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BUT CAN'T THEY HEDGE??? (MANAGING FOREIGN EXCHANGE RISK UNDER "ORIGINAL SIN")

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1. Introduction

By now, no stone has been left unturned in search of an explanation for the spectacular macroeconomic collapse in five emerging economies in East Asia in 1997. One popular theory has maintained that the crisis was precipitated by volatility in the yen-dollar exchange rate (see Figure 1), coupled with the soft pegs to the US dollar practiced by most countries in the region prior to 1997. Frankel and Wei (1994) were the first to show that the entire region was on a *de facto* dollar peg in the pre-crisis period, with weights on the dollar in the vicinity of 90% in most countries. A dollar peg meant that East Asian economies floated freely against the Japanese yen. Given the yen's regional importance, 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 in the economic profession on the *positive* issue: yen-dollar exchange rate volatility has significantly affected the region.[2] 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? Many 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 the crisis. Instead, these authors have argued for greater flexibility in dollar rates and for greater emphasis on the Japanese yen. In particular, some have recommended that East Asian economies stabilize their currencies relative to a basket in which the dollar and yen are weighted about equally, according to their relative importance in trade flows between East Asia and the rest of the world.

On the other side of the debate, where the current paper falls, economists have argued that keying on the dollar was (and, in fact, remains) the optimal monetary regime for the emerging East Asian economies. Various arguments in favor of the East Asian informal dollar standard have been advanced – for a recent discussion, see McKinnon and Schnabl (2002). For a start, these authors point out that the Japanese yen is not nearly as important as commonly thought on the real side – most of emerging East Asia's trade is

[2] See Slavov (2003a), for example.

dollar-invoiced. In particular, intra-regional trade is overwhelmingly invoiced in US dollars. Even half of Japan's own exports to the region are dollar-invoiced.

Slavov (2003b) shows that putting a very high weight on the dollar in East Asia is justified not only because of the dollar's importance as an invoice currency for trade in goods, but also because the dollar dominates the currency structure of foreign debt in these countries. The paper illustrates how financial market imperfections and unhedged foreign borrowing, which typically afflict financial markets 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.

However, that paper takes a convenient shortcut. It treats the amount of unhedged foreign exchange exposure at the macroeconomic level as exogenous.[3] This assumption could be justified in the context of a stylized macro model populated by representative agents. The current contribution pays more attention to microeconomic heterogeneity in East Asian debtor countries. Extending a hedging model from McKinnon (1979), it explores the hedging problem of economic agents operating under a form of market incompleteness famously dubbed "original sin" by Eichengreen and Hausmann (1999).

"Original sin" refers to the inability of emerging economies to borrow abroad in their own currencies, or borrow long-term. The resulting currency and maturity mismatches generate "financial fragility." A domestic-currency bond is identical to a foreign-currency bond, plus a hedge. Therefore, if net debtor countries in East Asia can't borrow abroad in their currencies, they are by definition unable to hedge foreign currency debt, because nobody is willing to stand on the other side in the forward market.

Section **2** discusses the issue of "original sin" as well as other explanations for the observed lack of hedging of forex risk in emerging markets. It reviews the relevant literature and offers some fresh empirical evidence.

Section **3** sets up a simple optimal hedging model and uses it to illustrate how much difference market incompleteness ("original sin") makes for debtors' risk management problem. In the model, an East Asian debtor in yen or dollars chooses the optimal portfolio of forward contracts, taking the exchange rate regime as given. The dollar-yen exchange rate is the major source of uncertainty in the model.

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[3] Hence the question: "But can't they hedge???"

In Section **4**, I use numerical methods to explore how risk management decisions by yen or dollar debtors are affected by the exchange rate regime and by the relationship between exchange rates and goods prices. Throughout, I consider three risk management scenarios – "no hedging," "original sin," and "complete markets." The simulated differences between "no hedging" and "original sin" illustrate the relative benefits from resorting to the yen-dollar forward market when there is no forward market in the domestic currency. The difference between "original sin" and "complete markets" illustrates the economic costs of market incompleteness.

The numerical simulations in that section provide several justifications for the exchange rate regimes East Asian economies implemented before the 1997 crisis. First, given market incompleteness, it turns out that a soft dollar peg makes dollar debtors indifferent between no hedging at all and hedging in the yen-dollar market. Furthermore, stabilizing the dollar exchange rate minimizes the costs of market incompleteness to dollar debtors, who dominate the economy. Yen debtors, who are in the minority in East Asia, should then find it optimal to buy yen for dollars forward and implicitly rely on the peg to protect them from dollar risk. Second, a single-currency peg implies a zero correlation between the domestic yen and dollar exchange rates. It turns out that this scenario minimizes the costs of market incompleteness for both types of debtors, relative to a basket peg or a crawl (under which the correlation coefficient would be highly negative or highly positive, respectively).

A final interesting results from this section is that a high correlation between goods prices and exchange rates is a substitute for forex hedging.

Section **5** summarizes the arguments against basket pegs. Basket pegs are confusing, have credibility and transparency problems, may discourage foreign trade, present certain implementation problems, and may thwart the development of forward markets in the domestic currency. The last two points are illustrated by a case study of Latvia, a country which has maintained a basket peg for the past nine years.

Section **6** concludes.

2. Why don't they hedge – a literature review

Economic theory maintains that hedging is a "free lunch " if there are no transaction costs and financial markets are complete. If agents hedge optimally their exposure to exchange rate risk, then the "separation theorem" applies – exchange rate volatility is irrelevant. On the other hand, abundant empirical evidence suggests that the five East Asian economies that crashed in 1997 were saddled with large stocks of unhedged foreign currency debt in the run-up to the crisis. Furthermore, exchange rate volatility played a very important role in both triggering and amplifying the East Asian crisis. Both the "free lunch proposition" and the "separation theorem" seem to fail in practice. There are several ways to answer the question "why don't they hedge???"

The most famous explanation is the doctrine of "original sin." "Original sin" is a form of financial market incompleteness, made famous by a string of papers Ricardo Hausmann wrote with a string of co-authors. See Eichengreen and Hausmann (1999), Hausmann, Panizza, and Stein (2000), Eichengreen, Hausmann, and Panizza (2002), Chamon and Hausmann (2002). One dimension of "original sin" is the inability of emerging economies to borrow abroad in their own currencies. Because a domestic-currency bond is identical to a foreign-currency bond plus a hedge, if a net debtor country can't borrow abroad in its own currency, it is by definition unable to hedge its foreign debt. Nobody is willing to stand on the other side in the forward market without demanding a risk compensation that the emerging economy is unwilling to pay. The inability to hedge foreign exchange risk is the flip side of the inability to borrow in one's currency abroad.

Forward markets for emerging economies' currencies do exist, to be sure. A quick look at Bloomberg, Datastream, or Reuters reveals that for most emerging economies in East Asia, Latin America, and Eastern Europe, such markets are available. For the particular case of East Asia, these forward markets currently operate at horizons of up to five years for all countries except Indonesia!

Figures 2 through 6 reveal where the real problem lies. The figures contain bid-ask spreads on 3-month forward contracts for the five East Asian economies which crashed in 1997: Indonesia, Korea, Malaysia, the Philippines, and Thailand. The data come from Bloomberg and are monthly, in the sense that snapshots were taken of bid and ask rates on the same date of each month (or on the first business day thereafter). Bloomberg keeps track of three types of forward markets: regular, on-shore, and non-deliverable futures (NDF). To make comparisons meaningful, all bid-ask spreads were normalized by the bid-ask spread on yen-dollar 3-month forwards.

The diagrams clearly illustrate that bid-ask spreads on forward contracts for East Asian currencies are anywhere from 5 to 50 times larger than the bid-ask spread on yen-dollar forwards. Note that the y-axis in each diagram is logarithmic. Thus, the forward markets do exist, but there is strong evidence that they are small and illiquid. The insurance they offer is very expensive, even when times are good.

A related stylized fact is that trading volumes in emerging economies' currencies are quite small. According to a survey of trading volumes in non-deliverable futures (NDFs) by the Trade Association for the Emerging Markets (EMTA), the size of that market in early 2003 was a paltry $174 billion, on a quarterly basis. Five countries' currencies take up 92% of total trading volume – Korea (50%), Brazil (19%), Chile (9%), Taiwan (9%), and China (5%). NDF markets have boomed in the past few years but have actually been around since before the 1997 crisis. Before the crisis, NDF markets were very small and illiquid. As a result, the insurance they offered was very expensive.

Burnside, Eichenbaum and Rebelo (1999) offer an interesting moral hazard explanation of why private agents in emerging economies with fixed exchange rates do not hedge. In their model, government guarantees eliminate banks' incentives to hedge. If banks prudently hedge their exposures, they make losses in good states (when the peg holds) and profits in bad states (when the peg fails). These profits are then seized by the government since devaluation causes bankruptcy. Consequently, the banks make portfolio decisions which minimize their net worth in bankruptcy states. It is optimal for banks to magnify their forex exposure by selling dollars forward. In good states they make a profit on the short sale; in bad states they go bankrupt and the government picks up the tab. Assuming the government prevents banks from engaging in such "reckless speculation," we get the no-hedging result.

Hau and Rey (2002, p. 2) point out that the "insufficient hedging" puzzle is by no means restricted to emerging markets but applies even to US global mutual funds, whose size and sophistication would have led one to expect otherwise. They quote results from a

1998 study by Levich, Hayt, and Ripston of derivative and risk management practices of U.S. institutional investors:

> "Levich *et al*. (1999) surveyed 298 U.S. institutional investors and found that more than 20 percent were not even permitted to hold derivative contracts in their investment portfolio. A further 25 percent of institutional investors were formally unconstrained, but did not trade in derivatives. The remaining 55 percent of institutional investors hedged only a minor proportion of their forex exposure. For the full sample, Levich *et al*. calculated that forex risk hedging concerned only 8 percent of the total foreign equity investment. Portfolio managers cited monitoring problems, lack of knowledge and public and regulatory perceptions as most important reasons for the restricted forex derivative use."

Hau and Rey (2002, p. 5) conclude that market incompleteness is not due to the absence of derivatives markets. Instead, it is explained by transaction or agency costs.

Wei (1998, p. 2) attributes the lack of hedging to restrictions which can be "so severe that exporters and importers do not find [these markets] of practical use." He also points to the transaction costs associated with the use of hedging instruments and the fact that these instruments are usually available for horizons which may be too short relative to the planning horizons of merchants (page 3).[4]

3. A little hedging model

In any East Asian debtor country, most of the stock of external debt is denominated in foreign currency, typically dollars and yen. Dollar and yen debtors must finance future debt payments out of earnings in local currency, and therefore are subject to exchange rate risk. Examples of such debtors include:

- importers of goods invoiced in foreign currency who have to repay trade credit in the near future and whose sales revenues are in local currency
- domestic firms which finance production of non-traded goods out of foreign currency loans (to pay for imported inputs, for example)

[4] Froot (1993) implicitly disputes this last point by noting that at long horizons the optimal hedge might very well be zero because purchasing power parity holds and there is no real exchange rate risk. PPP acts as a "natural hedge." Hedging due to real exchange rate risk only makes sense at short to medium horizons. Even then, transaction costs and counterparty risks might make "going naked" the optimal strategy (p. 4).

- local banks which finance domestic currency lending out of foreign currency deposits
- the domestic government which uses tax revenues in the local currency to repay foreign currency public debt

Domestic agents in a net debtor country find it hard to borrow abroad in their own currency, and cannot (or perhaps don't want to?!) hedge foreign exchange risk. However, domestic agents can still use volatility in the yen-dollar exchange rate as well as their access to deep and liquid markets in dollar-yen forward contracts to optimize their exposure to forex risk.

This section sets up and solves a simple model which describes the optimal hedging behavior of a risk-averse importer of yen- or dollar-invoiced goods, who owes a certain amount of hard currency in 90 days. More generally, one can think of the importer as a *debtor* in foreign currency.

Let's consider the problem of a Thai merchant of foreign goods who wants to hedge a future short position in yen or dollars. The basic assumptions and building blocks of the model are almost the same as in McKinnon (1979). I make the simplifying assumption that both inventory liquidation and payment to the foreign supplier take place at the same discrete point in time, say in 90 days. The merchant is therefore subject to both price and exchange rate risk. She is assumed to be risk-averse. For the sake of simplicity, I will assume that she minimizes the variance of future profits. The importer takes world exchange rates and domestic goods prices as given.

If financial markets are complete, the merchant has access to two types of forward contracts: she can trade forward baht for yen, and also dollars for yen. Implicitly, there is also a third forward contract (baht for dollars) but it is redundant, due to triangular currency arbitrage. Transaction costs are assumed away.

The model's solution is general. First, it does not depend on special assumptions about the exchange rate regime – it incorporates as special cases hard or soft pegs to the dollar, free floating, etc. Second, it includes "original sin" as a special case. Under "original sin," the Thai importer can hedge dollar-yen risk but not baht-dollar or baht-yen risk. Obviously, this is the empirically relevant scenario.

Let's define some notation. There are two types of imported goods in the model. P denotes the price of yen-invoiced imports in Thai baht, while Q stands for the price of dollar-invoiced imported goods in Thai baht. Y is the yen exchange rate (baht/yen); D is the dollar exchange rate (baht/dollar). Finally, C denotes the cross exchange rate (dollar/yen). By triangular currency arbitrage, we have $Y = DC$.

C_0 stands for the spot exchange rate today. C_{90} is the spot exchange rate in 90 days (all terms subscripted by "90" are random variables). C_f denotes the 90-day forward exchange rate. I assume that $C_0 = E(C_{90}) = C_f$. In other words, expectations are stationary and the forward rate is an unbiased predictor of the future spot exchange rate. I make the stationarity assumption for all three exchange rates. Furthermore, goods prices are also stationary: $P_0 = E(P_{90})$ and $Q_0 = E(Q_{90})$. A final assumption I make is that $P_0 = Y_0$ and $Q_0 = D_0$. In other words, today's prices of imports are normalized to 1 yen and 1 dollar, respectively and without loss of generality, so that their baht prices today equal the baht-yen and baht-dollar exchange rates, respectively. Implicitly, the law of one price holds.

Note that I am not making any special assumptions about the exchange rate regime. The implications of various exchange rate regimes will be explored in Section **4**.

3.1 The hedging problem for a yen debtor

Let's focus now on the hedging problem of a Thai merchant of yen goods who wants to hedge a future liability denominated in yen. If the Thai importer does not hedge at all, her (risky) per-unit profits in 90 days will be described by the expression:

$$\Pi_Y = P_{90} - Y_{90}$$

In expectation, profits are zero, because $E(P_{90}) = P_0 = Y_0 = E(Y_{90})$. The Thai importer is exposed to both price risk and exchange rate risk. Essentially, the above setup is a very simple stylized way to model currency mismatches. Currency mismatch is what makes "original sin" dangerous for a debtor country. One can also think of this equation as a balance sheet identity: net worth equals domestic-currency assets minus foreign-currency liabilities.

Suppose that the Thai importer hedges a fraction α_Y of her exposure against dollar-yen risk and a fraction β_Y against baht-yen risk. In the former case she purchases forward yen for dollars; in the latter case, she purchases forward yen for baht. Then her profit function is going to be:

$$\Pi_Y = P_{90} - \alpha_Y C_f D_{90} - \beta_Y Y_f - (1 - \alpha_Y - \beta_Y) Y_{90}$$

Of the four terms above, the first one refers to (risky) revenues in Thai baht from selling the good to consumers, while the next three refer to the costs of repaying in Japanese yen. The second term refers to debt hedged against dollar-yen risk but still exposed to baht-dollar risk. The third term refers to the completely hedged fraction of the debt. The fourth term refers to completely unhedged debt, which is fully exposed to baht-yen risk. Using the stationarity assumptions $C_f = C_0$ and $Y_f = Y_0$, we can re-write the profit function as follows:

$$\Pi_Y = P_{90} - \alpha_Y C_0 D_{90} - \beta_Y Y_0 - (1 - \alpha_Y - \beta_Y) Y_{90}$$

Expected profits are:

$$E(\Pi_Y) = E(P_{90}) - \alpha_Y C_0 E(D_{90}) - \beta_Y Y_0 - (1 - \alpha_Y - \beta_Y) E(Y_{90})$$

Since transaction costs are zero, $E(\Pi_Y) = 0$, due to stationary exchange rate and price expectations, combined with triangular currency arbitrage, as well as the normalization assumption $P_0 = Y_0$. Computing the variance of profits, we get:

$$\begin{aligned} Var(\Pi_Y) = \sigma_P^2 + \alpha_Y^2 C_0^2 \sigma_D^2 + (1 - \alpha_Y - \beta_Y)^2 \sigma_Y^2 - 2\alpha_Y C_0 Cov(P, D) - \\ - 2(1 - \alpha_Y - \beta_Y) Cov(P, Y) + 2\alpha_Y (1 - \alpha_Y - \beta_Y) C_0 Cov(Y, D) \end{aligned} \quad \textbf{(1)}$$

The Thai importer's objective is:

$$\min_{\alpha_Y, \beta_Y} Var(\Pi_Y)$$

<u>3.1.1 Complete financial markets</u>

In spite of its lack of realism, it is illustrative to start with the general case under which the importer has access to a complete set of financial assets. It will serve as a benchmark for subsequent analysis.

Let's consider a naïve suggestion for the optimal hedge. If baht-yen forwards are available, it is hard to see any use for the cross forwards. Perhaps the Thai importer should hedge fully using baht-yen forwards; the dollar-yen forwards are unnecessary and irrelevant. In other words: take $\beta_Y = 1$ and $\alpha_Y = 0$. The variance in profits will then be:

$$Var(\Pi_Y) = \sigma_P^2$$

Another naïve suggestion for the optimal hedge could be: dollar-yen forwards are still irrelevant ($\alpha_Y = 0$) but let's find out the optimal value for β_Y. The variance in profits reduces to:

$$Var(\Pi_Y) = \sigma_P^2 + (1-\beta_Y)^2 \sigma_Y^2 - 2(1-\beta_Y)Cov(P,Y)$$

The solution for β_Y^* is easy to compute, after taking the first-order condition:

$$\frac{\partial Var(\Pi_Y)}{\partial \beta_Y} = -2(1-\beta_Y)\sigma_Y^2 + 2Cov(P,Y) = 0$$

$$\beta_Y^* = 1 - \frac{Cov(P,Y)}{\sigma_Y^2}$$

A quick check of the second-order condition reveals that this is indeed a minimum.[5] Intuitively, the importer can exploit the covariance structure of the random variables to minimize the variance of her profits. Price adjustment accompanying a shock to the exchange rate provides some partial insurance to the importer, and therefore she needs not hedge her exposure fully. With small changes in notation, the solution above is really equivalent to the one proposed in McKinnon (1979).

However, it turns out that the Thai importer can do even better here, by finding a portfolio of the two forward contracts which lowers the variance of profits even further. The seemingly extraneous volatility in the cross exchange rate helps the merchant in further optimizing her risk exposure. Taking derivatives with respect to α_Y and β_Y, we get:

$$\frac{\partial Var(\Pi_Y)}{\partial \alpha_Y} = 2\alpha_Y C_0^2 \sigma_D^2 - 2(1-\alpha_Y-\beta_Y)\sigma_Y^2 - 2C_0 Cov(P,D) + 2Cov(P,Y) + \\ + 2(1-2\alpha_Y-\beta_Y)C_0 Cov(Y,D) = 0$$

$$\frac{\partial Var(\Pi_Y)}{\partial \beta_Y} = -2(1-\alpha_Y-\beta_Y)\sigma_Y^2 + 2Cov(P,Y) - 2\alpha_Y C_0 Cov(Y,D) = 0$$

Skipping several steps of tedious algebra, we solve for the optimal values of α_Y and β_Y:

$$\alpha_Y^* = \frac{\sigma_Y^2 Cov(P,D) - Cov(Y,D)Cov(P,Y)}{C_0\left[\sigma_D^2\sigma_Y^2 - (Cov(Y,D))^2\right]}$$

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5 $\frac{\partial^2 Var(\Pi_Y)}{\partial \beta_Y^2} = 2\sigma_Y^2 > 0$

$$\beta_Y^* = \frac{C_0\left[Cov(Y,D)Cov(P,D) + \sigma_D^2\sigma_Y^2 - \sigma_D^2 Cov(P,Y) - (Cov(Y,D))^2\right]}{C_0\left[\sigma_D^2\sigma_Y^2 - (Cov(Y,D))^2\right]} + \frac{Cov(Y,D)Cov(P,Y) - \sigma_Y^2 Cov(P,D)}{C_0\left[\sigma_D^2\sigma_Y^2 - (Cov(Y,D))^2\right]}$$

A quick check of the second-order conditions shows that the solution obtained above is indeed a minimum.[6] It might appear counterintuitive that $\alpha_Y^* \neq 0$, or, in other words, that the optimal hedge involves buying or selling forward yen for dollars. It might appear that just using baht-yen forwards should suffice. In general, however, for a risk-averse investor, a claim on anything that is expected to fluctuate can help optimize exposure to risk. Furthermore, volatility in the dollar-yen exchange rate *C* might be correlated with volatility in *D* or *Y* in a way which is publicly known. This is indeed the case when the government maintains a currency basket peg and the basket weights are public knowledge.

To develop more intuition about the complex formulae above, it is useful to consider two special cases. First, let's consider the case when all covariance terms are zero. In other words, noise in both exchange rates is "pure roulette" – it is not systematically related to any other variable in the model. Then the optimal hedges are:

$$\alpha_Y^* = 0 \qquad\qquad \beta_Y^* = 1$$

In this very special case, it is optimal to completely disregard yen-dollar forward markets and simply hedge the exposure completely using baht-yen forwards. Therefore, it is the covariance structure of the random variables that makes it optimal for a debtor not to hedge the entire exposure in the baht-yen market and to resort partially to yen-dollar forward contracts.

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[6] $$\frac{\partial^2 Var(\Pi_Y)}{\partial \alpha_Y^2} = 2C_0^2\sigma_D^2 + 2\sigma_Y^2 - 4C_0 Cov(Y,D) = 2Var(C_0 D_{90} - Y_{90}) > 0$$

$$\frac{\partial^2 Var(\Pi_Y)}{\partial \beta_Y^2} = 2\sigma_Y^2 > 0$$

$$\left(\frac{\partial^2 Var(\Pi_Y)}{\partial \alpha_Y^2}\right)\left(\frac{\partial^2 Var(\Pi_Y)}{\partial \beta_Y^2}\right) = 4C_0^2\sigma_D^2\sigma_Y^2 + 4\left(\sigma_Y^2\right)^2 - 8C_0 Cov(Y,D)\sigma_Y^2 >$$

$$> 4\left[\left(\sigma_Y^2\right)^2 - 2C_0 Cov(Y,D)\sigma_Y^2 + C_0^2\left(Cov(Y,D)\right)^2\right] = 4\left[\sigma_Y^2 - C_0 Cov(Y,D)\right]^2 = \left(\frac{\partial^2 Var(\Pi_Y)}{\partial \alpha_Y \partial \beta_Y}\right)^2$$

The inequality above, after canceling out several terms on both sides, reduces to the Cauchy-Schwartz inequality.

Second, let's consider the case of a hard peg to the dollar, so that all terms involving the second moments of *D* in equation **(1)** are set to zero. Proceeding with the minimization as before we get:

$$\alpha_Y^* + \beta_Y^* = 1 - \frac{Cov(P,Y)}{\sigma_Y^2}$$

Any combination of forward purchases of yen for dollars or for baht is optimal, as long as it sums up to the expression above. Of course, this indeterminacy is a direct consequence of the hard peg to the dollar – it no longer matters if you directly purchase yen for baht, or if you go through the dollar as an intermediate step. The risk management problem posed here boils down to the one outlined in McKinnon (1979).

3.1.2 The case of "original sin"

Next, let's turn to the empirically relevant case of "original sin." In the context of the hedging model described above, we can model "original sin" by setting $\beta_Y \equiv 0$. In other words, the Thai importer has no access to baht-yen (or baht-dollar) forward contracts. She can only trade dollar-yen forwards. The expression for per-unit profits becomes:

$$\Pi_Y = P_{90} - \alpha_Y C_0 D_{90} - (1 - \alpha_Y) Y_{90}$$

The expression for the variance in profits reduces to:

$$\begin{aligned} Var(\Pi_Y) = \sigma_P^2 + \alpha_Y^2 C_0^2 \sigma_D^2 + (1-\alpha_Y)^2 \sigma_Y^2 - 2\alpha_Y C_0 Cov(P,D) \\ - 2(1-\alpha_Y) Cov(P,Y) + 2\alpha_Y (1-\alpha_Y) C_0 Cov(Y,D) \end{aligned} \quad \textbf{(2)}$$

If the importer does not hedge at all ($\alpha_Y = 0$), the expression simplifies to:

$$Var(\Pi_Y) = \sigma_P^2 + \sigma_Y^2 - 2Cov(P,Y)$$

We can solve for the optimal α_Y under "original sin" by taking first-order conditions, as before. Jumping straight to the result, we get:

$$\alpha_Y^* = \frac{\sigma_Y^2 - Cov(P,Y) + C_0 Cov(P,D) - C_0 Cov(Y,D)}{C_0^2 \sigma_D^2 + \sigma_Y^2 - 2C_0 Cov(Y,D)}$$

To make the above formula more intuitive, let's again consider two special cases. First, suppose that all covariance terms are set to zero (noise in both exchange rates is "pure roulette"). The optimal hedge reduces to:

$$\alpha_Y^* = \frac{\sigma_Y^2}{C_0^2\sigma_D^2 + \sigma_Y^2}$$

In other words, the optimal purchase of yen for dollars on the forward market is directly proportional to the relative volatility in the yen exchange rate. The more volatile the baht-yen rate is, other things equal, the higher the optimal hedge.

Second, let's consider a hard peg to the dollar, so that all second-moment terms involving *D* in equation **(2)** are set to 0. The optimal hedge is then:

$$\alpha_Y^* = 1 - \frac{Cov(P,Y)}{\sigma_Y^2}$$

The risk management problem here once again boils down to the one outlined in McKinnon (1979).

3.1.3 An illustrative calibration

For the sake of comparison and illustration, I calibrated the model to the following parameter values:

$\sigma_P^2 = 1$	$Corr(P,Y) = 0.5$	$C_0 = 1$
$\sigma_Y^2 = 1$	$Corr(P,D) = 0.1$	
$\sigma_D^2 = 0.0121$	$Corr(Y,D) = -0.8$	

To the extent possible, the parameter values were chosen to match the model to quarterly Thai data from the IMF's International Financial Statistics for the period Q4:1984 – Q2:1997. Over this period, the Thai government maintained continuously a soft peg to the US dollar. Indeed, over that period, the baht-dollar rate was approximately 10 times less volatile than the baht-yen rate, in standard deviation terms, after adjusting for the different units of measurement. Furthermore, the correlation coefficient between *Y* and *D* was indeed around -0.8, a value which exposes the basket peg the Thai monetary authority was implicitly maintaining over the period.[7] The values for the variance of *P* and *Y*, and for C_0 are convenient normalizations. The correlations between exchange rates and *P* are *ad hoc*, since no separate price indices exist for yen- or dollar-denominated imports. I simply took an intermediate value for *Corr(P,Y)*, and set *Corr(P,D)* to a fifth of

[7] Under a perfect peg to a basket of the yen and the dollar, that correlation coefficient would have been exactly -1.

Corr(P,Y). Next, I computed the variance of profits for the Thai importer of yen-denominated goods under the several different scenarios outlined above. The table below summarizes the results:

Scenario	α_Y	β_Y	**Variance in profits**
Complete markets, full hedging using only baht-yen forwards	*0*	*1*	*1.0000*
Complete markets, optimal hedging using only baht-yen forwards	*0*	*	*0.7500*
Complete markets, optimal hedging	*	*	*0.0556*
"Original sin," no hedging	*0*	*0*	*1.0000*
"Original sin," optimal hedging	*	*0*	*0.6979*

"*" denotes the optimal value implied by the formulae derived earlier.

3.2 The hedging problem for a dollar debtor

A Thai importer of dollar-denominated goods will face a very similar hedging problem. Focusing only on the empirically relevant case of "original sin," her profit function will be:

$$\Pi_D = Q_{90} - \alpha_D \frac{Y_{90}}{C_f} - (1-\alpha_D) D_{90}$$

The expression for the variance of profits (after substituting $C_f = C_0$) will be:

$$Var(\Pi_D) = \sigma_Q^2 + \frac{\alpha_D^2}{C_0^2}\sigma_Y^2 + (1-\alpha_D)^2 \sigma_D^2 - 2\frac{\alpha_D}{C_0} Cov(Q,Y) - 2(1-\alpha_D) Cov(Q,D) + $$
$$+ 2\frac{\alpha_D(1-\alpha_D)}{C_0} Cov(Y,D)$$

The dollar debtor's objective is to minimize the variance of next period's profits:

$$\min_{\alpha_D} Var(\Pi_D)$$

Solving for the optimal hedge, we get:

$$\alpha_D^* = \frac{C_0^2\sigma_D^2 - C_0^2 Cov(Q,D) + C_0 Cov(Q,Y) - C_0 Cov(Y,D)}{C_0^2\sigma_D^2 + \sigma_Y^2 - 2C_0 Cov(Y,D)}$$

It is important to note that here α_D denotes the fraction of (dollar-denominated) debt hedged by buying forward <u>dollars for yen</u>, while α_Y denoted buying forward <u>yen for dollars</u>.

4. Numerical explorations

Having discussed the optimal hedging decisions of yen and dollar debtors, I now turn to a numerical analysis of how these decisions are affected by factors such as the exchange rate regime and the relationship between exchange rates and goods prices. In what follows, the optimal hedging behavior of indebted merchants is as described by the model of the previous section. Unless otherwise specified, the parameter values adopted for the simulations are the same as earlier in Section **3**:

$\sigma_P^2 = 1$	$Corr(P,Y) = Corr(Q,D) = 0.5$	$C_0 = 1$
$\sigma_Y^2 = 1$	$Corr(P,D) = Corr(Q,Y) = 0.1$	
$\sigma_D^2 = 0.0121$	$Corr(Y,D) = -0.8$	

Because in the real world there are no separate price indices for dollar- and yen-invoiced goods, I model the correlations involving *P* and *Q* symmetrically.

4.1 The importance of relative exchange rate volatility

The relative volatility in the domestic dollar and yen exchange rates is one of the dimensions of the exchange regime in an emerging East Asian economy. The relative volatility of exchange rates is denoted by:

$$\frac{Var(D)}{Var(Y)} C_0^2$$

We have to multiply the variance of the dollar rate by C_0^2 in order to adjust for the difference in units of measurement. (Of course, the normalization $C_0=1$ makes this particular concern moot here.) I let the relative volatility parameter range from 0.01 to 100. In standard deviation terms, I consider scenarios under which the dollar exchange rate is anywhere between 0.1 and 10 times as variable as the yen rate. The left bound on the relative volatility parameter is close to the actual value maintained in Thailand between 1984 and 1997. Therefore, in this numerical experiment I consider the consequences of letting the domestic exchange rate against the dollar float more freely, as recommended by Ito, Ogawa, and Sasaki (1998), Williamson (2000), Kwan (2001), and Kawai (2002).

In Figures 7 and 8, I plot the variance in profits for yen and dollar merchants, respectively, as functions of the relative volatility parameter. Note the natural log scale for the x-axis in both figures. I consider three different scenarios for risk management – "no hedging," "original sin," and "complete markets." The first scenario – no hedging – describes a case when, due to high transaction costs or other frictions, merchants find it optimal not to hedge at all. It is an implicit way of allowing transaction costs through the back door in the otherwise frictionless model of Section **3**. The "original sin" scenario is the most relevant one empirically. "Complete markets" serves as a benchmark, which helps get a sense of the economic costs of market incompleteness.

The vertical distance between the "no hedging" and "original sin" curves gives us a measure of the relative benefits of using the yen-dollar forward market to hedge under "original sin." Figure 7 tells us that, for a yen merchant, the benefits of using yen-dollar forwards are most impressive when the dollar rate is relatively stable and the yen rate is relatively noisy, as was indeed the case in pre-crisis East Asia. Increasing stability in the yen exchange rate makes partial hedging under "original sin" less attractive relative to staying completely unhedged. For a very stable yen exchange rate, there are no significant benefits to be had from hedging in the yen-dollar forward market. Exchange rate stability is a substitute for hedging.

Figure 8 shows that the dollar merchant's case is exactly upside down. The benefits from hedging are negligible when the dollar exchange rate is relatively stable. Given that East Asian economies were (and still are!) dominated by dollar debtors,[8] Figures 7 and 8 offer a justification for the exchange rate regimes East Asian economies maintained before the crisis. Under a soft peg to the dollar, dollar merchants (who dominate the economy) do not derive any benefits from hedging, so they might as well not hedge at all. Yen merchants, on the other hand, would benefit substantially from selling dollars for yen in the forward market (and from implicitly relying on the soft dollar peg to protect them from dollar exchange rate risk). The important point is that under a dollar peg a majority of debtors in the economy do not have to worry about hedging.

The vertical distance between the "original sin" and "complete markets" curves in both figures gives us a sense of the costs of market incompleteness. For a yen (dollar)

[8] According to Eichengreen and Hausmann (1999, p. 9), right before the 1997 crisis about 70% of private debt was denominated in dollars, and most of the rest was in yen.

merchant, these costs are largest when the yen (dollar) exchange rate is relatively noisy. Thus, one can think of dollar pegs as minimizing the costs of market incompleteness for the majority of debtors in the economy.

4.2 The importance of correlation in domestic exchange rates

Correlation between the domestic yen and dollar exchange rates is another important aspect of exchange rate policy in an East Asian emerging economy. I let the correlation of *D* and *Y* range from -0.8 to 0.9. The left bound on the correlation parameter is very close to the one prevailing in Thailand between 1984 and 1997. A correlation coefficient close to -1 indicates a basket peg regime in place. A correlation coefficient around 0 might indicate a single-currency peg.[9] A correlation coefficient close to 1 would indicate that the domestic currency tends to either appreciate or depreciate against *both* the yen and the dollar, as under a crawl.

Figures 9 and 10 plot variances in the profits of yen and dollar merchants, respectively, as functions of the correlation between the yen and dollar exchange rate, under the three alternative scenarios for risk management. The message of both figures is identical. The benefits of hedging under "original sin" relative to no hedging at all are highest when the correlation between *Y* and *D* is highly negative (as under a basket peg regime). The benefits of hedging are lowest when *Corr(Y,D)* gets close to 1.

Furthermore, the costs of market incompleteness (look at the vertical difference between "complete markets" and "original sin") are highest, in both cases, when the correlation between *Y* and *D* is high in absolute value, near the two corners. These costs are lowest, in both figures, when the correlation between the two exchange rates is approximately zero. This result supports the case for a single-currency peg, as opposed to a basket peg or a crawl.

4.3 The importance of the correlation between exchange rates and prices

The relationship between goods prices and exchange rates is another important parameter in the model. For yen merchants, I let *Corr(P,Y)* range between 0 and 0.5.

[9] Zero correlation is necessary but not sufficient for a single-currency peg.

Corr(P,D) is set to a fifth of *Corr(P,Y)*. For dollar merchants, *Corr(Q,D)* and *Corr(Q,Y)* are modeled symmetrically. Figures 11 and 12 present the results.

Figure 11 can be interpreted as saying that, for yen merchants, the relative benefits of hedging under "original sin" are highest when correlation between goods prices and exchange rates is low. The relative benefits from hedging decrease as the relationship between prices and exchange rates tightens. A high correlation between prices and exchange rates substitutes for hedging.

For dollar merchants (Figure 12), the relative benefits from hedging under "original sin" appear to be very small, regardless of the correlation between *Q* and *D*.

On the other hand, in both figures the costs of market incompleteness increase with the correlation between prices and exchange rates, as evidenced by the increasing vertical distance between the "original sin" and "complete markets" curves.

5. Why not a basket peg?

This paper has outlined several arguments against the basket pegs advocated by many for emerging East Asian economies. A single currency (the US dollar) dominates the currency structure of both trade and debt. The punchline of the hedging model developed and analyzed in sections **3** and **4** of this paper was that financial market incompleteness ("original sin") tips the scales further in favor of a peg to a single currency.

A few additional arguments against basket pegs need to be mentioned. First, basket pegs are confusing because they involve volatility against all currencies in the 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. Single-currency pegs are more transparent and therefore 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.

Fourth, basket pegs present certain implementation difficulties. This point is best illustrated with the case of Latvia, one of the three Baltic countries discussed extensively in Slavov (2003a, 2003b). Latvia has opted for a conventional peg to the SDR, the IMF-maintained basket of currencies. In order to maintain the peg, the Bank of Latvia has used as intervention currencies the individual currencies represented in the SDR: dollar, euro, yen, and pound. Each blip in the cross exchange rates among these four currencies should automatically trigger an adjustment in the intervention exchange rates by the Latvian monetary authority. As a practical matter, there might be an adjustment lag in the intervention rates, which invites speculation.

For example, the Bank of Latvia (BoL) stands ready to buy or sell unlimited amounts of the domestic currency (lats) for dollars or euros, in cash at its Cashier's Office, at predetermined rates which stay fixed for the entire day. Sizeable intra-day realignments in the euro-dollar exchange rate invite speculation against the BoL. Of course, this applies to cash transactions only and, presumably, it is a small enough market and cannot be used to launch a serious speculative attack.

Furthermore, the BoL buys and sells, without limits, foreign currency for lats with the Latvian banks. These are non-cash transactions. The intervention currencies in this case are the individual currencies represented in the SDR. Currently, the exchange rates are continuously updated electronically for each transaction, thus ruling out speculative attempts to profit from intra-day volatility in cross exchange rates. However, this continuous intra-day updating of exchange rates has only taken place since 1998. Thus, in the first few years of the basket peg arrangement exchange rates were set once a day, and it might have been possible to profitably attack the SDR peg following every little tweak in the cross exchange rates among the major currencies.

In addition to the spot transactions described above, the BoL has a long-standing currency swap facility. The currency swaps are very short-term (7, 28, and 91 days) and involve swapping deposits in lats for deposits in dollars or euro. At the swap auctions, the

BoL fixes spot exchange rates and interest rates on foreign deposits. Then it lets banks bid on the interest rate for lats deposits. That, in turn, fixes the implicit forward exchange rate for the swap. One hopes that any intra-day volatility in the spot exchange rate against the dollar or the euro is "auctioned off" to banks which accordingly bid the interest rate on lats up or down. However, the auction mechanism does raise the possibility for mispricing. It could also be used as a mechanism for (intentionally or inadvertently) distributing quasi-fiscal subsidies to the banking sector, given the differential between foreign and domestic interest rates and the implicit exchange rate guarantee.

In the past, the Bank of Latvia has used the short-term currency swap facility extensively in order to manage liquidity in the banking system. According to IMF data, in July 2000 the outstanding stock of short-term currency swaps reached a peak of 15% of total foreign reserves. Since 2001, under IMF pressure, the BoL has tried to limit the use of short-term currency swaps. Instead, it has relied more on repos and open market operations to manage bank liquidity.

A fifth and final argument against basket pegs is that they seem to thwart the development of a domestic forward exchange market. In other words, they further exacerbate the problem of "original sin." Under a basket peg, the domestic currency fluctuates against all currencies in the basket, and there is no obvious way to organize forward exchange markets in the domestic currency.

Again, Latvia serves as an illustration. Of the three Baltic countries, Latvia is the only one whose forward market is so small that it is not covered by Bloomberg. To be sure, the market does exist. However, Figure 13 makes it clear that it is miniscule. The Bank of Latvia has tried to compensate for the missing private forward markets by expanding its currency swap facility. Between May 2000 and December 2001, in addition to the short-term swaps discussed above, the Bank of Latvia auctioned off long-term currency swaps, with a maturity of two years. According to IMF data, outstanding long-term currency swaps peaked in mid-2001, claiming more than 15% of total foreign exchange reserves.

As a result, the secondary market in currency swaps has exhibited strong growth (see Figure 13), especially since 2000, the year when the BoL introduced long-term swaps and its use of short-term swaps for liquidity management peaked.

The IMF was quite critical of these long-term currency swaps. It persuaded the BoL to limit and completely discontinue their issue by the end of 2001. The IMF pointed out the possibility for mispricing, the possible emergence of a large open position, the quasi-fiscal subsidy aspect of such transactions, and the related implicit long-term exchange rate guarantee. One wonders if the sizeable secondary market in currency swaps will survive once the BoL calls in all of its swap lines, or if it will be reduced in size to the market in forward contracts.

6. Conclusion

This paper analyzed the optimal risk management problem of foreign currency debtors in East Asian emerging economies suffering from "original sin." The numerical simulations provide several justifications for the soft dollar pegs that most East Asian economies had in place before the crisis. Given market incompleteness, under a soft peg to the dollar the majority of debtors in the economy don't have to worry about hedging their exposure. Furthermore, stabilizing the dollar exchange rate minimizes the costs of market incompleteness to dollar debtors. Finally, a single-currency peg implies a zero correlation between the domestic yen and dollar exchange rates. It turns out that this scenario minimizes the costs of market incompleteness, relative to a basket peg or a crawl.

Baskets pegs have other problems as well. They are confusing, have credibility and transparency problems, may discourage foreign trade, present implementation problems, and may thwart the development of forward markets in the domestic currency.

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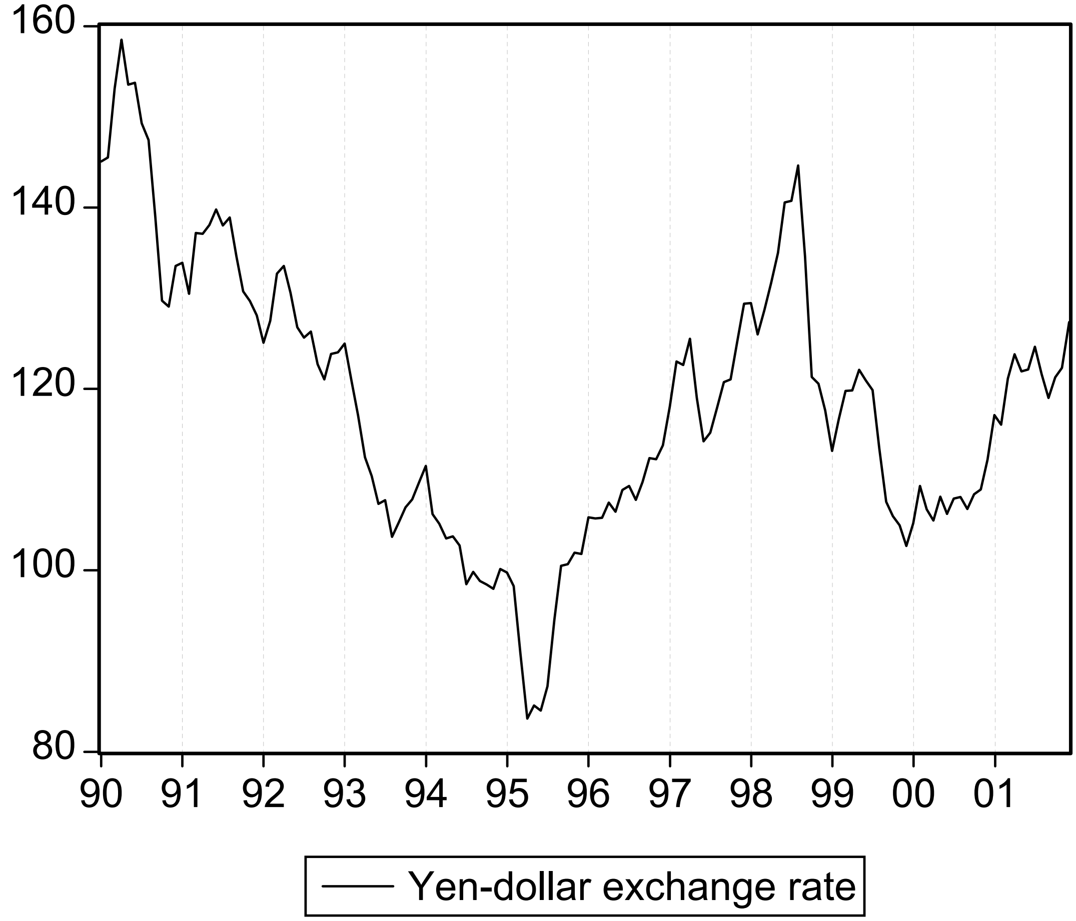
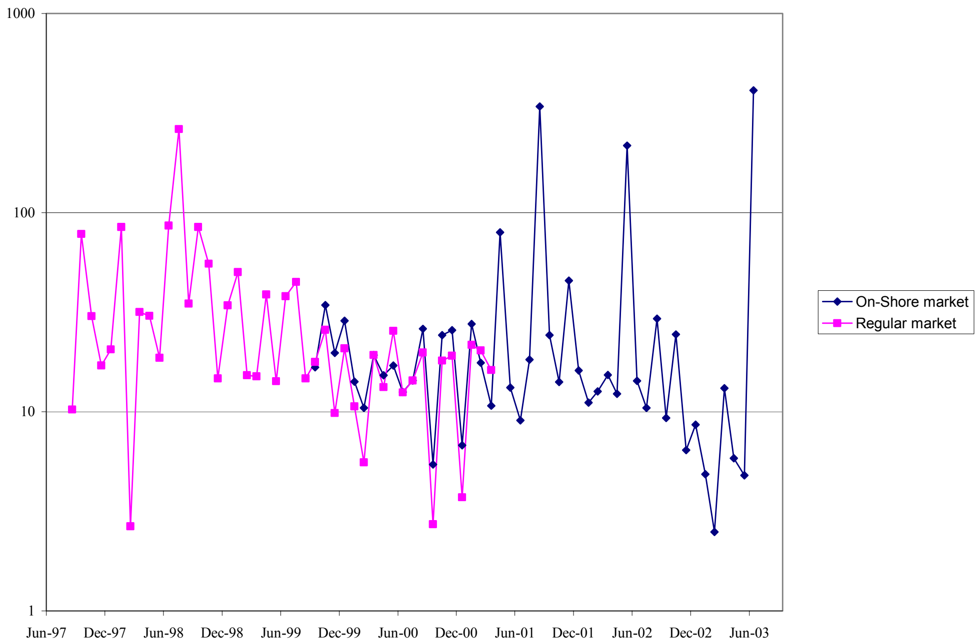
Figure 1: Yen-dollar exchange rate, Jan. 1990 – Dec. 2001 (monthly averages)



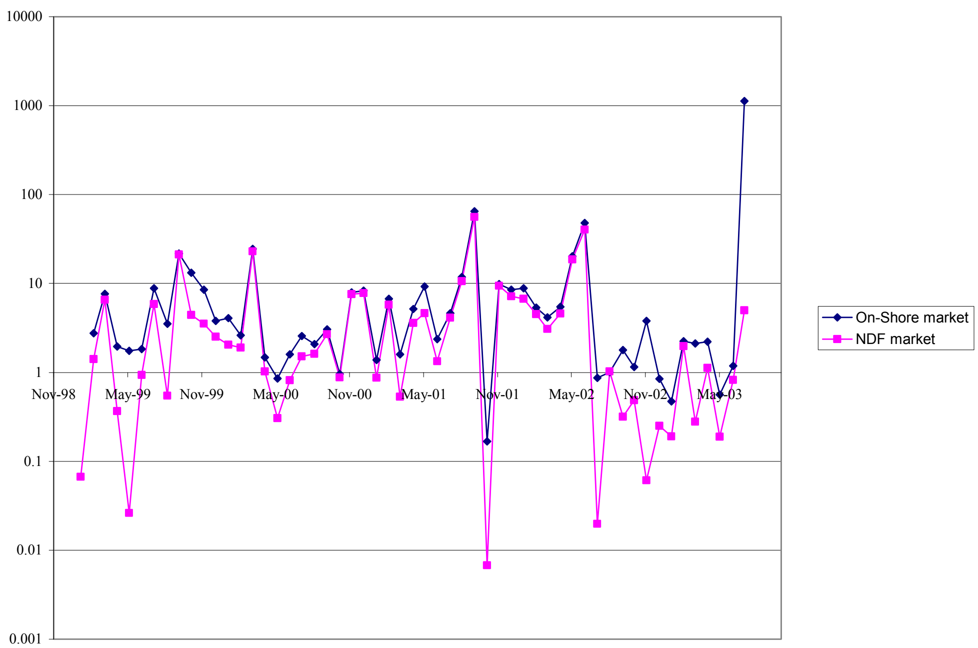
Source: IMF, International Financial Statistics

Figure 2: Bid-ask spread on the Indonesian Rupiah (IDR), relative to the yen-dollar spread (3-month forward contracts), September 1997 – July 2003



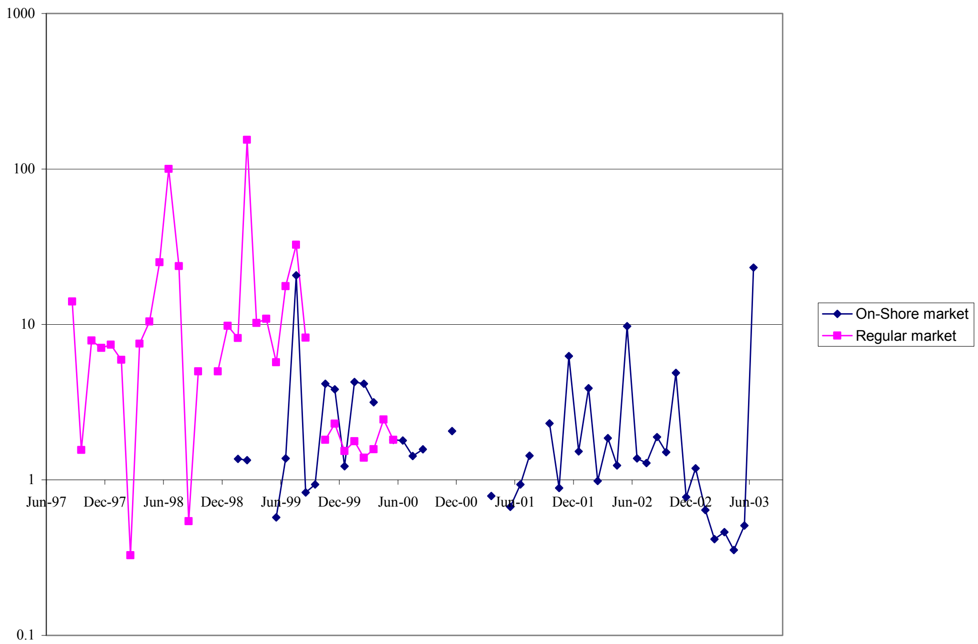
Source: Bloomberg

Figure 3: Bid-ask spread on the Korean won (KRW), relative to the yen-dollar spread (3-month forward contracts), January 1999 – July 2003



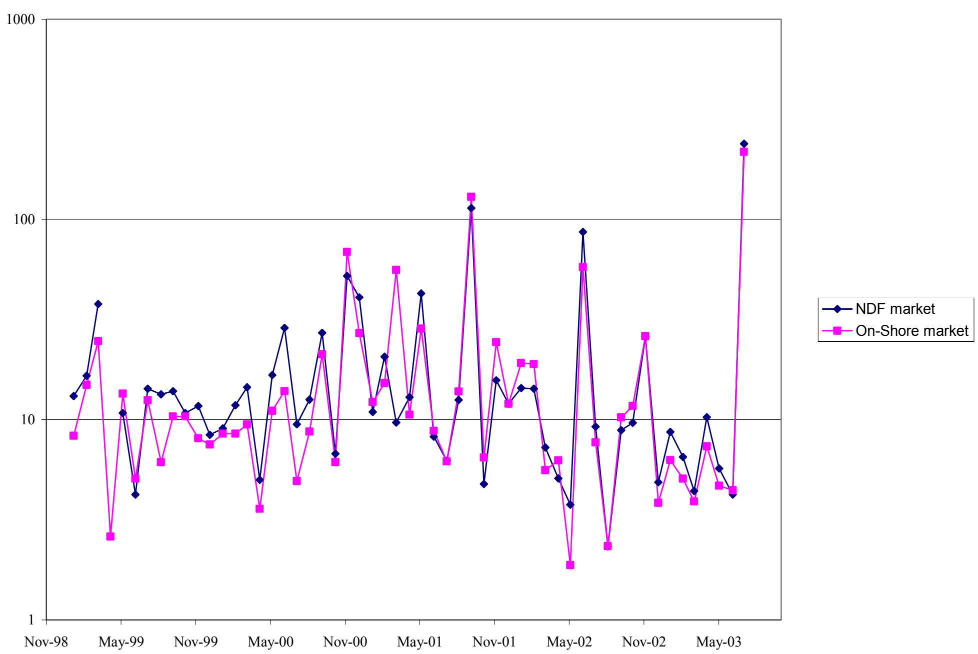
Source: Bloomberg

Figure 4: Bid-ask spread on the Malaysian ringgit (MYR), relative to the yen-dollar spread (3-month forward contracts), September 1997 – July 2003



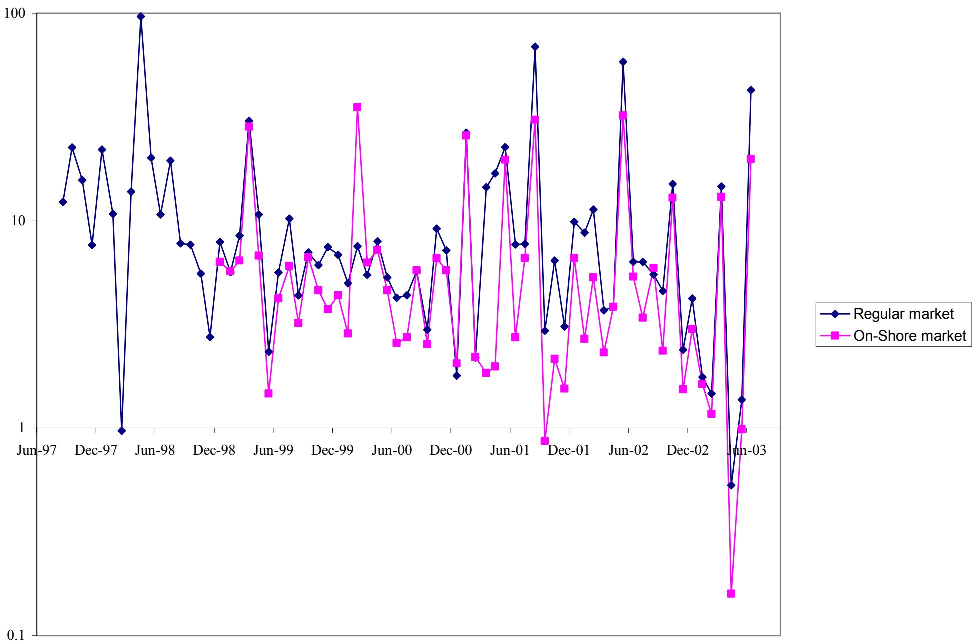
Source: Bloomberg

Figure 5: Bid-ask spread on the Philippines peso (PHP), relative to the yen-dollar spread (3-month forward contracts), January 1999 – July 2003



Source: Bloomberg

<u>Figure 6</u>: Bid-ask spread on the Thai baht (THB), relative to the yen-dollar forward spread (3-month forward contracts), September 1997 – July 2003



<u>Source</u>: Bloomberg

Figure 7: The importance of relative exchange rate volatility for importers of yen-invoiced goods

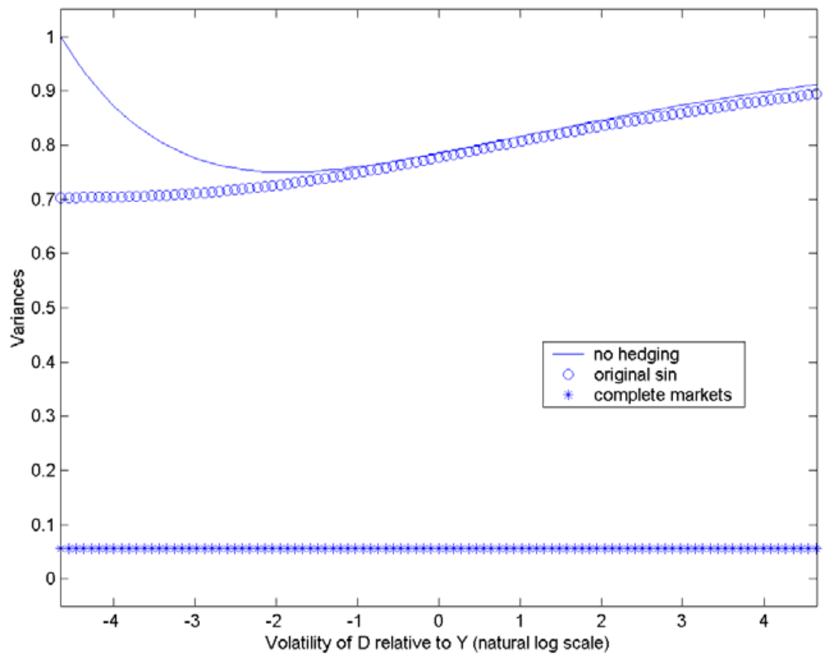
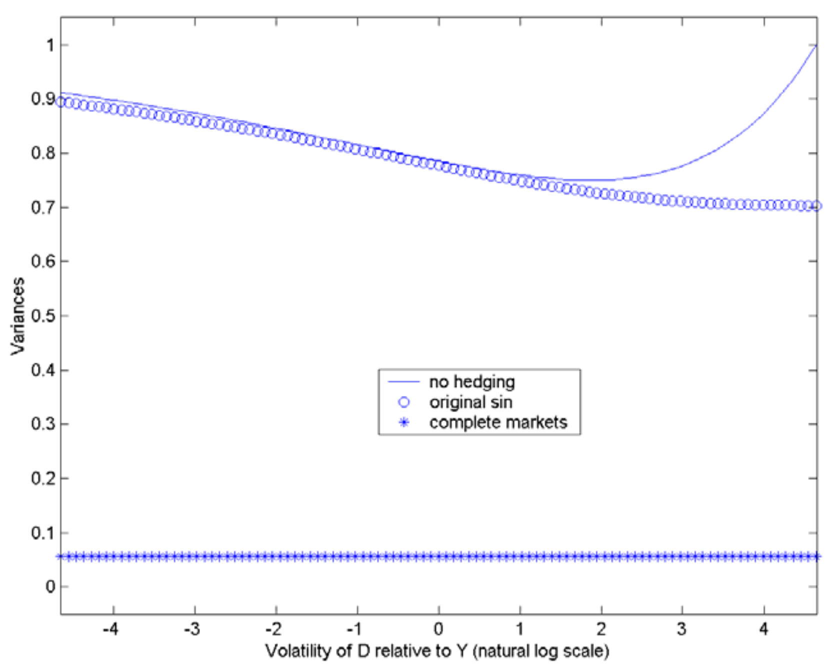
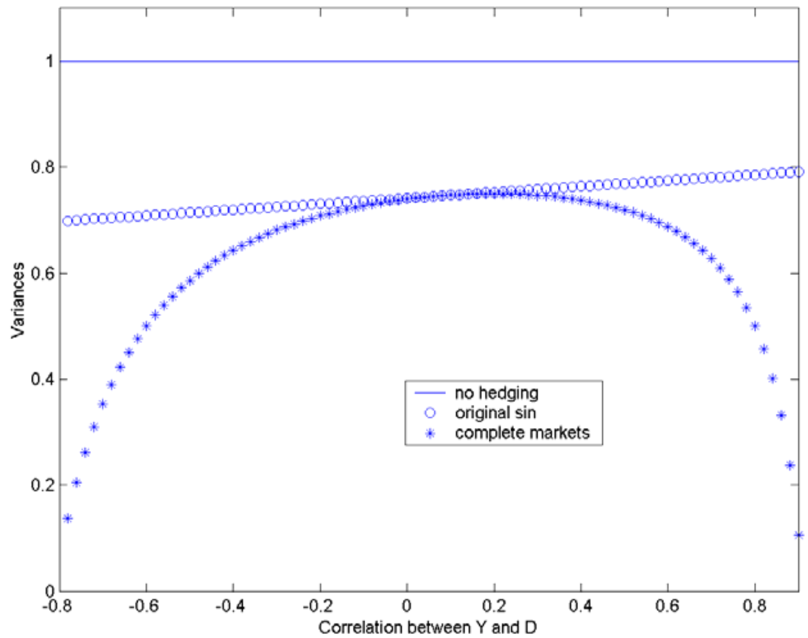


Figure 8: The importance of relative exchange rate volatility for importers of dollar-invoiced goods



<u>Figure 9</u>: The importance of correlation in domestic exchange rates for importers of yen-invoiced goods



<u>Figure 10</u>: The importance of correlation in domestic exchange rates for importers of dollar-invoiced goods

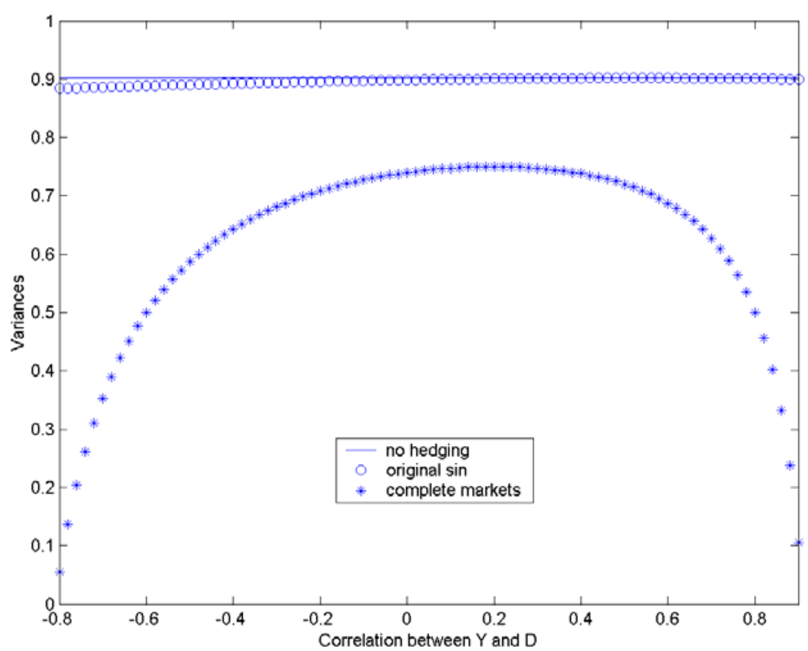


Figure 11: **The importance of correlation between goods prices and exchange rates for importers of yen-invoiced goods**

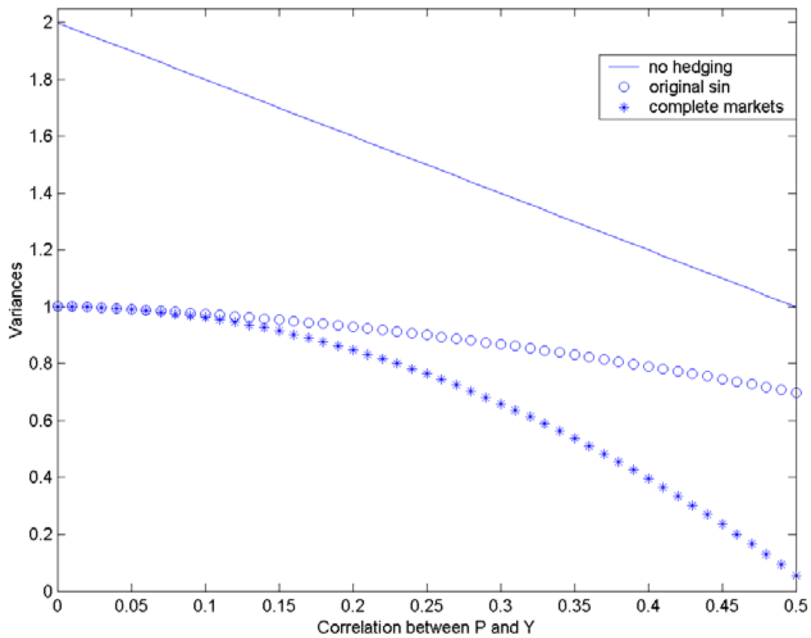
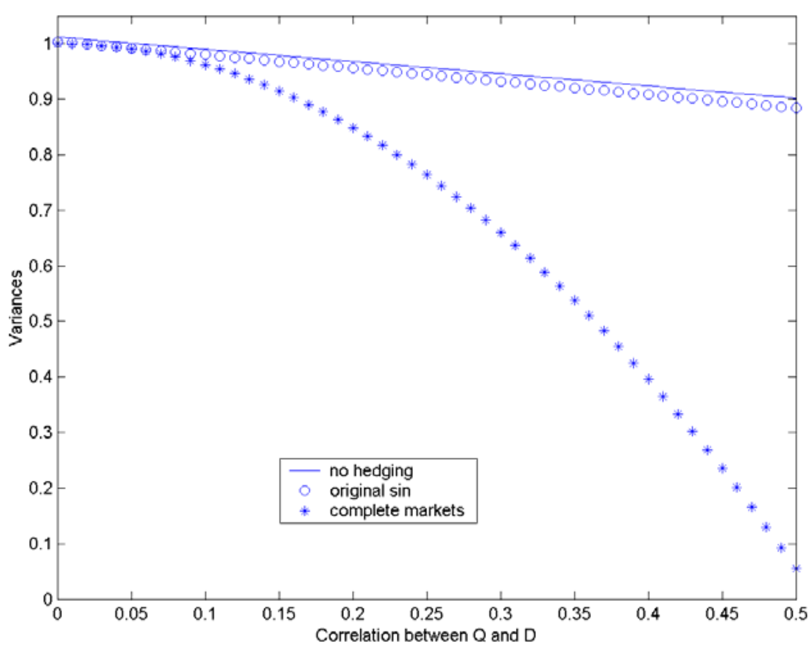
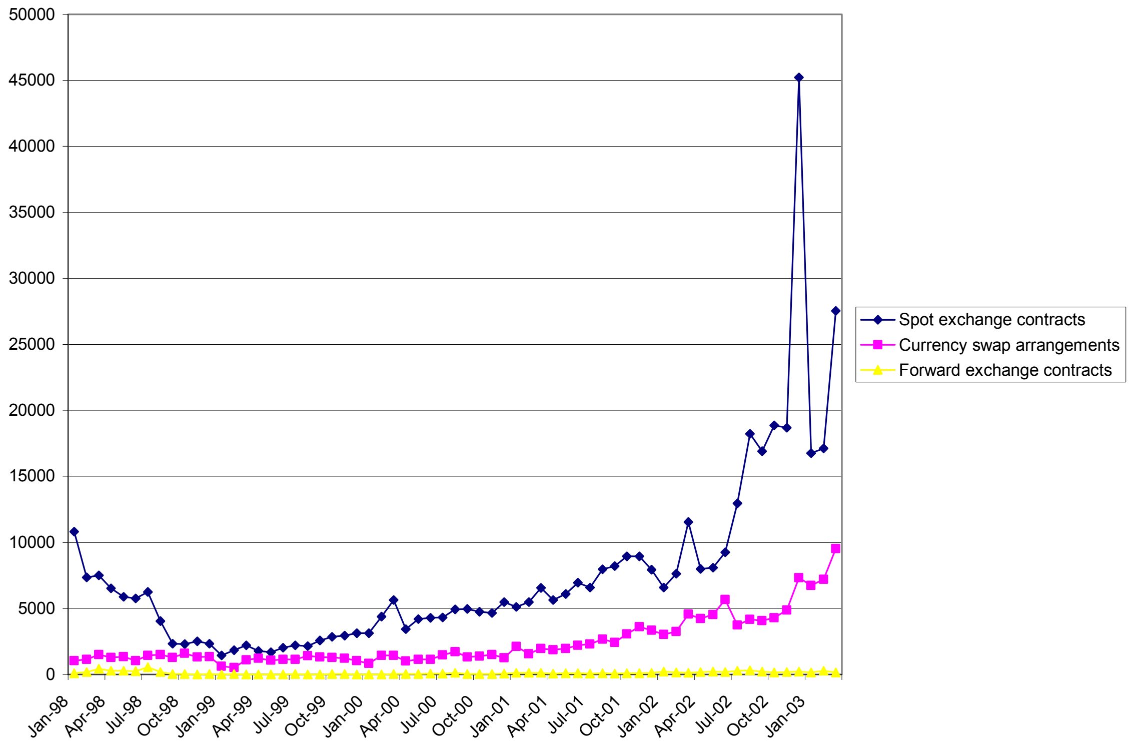


Figure 12: **The importance of correlation between goods prices and exchange rates for importers of dollar-invoiced goods**



<u>Figure 13</u>: Forex transactions in Latvia's banking sector, January 1998 - March 2003 (thousands of lats)



<u>Source</u>: Bank of Latvia