

**Should Small Open Economies in East Asia
Keep All Their Eggs in One Basket:
The Role of Balance Sheet Effects***

Slavi T. Slavov**

Exchange rate fluctuations among the world's major currencies increase macroeconomic instability in small open economies around the world. I investigate the choice of an optimal currency basket for these countries using a micro-founded, welfare-based approach. I build a sticky-price dynamic model of a small open economy whose foreign trade is priced in dollars and yen. First, I show the conditions under which it is optimal for this economy to peg to a trade-weighted basket of the two currencies. Then, I introduce net worth constraints and unhedged dollar borrowing which pull the optimal currency basket toward putting a much greater weight on the dollar. The model-generated optimal weights on the dollar for East Asian countries (like Korea and Thailand) are close to the empirical estimates for both the pre-1997 and post-1997 periods.

JEL Classification: F3, F4

Keywords: balance sheet effects, optimal basket pegs

* Received October 6, 2007. Accepted February 20, 2008.

** Department of Economics, Pomona College, 425 North College Avenue, Claremont, CA 91711, USA, Tel: 1-909-607-8843, Fax: 1-909-621-8576, E-mail: slavi@pomona.edu

1. INTRODUCTION

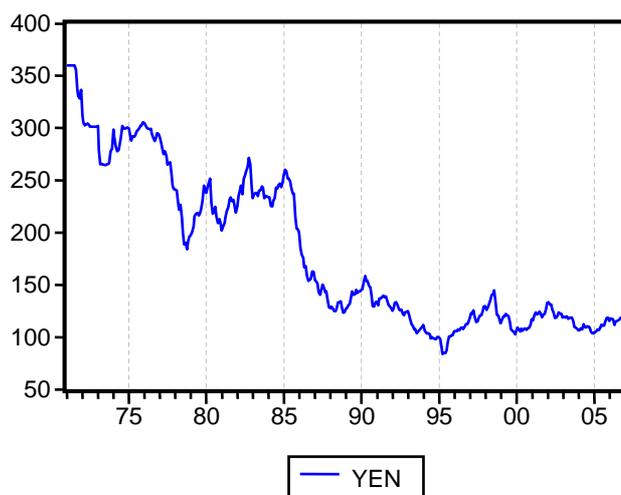
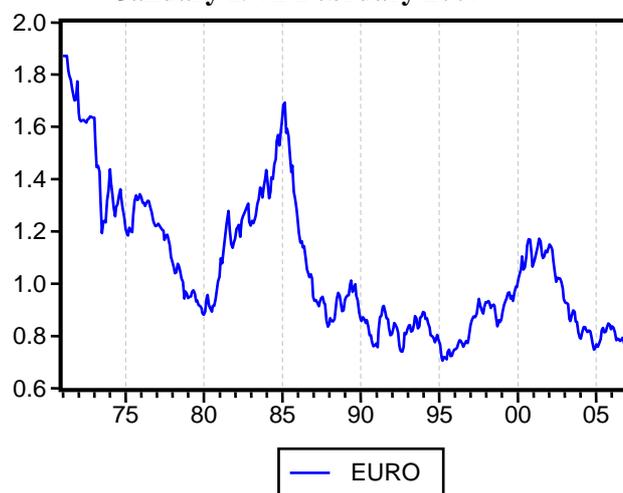
Ever since the end of the Bretton Woods system of fixed exchange rates, the world's major currencies have fluctuated widely against one another. Figure 1 illustrates the tremendous volatility in the euro-dollar and yen-dollar exchange rates since the 1970s.¹⁾ Given that the United States, the Euro Area, 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 economy. Many small 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.

A possible solution explored since the 1970s, both in practice and in theory, is for small economies to peg to a basket of currencies. This stabilizes a country's effective exchange rate and smoothes the impact of instability among the major currencies. 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. This paper investigates the

¹⁾ Before 1999, the euro-dollar exchange rate was spliced with the German mark-US dollar exchange rate.

Figure 1 Euro-dollar and Yen-dollar Exchange Rate, January 1971-February 2007



Note: Before 1999, the Euro-dollar exchange rate was spliced with the Deutsche mark-dollar rate.

Source: IMF, International Financial Statistics.

choice of an optimal currency basket for these countries using a micro-founded, welfare-based approach. I build a sticky-price dynamic model of a small open economy whose foreign trade is priced in dollars and yen. First, I

show the conditions under which it is optimal for this economy to peg to a trade-weighted basket of the two currencies. Then, I introduce net worth constraints and unhedged dollar borrowing which pull the optimal currency basket toward putting a much greater weight on the dollar. The paper's main result is that when choosing the optimal basket, 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. The paper's chief methodological contribution is that it offers a micro-founded, welfare-based analysis of the optimal currency basket. The paper updates on older literature which lacked explicit micro-foundations, and merges it with a current literature on credit market imperfections and balance sheet effects, which was started by Bernanke, Gertler, and Gilchrist (1998).

Several papers have already applied the Bernanke, Gertler, and Gilchrist (1998) framework to small open economy models.²⁾ The central issue in these papers is 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 stays away altogether from the issue of "fix or float?" and focuses instead on the issue of "fix to what?" While in theory, flexible exchange rates are superior to fixed ones, several recent papers have shown that fixed exchange rates can dominate flexible ones in models with balance sheet effects under realistic parametric assumptions.³⁾ A second objection to the claim that flexible exchange rates are superior to fixed ones, is that the theory takes an idealized view of how flexible exchange rates work in practice. Theoretical models assume a perfectly credible monetary authority as well as complete and well-functioning financial markets. The reality on the ground in many developing countries is very different. Therefore, the research question "fix to what?" has a lot of practical relevance for emerging economies.

²⁾ See Devereux and Lane (2003), Cespedes, Chang, and Velasco (2004), Choi and Cook (2004), Elekdag and Tchakarov (2004), Devereux and Poon (2004), and Devereux, Lane, and Xu (2006).

³⁾ See Choi and Cook (2004), Devereux and Poon (2004), and Elekdag and Tchakarov (2004).

Section 2 of this paper takes a closer look at East Asia where dollar-yen exchange rate fluctuations are an important driver of business cycles. 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 main insight lies in the difference between the two. First, in section 4 I show the conditions under which it is optimal for the small open economy 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 currency basket away from the trade-weighted basket and toward placing a substantially higher weight on the currency of borrowing. Section 6 concludes.

2. EAST ASIA: THE EXCHANGE RATE REGIME AND THE CURRENCY STRUCTURE OF TRADE AND DEBT

Recently, the literature on basket pegs has focused on the small emerging economies in East Asia. In the search for an explanation for the 1997 East Asian Crisis, one popular hypothesis has maintained that the crisis was precipitated by, among other factors, volatility in the yen-dollar exchange rate, coupled with *de facto* pegs to the dollar practiced by most of the crisis countries both before and after 1997.⁴⁾ A dollar peg means that East Asian economies float freely against the Japanese yen. Given the yen's alleged

⁴⁾ 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 around 90% and highly statistically significant for most countries and sub-periods. Moreover, using daily data for the period February 1994 - December 2003, McKinnon and Schnabl (2004) showed that, post-crisis, all of these economies (except Indonesia) have returned to their pre-crisis soft pegs to the US dollar. Ogawa (2004) reports very similar results, using daily data.

Table 1 Aggregate Direction of Trade for Nine East Asian Economies for the Year 2001

	Exports from East Asia to	Imports into East Asia from
East Asia	36.9%	41.5%
United States	20.4%	13.1%
Japan	12.3%	16.2%
Rest of the world	30.4%	29.2%
Total	100.0%	100.0%

Note: East Asia is defined to include China, Hong Kong, Indonesia, Korea, Malaysia, Philippines, Singapore, Taiwan, and Thailand.

Source: International Monetary Fund, Direction of Trade Statistics.

importance in regional trade and finance, that must lead 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 have been heated debates on what the optimal way is for emerging East Asian economies to manage their currencies. Some authors 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 US dollar before 1997.⁵⁾ 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.⁶⁾

One shortcoming of these analyses is that they typically stress the direction of trade of emerging East Asian countries. Table 1 reports data on the direction of trade of nine emerging East Asian countries in 2001. Twenty percent of their exports went to the US, 12% went to Japan, and 30% went to

⁵⁾ See Ito, Ogawa, and Sasaki (1998), Williamson (2000), Kwan (2001), Kawai (2002), among many others.

⁶⁾ In July 2005, under intense pressure from foreign policymakers and academics, China discontinued its long-standing peg to the US dollar and switched to a currency basket containing as many as 11 currencies whose weights remain unspecified.

the rest of the world (mostly to the European Union). 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. However, the currency structure of trade is at least as important as the direction of trade. Data on trade invoicing are notoriously hard to come by. Indirect evidence suggests that at least 60-65% of the foreign trade of East Asian countries is dollar-invoiced.⁷⁾ Only about 5-10% of their foreign trade is invoiced in yen. Direct evidence on invoicing is available only for Korea, Malaysia, and Thailand. According to data reported in McKinnon and Schnabl (2004), in the year 2002, 87% of Korean exports and 81% of Korean imports were invoiced in US dollars. According to Goldberg and Tille (2006), for Malaysia in 1996, the corresponding percentages were around 66%, while for Thailand in the same year, the corresponding percentages were around 84%. According to Fukuda and Ono (2005), 87% of Thai exports in the year 2000 were invoiced in dollars. In sum, East Asian trade is overwhelmingly dollarized and the yen plays a rather insignificant role. A basket with equal weights on the dollar, yen, and euro does not reflect the dollar's pre-eminence in the currency structure of East Asia's trade.⁸⁾

⁷⁾ At least half of trade with Japan is invoiced in US dollars. Almost all trade with the United States is dollarized. The same is true of intra-regional trade among East Asian countries. For example, according to Fukuda and Ono (2005), in the year 2002, 71% of Thai exports to Japan were invoiced in USD, as were 96% of exports to the US, 73% of exports to the European Union, and 89% of exports to other ASEAN countries. Furthermore, according to McKinnon and Schnabl (2004), in the year 2002, 71% of East Asian exports to Japan and 45% of East Asian imports from Japan were invoiced in dollars.

⁸⁾ Shioji (2006) emphasizes the discrepancy between trade shares and invoicing currency shares in a model using the new open economy macroeconomics (NOEM) framework. However, that paper lumps all of East Asia (excluding Japan) into a single entity and thus neglects completely intra-regional trade, which is overwhelmingly invoiced in US dollars. Furthermore, Shioji's model has single-period price stickiness, final goods only, no capital investment, and no role for capital flows. In contrast, the model developed in section 3 here has intermediate goods, multi-period price stickiness, capital investment, and capital flows play a key role.

A second weakness of arguments in favor of trade-weighted baskets is that they typically focus on trade in goods and either neglect capital flows or assume complete and perfectly-functioning financial markets. However, the currency structure of debt tips the scales further in favor of the dollar (see table 2). Note the remarkable build-up in dollar-denominated debt between 1996 and 2001: from an unweighted average of 38% in 1996 to 59% in 2001. Back in the pre-crisis 1996 all five countries were on *de facto* dollar pegs but were borrowing a lot (perhaps too much) in other currencies. This must have caused some macroeconomic discomfort due to balance sheet effects, as my theoretical model will illustrate.⁹⁾ 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 financial markets are incomplete — developing countries are unable to hedge currency risk. The “original sin” hypothesis advanced by Eichengreen and Hausmann (1999) stated that emerging economies are unable to borrow abroad in their own currency. Therefore, they are forced to borrow in foreign currency and they are also unable to hedge their foreign-currency debt in forward markets because a foreign-currency loan plus a hedge would have been equivalent to a domestic-currency loan. The reality in most emerging markets until very recently is that forward markets involving the domestic currency were either non-existent or they were thin and illiquid. Unhedged foreign borrowing by the private sector plays a crucial role in generating the balance sheet effects in the model of section 3. Financial market imperfections and incompleteness are the reason why the currency structure of debt matters so much for the exchange rate regime.

⁹⁾ Table 2 reports the currency structure of long-term debt (with maturity of 1 year or more). One might argue that what matters here is the currency structure of short-term debt, given that in the theoretical model of this paper there is no capital accumulation and capital investment is financed by short-term (one-period) bonds. Unfortunately, data on the currency structure of short-term debt is not available from the Global Development Finance database. Generally, short-term debt is difficult to monitor and keep track of. I thank an anonymous referee for bringing up this issue.

Table 2 Currency Composition of Long-term Debt for Five East Asian Economies (%)

Year	Currency: JPY					Currency: USD				
	Indonesia	Korea	Malaysia	Philippines	Thailand	Indonesia	Korea	Malaysia	Philippines	Thailand
1990	35	32	37	31	43	21	33	32	36	16
1991	36	31	36	34	45	19	39	30	33	18
1992	36	30	35	34	47	20	45	28	34	22
1993	38	32	37	38	50	20	46	29	30	22
1994	38	34	37	40	51	20	39	35	28	23
1995	35	38	35	39	48	22	39	48	27	27
1996	35	32	28	38	45	24	48	56	30	32
1997	33	23	26	36	39	27	60	56	34	47
1998	32	18	30	37	40	48	73	59	35	49
1999	35	22	30	39	46	47	72	60	39	45
2000	33	23	28	38	46	50	70	63	42	46
2001	28	18	22	39	45	57	76	71	41	48
2002	29	n.a.	21	40	57	55	n.a.	71	41	38
2003	29	n.a.	24	40	62	54	n.a.	69	42	33
2004	33	n.a.	23	40	64	45	n.a.	70	42	31
2005	36	n.a.	22	35	58	42	n.a.	71	50	38
2006	36	n.a.	20	33	62	42	n.a.	73	53	35

Source: World Bank, Global Development Finance.

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. Several papers have applied this framework to small open economy models: Devereux and Lane (2003), Cespedes, Chang, and Velasco (2004), Choi and Cook (2004), Elekdag and Tchakarov (2004), Devereux and Poon (2004), and Devereux, Lane, and Xu (2006). 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 stays away altogether from the issue of “fix or float?”

Many economists have argued that, in theory, flexible exchange rates are superior to fixed ones. This claim is debatable in the context of models with balance sheet effects. Several recent papers have shown that fixed exchange rates can dominate flexible ones in such models under fairly realistic parameter values. See Choi and Cook (2004), Devereux and Poon (2004), and Elekdag and Tchakarov (2004). That is one reason why this paper focuses on the optimal basket of currencies to peg to.

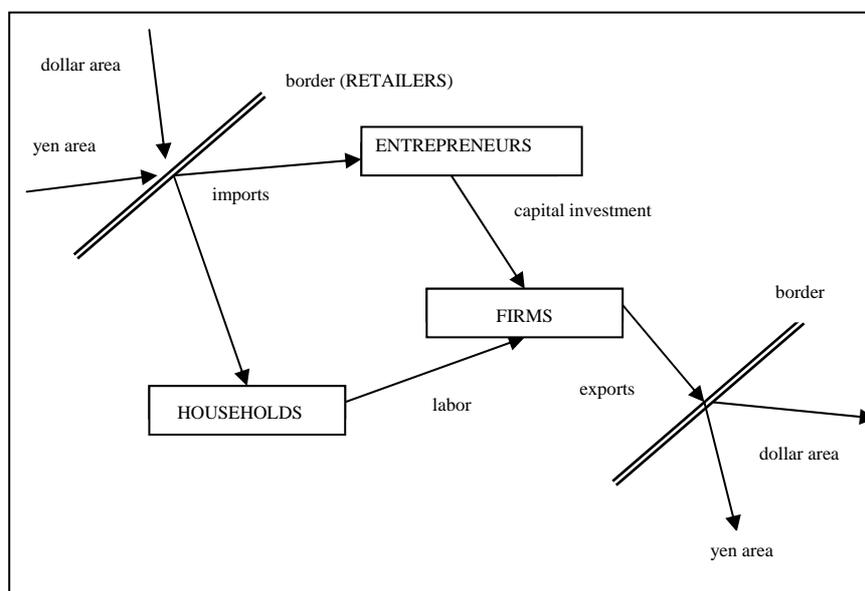
Another possible objection to the claim that flexible exchange rates are superior to fixed ones, is that the theory takes an idealized view of how flexible exchange rates work in practice. Theoretical models assume a perfectly credible monetary authority as well as complete and well-functioning financial markets. The reality on the ground in many developing countries is very different — central banks often lack credibility and financial markets are incomplete and underdeveloped. Given this, the research question “fix to what?” has a lot of practical relevance for emerging economies. This paper builds a model whose answer to that question is that when choosing the optimal basket, 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.

In the model, there are three economies in the world: two large economies A and B, and a small open economy in East Asia (which I will call “Home”). Think of Home as Korea or Thailand. The relative sizes of countries A and B will be γ and $1-\gamma$, respectively. One should think of A and B not as countries (US and Japan) but as currency areas — as a “dollar area” and a “yen area” in the sense that either the dollar or the yen is the dominant currency for pricing trade flows. For the typical small East Asian country, intraregional trade is overwhelmingly priced in dollars (see section 2). Therefore, in this model trade between Home and the “dollar area” A captures not only trade with the US but also trade with other East Asian economies.

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, there are five distinct sets of players: retailers, households, entrepreneurs, exporting firms, and the government. Figure 2

Figure 2 Flow of Goods in the Small Open Economy



summarizes the flow of goods in the small open economy. Monopolistically competitive retailers import a good from A and another good from B. They combine, differentiate, and re-sell imports to domestic households and to entrepreneurs. Infinitely-lived households consume imports and supply labor. They own retailers and exporting firms. Entrepreneurs (who are distinct from the households) buy imports from retailers, consume some imports, and re-sell the rest to exporting firms, which use them as productive capital. Exporting firms (owned by the households) purchase labor from households and capital from entrepreneurs, and export all output to A or B. None is consumed domestically. The government follows a simple exchange rate rule.

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. I do not consider a vast array of other possible exogenous shocks (to the technology shifter in the production function, to world interest rates, to the world terms of trade, and to export demand) because my main interest is in the impact of G-3 exchange rate volatility on small open economies. This is the one kind of shock which has not been studied, and therefore it is the main focus and the main contribution of this paper. However, the model could be extended to handle other types of shocks.

The model has the features necessary to generate both the positive and negative aspects of exchange rate depreciations. The expansionary side of depreciations comes from the mercantile effect they have on domestic exports, output, and consumption. The contractionary side of depreciations is due to the higher domestic prices of imports and due to the volatility-enhancing balance sheet effects on capital investment and future output.

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 (due to the monopolistically competitive retail sector). 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, Lane, and Xu (2006) 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 main contribution lies in the difference between the two. First, I consider a version of the model without any financial market imperfections. Under this condition, the model is stacked, by construction, in favor of the trade-weighted basket as the optimal currency basket. It is optimal to use the trade shares (γ and $1-\gamma$) as basket shares on the dollar and yen, respectively.

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 currency basket. The trade-weighted basket is no longer optimal. Instead, it is now optimal (welfare-maximizing) to place a weight on the dollar which exceeds γ , the dollar's trade share. Financial market imperfections and unhedged dollar borrowing 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 are infinitely-lived. They consume and supply labor to firms. They own retailers and exporting firms. Their utility function over consumption and leisure is given by

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

where L^A and L^B denote labor supplied to the two types of firms which 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 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. This is just a convenient modeling simplification. C_t is an index of differentiated goods (which households purchase from the monopolistically competitive retailers) and is given by

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

The elasticity of substitution between brands is given by ν . Demand for brand z is given by

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

where the consumer price index P_t is defined as

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

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

$$P_t C_t = W_t^A L_t^A + W_t^B L_t^B + \Pi_t, \quad (2)$$

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). The latter assumption is more tractable and perhaps more realistic — credit constraints at the household level have been shown to be an important driver of aggregate consumption dynamics.¹⁰⁾ The same assumption is employed in Krugman (1999), Devereux and Lane (2003), Devereux and Poon (2004), and Cespedes, Chang, and Velasco (2004). The first-order conditions guiding labor-leisure choice as well the allocation of effort between the two sectors are

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

3.2. Retailers

Retailers are monopolistically competitive, so they have some degree of price-setting power. Retailers are needed in the model in order to drive a wedge between import prices and the consumer price index. Because of them, we have price stickiness and imperfect exchange rate pass-through. Price stickiness and imperfect exchange rate pass-through are crucial because they create nominal non-neutrality and the need for government policy. Without these features, the exchange rate regime would have been irrelevant.¹¹⁾ There is a continuum of retailers of measure one. They are

¹⁰⁾ Also, note the inconsistency between assuming that households have full access to financial markets, while entrepreneurs remain credit-constrained.

¹¹⁾ Choi and Cook (2004) is another paper in which the retail sector plays the same role and is modeled the same way as here. See pp. 257-258 in that paper.

monopolistically competitive and are owned by the households. Each retailer purchases imports from both countries A and B and assembles them costlessly to produce a brand of the consumption good, using a Cobb-Douglas production function

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

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, by construction, 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)

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

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

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

where $\hat{Z}_t \equiv \frac{dZ_t}{Z}$ denotes percentage deviation from the non-stochastic 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 the real exchange rate between A and B. 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

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

In log-linear terms, the equation becomes

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

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

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

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

$$P_t = \frac{\nu}{\nu-1} MC_t. \quad (9)$$

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

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

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 exchange rate pass-through (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 will be irrelevant at the macroeconomic level. 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 rebated lump-sum to households and are given by the equation

$$\Pi_t = (P_t - MC_t)(C_t + K_t). \quad (11)$$

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

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

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

These 2 equations model exchange rate pass-through from fluctuations in the yen-dollar exchange rate to the yen and dollar prices of traded goods.¹²⁾ According to these equations, a depreciation of the yen against the dollar will have an inflationary effect on the yen prices of traded goods, and a deflationary effect on the dollar prices of traded goods. The persistence parameter φ_M 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 exchange rate pass-through to prices in large closed industrialized economies is low 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 found 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 inversely proportional to the 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. It has been well-established since Dornbusch (1987) that exchange rate pass-

¹²⁾ This is obviously a modeling simplification. In a small open economy model, world prices of traded goods are necessarily exogenous.

through depends inversely on economic size — larger economies exhibit lower exchange rate pass-through, and vice versa.

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 constant-returns-to-scale technologies

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

Capital depreciates completely each period.¹³⁾ Domestic firms are competitive price-takers in world markets.¹⁴⁾ They are owned by the households but perfect competition in combination with constant returns to scale means that they make zero profits in equilibrium. Exogenous prices in dollars and yen for Home's exported 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

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

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

¹³⁾ The assumption of complete capital depreciation each period ($\delta = 1$) buys us a lot of simplicity. The same assumption is made in Cespedes, Chang, and Velasco (2004) and in Elekdag and Tchakarov (2004). Intuitively, one may think of the export firms as “wheat farmers” or “corn farmers” so that seeds play the role of physical capital in this model.

¹⁴⁾ Essentially, here it is assumed that exporters can sell any quantity at an exogenous world prices. In other words, the demand elasticity for the small country's exports is infinite. The alternative would have been to assume that exporters face a downward-sloping demand. That would have implied that these exporters enjoy a degree of market power in world markets, which is not obviously the case for the typical small open economy.

A firm solves the following problem

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

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

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

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

3.4. Government

The currency structure of trade, the currency structure of debt, and the exchange rate regime are endogenous to each other. They are all jointly determined in equilibrium.¹⁵⁾ For the sake of analytical convenience, in this paper I model the government as setting the optimal exchange rate regime given the 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.¹⁶⁾ What domestic governments can and do control, however, is the exchange rate regime.

¹⁵⁾ There has been some recent work on the endogenous determination of the currency structure of trade — see Devereux and Engel (2001), Corsetti and Pesenti (2002), Devereux, Engel, and Storgaard (2004), Bacchetta and Wincoop (2005), and Goldberg and Tille (2006). There is a lack of consensus currently on how the currency structure of debt interacts with the exchange rate regime, though Berrospide (2006) offers an interesting model analyzing the feedback from the exchange rate regime to the currency composition of debt.

¹⁶⁾ Fukuda and Ono (2006) build a theoretical model which illustrates the substantial inertia in the choice of invoicing currency.

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

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

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

i) A yen peg ($\omega=0$):

$$S_t^B = 1 \text{ and } S_t^A = S_t^{BA}.$$

ii) A dollar peg ($\omega=1$):

$$S_t^A = 1 \text{ and } S_t^B = \frac{1}{S_t^{BA}}.$$

iii) A trade-weighted basket peg ($\omega = \gamma$). Then:

$$S_t^A = (S_t^{BA})^{1-\gamma} \text{ and } S_t^B = (S_t^{BA})^{-\gamma}.$$

All the 1's above are convenient normalizations, without any loss of generality. The table below summarizes the behavior of the percentage deviations from the non-stochastic steady state of the two bilateral exchange rates and of the nominal effective exchange rate $(S_t^A)^\gamma (S_t^B)^{1-\gamma}$, as functions of the yen-dollar exchange rate, under the three exchange rate regimes defined above:

Exchange Rate Regime	Yen Peg	Trade-weighted Basket Peg	Dollar Peg
Weight on the Dollar (ω)	0	γ	1
Home's Exchange Rate with Currency A (dollar) $\hat{S}_t^A = (1-\omega)\hat{S}_t^{BA} =$	\hat{S}_t^{BA}	$(1-\gamma)\hat{S}_t^{BA}$	0
Home's Exchange Rate with Currency B (yen) $\hat{S}_t^B = -\omega\hat{S}_t^{BA} =$	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	$-(1-\gamma)\hat{S}_t^{BA}$

The first row of that table can be interpreted as saying that a 1% depreciation of the yen against the dollar will cause

- i) under a yen peg: a 1% depreciation of Home's currency against the dollar
- ii) under a trade-weighted basket peg: a depreciation of $(1-\gamma)$ percentage points against the dollar
- iii) under a dollar peg: no change in Home's currency against the dollar

The last two rows of the table can be interpreted in a similar fashion.

One can think of the trade-weighted basket as aimed at stabilizing Home's nominal effective exchange rate $(S_t^A)^\gamma (S_t^B)^{1-\gamma}$. A quick look at equations (6) and (10) above 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 this

model, money 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 a simple policy rule. This is a common modeling strategy in the recent literature on optimal monetary policy — see Bernanke, Gertler, and Gilchrist (1998), Cespedes, Chang, and Velasco (2004), Corsetti and Pesenti (2002), Gali and Monacelli (2002), Choi and Cook (2004), and Devereux, Lane, and Xu (2006). In all of these papers, this is done for analytical convenience. Money demand could always be introduced into these models explicitly, either through the cash-in-advance or the money-in-the-utility-function channels. In this paper, as in the papers cited above, monetary policy is specified in terms of a simple policy rule. You can think of the central bank in this setup as constantly adjusting the domestic money supply in order to implement its policy rule.

Furthermore, the set of monetary regimes considered in this paper is restricted to a continuum of exchange rate pegs. The paper does not consider targeting the inflation rate, or the short-term nominal interest rate, or the money supply.¹⁷⁾ As discussed earlier, the monetary authorities in emerging markets tend to focus on the exchange rate as their preferred tool for conducting monetary policy. The question “fix to what?” appears to be the practically relevant one for emerging economies.

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

¹⁷⁾ However, as was shown earlier, the trade-weighted basket peg in this model is equivalent to a policy targeting the domestic price level.

with net worth constraints in the entrepreneurial sector. The paper's main insight lies in the difference between the two equilibria.

Here, entrepreneurs (who are distinct from the households) buy imports from retailers and re-sell these imports to firms, which use them as capital in producing exports. Capital is completely fungible with the composite consumption 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 non-stochastic steady-state solution of the model described by equations (2)-(3), (9), (11), (14), and (17)-(18), assuming the normalization $S^i = M^i = X^i = 1$, 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 $\gamma/(1-\gamma)$. 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 $\gamma/(1-\gamma)$. In other words, in the non-stochastic steady state, a fraction γ of output gets exported to country A and a fraction $1-\gamma$ gets exported to B.

The solution for the non-stochastic steady state of the model without credit market imperfections is deferred to the Technical Appendix (available from the author upon request). It is easier to analyze the model, as described in equations (2)-(3), (11), (14), and (17)-(18), in log-linear form

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

where $f = \frac{1}{\nu(1-\alpha) + \alpha}$.

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

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

where $g = \frac{\alpha(\nu-1)^2}{\nu[\nu(1-\alpha) + \alpha]}$,

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

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

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

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 . A stationary rational expectations equilibrium is defined in the usual way. The solution for the log-linear model without credit market imperfections is deferred to the Technical Appendix (available from the author upon request). In particular, the solution for real output is given by

$$\hat{Y}_t = \gamma\hat{Y}_t^A + (1-\gamma)\hat{Y}_t^B = \left(\frac{1+\alpha}{2(1-\alpha)} + \frac{g\nu}{2(\nu-1)} \right) \left(\hat{NEER}_t - \hat{P}_t \right). \quad (19)$$

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 $(S_t^A)^\gamma (S_t^B)^{1-\gamma}$. When the nominal effective exchange rate (in log-linear terms) 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 consumption, leisure, 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. 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 this 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 effect on the economy, consistent with the empirical results in Kwan (2001) and 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 now. They purchase the index consumption good at a price P_t from retailers and re-sell it to exporting firms at price R_t . Firms use it as capital in producing exports. Capital purchases are now financed by entrepreneurs' net worth and by borrowing. Due to "original sin" (as discussed earlier), entrepreneurs are forced to borrow in dollars and take on unhedged foreign currency debt. 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 as capital in *next* period's production of exports by firms

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

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

$$\Pi_t = (P_t - MC_t)(C_t + K_{t+1}). \quad (11a)$$

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

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

Lenders charge a higher risk premium when they observe that a lower fraction of capital investment is financed out of own net worth.¹⁸⁾ The higher the entrepreneurs' leverage, 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.

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

$$N_t = \delta \left(R_t K_t - (1+i^*)(1+\rho_t) S_t^A B_t \right). \quad (22)$$

Equation (22) shows that, *ceteris paribus*, a depreciation against the dollar

¹⁸⁾ Both entrepreneurs and foreign creditors are risk-neutral in this model. Thus, calling ρ_t “the risk premium” is just shorthand for “the external finance premium.” I thank an anonymous referee for bringing up this point. For the microfoundations behind the financial friction here, see the appendices to Bernanke, Gertler, and Gilchrist (1998) and Cespedes, Chang, and Velasco (2004). Briefly, the relationship between the creditor and the entrepreneur is subject to asymmetric information. There are random shocks to the return on the entrepreneur's investment in physical capital. The entrepreneur observes the realization of the shock for free. However, the creditor only observes that realization if he pays a monitoring cost. Given this informational asymmetry, the optimal contract is a standard debt contract specifying that in the good states (for a sufficiently high realization of the shock), the entrepreneur repays his debt in full and keeps the residual yield for himself. In the bad states, the entrepreneur defaults on the loan, while the creditor pays the monitoring cost, monitors the outcome, and seizes the whole yield on the investment. The entrepreneur gets nothing. Given the possibility of default, the creditor charges more than the risk-free interest rate in the good states. Hence, the “premium on external finance” or “the risk premium,” for short. The terms of this contract are designed so as to minimize expected monitoring costs. The lower the net worth of the entrepreneur (relative to debt), the higher the probability of a default, the higher the expected monitoring costs, and thus the higher the premium charged on external finance. This is the justification for equation (21) above, which is identical to equation (11) in Cespedes, Chang, and Velasco (2004).

will increase the *ex post* debt burden, reduce entrepreneurial net worth and, thus, reduce future investment. It is another key equation of the 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. 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.

Entrepreneurs are risk-neutral and that will ensure that entrepreneurs will equate return on capital investment to the external cost of funds, both in dollar terms

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

A closer look reveals that the above arbitrage condition is really a special case of risk-adjusted 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.

Using equations (2)-(3), (9), (11a), (14), (17)-(18), (20)-(23) we can compute the non-stochastic steady-state values for K^i , K , L^i , L , Y^i , Y , W^i , P , Π , C , R , N , B , ρ as functions of all the other parameters of the model, under the normalization $S^i = M^i = X^i = 1$, for $i = A, B$. The solution for the non-stochastic steady state of the model with credit market imperfections is deferred to the Technical Appendix (available from the author upon request). Note that in the non-stochastic steady state we have $\delta(1+i^*)(1+\rho) = 1$ and $B_{t+1} = B_t$. The non-stochastic 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 Technical Appendix also offers the equations of the log-linearized system and describes the solution method for the model with credit market imperfections, 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 Technical Appendix (available from the author upon request). The time unit of the model is one quarter. I set capital's income share α to 0.35, the consensus value in the business cycle literature. The monopolistic pricing parameter ν is set to 6, which implies a markup of 20% in the non-stochastic steady state. I set the domestic and foreign price stickiness parameters (φ , φ_M , φ_X) to 0.75, which implies that the average waiting period to update prices is 4 quarters. Setting $i^*=0.01$ implies an annual world risk-free interest rate of 4%, which is also common. Correspondingly, I set the discount factor β to 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 (again, as in Bernanke, Gertler, and Gilchrist, 1998). The steady-state debt-to-output ratio is then around 0.17.

The behavior of $\hat{M}C_t$ 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. For the sake of symmetry and simplicity, the simulation analyzes the case of $\gamma=0.5$.

Figure 3 Impact of a 10% Depreciation of the Yen against the Dollar under a Yen Peg

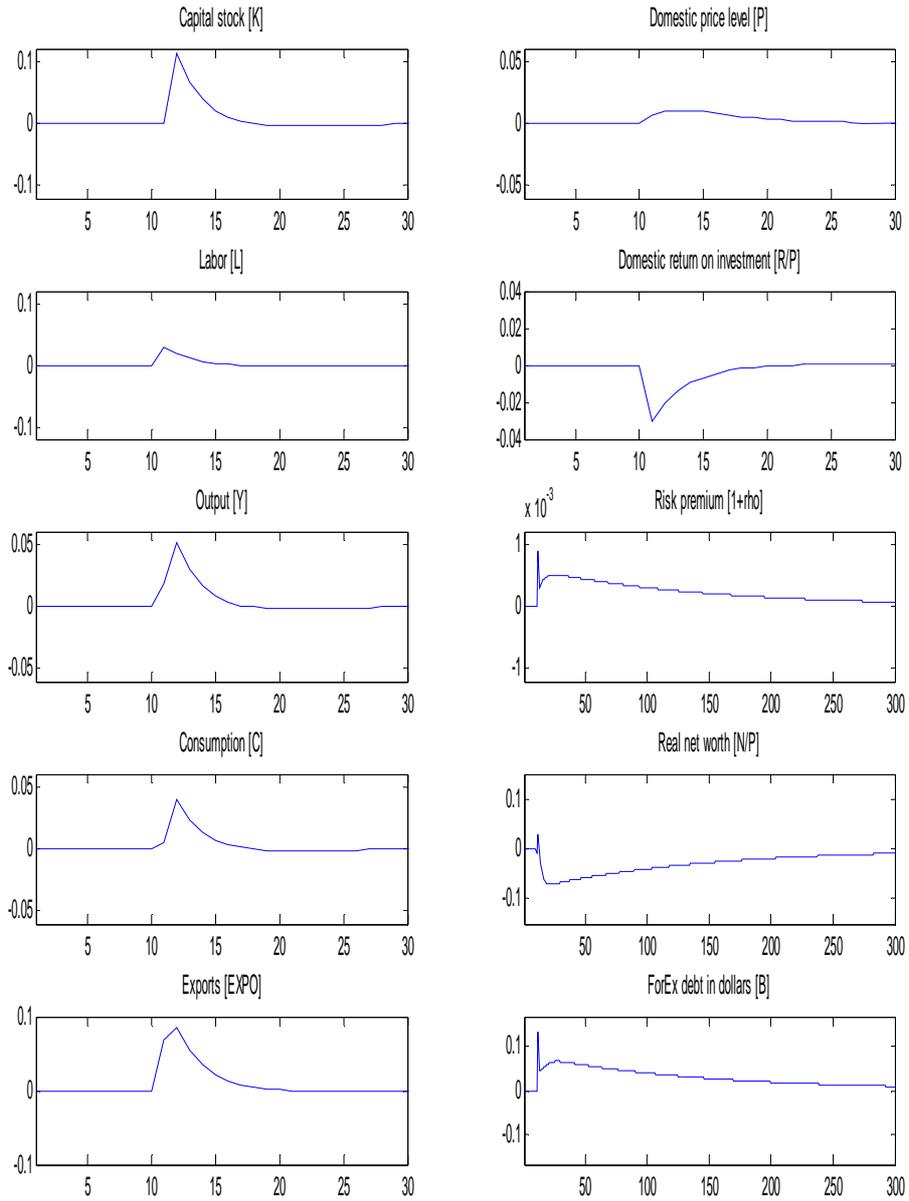


Figure 4 Impact of a 10% Depreciation of the Yen against the Dollar under a Trade-weighted Basket Peg

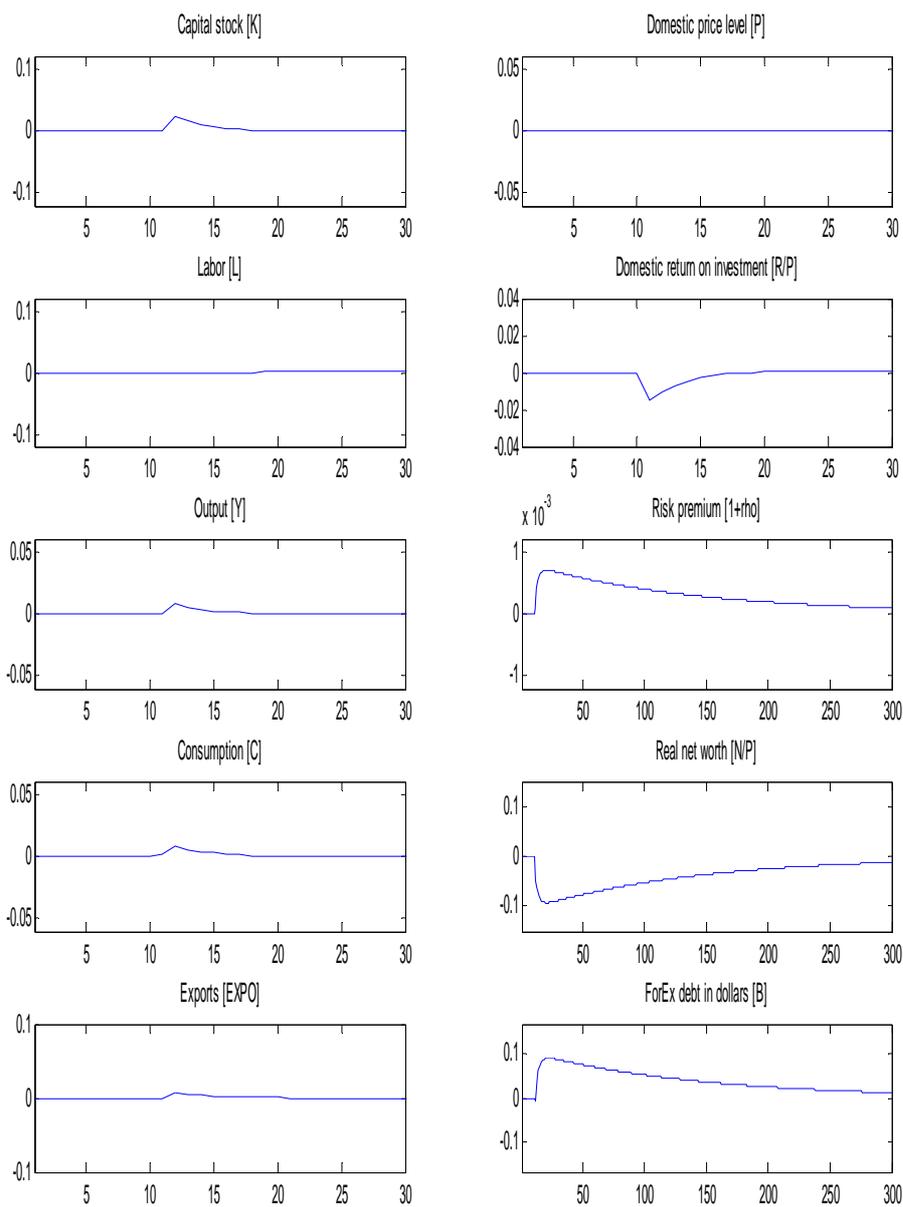
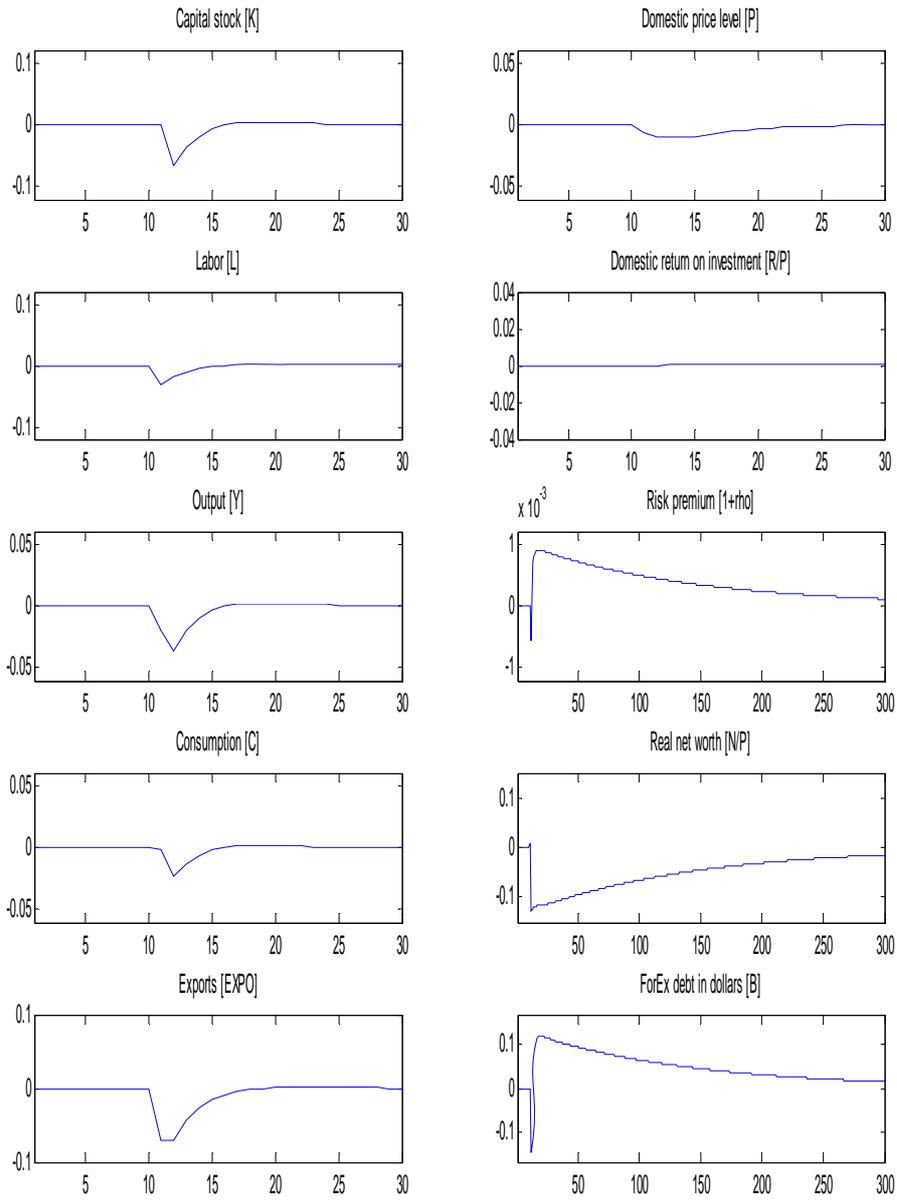


Figure 5 Impact of a 10% Depreciation of the Yen against the Dollar under a Dollar Peg



The figures plot one additional variable of interest. Total exports are defined as

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

In log-linear terms

$$\begin{aligned} \widehat{EXPO}_t &= \gamma(\widehat{S}_t^A + \widehat{X}_t^A + \widehat{Y}_t^A) + (1-\gamma)(\widehat{S}_t^B + \widehat{X}_t^B + \widehat{Y}_t^B) \\ &= \widehat{NEER}_t + \gamma\widehat{X}_t^A + (1-\gamma)\widehat{X}_t^B + \widehat{Y}_t. \end{aligned}$$

Note that a yen depreciation is expansionary under a yen peg and contractionary under a dollar peg (compare 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 my model 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 (as is the case under a yen peg) is sharper than when there are none (as is the case under a 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 numerically with an AR(1) stochastic process for \widehat{S}_t^{BA}

$$\widehat{S}_{t+1}^{BA} = \eta\widehat{S}_t^{BA} + u_{t+1}.$$

Above, $\eta = 0.95$ and u_{t+1} is a normally distributed zero-mean random variable

with a standard deviation of 0.005. The η parameter was calibrated to match the high persistence of deviations of actual G-3 exchange rates from their steady state paths, defined as a linear trend. 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} . Next, the economy is simulated 25000 times, each time over 2000 periods. From this numerical simulation, an estimate for the lifetime expected utility of the representative household is obtained. The welfare of entrepreneurs is not taken into account, since they are assumed to be risk-neutral, and therefore macroeconomic volatility does not affect their well-being. I am mindful of the caveats in Kim and Kim (2003) about welfare analysis based on log-linearized models. That is why the model was simulated with shocks to the yen-dollar exchange rate which are quite “small.” It is a standard result in the literature that as the variance of shocks gets closer to zero, the log-linearized model becomes more accurate.

In figure 6, 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 $\omega=0.61$. This weight is significantly 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 4.

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-degree line. The line above the 45-degree line gives the mapping from γ to ω^* which maximizes 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 still optimal to put a weight of 11% on the dollar. More generally, these

Figure 6 Lifetime Expected Utility as a Function of the Basket Weight on the Dollar ($\gamma=0.5$)

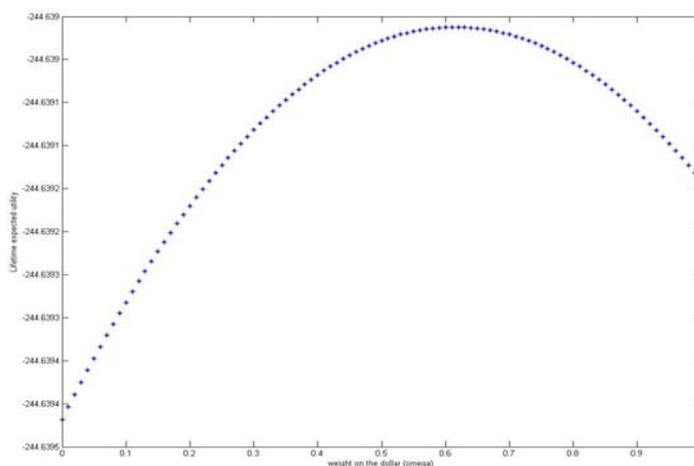
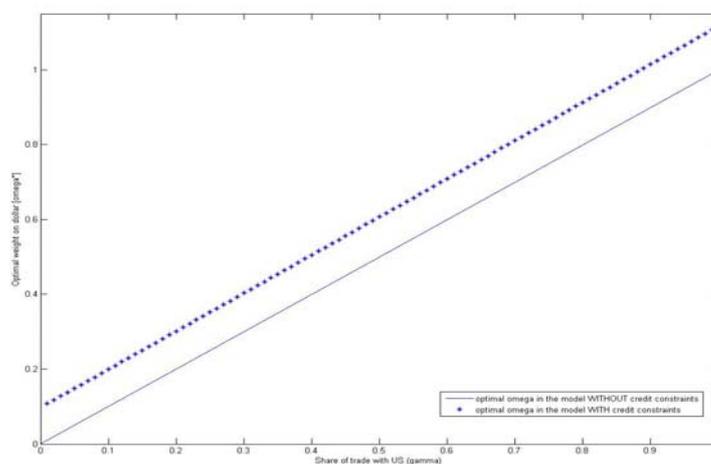


Figure 7 Optimal Weight on the Dollar as a Function of the Share of the Trade with the US



Note: Due to the high computational cost of simulating the model *with* credit constraints, I computed ω^* for 20 different values of γ uniformly spread over the interval (0, 1). The diagram reports the regression line fitted to the simulated data, whose R^2 is 0.97.

weights are always significantly higher (by about 10%) 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 at least 60-65% (see section 2), the optimal weight on the dollar would be at least 71-76%. For Korea and Thailand, where the dollar's share in foreign trade is estimated at 80-85%, the optimal weight on the dollar would be 91-96%. These numbers are quite close to the actual basket weights on the US dollar estimated by Frankel and Wei (1994) for the pre-crisis period, and by McKinnon and Schnabl (2004) and Ogawa (2004) for the post-1997 years.

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 currency basket 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 priced in dollars, but also because most of their foreign debt is dollar-denominated and unhedged.

In principle, the model developed in this paper can be used to compute the optimal currency basket for each East Asian country. In order to do so, we would need detailed data on each country's currency structure of trade (the invoicing shares of the dollar, yen, euro, etc.) and on each country's currency structure of debt. In practice, data on trade invoicing are difficult to come by. As should be obvious from the discussion in section 2, invoicing data are available only for some countries and only for some years. Korea has

reasonably good annual data; however, for all other countries in the region what we have at best is invoicing data for one or two years. Furthermore, while we have good data on the currency structure of long-term debt (see table 2), data on the currency structure of short-term debt is not available from the World Bank's Global Development Finance database. Generally, short-term debt (with maturity of one year or less) is very difficult to monitor and keep track of.

While McKinnon and Schnabl (2004) and Ogawa (2004) found that most East Asian countries have gone back to their pre-1997 soft pegs to the US dollar, more recently the estimated weights on the dollar have been falling. This may have happened for several reasons. First, the theoretical model in this paper stresses the importance of unhedged dollar-denominated debt in these countries. However, the share of dollar-denominated debt has declined recently in some countries (such as Thailand and Indonesia) — see table 2. Second, hedging instruments are more widely available today — for example, the market for non-deliverable futures (NDFs) has boomed in the past 5-10 years. Third, it might be the case that many East Asian countries are “learning to float,” as pointed out by Hakura (2005). These countries are putting in place the monetary and financial policy institutions and frameworks needed to successfully implement inflation-targeting regimes.

In light of the discussion above, two extensions of this paper appear particularly worthwhile. First, while the paper focuses on the optimal basket peg, the model could be modified in order to include other monetary rules in the policy menu, such as targeting the inflation rate, or the short-term nominal interest rate, or the money supply. Second, while the paper assumes that all debt is dollar-denominated, it might be useful to allow the fraction of such debt to vary freely between zero and unity, and explore the implications of such an extension for the optimal basket peg.

REFERENCES

- Bacchetta, Philippe and Eric van Wincoop, "A theory of the currency denomination of international trade," *Journal of International Economics*, 67, 2005, pp. 295-319.
- Bernanke, Ben, Mark Gertler, and Simon Gilchrist, "The financial accelerator in a quantitative business cycle framework," NBER Working Paper 6455, 1998.
- Berrospide, Jose, "Exchange rates, optimal debt composition and hedging in small open economies," University of Michigan, manuscript, 2006.
- Blanchard, Olivier and Charles M. Kahn, "The solution of linear difference models under rational expectations," *Econometrica*, 48, 1980, pp. 1305-1311.
- Bleakley, Hoyt and Kevin Cowan, "Corporate dollar debt and devaluations: much ado about nothing?," MIT, manuscript, 2002.
- Calvo, Guillermo A., "Staggered prices in a utility-maximizing framework," *Journal of Monetary Economics*, 12, 1983, pp. 383-398.
- Céspedes, Luis F., Roberto Chang, and Andres Velasco, "Balance sheets and exchange rate policy," *American Economic Review*, 94, 2004, pp. 1183-1193.
- Choi, Woon Gyu and David Cook, "Liability dollarization and the bank balance sheet channel," *Journal of International Economics*, 64, 2004, pp. 247-275.
- Choudhri, Ehsan U. and Dalia S. Hakura, "Exchange rate pass-through to domestic prices: does the inflationary environment matter?," IMF Working Paper WP/01/194, 2001.
- Corsetti, Giancarlo and Paolo Pesenti, "Self-validating optimum currency areas," NBER Working Paper 8783, 2002.
- Devereux, Michael B. and Charles Engel, "Endogenous currency of price setting in a dynamic open economy model," NBER Working Paper 8559, 2001.

- Devereux, Michael B., Charles Engel, and Peter E. Storgaard, "Endogenous exchange rate pass-through when nominal prices are set in advance," *Journal of International Economics*, 63, 2004, pp. 263-291.
- Devereux, Michael B. and Philip R. Lane, "Understanding bilateral exchange rate volatility," *Journal of International Economics*, 60, 2003, pp. 109-132.
- Devereux, Michael B., Philip R. Lane, and Juanyi Xu, "Exchange rates and monetary policy in emerging market economies," *The Economic Journal*, 116, 2006, pp.478-506.
- Devereux, Michael B. and Doris Poon, "A simple model of optimal monetary policy with financial constraints," University of British Columbia, manuscript, 2004.
- Dornbusch, Rudiger, "Exchange rates and prices," *American Economic Review*, 77, 1987, pp. 93-106.
- Eichengreen, Barry and Ricardo Hausmann, "Exchange rates and financial fragility," NBER Working Paper 7418, 1999.
- Elekdag, Selim and Ivan Tchakarov, "Balance sheets, exchange rate policy, and welfare," IMF Working Paper WP/04/63, 2004.
- Engel, Charles, "Accounting for U.S. real exchange rate changes," *Journal of Political Economy*, 107, 1999, pp. 507-538.
- Frankel, Jeffrey A. and Shang-Jin Wei, "Yen bloc or dollar bloc? Exchange rate policies of the East Asian economies," in *Macroeconomic linkage: savings, exchange rates, and capital flows*, ed. by Takatoshi Ito and Anne O. Krueger, pp. 295-329. Chicago, IL: University of Chicago Press, 1994.
- Fukuda, Shin-ichi and Masanori Ono, "The choice of invoice currency under exchange rate uncertainty: theory and evidence from Korea," *The Journal of the Korean Economy*, 6, 2005, pp. 161-193.
- _____, "On the determinants of exporters' currency pricing: history vs. expectations," *Journal of the Japanese and International Economies*, 20, 2006, pp. 548-568.

- Gali, Jordi and Tommaso Monacelli, "Monetary policy and exchange rate volatility in a small open economy," NBER Working Paper 8905, 2002.
- Goldberg, Linda S. and Cedric Tille, "Vehicle currency use in international use," Federal Reserve Bank of New York, manuscript, 2006.
- Goldfajn, Ilan and Sergio R. C. Werlang, "The pass-through from depreciation to inflation: a panel study," PUC-Rio Working Paper, 2000.
- Hakura, Dalia S., "Are Emerging Market Countries Learning to Float?," IMF Working Paper WP/05/98, 2005.
- Ito, Takatoshi, Eiji Ogawa, and Yuri Nagataki Sasaki, "How did the dollar peg fail in Asia?," NBER Working Paper 6729, 1998.
- Kawai, Masahiro, "Exchange rate arrangements in East Asia: lessons from the 1997-98 currency crisis," Japanese Ministry of Finance, manuscript, 2002.
- Kim, Jinill and Sunghyun Henry Kim, "Spurious welfare reversals in international business cycle models," *Journal of International Economics*, 60, 2003, pp. 471-500.
- Krugman, Paul, "Balance sheets, the transfer problem, and financial crises," in Assaf Razin and Andrew K. Rose, eds., *International finance and financial crises: essays in honor of Robert P. Flood, Jr.*, Norwell: Kluwer Academic Publishers, 1999, pp. 31-44.
- Kwan, C. H., *Yen bloc: toward economic integration in Asia*, Washington, DC: Brookings Institution Press, 2001.
- McKinnon, Ronald I. and Gunther Schnabl, "Synchronized business cycles in East Asia: fluctuations in the yen/dollar exchange rate and China's stabilizing role," Stanford University, manuscript, 2002.
- _____, "The East Asian dollar standard, fear of floating, and original sin," *Review of Development Economics*, 8, 2004, pp. 331-360.
- Monacelli, Tommaso, "A dynamic neo-Keynesian model with imperfect competition," Boston College, manuscript, 2001.

- Monacelli, Tommaso and Fabio Natalucci, "Solving non-singular systems of expectational difference equations: an application," NYU, manuscript, 2002.
- Obstfeld, Maurice and Kenneth Rogoff, *Foundations of international economics*, Cambridge, MA: MIT Press, 1996.
- Ogawa, Eiji, "Regional monetary cooperation in East Asia against asymmetric responses to the US dollar depreciation," *The Journal of the Korean Economy*, 5, 2004, pp. 43-72.
- Shioji, Etsuro, "Invoicing currency and the optimal basket peg for East Asia: analysis using a new open economy macroeconomic model," *Journal of the Japanese and International Economies*, 20, 2006, pp. 569-589.
- Turnovsky, Stephen J., "A determination of the optimal currency basket: a macroeconomic analysis," *Journal of International Economics*, 12, 1982, pp. 333-354.
- Williamson, John, *Exchange rate regimes for emerging markets: reviving the intermediate option*, Washington, DC: Institute for International Economics, 2000.
- Yun, Tack, "Nominal price rigidity, money supply endogeneity, and business cycles," *Journal of Monetary Economics*, 37, 1996, pp. 345-370.