition, $(1+r)\mathbf{r} = 1$, we have a standard Euler equation.

$$(A7) \quad u'(C_t) = u'(C_{t+1}).$$

We can rewrite (A5) by using (A2), (A3), and (A7):

$$(A8a) \quad \frac{(1-\mathbf{q})\mathbf{g}}{M_{1t}} + \frac{\mathbf{r}\mathbf{q}u'(C_t)}{P_{t+1}} - \frac{\mathbf{q}u'(C_t)}{P_t} = 0,$$

This equation (A8a) gives the domestic money demand function:

$$(A8b) \quad \frac{M_{1t}}{P_t} = \left(\frac{1-\mathbf{q}}{\mathbf{q}} \right) \mathbf{g} [u'(C_t)]^{-1} \left(\frac{1+i_{t+1}}{i_{t+1}} \right),$$

where i is nominal interest rate, i.e., $i_{t+1} = (1+r)(P_{t+1}/P_t) - 1$. Similarly, from (A6) combined with (A2), (A3), and (A7) we obtain

$$(A9a) \quad \frac{(1-\mathbf{q})(1-\mathbf{g})}{M_{Ft}} + \frac{\mathbf{r}\mathbf{q}u'(C_t)\mathbf{e}_{t+1}}{P_{t+1}} - \frac{\mathbf{q}u'(C_t)\mathbf{e}_t}{P_t} = 0.$$

which gives the foreign money demand function as follows:

$$(A9b) \quad \frac{\mathbf{e}_t M_{Ft}}{P_t} = \left(\frac{1-\mathbf{q}}{\mathbf{q}} \right) (1-\mathbf{g}) [u'(C_t)]^{-1} \left(\frac{1+i_{t+1}}{i_{t+1} - z_{t+1}} \right)$$

where z_{t+1} is (future) devaluation rate, i.e., $\mathbf{e}_{t+1}/\mathbf{e}_t = 1 + z_{t+1}$.

Appendix B: derivation of the currency substitution variable

Combining equations (A8b) and (A9b) yields

$$(B1) \quad \mathbf{a}_t = \frac{\mathbf{e}_t M_{Ft}}{\mathbf{e}_t M_{Ft} + M_{1t}} = \frac{\frac{1-g}{i_{t+1} - z_{t+1}}}{\frac{1-g}{i_{t+1} - z_{t+1}} + \frac{g}{i_{t+1}}} = \frac{(1-g)i_{t+1}}{i_{t+1} - g z_{t+1}},$$

where i_t is the nominal interest rate, which is defined by the following expression: $i_{t+1} = (1+r)(P_{t+1}/P_t) - 1$. We can easily show that $\partial \mathbf{a}_t / \partial z_{t+1} > 0$, indicating that exchange rate devaluation will induce currency substitution under the assumption of sticky prices. What happens when the prices adjust instantaneously? To see this, we assume that the purchasing power parity (PPP) condition holds because of the instantaneous and complete price adjustments. In this case, we have $P_t = \mathbf{e}_t P^*$, where P^* is the foreign price level which is assumed to be constant to avoid unnecessary complications, while our qualitative results will not change in the following relevant argument even if we assume that P^* is not constant. Then equation (5) becomes

$$(B2) \quad \mathbf{a}_t = \frac{(1-g)[(1+r)(1+z_{t+1})-1]}{[(1+r)(1+z_{t+1})-1]-g z_{t+1}} = \frac{(1-g)[r+(1+z_{t+1})]}{r+(1+r-g)z_{t+1}}$$

Then we can show that

$$(B3) \quad \begin{aligned} \frac{\partial \mathbf{a}_t}{\partial z_{t+1}} &= \frac{(1-g)(1+r)}{r+(1+r-g)z_{t+1}} - \frac{(1-g)[r+(1+r)z_{t+1}]}{[r+(1+r-g)z_{t+1}]^2} (1+r-g) \\ &= \frac{(1-g)(1+r)[r+(1+r-g)z_{t+1}] - (1-g)[r+(1+r)z_{t+1}](1+r-g)}{[r+(1+r-g)z_{t+1}]^2} \\ &= \frac{(1-g)\{(1+r)[r+(1+r-g)z_{t+1}] - [r+(1+r)z_{t+1}](1+r-g)\}}{[r+(1+r-g)z_{t+1}]^2} \\ &= \frac{(1-g)\{(1+r)r - r(1+r-g)\}}{[r+(1+r-g)z_{t+1}]^2} \\ &= \frac{(1-g)rg}{[r+(1+r-g)z_{t+1}]^2} > 0 \end{aligned}$$

This comparative statics result indicates that currency substitution is induced by (future) devaluation. Facing fears of depreciation of the foreign exchange rate, households optimally switch their domestic currency to foreign currency, in order to maximize their intertemporal utility.

Appendix C: proof of the proposition 1

The above comparative statics results hold in general, regardless of the speed of price adjustment. It is summarized by the following proposition:

Proposition 1 (Devaluation-induced Currency Substitution): *Regardless of the adjustment speed of goods prices, a (future) devaluation induces currency substitution unambiguously.*

Proof: Let ω represents the speed of goods price adjustments, where $1 \geq \omega \geq 0$. Then, assuming P^* is constant, the domestic inflation rate in equation (3b) can be represented as a weighted average of devaluation rate and domestic inflation rate, i.e., $P_{t+1}/P_t = (1-\omega)(1+z_t) + \omega(P_{t+1}/P_t)$. Note that $\omega=1$ is the case of instantaneous price adjustment, while $\omega=0$ represents the case of completely sticky price. In this case, the currency substitution parameter becomes:

$$a_t = \frac{(1-g)\{(1+r)[w(1+z_{t+1}) + (1-w)(P_{t+1}/P_t)] - 1\}}{\{(1+r)[w(1+z_{t+1}) + (1-w)(P_{t+1}/P_t)] - 1\} - g z_{t+1}}. \text{ Let } \Pi_{t+1} \equiv w(1+z_t) + (1-w)(P_{t+1}/P_t).$$

Then, it is straightforward to show that

$$\begin{aligned} \frac{\partial a_t}{\partial z_{t+1}} &= \frac{(1-g)(1+r)w}{[(1+r)\Pi_{t+1} - 1] - g z_{t+1}} - \frac{(1-g)[(1+r)\Pi_{t+1} - 1][(1+r)w - g]}{\{[(1+r)\Pi_{t+1} - 1] - g z_{t+1}\}^2} \\ &= \frac{(1-g)(1+r)w\{[(1+r)\Pi_{t+1} - 1] - g z_{t+1}\} - (1-g)[(1+r)\Pi_{t+1} - 1][(1+r)w - g]}{\{[(1+r)\Pi_{t+1} - 1] - g z_{t+1}\}^2} \\ &= \frac{(1-g)\{-(1+r)w g z_{t+1} + [(1+r)\Pi_{t+1} - 1]g\}}{\{[(1+r)\Pi_{t+1} - 1] - g z_{t+1}\}^2} \\ &= \frac{(1-g)[(1+r)(\Pi_{t+1}g - w g z_{t+1}) - g]}{\{[(1+r)\Pi_{t+1} - 1] - g z_{t+1}\}^2} \\ &= \frac{(1-g)g\{(1+r)[w + (1-w)(P_{t+1}/P_t)] - 1\}}{\{[(1+r)\Pi_{t+1} - 1] - g z_{t+1}\}^2} > 0, \end{aligned}$$

given $z_{t+1} \geq 0$ and $P_{t+1}/P_t \geq 1$. *Q.E.D.*

References

- Agénor, Pierre-Richard (1994), "Credibility and Exchange Rate Management in Developing Countries," *Journal of Development Economics*, 45 (October): 1-15.
- Barro, Robert J. and David B. Gordon (1983), "Rules, Discretion and Reputation in a Model of Monetary Policy," *Journal of Monetary Economics*, 12 (July): 101-121.
- Blanchard, Oliver and Stanley Fischer (1989), *Lectures on Macroeconomics*. Cambridge, MA: MIT Press.
- Baumol, William (1952), "The Transactions Demand for Cash: An Inventory Theoretic Approach," *Quarterly Journal of Economics*, 66: 545-556.
- Calvo, Guillermo A. and Carlos Végh (1996), "From Currency Substitution to Dollarization and Beyond: Analytical and Policy Issues," in Guillermo A. Calvo, *Money, Exchange Rates and Output*. Boston, MA: MIT Press.
- Calvo, Guillermo A., Leonardo Leiderman, and Carmen M. Reinhart (1993), "Capital Inflows and Real Exchange Rate Appreciation in Latin America," *IMF Staff Papers*, 40 (1): 108-151.
- Cavallari, Lilia and Giancarlo Corsetti (2000), "Shadow Rates and Multiple Equilibria in the Theory of Currency Crisis," *Journal of International Economics*, 51: 275-286.
- Cho, Yoon Je and Changyong Rhee (1999), "Macroeconomic Adjustment of the East Asian Economies after the Crisis: A Comparative Study," *Seoul Journal of Economics*, 12 (winter): 347-389.
- Clower, Robert W. (1967), "A Reconsideration of the Microfundamentals of Monetary Theory," *Western Economic Journal*, 6: 1-19.
- Cole, David C. and Betty F. Slade (1998), "The Crisis and Financial Sector Reform," *ASEAN Economic Bulletin*, 15 (3): 338-346.
- Eichengreen, Barry, Andrew K. Rose, and Charles Wyplosz (1994), "Speculative Attacks on Pegged Exchange Rates: An Empirical Exploration with Special Reference to the European Monetary System." *NBER Working Paper* No. 4898.
- Ernst & Whinney (various years), *Foreign Exchange Rates and Restrictions*.
- Feenstra, Robert (1986), "Functional Equivalence between Liquidity Costs and the Utility of Money," *Journal of Monetary Economics*, 17: 271-291.

- Flood, Robert and Peter Garber (1984), "Collapsing Exchange Rate Regimes: Some Linear Examples," *Journal of International Economics*, 17(August): 1-13.
- Flood, Robert and Nancy P. Marion (2000), "Self-fulfilling Risk Predictions: An Application to Speculative Attacks," *Journal of International Economics*, 50: 245-268.
- Frank, Robert H. (1985), *Choosing the Right Pond*. New York: Oxford University Press.
- Frank, Robert H. and Philip J. Cook (1976), *The Winner-Take-All Society: Why the Few at the Top Get So Much More Than the Rest of Us*. New York: Penguin.
- Girton, Lance and Don Roper (1981), "Theory and Implications of Currency Substitution," *Journal of Money, Credit and Banking*, 13 (1): 12-30.
- Giovamini, Alberto and Bart Turtelboom (1994), "Currency Substitution," in Frederick van der Ploeg, ed., *The Handbook of International Macroeconomics*. Oxford: Basil Blackwell.
- Hirsh, Fred (1976), *Social Limits to Growth*. Cambridge, MA: Harvard University Press.
- Kareken, John and Neil Wallace (1981), "On the Indeterminacy of Equilibrium Exchange Rates," *Quarterly Journal of Economics*, 96 (2): 207-222.
- Keynes, John Maynard (1923), *A Tract for Monetary Reform*. New York: Macmillan.
- Kravis, Irving B., Alan Heston and Robert Summers (1982), *World Product and Income: International Comparisons of Real Gross Product*. Baltimore, MD: Johns Hopkins.
- Krugman, Paul R. (1979) "A Model of Balance-of-Payments Crises," *Journal of Money, Credit and Banking*, 11: 311-25.
- Lucas, Robert and Nancy L. Stokey (1987), "Money and Interest in a Cash-in-Advance Economy," *Econometrica*, 55 (May): 491-513.
- McKinnon, Ronald.I. (1979), *Money in International Exchange*. New York: Oxford University Press.
- Obstfeld, M. (1996), "Models of Currency Crisis with Self-fulfilling Features," *European Economic Review*, 40: 1037-1047.
- Obstfeld, Maurice and Kenneth Rogoff (1996), *Foundations of International Macroeconomics*. Cambridge, MA: MIT Press.

- Pagano, Ugo (1999), "Is Power an Economic Good? Notes on Social Scarcity and the Economics of Positional Goods," in Samuel Bowles, Maurizio Franzini and Ugo Pagano, eds., *The Politics and Economics of Power*. London: Routledge. Pp. 63-84.
- Sidrauski, Miguel (1967), "Rational Choice and Patterns of Growth in a Monetary Economy," *American Economic Review*, 57 (2): 534-544.
- Stiglitz, Joseph E. and Andrew Weiss (1981), "Credit Rationing in Markets with Imperfect Information," *American Economic Review*, 71 (June): 393-410.
- Summers, Robert and Alan Heston (1991), "The Penn World Table (Mark 5): An Expanded Set of International Comparisons, 1950-1988," *Quarterly Journal of Economics*, 106 (May): 327-368. Homepage: <http://pwt.econ.upenn.edu>
- Tobin, James (1956), "The Interest Rate Elasticity of Transactions Demand for Cash," *Review of Economics and Statistics*, 38: 241-247.
- Uribe, Martin (1997), "Hysteresis in a Simple Model of Currency Substitution," *Journal of Monetary Economics* 40, 185-202.
- Wood, Adrian (1999), "Data on Black Market Premium." University of Sussex, Institute of Development Studies (Compact Disk).
- Yotopoulos, Pan A. (1996), *Exchange Rate Parity for Trade and Development: Theory, Tests, and Case Studies*. London and New York: Cambridge University Press.
- Yotopoulos, Pan A. (1997), "Financial Crises and the Benefits of Mildly Repressed Exchange Rates." Stockholm School of Economics Working Paper Series in Economics and Finance, No. 202 (October).
- Yotopoulos, Pan A. and Yasuyuki Sawada (1999), "Free Currency Markets, Financial Crises and the Growth Debacle: Is There a Causal Relationship?" *Seoul Journal of Economics*, 12 (winter): 419-456..

Table 1
Summary Statistics

Variable Name	Mean (Standarddeviation)
Black market premium (%)	4.03 (.57)
Yotopoulos' exchange rate distortion index	-0.171 (0.304)
Per capita GDP	6781.64 (3884.00)
Number of observations	75

Table 2
Estimation of the Currency Softness Index

[Equation (19a)]
Dependent Variable = black market premium, *BP*

Variable Name	Coefficient (t-statistics)
Log <i>NER</i> distortion index (<i>lnDNER</i>)	1 ⁺
Capital control dummy (=1 if foreign capital is controlled)	0.458 (7.70)***
Year dummy for 1980	0.018 (0.23)
Year dummy for 1985	0.293 (3.90)***
Constant	-0.118 (1.863)*
Number of Observations	75
R-squared	0.491

Note 1) + indicates the coefficient is constrained to be one

Note 2) *** and * indicate statistical significance at 1% and 10%, respectively

Table 3
The Relationship between the Softness Index and Income Level

Dependent Variable = the currency softness index [Equation (20)]

Variable Name	Coefficient (t-statistics)
Summers and Heston (1991``) Real GDP per capita (thousand dollars)	-0.025 (3.765)***
Year dummy for 1980	-0.007 (0.097)
Year dummy for 1985	0.061 (0.89)
Constant	0.153 (1.983)*
Number of observations	75
R-squared	0.140

Note: *** and * indicate statistical significance at 1% and 10%, respectively

Figure 1
Timing of the Crisis

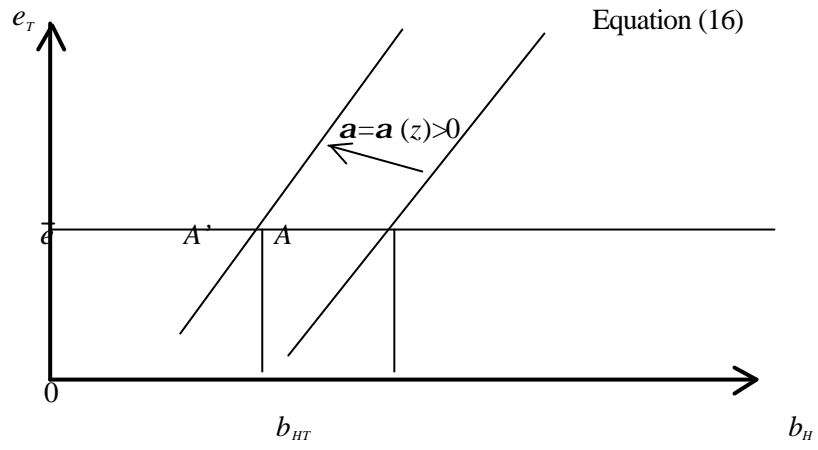
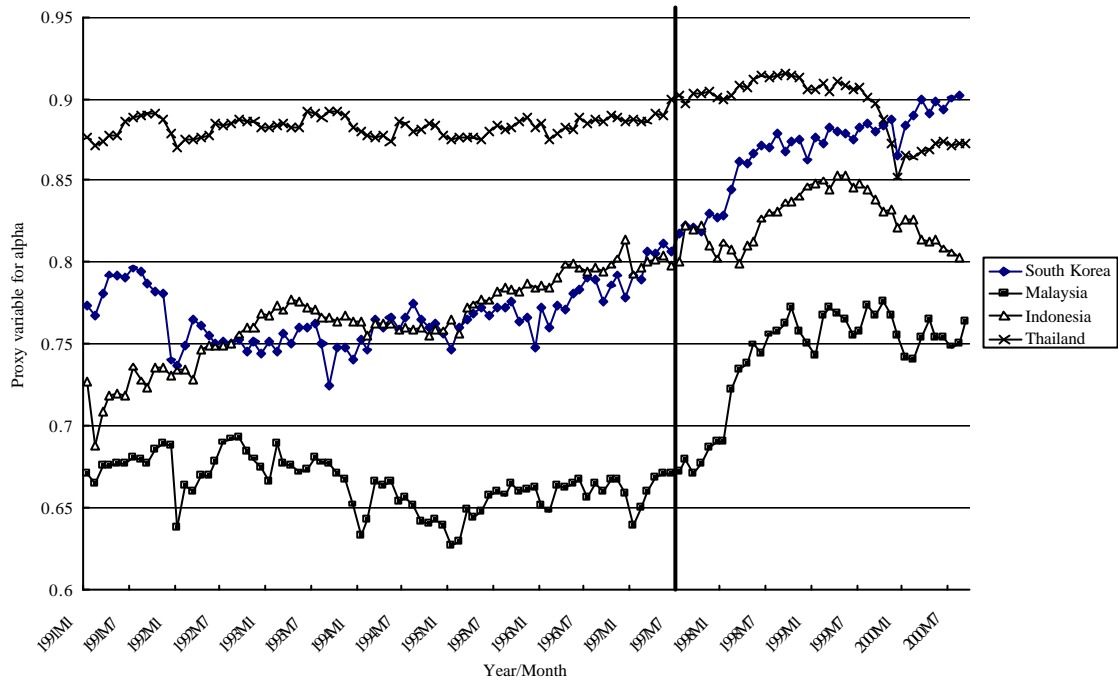


Figure 2
Estimated Currency Substitution Variable



Data Source: IMF, *International Financial Statistics*.

Figure 3-a
Determination of Equilibrium PPP Exchange Rate
Through International Trade of Goods

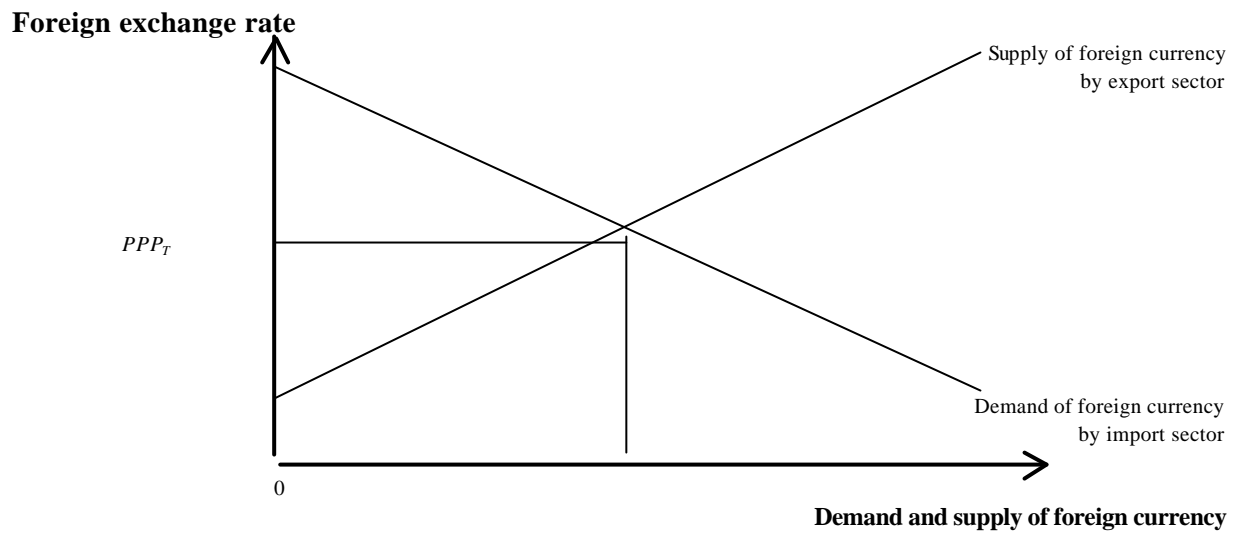


Figure 3-b
Determination of Equilibrium Exchange Rate
Under PPP and Perfect Capital Mobility

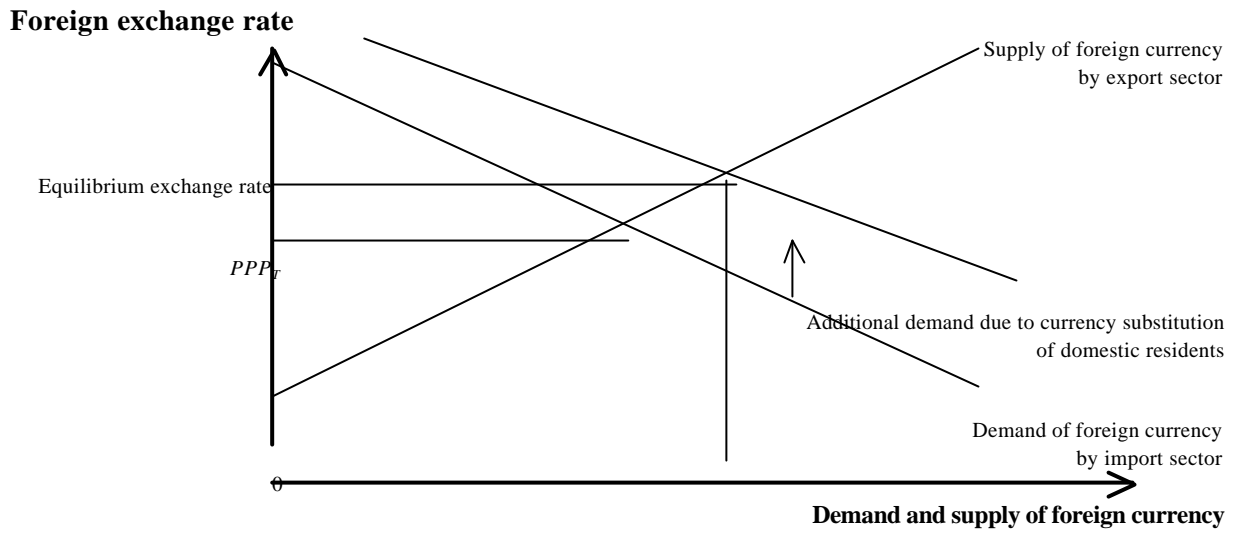


Figure 3-c
Determination of Equilibrium Exchange Rate
Under PPP and Strict Capital Control

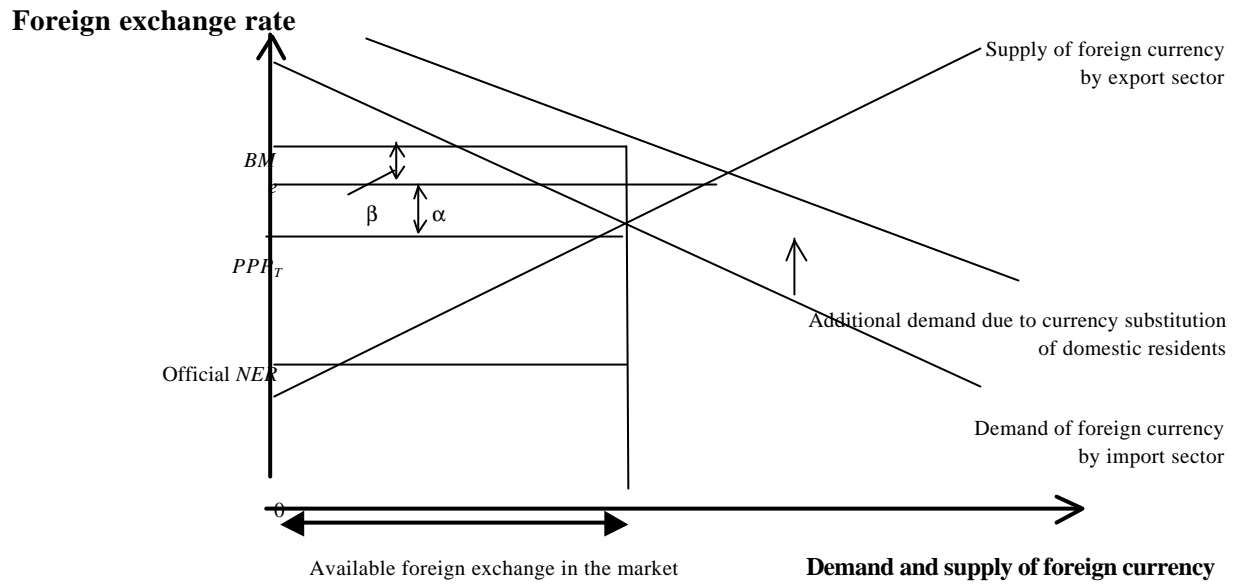
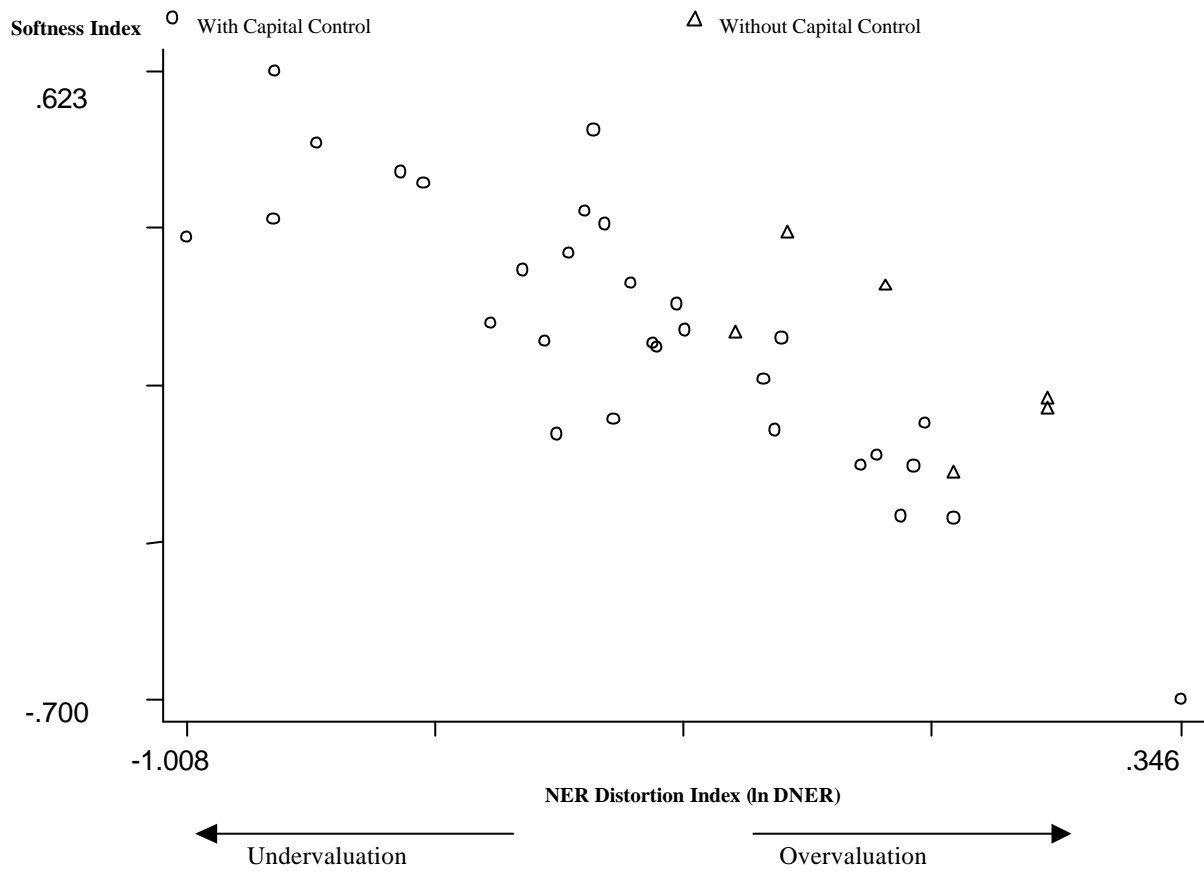


Figure 4
Currency Softness Index and Nominal Exchange Rate Distortion Index
(Pooled data of 1975, 80, and 85)



Note: The above table does not contain the samples with BP=0. In these cases, the softness index and the NER distortion index are linearly dependent by construction.

Figure 5
Currency Softness Index and Level of Economic Development
(Pooled data of 1975, 80, and 85)

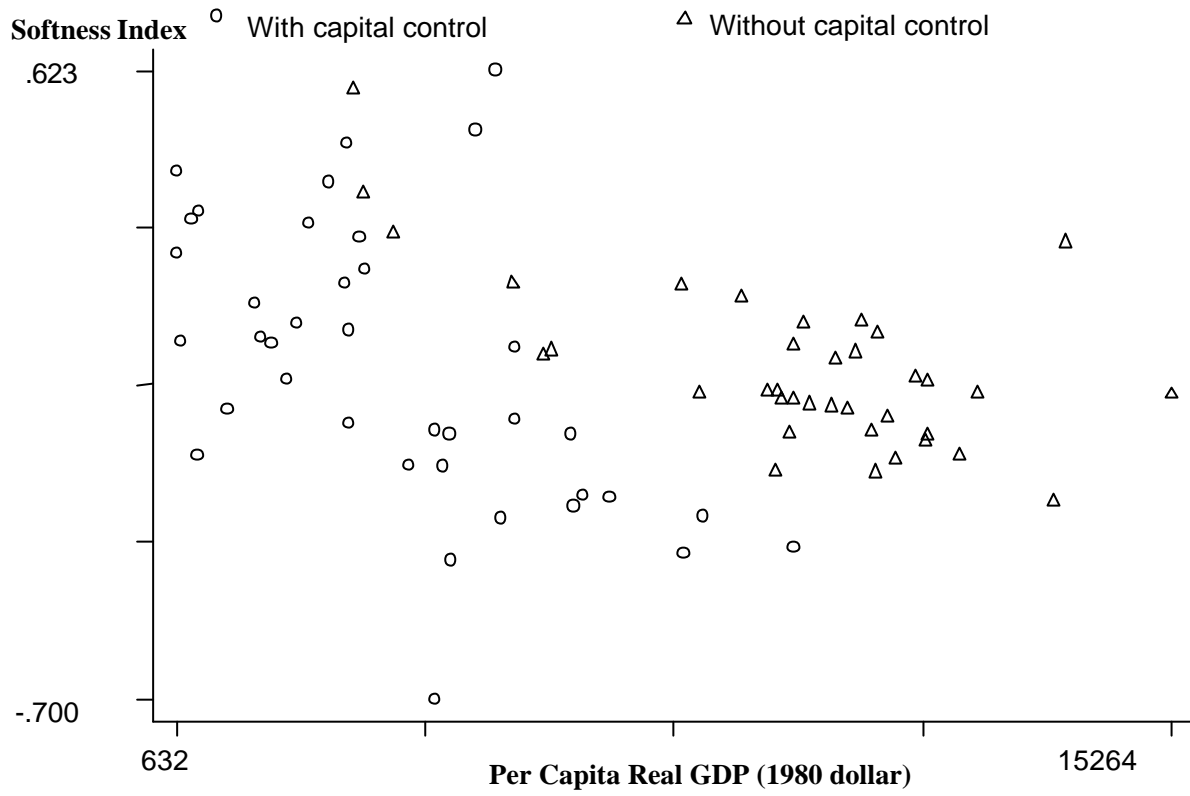


Table A1
Basic Data Based on Micro ICP

Country (Data Quality)		YEAR	RPL(T)	NER dist.	Per capita GDP
			PPP ^T / _e	ln DNER	RGDPCH
Australia	A-	1985	0.884	-0.123	12422.6
Austria	A-	1985	0.824	-0.194	10322.2
Belgium	A	1985	0.811	-0.209	10617.4
Canada	A-	1985	0.887	-0.120	15264.4
Denmark	A-	1985	0.968	-0.033	11685
Finland	A-	1985	1.017	0.017	11221.2
France	A	1985	0.854	-0.158	11489.8
Germany	A	1985	0.862	-0.149	11671.8
Greece	A-	1985	0.653	-0.426	5614
Hungary	B	1985	0.412	-0.887	5328
India	C	1985	0.595	-0.519	696.6
Ireland	A-	1985	0.816	-0.203	6031
Jamaica	C	1985	0.552	-0.594	2393
Japan	A	1985	1.037	0.036	10907
Kenya	C	1985	0.411	-0.889	859
Netherlands	A	1985	0.771	-0.260	10937
New Zealand	A-	1985	0.763	-0.270	9848.6
Norway	A-	1985	1.112	0.106	13521
Poland	B	1985	0.507	-0.679	3844
Portugal	A-	1985	0.604	-0.504	4643
Spain	A-	1985	0.696	-0.362	6605
Sweden	A-	1985	1.01	0.010	12158
Turkey	C	1985	0.365	-1.008	3317
Uk	A	1985	0.76	-0.274	10715

(Source) Background estimation of Yotopoulos (1996), Summers and Heston (1991)

Table A1
Basic Data Based on Micro ICP (continued)

Country (Data Quality)		YEAR	RPL(T)	NER dist.	Per capita GDP
			PPP ^{7/e}	ln DNER	RGDPCH
Argentina	C	1980	1.414	0.346	4437
Austria	A-	1980	1.163	0.151	9453.4
Belgium	A	1980	1.198	0.181	10248.4
Bolivia	C	1980	0.82	-0.198	1852
Canada	A-	1980	0.847	-0.166	13713.8
Chile	C	1980	0.914	-0.090	4045
Colombia	C	1980	0.577	-0.550	3392
Costa Rica	C	1980	0.826	-0.191	3827
Dom Rep	C	1980	0.801	-0.222	2250
Ecuador	C	1980	0.668	-0.403	3092
El Salvador	C	1980	0.7	-0.357	1898
France	A	1980	1.224	0.202	11088.8
Germany	A	1980	1.26	0.231	10850.4
Greece	A-	1980	1.038	0.037	5408
Guatemala	C	1980	0.645	-0.439	2574
Honduras	C	1980	0.766	-0.267	1376
Hungary	B	1980	0.636	-0.453	5034
India	C	1980	0.489	-0.715	641
Ireland	A-	1980	1.065	0.063	6150
Israel	B	1980	0.966	-0.035	8369
Italy	A	1980	1.023	0.023	9714
Japan	A	1980	1.181	0.166	9534
Kenya	C	1980	0.628	-0.465	951
Korea Rp	B-	1980	0.719	-0.330	3174
Mexico	C	1980	0.692	-0.368	5621
Netherlands	A	1980	1.179	0.165	10503.2
Norway	A-	1980	1.292	0.256	11635.8
Panama	C	1980	0.763	-0.270	3368
Peru	C	1980	0.436	-0.830	3141
Philpnes	C	1980	0.688	-0.374	2026
Portugal	A-	1980	0.813	-0.207	4439
Spain	A-	1980	0.939	-0.063	6476
U.K	A	1980	1.054	0.053	9696.4
Venezuela	C	1980	0.921	-0.082	7000
Yugoslavia	B	1980	0.983	-0.017	4551

(Source) Background estimation of Yotopoulos (1996), Summers and Heston (1991)

Table A1
Basic Data Based on Micro ICP (continued)

Country (Data Quality)	YEAR	RPL(T)	NER dist.	Per capita GDP	
		PPP ^{T/e}	ln DNER	RGDPCH	
Austria	A-	1975	1.186	0.171	8331.6
Belgium	A	1975	1.183	0.168	9326.2
Colombia	C	1975	0.504	-0.685	2861
Denmark	A-	1975	1.397	0.334	9433.2
France	A	1975	1.214	0.194	9950.6
Germany	A	1975	1.293	0.257	9634.2
India	C	1975	0.614	-0.488	632
Ireland	A-	1975	0.941	-0.061	5568.2
Italy	A	1975	1.055	0.054	8088.6
Jamaica	C	1975	0.998	-0.002	3174
Japan	A	1975	0.946	-0.056	8053
Kenya	C	1975	0.933	-0.069	938
Malaysia	C	1975	0.626	-0.468	3217
Mexico	C	1975	1.07	0.068	4671
Netherlands	A	1975	1.179	0.165	9702.8
Philippines	C	1975	0.711	-0.341	1764
Spain	A-	1975	0.821	-0.197	6434.6
U.K	A	1975	0.969	-0.031	8943
Yugoslavia	B	1975	0.901	-0.104	3689

(Source) Background estimation of Yotopoulos (1996), Summers and Heston (1991)

Table A1
Basic Data Based on Micro ICP (continued)

Country (Data Quality)	YEAR	RPL(T)	NER dist.	Per capita GDP	
		PPP ^{7/e}	ln DNER	RGDPCH	
Belgium	A	1970	0.863	-0.147	7764.8
France	A	1970	0.913	-0.091	8458.8
Germany	A	1970	0.974	-0.026	8506.2
India	C	1970	0.57	-0.562	648
Italy	A	1970	0.874	-0.135	6817.8
Japan	A	1970	0.802	-0.221	6544
Kenya	C	1970	0.514	-0.666	801
Korea	B-	1970	0.502	-0.689	1712
Malaysia	C	1970	0.445	-0.810	2435
Netherlands	A	1970	0.827	-0.190	8362
Philippines	C	1970	0.617	-0.483	1499
U.K.	A	1970	0.745	-0.294	7992.4

(Source) Background estimation of Yotopoulos (1996), Summers and Heston (1991)

Table A2
Basic Data for Estimating the Relationship between Income Level and Currency Softness

Country	Black Market Premium (%)	Year	NER Distortion Index	Per Capital Real GDP	Dummy for Capital Control	Currency Softness Index
Country	bmp	year	ln DNER	Rgdpch	Control	alpha
Argentina	0.33	1980	0.346	4437	1	-0.70
Australia	0.00	1985	-0.123	12422.6	0	-0.05
Austria	0.00	1975	0.171	8331.6	0	-0.05
Austria	0.00	1980	0.151	9453.4	0	-0.05
Austria	0.00	1985	-0.194	10322.2	0	0.02
Belgium	0.00	1975	0.168	9326.2	0	-0.05
Belgium	0.00	1980	0.181	10248.4	0	-0.08
Belgium	0.00	1985	-0.209	10617.4	0	0.03
Bolivia	22.00	1980	-0.198	1852	1	0.06
Canada	0.00	1980	-0.166	13713.8	0	0.27
Canada	0.00	1985	-0.12	15264.4	0	-0.06
Chile	5.90	1980	-0.09	4045	1	-0.21
Colombia	4.26	1975	-0.685	2861	1	0.39
Colombia	1.14	1980	-0.55	3392	1	0.20
Costa Rica	-0.48	1980	-0.191	3827	0	0.29
Denmark	0.00	1975	0.334	9433.2	0	-0.22
Denmark	0.00	1985	-0.033	11685	0	-0.14
Dom Rep	10.74	1980	-0.222	2250	1	-0.03
Ecuador	13.00	1980	-0.403	3092	1	0.18
Finland	0.00	1985	0.017	11221.2	0	-0.19
France	0.00	1975	0.194	9950.6	0	-0.08
France	0.00	1980	0.202	11088.8	0	-0.10
France	0.00	1985	-0.158	11489.8	0	-0.02
Germany	0.00	1975	0.257	9634.2	0	-0.14
Germany	0.00	1980	0.231	10850.4	0	-0.13
Germany	0.00	1985	-0.149	11671.8	0	-0.03
Greece	7.43	1980	0.037	5408	1	-0.32
Greece	9.61	1985	-0.426	5614	1	-0.11
Guatemala	22.00	1980	-0.439	2574	1	0.30
Honduras	0.00	1980	-0.267	1376	1	-0.09

Table A2 (continued)

Basic Data for Estimating the Relationship between Income Level and Currency Softness

Country	Black Market Premium (%)	Year	NER Distortion Index	Per Capital Real GDP	Dummy for Capital Control	Currency Softness Index
Country	bmp	year	ln DNER	Rgdpch	Control	alpha
Ireland	0.00	1980	0.063	6150	0	0.04
Ireland	0.00	1985	-0.203	6031	0	0.03
Ireland	0.00	1975	-0.061	5568.2	0	0.18
Israel	0.66	1980	-0.035	8369	1	-0.32
Italy	0.00	1975	0.054	8088.6	1	-0.39
Italy	0.00	1980	0.023	9714	1	-0.38
Jamaica	21.98	1975	-0.002	3174	1	-0.12
Jamaica	12.86	1985	-0.594	2393	1	0.09
Japan	-0.05	1975	-0.056	8053	0	0.17
Japan	0.00	1980	0.166	9534	0	-0.07
Japan	-0.82	1985	0.036	10907	0	-0.22
Kenya	8.35	1975	-0.069	938	1	-0.19
Kenya	21.91	1980	-0.465	951	1	0.33
Kenya	5.53	1985	-0.889	859	1	0.31
Korea Rp	10.47	1980	-0.33	3174	1	0.08
Malaysia	0.00	1975	-0.468	3217	0	0.59
Mexico	0.00	1975	0.068	4671	1	-0.41
Mexico	3.18	1980	-0.368	5621	1	0.04
Netherlands	-1.90	1975	0.165	9702.8	0	-0.07
Netherlands	-2.13	1980	0.165	10503.2	0	-0.09
Netherlands	-1.05	1985	-0.26	10937	0	0.07
New Zealand	0.00	1985	-0.27	9848.6	0	0.09
Norway	0.00	1980	0.256	11635.8	0	-0.16
Norway	0.00	1985	0.106	13521	0	-0.28
Panama	0.00	1980	-0.27	3368	0	0.37
Peru	-0.05	1980	-0.83	3141	1	0.47
Philippines	13.18	1975	-0.341	1764	1	0.13
Philippines	3.29	1980	-0.374	2026	1	0.05
Portugal	1.62	1980	-0.207	4439	1	-0.13
Portugal	-1.35	1985	-0.504	4643	1	-0.14
Spain	0.00	1975	-0.197	6434.6	1	-0.14