SHOULD SMALL OPEN ECONOMIES IN EAST ASIA KEEP ALL THEIR EGGS IN ONE BASKET: THE ROLE OF BALANCE SHEET EFFECTS

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Abstract

Yen-dollar fluctuations increase macroeconomic instability in small economies in East Asia. I investigate the choice of an exchange rate regime for these countries so as to minimize the adverse effects of this volatility. I build a sticky-price dynamic model of a small economy whose trade is invoiced in dollar and yen. First, I show the conditions under which pegging to a trade-weighted basket of the two currencies is the optimal policy for the small economy. Then, I introduce net worth constraints and unhedged dollar borrowing which pull the optimal policy away toward putting a much greater weight on the dollar.

Keywords: East Asia, optimal basket pegs, balance sheet effects, exchange rate regimes

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1. Introduction

Ever since the end of the Bretton Woods system of fixed exchange rates, the world's three major currencies have fluctuated widely against one another. Figure 1 illustrates the tremendous volatility in the euro-dollar and yen-dollar exchange rates since the 1970s.[2] Given that the United States, the Euro Area, and Japan are very large and fairly closed economies with sophisticated financial markets, they are largely immune to sharp fluctuations in the external values of their monies. In contrast, in developing small open economies with imperfect and incomplete financial markets the exchange rate is probably the single most important price in the entire economy. Many small open economies have chosen to peg to one of the world's major currencies, typically the one which dominates their trade and financial flows. By pegging to a single currency, those developing countries with a more diversified direction of trade and finance have exposed themselves to fluctuations against all the other major currencies. This has brought sharp fluctuations in their *effective* exchange rates and has led to increased macroeconomic instability.

Recent attention to this issue has been scant. Reinhart and Reinhart (2001) have noted that there is a trade-off between G-3 exchange rate volatility, on the one hand, and G-3 interest rate and spending volatility, on the other. All three factors matter for business cycles in the developing world. The authors also find that during periods of high G-3 exchange rate volatility and low US interest rate volatility we tend to witness more crises in emerging economies. Esquivel and Larrain (2002) question the trade-off between G-3 exchange rate and interest rate volatility. They estimate that G-3 exchange rate volatility decreases the real exports of developing countries by about 2% on average, and by 3% in East Asia. Furthermore, G-3 currency instability increases the probability of an exchange rate crisis in emerging economies by about 2.5%. It also reduces FDI into certain regions of the developing world (East Asia, for example). Finally, based on its own empirical models, IMF (2003) finds that the impact of G-3 exchange rate volatility on developing countries is small overall, but might be quite important for certain regions such as East Asia, due to pervasive liability dollarization.

One can think of G-3 exchange rate volatility as a negative externality. It affects small open economies the same way the smoke from the factory chimney affects nearby farmers in the classical textbook example. The first-best solution would be to shut down the chimney – that is, restore stability to the relative values of the world's major currencies, as was the case under the Bretton Woods system. This is beyond the reach of developing small open economies. Unfortunately, the issuers of the world's major currencies do not seem particularly interested in such an arrangement. A second-best solution explored since the 1970s, both in practice and in theory, is to peg to a basket of currencies. This stabilizes a country's effective exchange rate and smoothes the impact of instability in major currency exchange rates. The number of countries practicing

[2] Before 1999, the euro-dollar exchange rate was spliced with the German mark-dollar rate.

currency basket arrangements peaked in the 1980s and has declined since then.[3] Theoretical models of the optimal currency basket proliferated in the early 1980s. Most of them were reduced-form real models, focusing on trade in goods and neglecting money and capital flows. Turnovsky (1982) is one exception: the paper offers a reduced-form general equilibrium model *with capital mobility*.

While basket pegs have waxed and waned in academic and policy fashion, the problem they sought to redress has persisted. Small open economies continue to seek an external nominal anchor in a world where the major currencies fluctuate widely against one another. In a recent revival, the literature on basket pegs has focused on the small emerging economies in East Asia. By now, no stone has been left unturned in search of an explanation for the spectacular macroeconomic collapse five of them experienced in 1997. One popular theory has maintained that the crisis was precipitated by volatility in the yen-dollar exchange rate, coupled with *de facto* pegs to the dollar practiced by most of the crisis countries prior to 1997. A dollar peg meant that East Asian economies floated freely against the Japanese yen. Given the yen's alleged importance in regional trade and finance, that led to increased macroeconomic instability. The sharp depreciation of the yen against the dollar after mid-1995 was particularly disruptive for the region, and is alleged to have triggered the crisis.

There is general consensus on the *positive* issue: yen-dollar volatility has significantly affected emerging economies in East Asia. However, two strands of literature have emerged on the *normative* issue: what, then, is the optimal way for emerging East Asian economies to manage their currencies? Various authors – Ito, Ogawa, and Sasaki (1998), Williamson (2000), Kwan (2001), Kawai (2002) – have argued that the right lesson to draw from the 1997 crisis is that exchange rate policies in East Asia had focused too much on the dollar before 1997. These authors have argued that small East Asian economies ought to put a greater weight on the Japanese yen, given the extensive trade and financial linkages with Japan. A trade-weighted basket, in particular, has emerged as the most commonly advocated solution. Even more recently, a trade-weighted basket peg has been recommended by many economists and government officials as the appropriate exchange rate regime for China.

A shortcoming of all these analyses is that they typically focus on trade in goods and either neglect capital flows or assume complete and perfectly-functioning financial markets. As a result, they end up arguing in favor of a trade-weighted basket. On the contrary, in this paper I will argue that keying on the dollar was and remains the optimal exchange rate regime for emerging East Asian economies, not only because the bulk of their trade is invoiced in dollars, but also because most of their foreign debt is dollar-denominated and because their financial markets are imperfect and incomplete. More generally, I will show that the choice of an exchange rate regime by small open economies facing volatility among the major currencies is complicated by unhedged foreign borrowing and net worth constraints. These frictions pull the

[3] See Mussa *et al* (2000), p. 27.

optimal policy away from the trade-weighted basket, and toward putting a greater weight on the currency in which foreign debt is denominated.

Section 2 of this paper takes a closer look at East Asia where the dollar competes with the yen. The main focus is on motivating the modeling assumptions employed later. Section 3 builds a dynamic sticky-price model of a small open economy that trades with two large countries and is vulnerable to fluctuations in the exchange rate between the two. There are two versions of the model and the paper's punchline hangs in the difference between the two. First, in Section 4 I show the conditions under which the optimal policy for a small open economy is to peg to a trade-weighted basket of the two large countries' currencies. Then, in Section 5 I introduce credit market imperfections *a la* Bernanke, Gertler, and Gilchrist (1998) and unhedged foreign borrowing, which pull the optimal policy away from the trade-weighted basket and toward placing a substantially higher weight on the currency of borrowing. The paper's main result is that the currency structure of debt is quite important in deciding how to manage the exchange rate in response to fluctuations in G-3 exchange rates. Small East Asian economies should continue keying on the dollar, not only because the bulk of their trade is invoiced in dollars, but also because most of their foreign debt is dollar-denominated and unhedged. The paper's chief methodological contribution is that it updates on older literature on the optimal currency basket which lacked explicit micro-foundations, and merges it with a current literature on credit market imperfections and balance sheet effects. Section 6 concludes.

2. Building blocks

This section discusses the building blocks for the model of Section 3, with special emphasis on the small economies in East Asia and their vulnerability to fluctuations in the yen-dollar exchange rate.

2.1 The exchange rate regime and the currency structure of trade and debt

Selecting the exchange rate regime and the currency structure of trade and debt is a joint exercise in optimal risk management by the private sector and by the government. Subject to certain constraints, the private sector chooses the currency structure for trade and debt. Over short horizons, governments choose the exchange rate regime with a view on maintaining competitiveness and/or providing the economy with a nominal anchor. Over longer horizons, governments of emerging markets subject to financial fragility and "original sin" often choose to maintain exchange rate stability in order to minimize payments risk and provide an informal hedge to the private sector (McKinnon (2001)). There are tangible benefits when the exchange rate regime matches the currency structure of trade and debt. Frankel and Rose (2002) estimate that belonging to a currency union triples trade. Empirical work by Devereux and Lane (2001b) shows the link between the exchange rate regime and the currency structure of debt in developing countries. Using cross-section data, they find that bilateral exchange rate volatility is strongly negatively affected by the stock of net bilateral debt. In other words, governments tend to stabilize bilateral exchange rates with countries in whose currencies they tend to borrow.

The currency structure of trade, the currency structure of debt, and the exchange rate regime are all endogenous to each other. They are all jointly determined in equilibrium. However, in this paper I will model the government as setting the optimal exchange rate regime in response to fixed and exogenous currency structure of trade and debt. Governments often have imperfect (if any) control over the currency structure of trade and debt. Those are either chosen by the private sector or imposed by world markets, and are often subject to network externalities and inertia. What domestic governments can and do control, however, is the exchange rate regime.

Frankel and Wei (1994) used weekly exchange rate data for 1979-1992 to show that all of emerging East Asia was on a *de facto* dollar peg, in the sense that weights on the dollar were estimated to be above 90% and highly statistically significant for most countries and sub-periods. Moreover, using daily data for the period February 1994 – April 2002, McKinnon and Schnabl (2002) showed that, post-crisis, all of these economies (except Indonesia) have returned to their pre-crisis dollar pegs.

Arguments in favor of baskets pegs typically stress the direction of trade of emerging East Asian countries. If we look at the direction of trade of nine emerging East Asian countries[4] in 2001, 20% of their exports went to the US, 12% went to Japan, and 30% went to the rest of the world (mostly the EU). Thirteen percent of their imports came from the US, 16% came from Japan, and 29% came from the rest of the world. Based on these numbers, many economists have recommended a trade-weighted basket with roughly equal weights on the dollar, yen, and euro.

There are three major problems with this policy recommendation. First, I believe we should look not at the direction of trade but at the currency structure of trade. According to McKinnon and Schnabl (2002), 74% of East Asian exports to Japan and 50% of imports from Japan in the year 2000 were invoiced in US dollars, while the rest was yen-invoiced.

Second, the trade shares above omit intraregional trade among the nine East Asian countries – 37% of their exports and 42% of their imports are with each other. According to McKinnon (2000), intraregional trade is heavily dollarized, as is trade with the US. Taking all these adjustments into account, we can infer that at least 66% of exports and 63% of imports by East Asian countries are dollar-invoiced. Only about 3% of exports and 8% of imports are invoiced in yen.[5] In other words, East Asian trade is overwhelmingly

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[4] Defined to include China, Hong Kong, Indonesia, Korea, Malaysia, the Philippines, Singapore, Taiwan, Thailand. All numbers come from the IMF's Direction of Trade Statistics.

[5] The argument here is indirect because data on trade invoicing is unavailable. Direct evidence on invoicing is available for Korea only. According to McKinnon and Schnabl (2002), 85% of Korean exports and 80% of Korean imports in the year

dollarized and the yen plays a rather insignificant role. A basket with equal weights on the dollar, yen, and euro makes no sense then. The basket should reflect the dollar's pre-eminence in the currency structure of East Asia's trade.

Third, the currency structure of debt tips the scales further in favor of the dollar (see Table 1). Note the remarkable build-up in dollar-denominated debt between 1996 and 2001: from an unweighted average of 38% in 1996 to 60% in 2001. Back in pre-crisis 1996 all five countries were on *de facto* dollar pegs but were borrowing a lot (too much?) in other currencies. This must have caused some macroeconomic discomfort due to balance sheet effects, as my theoretical model will illustrate. In 2001, East Asian countries had largely returned to dollar pegging but had also started borrowing more in dollars, consistent with their exchange rate policies.

In addition, there is evidence that developing countries are either unable or choose not to hedge foreign borrowing.[6] Unhedged foreign borrowing by the private sector plays a crucial role in generating the balance sheet effects in the model of Section 3. Given that the bulk of foreign borrowing in emerging East Asia is dollar-denominated and unhedged, that gives an extra reason to key on dollar. Financial market imperfections and incompleteness are the reason why the currency structure of debt matters so much for the exchange rate regime.

2.2 The yen-dollar exchange rate and the real economy

Kwan (2001) has outlined four plausible transmission channels through which fluctuations in the yen-dollar exchange rate can have short-run cyclical effects on emerging East Asian economies. Since most of them practiced informal dollar pegs before 1997, a yen depreciation against the dollar translated into an appreciation of East Asian currencies against the yen, in lockstep with the dollar. First, a yen depreciation against the dollar reduces foreign direct investment into East Asia since the region's cost advantages vis-à-vis Japan diminish. Second, a yen depreciation causes a loss of trade competitiveness vis-à-vis Japan. Third, a yen depreciation lowers the domestic currency price of intermediate goods imported from Japan and that means lower input prices and higher profits for domestic producers. Finally, a yen depreciation eases the burden of servicing yen-denominated debt by reducing the *ex post* real rate of interest.

Note that the first and second channels have a contractionary effect on emerging East Asian economies, while the third and fourth ones should be expansionary. Which set of channels prevails in reality is an empirical question. Kwan (2001) and McKinnon and Schnabl (2002) have found that yen depreciations

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2000 were invoiced in dollars. Only 5% of exports and 12% of imports were invoiced in yen. Shares of other currencies were miniscule. This reinforces the point that trade in East Asia is largely dollarized.

[6] See the ongoing debate on Ricardo Hausmann's concept of "original sin."

cause a cyclical downturn in the region. The model in Section 3 incorporates the second, third, and fourth transmission channels discussed above.

3. The model

A seminal contribution by Bernanke, Gertler, and Gilchrist (1998) offered a tractable way of merging the business cycle literature with that on credit market imperfections. Cespedes, Chang, and Velasco (2000) and Devereux and Lane (2001a, 2001b) have applied this framework to small open economy models. The central issue in these papers is the optimal monetary policy for a small open economy, in particular, the time-honored question of whether the exchange rate should be fixed or floating. While I follow these contributions in using many of the same building blocks, this paper moves past the issue of “fix or float?” and on to the next stage by asking the question “fix to what?” The model’s answer is that when choosing the optimal basket of yen and dollar for small East Asian countries, we need to take into account not only the currency structure of trade but also the currency structure of debt, because of financial markets imperfections and incompleteness. For small East Asian countries, an additional reason to put a very high weight on the dollar is given by the fact that most foreign borrowing is dollar-denominated and unhedged.

In the model, there are three countries in the world: two large economies A and B (think of the US and Japan) and a small open economy in East Asia (which I will call “Home”). The relative sizes of countries A and B will be γ and $1-\gamma$, respectively. One could also think of A and B as a “dollar area” and a “yen area” in the sense that the dollar or the yen is the dominant currency for invoicing trade flows.[7] Nominal exchange rates (in units of Home’s currency per one unit of foreign currency) will be denoted by S_t^A and S_t^B. By triangular arbitrage, we have $S_t^A = S_t^B S_t^{BA}$, where S_t^{BA} is the exchange rate between B’s and A’s currencies (“yen per dollar”).

In the small open economy, domestically-owned retailers import a good from A and another good from B. They combine, differentiate, and re-sell imports to domestic households and to entrepreneurs. Households consume imports and supply labor. Entrepreneurs consume some imports and sell the rest to domestic firms, who use them as productive capital. Domestic firms produce a couple of goods out of labor and capital, and export all output to A or B. None is consumed domestically. Figure 2 summarizes the flow of goods in the small open economy.

[7] I do not distinguish between direction of trade and currency structure of trade – they are the same thing in the model. However, it is important to note once again that while the US is not important in East Asia’s direction of trade, the US dollar dominates the currency structure of trade of East Asian emerging economies. That dominance provides the primary justification for the soft pegs to the dollar East Asian countries practiced before the 1997 crisis.

The *only* source of uncertainty in the model is the yen-dollar exchange rate S_t^{BA}. There are no other sources of uncertainty in the model. In particular, there are no domestic nominal shocks. Therefore, unlike most small open economy models, domestic monetary control is not at issue here. I do not consider a kitchen sink of other possible exogenous shocks, since I am singularly interested in the impact of G-3 exchange rate volatility on small open economies, and in particular in the impact of yen-dollar volatility on emerging East Asia.

The model has the features necessary to generate both the "good" and "bad" aspects of exchange rate depreciations. The "good" side of depreciations comes from the *mercantile* effect they have on domestic exports, output, and consumption. The "bad" side of depreciations is due to higher domestic prices of imports and to volatility-enhancing balance sheet effects on capital investment and future output. These three features can be traced back to the transmission channels identified in Section 2.2.

All the action in the model is generated by instability in S_t^{BA} combined with financial market incompleteness and imperfect pass-through to the domestic price level. In particular, incomplete exchange rate pass-through makes balance sheet effects more dangerous. One can think of imperfect pass-through as a form of price stickiness, which is addressed by monetary policy in the model below. Devereux and Lane (2001a) have found that financial frictions generate an amplification effect to shocks, *without* altering the welfare ranking of alternative monetary policy rules for a small open economy. In contrast, in the model below financial market imperfections not only amplify shocks but also affect the choice of the optimal exchange rate regime.

I consider two versions of the model, and the paper's punchline hangs in the difference between the two. First, I consider a version of the model without any financial market imperfections. It turns out that under this condition, the optimal exchange rate regime is the trade-weighted basket. It is optimal to use the trade shares γ and $1-\gamma$ as basket shares on the dollar and yen, respectively. A trade-weighted basket will completely stabilize domestic prices, output, and consumption.

Second, I consider a version of the model with credit market imperfections. Now, entrepreneurs finance purchases of imports (for capital investment and consumption) out of their own net worth and out of unhedged foreign borrowing in dollars. There is an interest rate premium on dollar debt, which is increasing in entrepreneurial leverage. These frictions amplify the impact of yen-dollar shocks on the small open economy. Furthermore, they also affect the optimal exchange rate regime. The trade-weighted basket is no longer optimal. Instead, it is now optimal to place a weight on the dollar which far exceeds γ, the dollar's trade share. Even if there is no trade at all in dollars, it is still optimal to put a sizeable weight on it. Financial market imperfections and unhedged dollar borrowing in East Asia pull the optimal policy away from a trade-weighted basket, and toward putting a much greater weight on the currency in which foreign debt is denominated.

Having broadly outlined the model, I now proceed to the detailed setup and analysis. In Home, there are households, retailers, exporting firms, a government, and entrepreneurs. I discuss each sector in turn.

3.1 Households

Households consume and supply labor to firms. Their utility function over consumption and effort is:

$$U_t = E_t\left[\sum_{s=t}^{\infty}\beta^{s-t}\left(\log(C_s) - \frac{(1-\gamma)\kappa}{2}\left(L_s^A\right)^2 - \frac{\gamma\kappa}{2}\left(L_s^B\right)^2\right)\right],$$

where L^A and L^B denote labor supplied to the two types of firms who export to A and B, respectively. κ is the disutility of effort parameter. The disutility from labor supplied to the two types of firms is weighted in a very particular way in order to generate a steady-state direction of trade in which a fraction γ of exports will go to country A and $1-\gamma$ will go to B. C_t is an index of differentiated goods (which households purchase from monopolistically competitive retailers) and is given by:

$$C_t = \left[\int_0^1 C_t(z)^{\frac{\upsilon-1}{\upsilon}}\,dz\right]^{\frac{\upsilon}{\upsilon-1}}, \quad \upsilon > 1 \tag{1}$$

The elasticity of substitution between brands is given by υ. Following standard Dixit-Stiglitz math, demand for brand z is given by:

$$C_t(z) = \left(\frac{P_t(z)}{P_t}\right)^{-\upsilon} C_t,$$

where the consumer price index P_t is defined as:

$$P_t = \left[\int_0^1 P_t(z)^{1-\upsilon}\,dz\right]^{\frac{1}{1-\upsilon}}$$

Households do not have access to financial markets and must spend all of their labor and dividend income within the current period. Their period budget constraint is:

$$P_t C_t = W_t^A L_t^A + W_t^B L_t^B + \Pi_t, \tag{2}$$

where W_t^i is the nominal wage paid in sector i ($i = A, B$), and Π_t denotes lump-sum dividends from retailers. A wage differential between the two sectors is necessary to compensate households for the varying disutility of effort in each sector. The household’s allocation problem is a static one. Households play a passive role in this model – that is why the household sector is modeled as simply as possible. Typically, other authors have assumed that households either have access to complete financial markets or are completely shut off from them (as is the case here). Both assumptions are unrealistic; the latter is simply more tractable. The same assumption is employed in Krugman (1999), Cespedes, Chang, and Velasco (2000), and Devereux and Lane (2001b). The first-order conditions guiding labor-leisure choice as well the allocation of effort between the two sectors are:

$$\frac{1}{P_t C_t} = \frac{(1-\gamma)\kappa L_t^A}{W_t^A} = \frac{\gamma \kappa L_t^B}{W_t^B} \tag{3}$$

3.2 Retailers

Retailers are monopolistically competitive and are owned by the households. They purchase imports from both countries A and B and assemble them costlessly to produce a brand of the consumption good, using a Cobb-Douglas production function:

$$C_t(z) = \frac{\left(C_t^A(z)\right)^{\gamma}\left(C_t^B(z)\right)^{1-\gamma}}{\gamma^{\gamma}\left(1-\gamma\right)^{1-\gamma}}, \tag{4}$$

where $C_t^A(z)$ and $C_t^B(z)$ denote imports of homogenous goods from countries A and B used in the production of brand z. Note that the weights above coincide with the relative sizes of the two large countries. Once again, this will generate a steady-state direction of trade under which a fraction γ of imports will come from country A. By solving a standard expenditure minimization problem, we can derive retailers' nominal marginal cost (in Home currency units):

$$MC_t = \left(M_t^A S_t^A\right)^{\gamma}\left(M_t^B S_t^B\right)^{1-\gamma}, \tag{5}$$

where M^A and M^B are the foreign-currency prices of imports. Note that the nominal marginal cost equation will be identical for all retailers. In log-linear terms, it becomes:

$$\hat{MC}_t = \gamma \hat{S}_t^A + (1-\gamma)\hat{S}_t^B + \gamma \hat{M}_t^A + (1-\gamma)\hat{M}_t^B, \tag{6}$$

where $\hat{Z}_t \equiv \frac{dZ_t}{Z}$ denotes percentage deviation from the constant steady state. A retailer's choice of inputs will be driven by the following first-order condition:

$$\frac{1-\gamma}{\gamma}\frac{C_t^A}{C_t^B} = \frac{M_t^B S_t^B}{M_t^A S_t^A} = \left(\frac{M_t^B}{M_t^A}\right)\frac{1}{S_t^{BA}}$$

The last term above is a time-varying real exchange rate. An increase in S^{BA}, combined with sticky M^B and M^A, would amount to a depreciation (both nominal and real) of the yen against the dollar and will relocate retailers' demand for imports from dollar-invoiced toward yen-invoiced goods.

In modeling retailers' price-setting decisions, I follow the tradition of Calvo (1983) and Yun (1996). Retailers update their prices infrequently. Independently of past history, each period a fraction $1-\varphi$ of them gets a chance to adjust prices. Due to the law of large numbers, there is no aggregate uncertainty or income uncertainty for the representative household. The consumer price index P_t will evolve according to:

$$P_t = \left[\varphi P_{t-1}^{1-\upsilon} + (1-\varphi)\left(P_t^{new}\right)^{1-\upsilon}\right]^{\frac{1}{1-\upsilon}}$$

In log-linear terms, the equation becomes:

$$\hat{P}_t = \varphi\hat{P}_{t-1} + (1-\varphi)\hat{P}_t^{new} \tag{7}$$

A profit-maximizing retailer can be shown to follow a log-linear price-setting equation whose derivation is standard (see, for example, Monacelli (2001)):

$$\hat{P}_t^{new} = (1-\beta\varphi)E_t\left[\sum_{k=0}^{\infty}(\beta\varphi)^k\left(\hat{MC}_{t+k}\right)\right], \tag{8}$$

where $\hat{MC}_t$ is given by **(6)**. If prices are completely flexible ($\varphi=0$), retailers will set prices according to the standard static monopolistic pricing condition:

$$P_t = \frac{\upsilon}{\upsilon-1}MC_t \tag{9}$$

Combining equations **(7)** and **(8)**, we get the model's endogenous exchange rate pass-through equation:

$$\hat{P}_t = \varphi\hat{P}_{t-1} + (1-\varphi)(1-\beta\varphi)E_t\left[\sum_{k=0}^{\infty}(\beta\varphi)^k\left(\hat{MC}_{t+k}\right)\right] \tag{10}$$

Following a permanent shock to the nominal effective exchange rate $\hat{NEER}_t \equiv \gamma\hat{S}_t^A + (1-\gamma)\hat{S}_t^B$, and hence to nominal marginal cost, pass-through will be low in the very first period, but will reach unity eventually. This is consistent with the evidence on ERPT in developing countries reported in Goldfajn and Werlang (2000) and in Choudhri and Hakura (2001). If Home unilaterally devalues its currency vis-à-vis the rest of the world (that is, it increases both S_t^A and S_t^B by the same percentage amounts), its domestic price level will increase proportionately in the long run. Imperfect short-run pass-through is crucial in generating the model's results. If ERPT were instantaneously unity, the impact of shocks to S_t^{BA} on Home will be *completely independent* of the exchange rate regime, as I show in Section 4. In other words, the exchange rate regime would be irrelevant at the macroeconomic level.[8] This is just a special case of nominal neutrality when prices are completely flexible. The behavior of S_t^A and S_t^B will depend on Home's exchange rate regime. Below I will assume that the government sets S_t^A and S_t^B as simple functions of S_t^{BA}.

Retailers' profits each period are given by the equation:

$$\Pi_t = (P_t - MC_t)(C_t + K_t) \tag{11}$$

[8] However, the exchange rate regime still matters in its microeconomic consequences.

Note that equation **(11)** keeps track of the profits retailers generate from selling to *both* households and entrepreneurs. I will assume that M^A and M^B are affected by volatility in the yen-dollar exchange rate S^{BA}, according to the following set of (log-linear) forward-looking equations:

$$\hat{M}_t^A = \varphi \hat{M}_{t-1}^A + (1-\varphi)(1-\beta\varphi)E_t\left[\sum_{k=0}^{\infty}(\beta\varphi)^k\left[-(1-\gamma)\left(\hat{S}_{t+k}^{BA}\right)\right]\right] \quad \textbf{(12)}$$

$$\hat{M}_t^B = \varphi \hat{M}_{t-1}^B + (1-\varphi)(1-\beta\varphi)E_t\left[\sum_{k=0}^{\infty}(\beta\varphi)^k\left[\gamma\left(\hat{S}_{t+k}^{BA}\right)\right]\right], \quad \textbf{(13)}$$

The persistence parameter φ will be calibrated to a value close to unity to capture the idea that both prices are sticky in the producer's currency and are relatively unaffected by shocks to S_t^{BA} in the short run. This is consistent with the empirical evidence presented in Goldfajn and Werlang (2000) and Choudhri and Hakura (2001) that pass-through to domestic prices in large closed industrialized economies is very close to zero, especially in the short run. Therefore, shocks to S_t^{BA} will cause substantial fluctuations in the relative prices of traded goods from countries A and B at shorter horizons. Engel (1999) has documented persuasively that most of the volatility in real exchange rates among industrialized countries is accounted for by fluctuations in the relative prices of traded goods. These fluctuations, in turn, are largely driven by a combination of sticky prices and volatile exchange rates.

According to equations **(12)-(13)**, in the very long run domestic prices will adjust to restore the real exchange rate to its equilibrium level. The division of "effort" between the two price levels will be according to the relative sizes of countries A and B. For example, if the yen permanently depreciates against the dollar by 1%, then dollar (country A) prices will eventually fall by $1-\gamma$ percent, while yen (country B) prices will eventually rise by γ percent.

3.3 Exporting firms

Domestic exporters to both A and B purchase labor from households and capital from entrepreneurs in order to produce their export good, according to identical CRS technologies:

$$Y_t^i = \left(L_t^i\right)^{1-\alpha}\left(K_t^i\right)^{\alpha}, \qquad i = A, B \quad \textbf{(14)}$$

I assume that capital depreciates completely each period. Domestic firms are competitive price-takers in world markets. Prices in dollars and yen for Home's exports goods are denoted by X^A and X^B, respectively. These prices will be affected by fluctuations in the yen-dollar exchange rate similarly to the prices of imported goods:

$$\hat{X}_t^A = \varphi \hat{X}_{t-1}^A + (1-\varphi)(1-\beta\varphi)E_t\left[\sum_{k=0}^{\infty}(\beta\varphi)^k\left[-(1-\gamma)\left(\hat{S}_{t+k}^{BA}\right)\right]\right] \quad \textbf{(15)}$$

$$\hat{X}_t^B = \varphi \hat{X}_{t-1}^B + (1-\varphi)(1-\beta\varphi)E_t\left[\sum_{k=0}^{\infty}(\beta\varphi)^k\left[\gamma\left(\hat{S}_{t+k}^{BA}\right)\right]\right] \quad \textbf{(16)}$$

A firm solves the following problem:

$$\max_{L_t^i, K_t^i}\left(S_t^i X_t^i Y_t^i - W_t^i L_t^i - R_t K_t^i\right), \qquad i = A, B$$

R_t denotes the nominal price of capital, which is completely mobile between sectors. The first-order conditions are standard:

$$\left(1-\alpha\right)\frac{S_t^i X_t^i Y_t^i}{L_t^i} = W_t^i, \qquad i = A, B \quad \textbf{(17)}$$

$$\alpha \frac{S_t^i X_t^i Y_t^i}{K_t^i} = R_t, \qquad i = A, B \quad \textbf{(18)}$$

3.4 Government

The government's only role in this model is to set the two exchange rates S_t^A and S_t^B as functions of S_t^{BA}. I allow for a continuum of exchange rate regimes which can be generalized as a basket peg with weights ω and $1-\omega$ on the dollar and the yen, respectively:

$$\left(S_t^A\right)^{\omega}\left(S_t^B\right)^{1-\omega} = 1$$

By triangular currency arbitrage we get: $S_t^A = \left(S_t^{BA}\right)^{(1-\omega)}$ and $S_t^B = \left(S_t^{BA}\right)^{-\omega}$. By varying ω, we get the following three special cases:

1. A yen peg *(ω=0)*: $S_t^B = 1$ and $S_t^A = S_t^{BA}$
2. A dollar peg *(ω=1)*: $S_t^A = 1$ and $S_t^B = \frac{1}{S_t^{BA}}$
3. A trade-weighted basket peg *(ω=γ)*. Then: $S_t^A = \left(S_t^{BA}\right)^{1-\gamma}$ and $S_t^B = \left(S_t^{BA}\right)^{-\gamma}$.

The table below summarizes the behavior of the percentage deviations from the constant steady state of the two bilateral exchange rates and of the nominal *effective* exchange rate, as functions of the yen-dollar exchange rate, under the three exchange rate regimes defined above:

Exchange rate regime	Yen peg	Basket peg	Dollar peg
$\omega =$	**0**	γ	**1**
Home's exchange rate with A $\hat{S}_t^A = (1-\omega)\hat{S}_t^{BA} =$	$\hat{S}_t^{BA}$	$(1-\gamma)\hat{S}_t^{BA}$	0
Home's exchange rate with B $\hat{S}_t^B = -\omega\hat{S}_t^{BA} =$	0	$-\gamma\hat{S}_t^{BA}$	$-\hat{S}_t^{BA}$
Home's nominal effective exchange rate $NE\hat{E}R_t = \gamma\hat{S}_t^A + (1-\gamma)\hat{S}_t^B = (\gamma-\omega)\hat{S}_t^{BA}$	$\gamma\hat{S}_t^{BA}$	0	$-(1-\gamma)\hat{S}_t^{BA}$

One can think of the trade-weighted basket as aimed at stabilizing Home's nominal *effective* exchange rate $\gamma\hat{S}_t^A + (1-\gamma)\hat{S}_t^B$. A quick look at equations **(6)** and **(10)** shows that we can also think of the trade-weighted basket peg as a policy of targeting nominal marginal cost MC_t and hence the domestic consumer price index P_t.

As you might notice, nominal money balances do not enter the representative household's utility function nor its budget constraint. In other words, money in this model is non-distortionary and exists simply as a *unit of account*. The model does not have a demand function for real money balances. Monetary policy is specified in terms of simple policy rules. This is a common modeling strategy in the recent literature on optimal monetary policy – papers include Bernanke, Gertler, and Gilchrist (1998), Cespedes, Chang, and Velasco (2000), Gali and Monacelli (2002), and Devereux and Lane (2001b).

Furthermore, the set of monetary regimes considered in this paper is restricted to a continuum of exchange rate pegs. The paper does not consider inflation-targeting or targeting short-term nominal interest rates or the money supply.[9] The large literature on "fear of floating" started by Calvo and Reinhart (2002) has demonstrated persuasively that the monetary authorities in emerging markets tend to focus on the exchange rate as their preferred tool for conducting monetary policy.

4. Entrepreneurs, equilibrium, and the optimal exchange rate regime without net worth constraints

Recall that I consider two variations of the model. This section analyzes a version of the model without any financial market imperfections in the entrepreneurial sector. In Section 5 I set up and solve a version of the model with net worth constraints in the entrepreneurial sector. The paper's punchline hangs in the difference between the two equilibria.

Here, entrepreneurs buy re-packaged imports from retailers and re-sell these imports to firms, which then use them as capital in producing exports. Capital is completely fungible with the composite consumption

[9] However, as pointed out earlier, the trade-weighted basket peg could be considered as targeting the domestic price level.

good (see equation **(4)**) and therefore the purchase price entrepreneurs pay is P_t. For now, I will assume away any frictions. Entrepreneurs simply re-sell to firms and make zero profits in the process: $R_t = P_t$.

A quick discussion is in order for the constant steady-state solution of the model described by equations **(2)-(3)**, **(9), (11), (14)**, and **(17)-(18)**, assuming that in steady state we have $S^i = M^i = X^i = 1$, for $i = A, B$, without loss of generality. The exogenous cost of capital will equalize the capital-labor ratios in both exporting sectors. That, in turn, will make sure that wages in both sectors will also be equal. Finally, equation **(3)** reveals that when wages are equal, the ratio of labor supplies by households to sectors A and B will be exactly $\frac{\gamma}{1-\gamma}$. Due to equal capital-labor ratios and constant-returns-to-scale technologies in the two sectors, the ratios of capital and output in both sectors will also equal $\frac{\gamma}{1-\gamma}$. In other words, in the constant steady state, a fraction γ of output gets exported to country A and a fraction $1-\gamma$ gets exported to B.

The flex-price constant steady state values of the model's variables are:

$$P = \frac{\upsilon}{\upsilon-1}MC$$

$$W^A = W^B = W = (1-\alpha)\left(\frac{\alpha}{P}\right)^{\frac{\alpha}{1-\alpha}}$$

$$L \equiv L^A + L^B = \sqrt{\frac{\upsilon-1}{\left(\upsilon+\frac{\alpha}{1-\alpha}\right)\gamma(1-\gamma)\kappa}} \qquad L^A = \gamma L \qquad L^B = (1-\gamma)L$$

$$K \equiv K^A + K^B = L\left(\frac{\alpha}{P}\right)^{\frac{1}{1-\alpha}} \qquad K^A = \gamma K \qquad K^B = (1-\gamma)K$$

$$Y \equiv Y^A + Y^B = L\left(\frac{\alpha}{P}\right)^{\frac{\alpha}{1-\alpha}} \qquad Y^A = \gamma Y \qquad Y^B = (1-\gamma)Y$$

$$C = \frac{WL}{P}\left(\frac{\upsilon+\frac{\alpha}{1-\alpha}}{\upsilon-1}\right)$$

$$\Pi = \frac{PL}{\upsilon}\left[\left(\frac{\alpha}{P}\right)^{\frac{1}{1-\alpha}} + \left(\frac{W}{P}\right)\left(\frac{\upsilon+\frac{\alpha}{1-\alpha}}{\upsilon-1}\right)\right]$$

It is easier to analyze the model, as described in equations **(2)-(3)**, **(11), (14)**, and **(17)-(18)**, in log-linear form:

$$\hat{P}_t + \hat{C}_t = \gamma(1-f)\left(\hat{W}_t^A + \hat{L}_t^A\right) + (1-\gamma)(1-f)\left(\hat{W}_t^B + \hat{L}_t^B\right) + f\hat{\Pi}_t,$$

where $f = \dfrac{1}{\upsilon(1-\alpha)+\alpha}$

$$-\hat{C}_t - \hat{P}_t = \hat{L}_t^i - \hat{W}_t^i, \qquad i = A, B$$

$$f\hat{\Pi}_t = \hat{P}_t + \hat{C}_t - \frac{\upsilon-1}{\upsilon}\left(\hat{MC}_t + \hat{C}_t\right) + \left(f + g - \frac{1}{\upsilon}\right)\left(\hat{P}_t + \hat{K}_t\right) - g\left(\hat{MC}_t + \hat{K}_t\right),$$

where $g = \dfrac{\alpha(\upsilon-1)^2}{\upsilon[\upsilon(1-\alpha)+\alpha]}$

$$\hat{Y}_t^i = (1-\alpha)\hat{L}_t^i + \alpha\hat{K}_t^i, \qquad i = A, B$$

$$\hat{S}_t^i + \hat{X}_t^i + \hat{Y}_t^i = \hat{W}_t^i + \hat{L}_t^i, \qquad i = A, B$$

$$\hat{S}_t^i + \hat{X}_t^i + \hat{Y}_t^i = \hat{P}_t + \hat{K}_t^i, \qquad i = A, B$$

The endogenous variables of this model are K^i, K, L^i, L, Y^i, Y, W^i, Π, C. On the other hand, MC and P are set according to equations **(6)** and **(10)**. The dynamics of $\hat{M}_t^i$ and $\hat{X}_t^i$ are given by equations **(12)-(13)** and **(15)-(16)**. The government sets the exchange rates S^i. The solutions are:

$$\hat{W}_t^i = \frac{\hat{S}_t^i + \hat{X}_t^i - \alpha\hat{P}_t}{1-\alpha}, \qquad i = A, B$$

$$\hat{C}_t = \frac{\hat{EPI}_t - \hat{P}_t}{1-\alpha} - \left(\frac{1}{2} + \frac{g\upsilon}{2(\upsilon-1)}\right)\left(\hat{MC}_t - \hat{P}_t\right) = \left(\frac{1+\alpha}{2(1-\alpha)} - \frac{g\upsilon}{2(\upsilon-1)}\right)\left(\hat{NEER}_t - \hat{P}_t\right)$$

$$\hat{\Pi}_t = \hat{P}_t + \frac{1}{f}\left[\frac{f}{1-\alpha}\left(\hat{EPI}_t - \hat{P}_t\right) + (f-2)\left(\frac{1}{2} + \frac{g\upsilon}{2(\upsilon-1)}\right)\left(\hat{MC}_t - \hat{P}_t\right)\right] =$$

$$= \hat{P}_t + \frac{1}{f}\left[\frac{f}{1-\alpha} + (f-2)\left(\frac{1}{2} + \frac{g\upsilon}{2(\upsilon-1)}\right)\right]\left(\hat{NEER}_t - \hat{P}_t\right)$$

$$\hat{L}_t = \gamma\hat{L}_t^A + (1-\gamma)\hat{L}_t^B = \left(\frac{1}{2} + \frac{g\upsilon}{2(\upsilon-1)}\right)\left(\hat{MC}_t - \hat{P}_t\right) = \left(\frac{1}{2} + \frac{g\upsilon}{2(\upsilon-1)}\right)\left(\hat{NEER}_t - \hat{P}_t\right)$$

$$\hat{K}_t = \gamma\hat{K}_t^A + (1-\gamma)\hat{K}_t^B = \frac{\hat{EPI}_t - \hat{P}_t}{1-\alpha} - \left[\frac{1}{2} + \frac{g\upsilon}{2(\upsilon-1)}\right]\left(\hat{MC}_t - \hat{P}_t\right) =$$

$$= \left(\frac{3-\alpha}{2(1-\alpha)} + \frac{g\upsilon}{2(\upsilon-1)}\right)\left(\hat{NEER}_t - \hat{P}_t\right)$$

$$\hat{Y}_t = \gamma\hat{Y}_t^A + (1-\gamma)\hat{Y}_t^B = \frac{\alpha\left(\hat{EPI}_t - \hat{P}_t\right)}{1-\alpha} + \left(\frac{1}{2} + \frac{g\upsilon}{2(\upsilon-1)}\right)\left(\hat{MC}_t - \hat{P}_t\right) =$$

$$= \left(\frac{1+\alpha}{2(1-\alpha)} + \frac{g\upsilon}{2(\upsilon-1)}\right)\left(\hat{NEER}_t - \hat{P}_t\right) \tag{19}$$

Above, $\hat{EPI}_t \equiv \gamma\left(\hat{S}_t^A + \hat{X}_t^A\right) + (1-\gamma)\left(\hat{S}_t^B + \hat{X}_t^B\right)$ is the export price index. I also repeatedly substituted for $\hat{MC}_t$ using equation **(6)**. Finally, a quick look at equations **(12)-(13)** and **(15)-(16)** shows that the terms $\gamma\hat{X}_t^A + (1-\gamma)\hat{X}_t^B$ and $\gamma\hat{M}_t^A + (1-\gamma)\hat{M}_t^B$ will not be affected by shocks to S^{BA}.

Equation **(19)** is one of the crucial equations of the model. It illustrates the "competitiveness channel" for a depreciation in Home's nominal *effective* exchange rate $\gamma\hat{S}_t^A + (1-\gamma)\hat{S}_t^B$. When the nominal effective exchange rate $\gamma\hat{S}_t^A + (1-\gamma)\hat{S}_t^B$ rises relative to $\hat{P}_t$, Home's output is up, according to equation **(19)**.

First, note that if exchange rate pass-through were instantaneously unity and the price level P always moved in lockstep with the nominal effective exchange rate and with marginal cost, then shocks to S_t^{BA} would have no impact whatsoever on Home, regardless of the exchange rate regime. In other words, the exchange rate regime would be irrelevant at the macroeconomic level.

Second, with incomplete pass-through, it is easy to see that a trade-weighted basket peg (with $\omega=\gamma$) will completely stabilize output and all other variables of the system. Therefore, in the context of this simple model without financial market imperfections in the entrepreneurial sector, the trade-weighted basket peg is the optimal monetary policy. Of course, the model is deliberately stacked in order to generate this result when there are no financial market imperfections. It produces a benchmark against which to compare the results from Section 5. The key point is that net worth constraints in the entrepreneurial sector will pull away from the trade-weighted basket and toward a greater weight on the foreign currency in which entrepreneurial debt is denominated.

Under a yen peg *($\omega=0$)*, a depreciation of the yen against the dollar ($S_t^{BA}\uparrow$) causes a depreciation in Home's nominal effective exchange rate, and, by equation **(19)**, a jump in real output. Capital, labor, and consumption all go up as well. A depreciation has an expansionary mercantile effect on the economy, consistent with the empirical results in Kwan (2001) and in McKinnon and Schnabl (2002). Under a dollar peg *($\omega=1$)*, a yen depreciation has the exact opposite effects – a nominal effective appreciation leads to contraction in real output and all other domestic variables.

5. Entrepreneurs, equilibrium, and the optimal exchange rate regime with net worth constraints

Next, I set up and solve a version of the model in which there are balance sheet effects generated by net worth constraints on entrepreneurs.

5.1 Setup of the entrepreneurial sector and equilibrium

Entrepreneurs play a crucial role here. They purchase the index consumption good at a price P_t from retailers and re-sell it to firms at price R_t. Firms use it as capital in producing exports. Now capital purchases are financed by entrepreneurs' net worth and by their borrowing in A's currency (dollars). Entrepreneurs are either forced or choose to borrow in dollars and take on unhedged foreign currency debt.[10] Dollars-only foreign borrowing is an institutional constraint on the model which captures the role of the dollar as "international money," especially in international capital flows in East Asia.

At the end of each period t, entrepreneurs combine their nominal net worth N_t with dollar-denominated borrowing B_{t+1} to finance purchases of imports which will be used in *next* period's production of exports by firms:

$$N_t + S_t^A B_{t+1} = P_t K_{t+1}, \text{ where } K \equiv K^A + K^B \qquad \textbf{(20)}$$

As a result of this timing convention, equation **(11)** should be modified slightly to:

$$\Pi_t = (P_t - MC_t)(C_t + K_{t+1}) \qquad \textbf{(11-A)}$$

The gross interest rate on B_t is $(1+i^*)(1+\rho_{t+1})$, where i^* is the exogenous and constant world interest rate, and ρ_{t+1} is a risk premium which is increasing in the entrepreneur's leverage:

$$1+\rho_{t+1} = \left(\frac{P_t K_{t+1}}{N_t}\right)^{\mu}, \ \mu > 0 \qquad \textbf{(21)}$$

Lenders charge a higher risk premium when they observe that a lower fraction of capital investment is financed out of own net worth. The higher the entrepreneurs' debt-to-equity ratio, the less they have at stake and the more likely they are to default on the loan. Above, $\rho_{t+1} = 0$ when $P_t K_{t+1} = N_t$, that is, when investment is entirely financed out of net worth. K_{t+1} and ρ_{t+1} are part of time t's information set. It is important to state that I will only consider small temporary shocks to S_t^{BA}, in order to rule out a scenario in which N_t falls to zero and ρ_t explodes to infinity.

At the beginning of each period, after observing the realization of S_t^{BA}, entrepreneurs receive payment $R_t K_t$ from firms for the services of capital that entrepreneurs secured for them at the end of $t-1$. They also repay the dollar debt they incurred at $t-1$. Finally, they consume a fraction $1-\delta$ of their net income. Entrepreneurs consume the same index of differentiated goods as households – see equations **(1)** and **(4)**. Their net worth is then given by:

$$N_t = \delta\left(R_t K_t - (1+i^*)(1+\rho_t) S_t^A B_t\right) \qquad \textbf{(22)}$$

Equation **(22)** shows that, *ceteris paribus*, a depreciation against the dollar will increase the *ex post* debt burden, reduce entrepreneurial net worth and, thus, reduce future investment. It is another key equation of the

[10] See the debate on "original sin" which started with Eichengreen and Hausmann (1999).

model (in addition to **(19)**) since it generates the “balance sheet channel” which provides the rationale for paying more attention to the dollar exchange rate than was the case in Section 4 with the frictionless entrepreneurial sector.

Entrepreneurs are assumed to be *risk-neutral*. Free entry in the entrepreneurial sector will ensure that entrepreneurs will equate return on capital investment to the external cost of funds, both in dollar terms:

$$\frac{E_t\left(\frac{R_{t+1}K_{t+1}}{S_{t+1}^A}\right)}{\frac{P_tK_{t+1}}{S_t^A}} = \left(1+i^*\right)\left(1+\rho_{t+1}\right) \quad \Leftrightarrow \quad E_t\left(\frac{R_{t+1}}{S_{t+1}^A}\right) = \frac{P_t}{S_t^A}\left(1+i^*\right)\left(1+\rho_{t+1}\right) \qquad \textbf{(23)}$$

A closer look would reveal that the above arbitrage condition is really a special case of uncovered interest parity. The setup of the entrepreneurial sector is standard in the literature started by Bernanke, Gertler, and Gilchrist (1998). Since the currency structure of debt and the debt-to-equity ratio matter in this model, we have a failure of the Modigliani-Miller theorem.

In order to find the economy-wide current account equation (in dollar terms), use **(22)** to substitute for N_t in **(20)**. Then combine **(17)** and **(18)**, and use that to substitute out for R_tK_t. Finally, use **(2)** to substitute for $W^A_tL^A_t+W^B_tL^B_t$, and rearrange. The result is:

$$B_{t+1} = \delta(1+i^*)(1+\rho_t)B_t + \frac{P_tK_{t+1} + \delta\left(P_tC_t - S_t^A X_t^A Y_t^A - S_t^B X_t^B Y_t^B - \Pi_t\right)}{S_t^A} \qquad \textbf{(24)}$$

Note that B_t denotes foreign *debt*, not foreign *assets*.

Using equations **(2)-(3)**, **(9), (11-A), (14), (17)-(18)**, **(20)-(23)** we can compute the flex-price constant steady-state equilibrium values for $K^i, K, L^i, L, Y^i, Y, W^i, P, \Pi, C, R, N, B, \rho$ as functions of all the other parameters of the model, under the assumption that $S^i = M^i = X^i = 1$, for $i = A, B$. The solutions for the constant steady state are deferred to the Appendix. Note that in the constant steady state we have $\delta\left(1+i^*\right)\left(1+\rho\right)=1$ and $B_{t+1} = B_t$. It then follows from equation **(24)** above that trade is balanced in the steady state. However, the constant steady-state level of debt is non-zero (positive) because entrepreneurs must borrow each period (including the initial one) in order to finance investment into next period’s capital stock. The Appendix also offers the equations of the log-linearized system and describes the solution method for the model, which is along the lines of Blanchard and Kahn (1980).

5.2 The optimal exchange rate regime with net worth constraints

This section simulates numerically the log-linear model solved in the Appendix. The time unit of the model is one quarter. I set α to 0.35, the consensus value in the business cycle literature. The monopolistic pricing parameter υ is set to 6. I set the price stickiness parameter φ to 0.75, also a standard value. Setting

$i^*=0.01$ implies a *per annum* world interest rate of 4%, which is also common. Correspondingly, I set $\beta=0.99$. I calibrate the preference parameter κ so that it generates a steady-state value for overall labor supply ($L \equiv L^A + L^B$) of 0.36 (40 hours of labor out of 112 waking hours per week). Combining i^* with a value of 0.985 for δ implies a steady-state risk premium of 200 basis points *per annum*, as in Bernanke, Gertler, and Gilchrist (1998). Finally, I set μ to 0.0075 in order to obtain a steady-state debt-to-equity ratio of unity. The steady-state debt-to-output ratio is then around 0.17.

The behavior of $\hat{MC}_t$ and $\hat{P}_t$ is pinned down by equations **(6)** and **(10)**. The dynamics of $\hat{M}_t^i$ and $\hat{X}_t^i$ are given by equations **(12)-(13)** and **(15)-(16)**. The behavior of $\hat{S}_t^i$ was described in Section 3.4.

Now suppose that the yen depreciates against the dollar by 10% (S^{BA} jumps up from 1 to 1.1). The shock is temporary and gradually fades away. Figures 3 through 5 describe the response of the system to this shock under the three alternative exchange rate regimes outlined in Section 3.4. The simulation assumes the symmetric case of $\gamma=0.5$. The figures plot one additional variable of interest. Total exports are defined as:

$$EXPO_t \equiv S_t^A X_t^A Y_t^A + S_t^B X_t^B Y_t^B$$

$$\hat{EXPO}_t = \gamma\left(\hat{S}_t^A + \hat{X}_t^A + \hat{Y}_t^A\right) + (1-\gamma)\left(\hat{S}_t^B + \hat{X}_t^B + \hat{Y}_t^B\right) =$$

$$= \hat{NEER}_t + \gamma\hat{X}_t^A + (1-\gamma)\hat{X}_t^B + \hat{Y}_t$$

Note that a yen depreciation is expansionary under a yen peg and contractionary under a dollar peg (Figures 3 and 5). Thus, my theoretical model is consistent with the empirical results reported in Bleakley and Cowan (2002). That paper dismissed the claim that dollar debt and balance sheet effects make depreciations against the dollar contractionary. In the model here, depreciations against the dollar are not contractionary – instead, they amplify the expansions. Currency mismatches play an *amplification* role – the cyclical effect when there are currency mismatches (yen peg) is sharper than when there are none (dollar peg). The dollar price of investment goods (P/S^A) plays an important role in the amplification mechanism. Under a dollar peg, it stays largely unchanged, due to slow pass-through. Under a yen peg it falls, due to the increase in S^A relative to P. Since purchases of imports for capital investment are partially financed by dollar borrowing, the drop in (P/S^A) makes it cheaper, in dollar terms, for entrepreneurs to buy investment goods.

As a next step, the log-linear model was simulated for a large number of periods, with an AR(1) stochastic process for $\hat{S}_t^{BA}$:

$$\hat{S}_{t+1}^{BA} = \eta\hat{S}_t^{BA} + u_{t+1}, \qquad \eta = 0.95, \qquad u_{t+1} \sim N(0,1)$$

The η parameter was calibrated to match the high persistence of deviations of actual G-3 exchange rates from their steady state paths, where the "steady state" was defined as a linear trend. Obviously, S_t^{BA} is a stationary variable in the model: it always reverts to a constant steady-state level. Since I am concerned with deviations from the steady state, I do not model drift in the steady-state value of S_t^{BA}. Later, I will explore the sensitivity of the results to the value of the persistence parameter.[11]

In Figure 5, I plot the expected lifetime utility of the representative household (see Section 3.1) as a function of the weight on the dollar in the country's basket peg. I set γ to 0.5 in order to study the symmetric case in which trade shares are equal. It turns out that utility is maximized by putting a weight on the dollar of $\omega=0.54$. This weight is higher than the trade share. Credit market imperfections and unhedged foreign borrowing in the entrepreneurial sector create an asymmetry in favor of the currency of debt denomination. It is optimal to place a higher weight on S_t^A than the one suggested by the frictionless model studied in Section 3.2.

Figure 7 plots the optimal (expected lifetime utility maximizing) weight on the dollar ω^* as a function of γ, the share of Home's trade in dollars. When there are no financial market imperfections in the entrepreneurial sector (as in Section 4), the mapping from γ to ω^* is simply the 45° line. The line above the 45° line gives the values of ω (for each value of γ) which maximize expected lifetime utility for the representative household in the model with credit constraints. Even if there is next to no trade in dollars, it is optimal to put a weight of 12% on the dollar! More generally, these weights are significantly higher than the dollar's trade share. Due to net worth constraints and unhedged dollar borrowing in the entrepreneurial sector, it is optimal to place a higher weight on the dollar than the one suggested by the frictionless model studied in Section 4. For an emerging East Asian economy in which the fraction γ of dollar-invoiced trade is about 65% (see Section 2.1), the optimal weight on the dollar would be in the vicinity of 75-80%. This is very close to the actual weights estimated for the pre-crisis period by Frankel and Wei (1994).

6. Conclusion

This paper has shown that the choice of an exchange rate regime by small open economies facing G-3 monetary instability is complicated by credit market imperfections involving unhedged foreign borrowing and net worth constraints. In general, these frictions pull the optimal policy away from the trade-weighted basket, and toward putting a greater weight on the currency in which foreign debt is denominated. In particular, East Asian economies should continue keying on the dollar, not only because the bulk of their trade is invoiced in dollars, but also because most of their foreign debt is dollar-denominated and unhedged.

This paper has argued in favor of a basket which places a very high weight on the dollar (and some small weight on the Japanese yen). It is possible to go one step further and argue in favor of a pure peg to the dollar. First, basket pegs are confusing because they involve some volatility against all currencies in the

[11] This sensitivity check is available from the author upon request.

basket. The average cab driver on the streets of Bangkok will be hopelessly confused. A second (and related) point is that basket pegs have transparency and credibility problems. The cab driver might question the credibility of the monetary authority's claim that exchange rate policy is guided by rules rather than discretion, especially when the composition and weights of the basket are kept secret, as was the case in many East Asian countries before the 1997 crisis. Basket pegs reduce the microeconomic and informational benefits of pegging (Mussa *et al* (2000)). Single-currency pegs are easier to administer, and therefore more transparent and more credible. Third, recent empirical work decisively establishes that exchange rate volatility discourages foreign trade (Frankel and Rose (2002)). In particular, their empirical work has shown that the benefits of reduced exchange rate volatility, in terms of trade flows, are small compared to a currency union. A basket peg involves some limited volatility against all currencies in the basket. Therefore, it is inferior to a single-currency peg in terms of its effect on trade flows.

APPENDIX

A. Steady state for the model with credit market imperfections

The solution for the flex-price constant steady state of the model of Section 5.1 assumes that $S^i = M^i = X^i = 1$, for $i = A, B$, and is given by:

$$P = \frac{\upsilon}{\upsilon - 1} MC$$

$$W^A = W^B = (1-\alpha)\left(\frac{\alpha\delta}{P}\right)^{\frac{\alpha}{1-\alpha}}$$

$$L \equiv L^A + L^B = \sqrt{\frac{\upsilon - 1}{\left(\upsilon + \frac{\alpha\delta}{1-\alpha}\right)\gamma(1-\gamma)\kappa}} \qquad L^A = \gamma L \qquad L^B = (1-\gamma)L$$

$$K \equiv K^A + K^B = L\left(\frac{\alpha\delta}{P}\right)^{\frac{1}{1-\alpha}} \qquad K^A = \gamma K \qquad K^B = (1-\gamma)K$$

$$Y \equiv Y^A + Y^B = L\left(\frac{\alpha\delta}{P}\right)^{\frac{\alpha}{1-\alpha}} \qquad Y^A = \gamma Y \qquad Y^B = (1-\gamma)Y$$

$$C = \frac{WL}{P}\left(\frac{\upsilon + \frac{\alpha\delta}{1-\alpha}}{\upsilon - 1}\right)$$

$$\Pi = \frac{PL}{\upsilon}\left[\left(\frac{\alpha\delta}{P}\right)^{\frac{1}{1-\alpha}} + \left(\frac{1-\alpha}{P}\right)\left(\frac{\alpha\delta}{P}\right)^{\frac{\alpha}{1-\alpha}}\left(\frac{\upsilon + \frac{\alpha\delta}{1-\alpha}}{\upsilon - 1}\right)\right]$$

$$\frac{R}{P} = \frac{1}{\delta}$$

$$1 + \rho = \frac{1}{\delta(1+i^*)}$$

$$B = PK\left[1 - \left[\delta(1+i^*)\right]^{\frac{1}{\mu}}\right]$$

$$N = PK\left[\delta(1+i^*)\right]^{\frac{1}{\mu}}$$

Note that we need $1/\delta > 1+i^*$ in order to have $\rho > 0$ in steady state. Note also that the steady-state gross markup *R/P* charged by entrepreneurs to firms equals the inverse of entrepreneurs' saving rate.

B. The log-linear model and its solution

Next, I log-linearize equations **(2)-(3)**, **(11-A), (14), (17)-(18)**, **(20)-(23)** around the constant steady state:

$$\hat{P}_t + \hat{C}_t = \gamma(1-f)\left(\hat{W}_t^A + \hat{L}_t^A\right) + (1-\gamma)(1-f)\left(\hat{W}_t^B + \hat{L}_t^B\right) + f\hat{\Pi}_t,$$

$$\text{where } f = \frac{1-\alpha+\alpha\delta}{\upsilon(1-\alpha)+\alpha\delta}$$

$$-\hat{C}_t - \hat{P}_t = \hat{L}_t^i - \hat{W}_t^i, \qquad i = A, B$$

$$f\hat{\Pi}_t = \hat{P}_t + \hat{C}_t - \frac{\upsilon-1}{\upsilon}\left(\hat{MC}_t + \hat{C}_t\right) + \left(f + g - \frac{1}{\upsilon}\right)\left(\hat{P}_t + \hat{K}_{t+1}\right) - g\left(\hat{MC}_t + \hat{K}_{t+1}\right),$$

$$\text{where } g = \frac{\alpha\delta(\upsilon-1)^2}{\upsilon\left[\upsilon(1-\alpha)+\alpha\delta\right]}$$

$$\hat{Y}_t^i = (1-\alpha)\hat{L}_t^i + \alpha\hat{K}_t^i, \qquad i = A, B$$

$$\hat{S}_t^i + \hat{X}_t^i + \hat{Y}_t^i = \hat{W}_t^i + \hat{L}_t^i, \qquad i = A, B$$

$$\hat{S}_t^i + \hat{X}_t^i + \hat{Y}_t^i = \hat{R}_t + \hat{K}_t^i, \qquad i = A, B$$

$$\hat{N}_t + (a_1 - 1)\left(\hat{S}_t^A + \hat{B}_{t+1}\right) = a_1\left(\hat{P}_t + \hat{K}_{t+1}\right), \qquad \text{where } a_1 = \left[\delta(1+i^*)\right]^{-\frac{1}{\mu}}$$

$$(1+\hat{\rho}_{t+1}) = \mu\left(\hat{P}_t + \hat{K}_{t+1} - \hat{N}_t\right)$$

$$\hat{N}_t = a_1\left(\hat{R}_t + \hat{K}_t\right) - (a_1 - 1)\left[(1+\hat{\rho}_t) + \hat{S}_t^A + \hat{B}_t\right]$$

$$E_t\left(\hat{R}_{t+1}\right) = \hat{P}_t + E_t\left(\hat{S}_{t+1}^A\right) - \hat{S}_t^A + \left(1+\hat{\rho}_{t+1}\right)$$

In general, $\hat{Z}_t \equiv dZ_t/Z$, with the exception of $(1+\hat{\rho}_t) \equiv \log(1+\rho_t) - \log(1+\rho)$. *MC* and *P* are set according to equations **(6)** and **(10)**. The dynamics of $\hat{M}_t^i$ and $\hat{X}_t^i$ are given by equations **(12)-(13)** and **(15)-(16)**. The government sets the exchange rates S^i. In the above system, $\hat{B}_t, \hat{K}_t,$ and $(1+\hat{\rho}_t)$ are predetermined variables.

Most of the variables of the system can be easily substituted out:

$$\hat{W}_t^i = \frac{\hat{S}_t^i + \hat{X}_t^i - \alpha\hat{R}_t}{1-\alpha}, \qquad i = A, B$$

$$\hat{L}_t = \gamma\hat{L}_t^A + (1-\gamma)\hat{L}_t^B = \frac{\hat{EPI}_t - \alpha\hat{R}_t}{1-\alpha} - \hat{P}_t - \hat{C}_t,$$

where the export price index (EPI) is defined as: $\hat{EPI}_t \equiv \gamma\left(\hat{S}_t^A + \hat{X}_t^A\right) + (1-\gamma)\left(\hat{S}_t^B + \hat{X}_t^B\right)$

$$\hat{Y}_t = \gamma\hat{Y}_t^A + (1-\gamma)\hat{Y}_t^B = \left(\frac{1+\alpha}{1-\alpha}\right)\hat{EPI}_t - \frac{2\alpha}{1-\alpha}\hat{R}_t - \hat{P}_t - \hat{C}_t$$

$$\hat{C}_t = \frac{\frac{2(1-f)}{1-\alpha}\left(\hat{EPI}_t - \alpha\hat{R}_t\right) - \left(1-2f-g+\frac{1}{\upsilon}\right)\hat{P}_t - \left(\frac{\upsilon-1}{\upsilon}+g\right)\hat{MC}_t - \left(\frac{1}{\upsilon}-f\right)\hat{K}_{t+1}}{\frac{\nu-1}{\nu}+(1-f)}$$

$$(1+\hat{\rho}_t) = \mu\left(\hat{P}_{t-1}+\hat{K}_t-\hat{N}_{t-1}\right)$$

$$\hat{B}_{t+1} = \frac{a_1\left(\hat{P}_t+\hat{K}_{t+1}\right)-\hat{N}_t}{a_1-1} - \hat{S}_t^A$$

For the remaining 3 variables – the rental price of capital *R*, net worth *N*, and the capital stock *K* – one can write the following system of 3 first-order difference equations:

$$\begin{pmatrix} E_t(\hat{R}_{t+1}) \\ \hat{N}_t \\ \hat{K}_{t+1} \end{pmatrix} = A\begin{pmatrix} \hat{R}_t \\ \hat{N}_{t-1} \\ \hat{K}_t \end{pmatrix} + B,$$ where *A* is a (3x3) matrix and *B* is a (3x1) matrix, such that:

$$A(1,1) = \mu[A(3,1)-A(2,1)] \qquad A(2,1) = a_1$$

$$A(1,2) = \mu[A(3,2)-A(2,2)] \qquad A(2,2) = \mu(a_1-1)+1$$

$$A(1,3) = \mu[A(3,3)-A(2,3)] \qquad A(2,3) = -\mu(a_1-1)$$

$$A(3,1) = \frac{\frac{\upsilon-1}{\upsilon}(1+\alpha)+(1-\alpha)(1-f)}{\left(\frac{1}{\upsilon}-f\right)(1-\alpha)}$$

$$A(3,2) = 0$$

$$A(3,3) = \frac{2-\frac{1}{\upsilon}-f}{\frac{1}{\upsilon}-f}$$

$$B(1,1) = E_t\left(\hat{S}_{t+1}^A\right) - \hat{S}_t^A + (1+\mu)\hat{P}_t + \mu[B(3,1)-B(2,1)]$$

$$B(2,1) = -(a_1-1)\left[\left(\mu+\frac{a_1}{a_1-1}\right)\hat{P}_{t-1} + \hat{S}_t^A - \hat{S}_{t-1}^A\right]$$

$$B(3,1) = \frac{-\left(\frac{\upsilon-1}{\upsilon}+g\right)(1-\alpha)\hat{MC}_t - 2\frac{\upsilon-1}{\upsilon}\hat{EPI}_t + (1-\alpha)\left(1+f+g-\frac{2}{\upsilon}\right)\hat{P}_t}{\left(\frac{1}{\upsilon}-f\right)(1-\alpha)}$$

To solve this system, I followed the method outlined in Monacelli and Natalucci (2002), which is a simplified version of Blanchard and Kahn (1980). Of the 3 eigen values I computed for matrix *A*, using the parameter values of Section 5.2, one is outside and two are inside the unit circle. Given that I have one unstable (*R*) and two stable (*N* and *K*) variables in the system, the solution is unique.

C. Log-linearizing equation (23)

Equation **(23)** is the hardest one to log-linearize because it contains the expectation of a non-linear function of two random variables on its left-hand side. Because of Jensen's inequality, a first-order Taylor approximation is inappropriate. I use a trick from Obstfeld and Rogoff (1996, p. 504), where they show how to linearize a stochastic Euler equation.

The right-hand side is easy – just take logs to get:

$$\log P_t - \log S_t^A + \log(1+i^*) + \log(1+\rho_{t+1})$$

For the left-hand side, assume that the random variable R_{t+1}/S_{t+1}^A is lognormally distributed with a conditional variance which is constant over time. This is consistent with the assumption (adopted in Section 5.2) of Normal shocks to $\hat{S}_t^{BA}$. Then:

$$E_t\left(\frac{R_{t+1}}{S_{t+1}^A}\right) = E_t\left[\exp\left(\log\frac{R_{t+1}}{S_{t+1}^A}\right)\right] = \exp\left[E_t(\log R_{t+1}) - E_t(\log S_{t+1}^A) + \frac{1}{2}Var\left(\log\frac{R_{t+1}}{S_{t+1}^A}\right)\right]$$

Take logs to get:

$$E_t(\log R_{t+1}) - E_t(\log S_{t+1}^A) + \frac{1}{2}Var\left(\log\frac{R_{t+1}}{S_{t+1}^A}\right)$$

Since I am interested in the system's dynamic response to shocks, and not in trend movements, I omit (as do Obstfeld and Rogoff) the constant variance term. In logs, equation **(23)** is approximated by:

$$E_t(\log R_{t+1}) - E_t(\log S_{t+1}^A) = \log P_t - \log S_t^A + \log(1+i^*) + \log(1+\rho_{t+1})$$

Re-arrange to get:

$$E_t(\log R_{t+1}) = E_t(\log S_{t+1}^A) - \log S_t^A + \log P_t + \log(1+i^*) + \log(1+\rho_{t+1})$$

Use the steady-state relationship:

$$\frac{R}{P} = \frac{1}{\delta} = (1+i^*)(1+\rho) \quad \Leftrightarrow \quad \log R = \log P + \log(1+i^*) + \log(1+\rho)$$

Subtract the log equation above from the preceding one to finally arrive at:

$$E_t(\hat{R}_{t+1}) = E_t(\hat{S}_{t+1}^A) - \hat{S}_t^A + \hat{P}_t + \left(\widehat{1+\rho_{t+1}}\right)$$

Note that ρ_{t+1} is not a random variable – it is pre-determined at time *t*.

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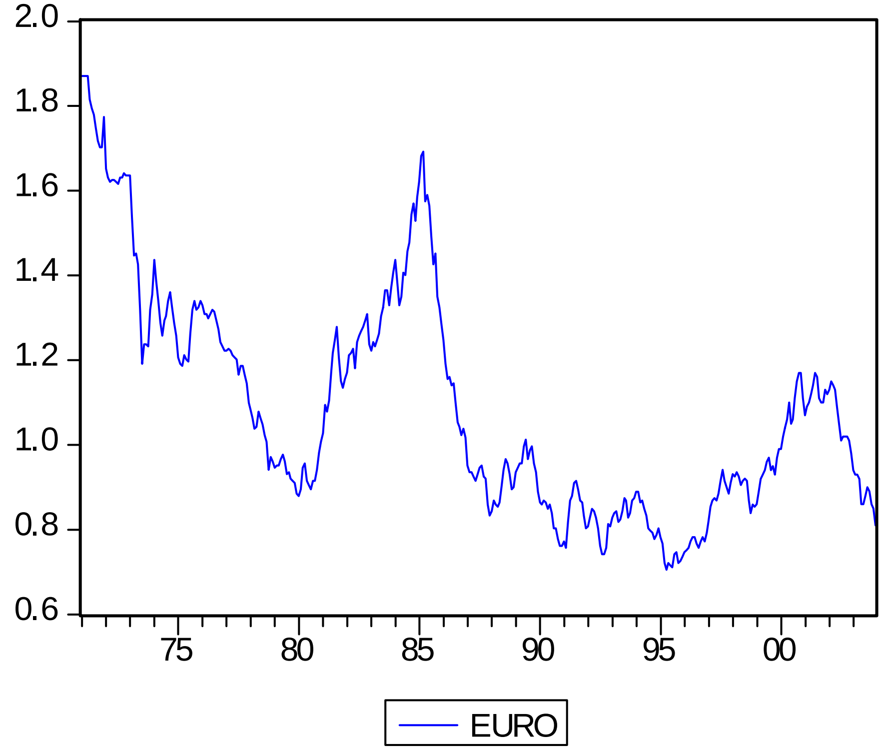
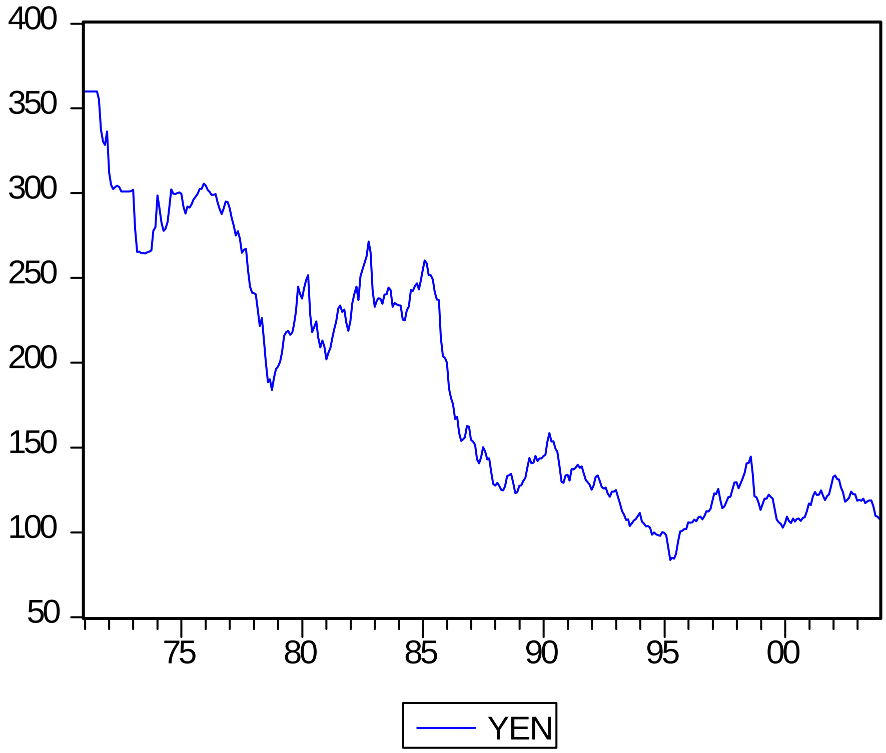
Table 1: Currency composition of long-term debt for the five East Asian economies (%)

Country	Currency	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Indonesia	JPY	35	36	36	38	38	35	35	33	32	36	33	28
Korea	JPY	32	31	30	32	34	38	32	23	18	22	23	18
Malaysia	JPY	37	36	35	38	38	35	28	27	30	30	28	23
Philippines	JPY	31	34	35	38	40	40	38	37	38	39	38	34
Thailand	JPY	43	45	47	50	51	48	45	39	40	46	46	44
Indonesia	USD	21	19	20	20	20	22	24	27	48	47	50	57
Korea	USD	33	39	45	46	39	39	48	60	73	72	70	76
Malaysia	USD	32	30	28	29	35	49	56	56	59	60	63	71
Philippines	USD	36	33	34	30	28	28	30	34	35	39	43	48
Thailand	USD	16	18	22	22	23	27	32	47	49	45	46	49

Source: World Bank, Global Development Finance

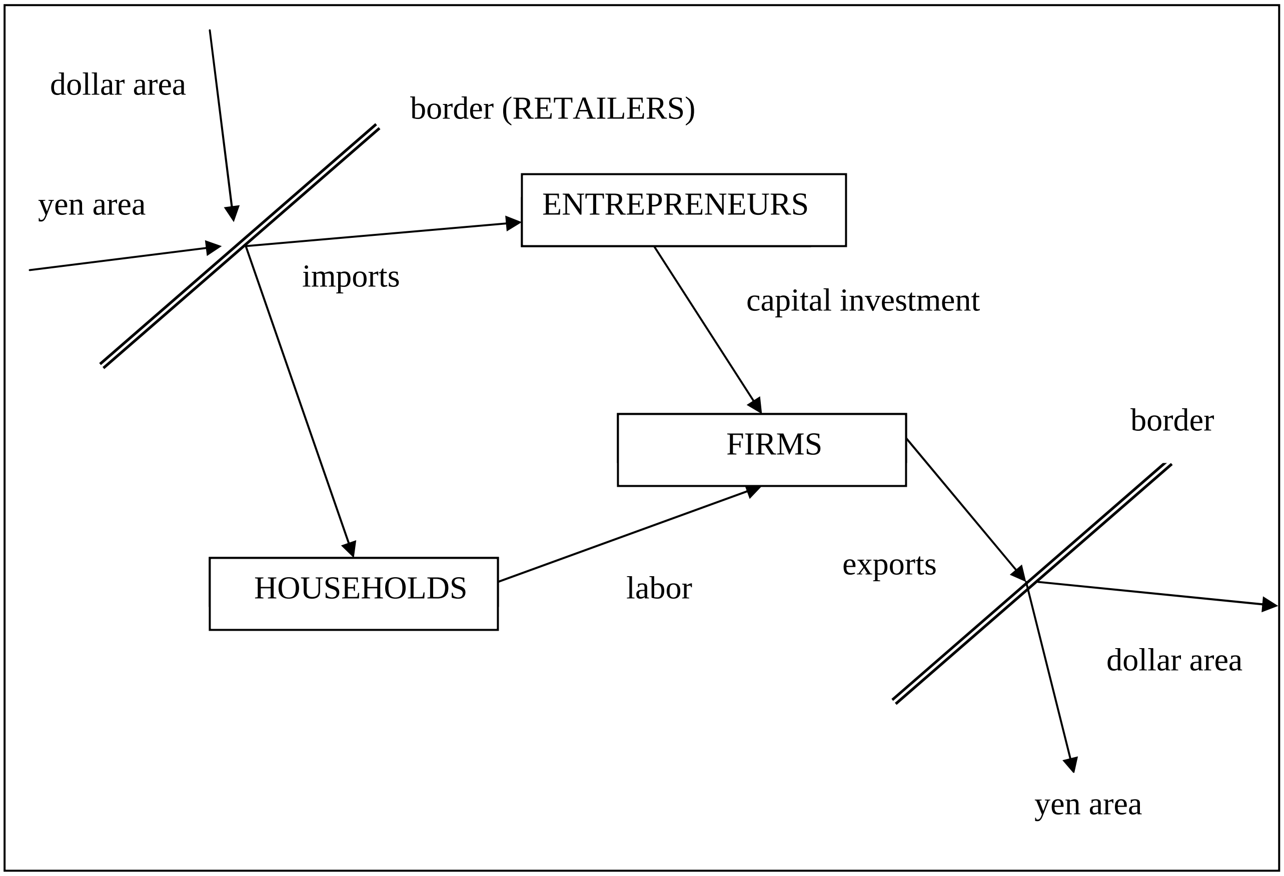
<u>Figure 1</u>: Euro-dollar and yen-dollar exchange rate, January 1971 – December 2003



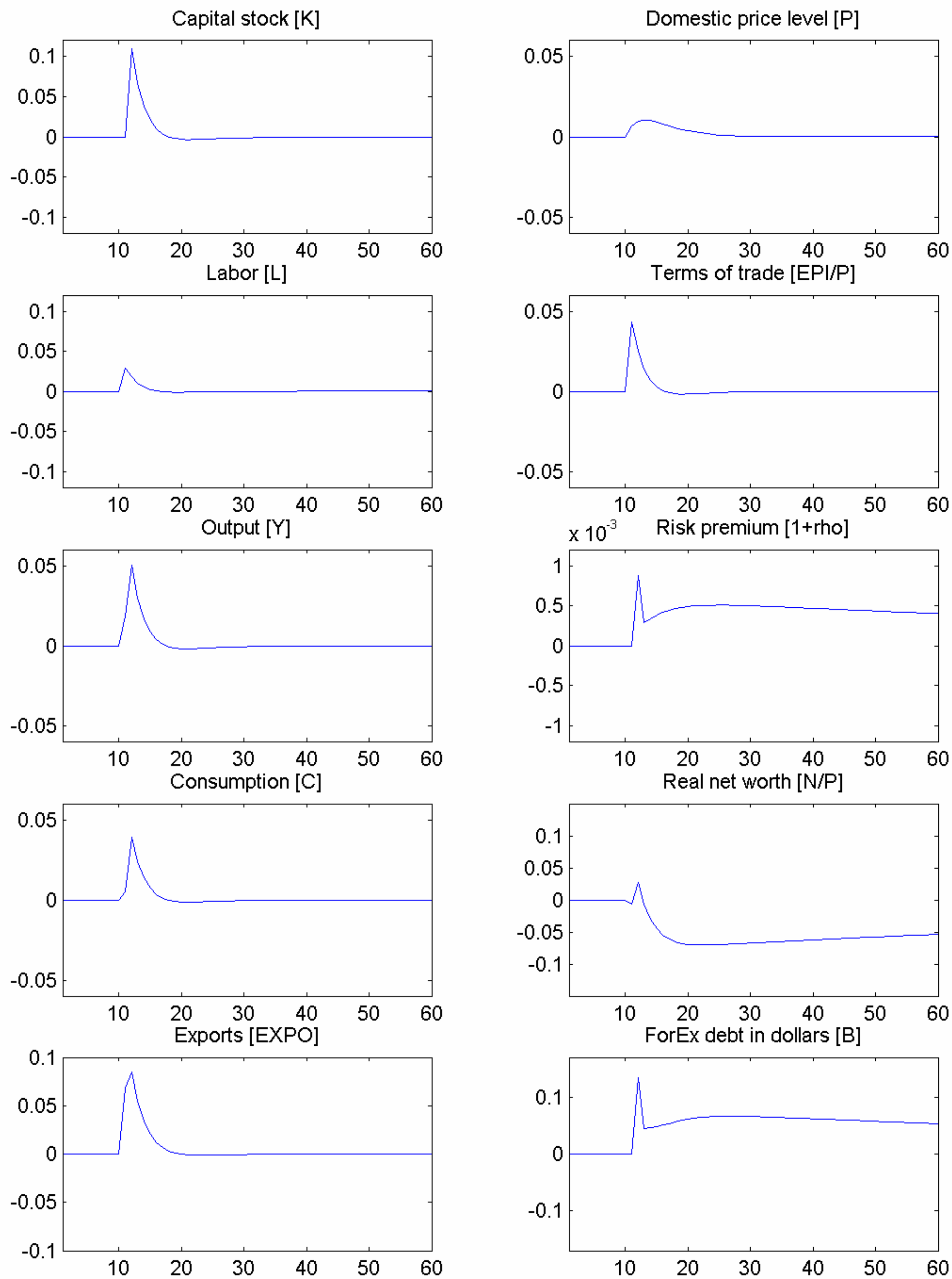


<u>Source</u>: IMF, <u>International Financial Statistics</u>
<u>Note</u>: Before 1999, the euro-dollar exchange rate is spliced with the Deutsche mark-dollar rate.

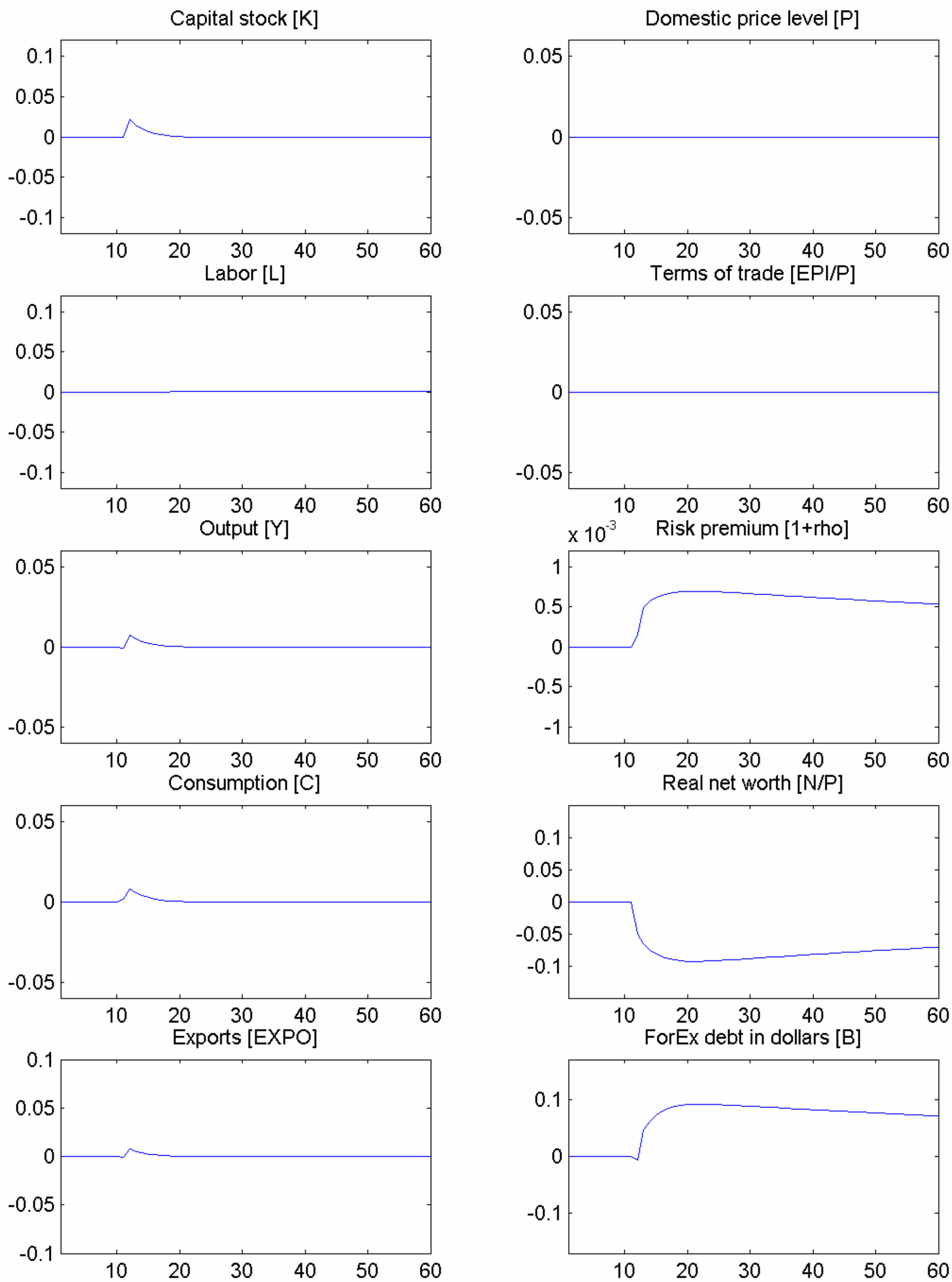
<u>Figure 2</u>: Flow of goods in the small open economy



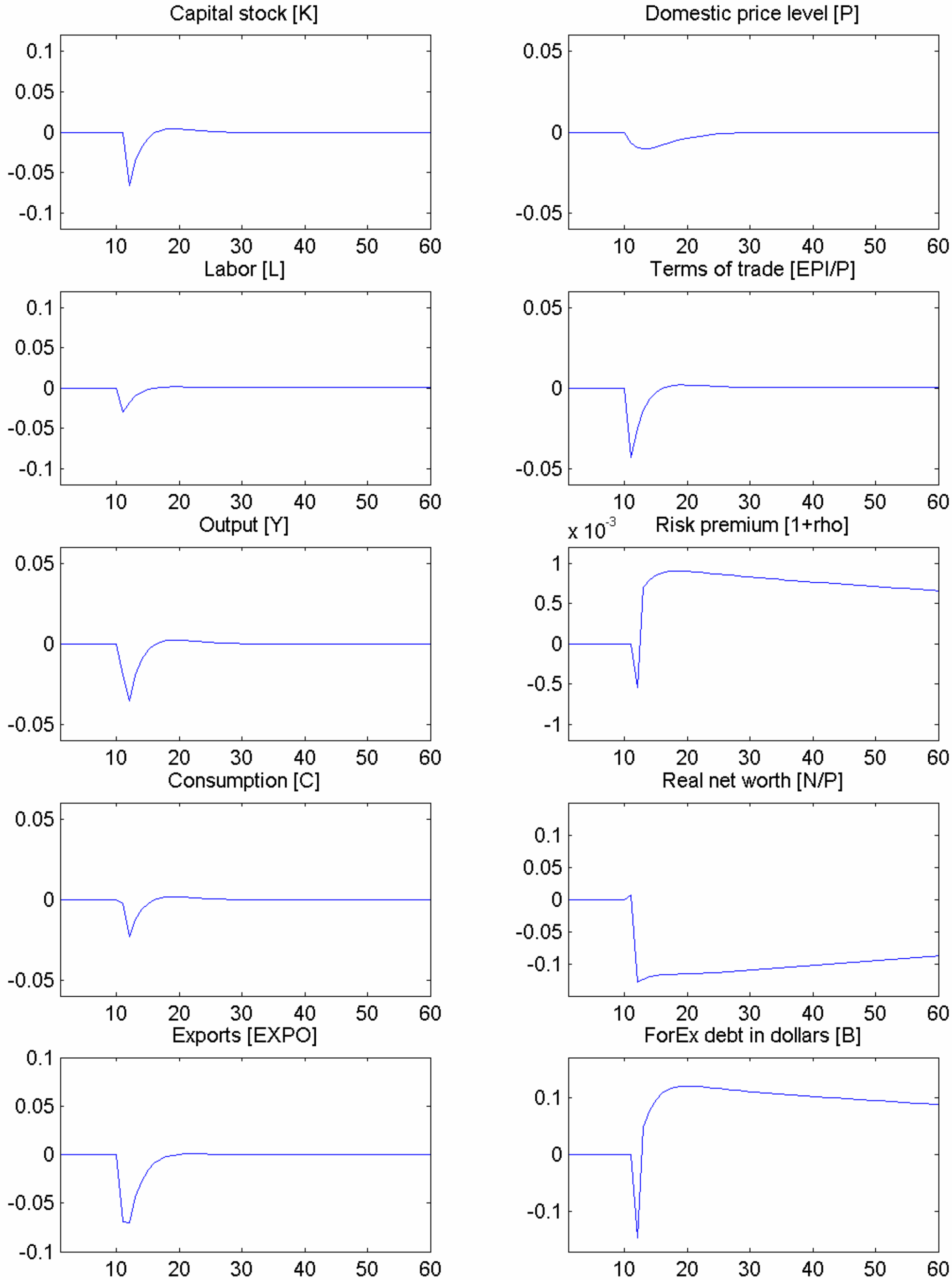
<u>Figure 3</u>: Impact of a 10% depreciation of the yen against the dollar under a yen peg



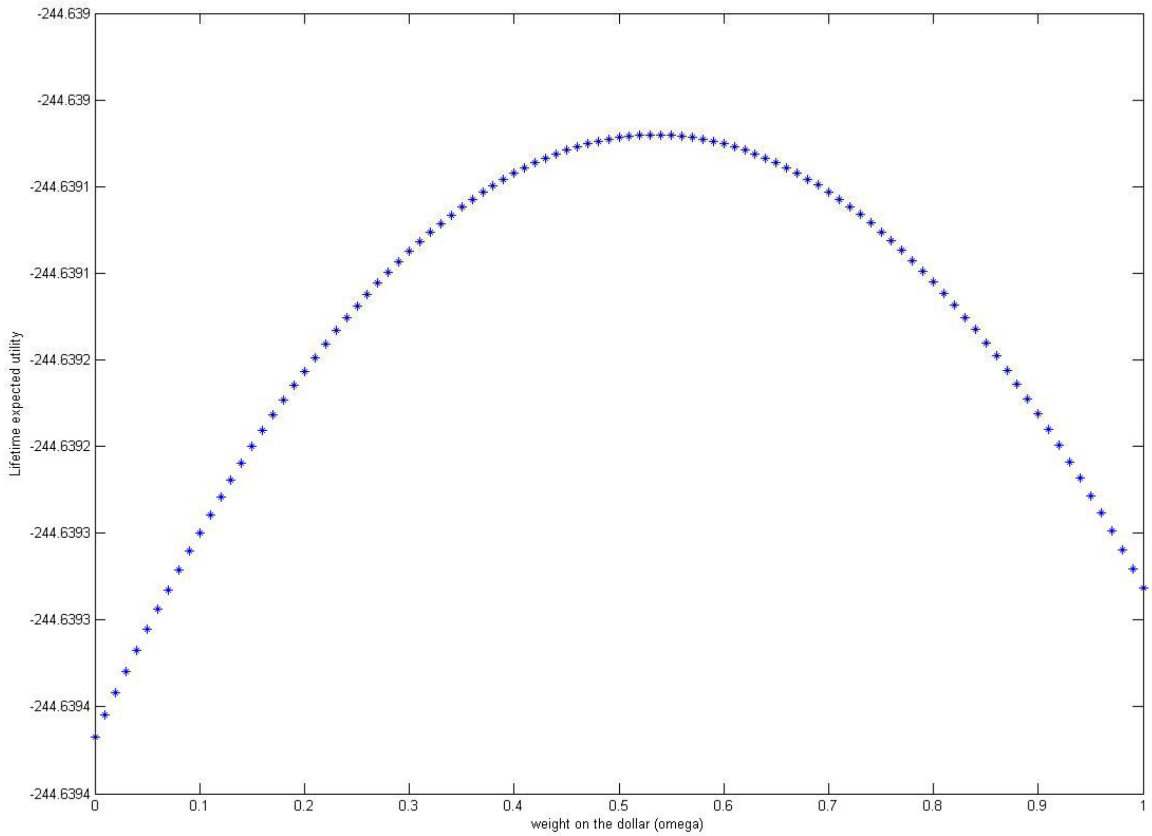
<u>Figure 4</u>: Impact of a 10% depreciation of the yen against the dollar under a trade-weighted basket peg



<u>Figure 5</u>: Impact of a 10% depreciation of the yen against the dollar under a dollar peg



<u>Figure 6</u>: Expected lifetime utility as a function of the basket weight on the dollar (γ=*0.5*)



<u>Figure 7</u>: Optimal weight on the dollar as a function of the share of trade with the US