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FOREIGN EXCHANGE EXPOSURE AND EXCHANGE RATE  
ARRANGEMENTS IN EAST ASIA

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# Foreign Exchange Exposure and Exchange Rate Arrangements in East Asia

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## Abstract

This paper shows that many East Asian firms are significantly exposed to foreign exchange risk. Their exposure appears to be much more widespread than is typical for the large industrialized economies. The East Asian firms are most exposed to fluctuations in the U.S. dollar, though the mark and yen are important in a few countries. The extent of exchange rate exposure has varied over the last decade, but it does not appear to have diminished. The most widespread exchange rate sensitivity (not just the most exchange rate fluctuation) occurred during the Asian Crisis period; this is evident even after accounting for the local macroeconomic conditions that affect aggregate local returns. Finally, the East Asian evidence examined here provides no support for the idea that an exchange rate peg reduces foreign exchange exposure.

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# 1. Introduction

As recent international financial events have demonstrated, an exchange rate crisis can expand quickly into a broader financial and economic crisis. The rapid expansion of exchange rate crises beyond the foreign exchange markets reflects in part the importance of the exchange rate to firm profitability. Exchange rates affect profitability through many routes. First, they affect directly those firms with financial assets and liabilities (most notably debt) denominated in foreign currency and those firms with foreign operations. However, through their effect on foreign competition and domestic macroeconomic conditions, exchange rates also impact the profitability of firms with no nominal foreign exposure at all. Thus, a potentially wide range of firms could be exposed to movements in foreign exchange rates, regardless of their direct financial exposure.

Most empirical studies of exchange rate exposure to date have focused on large industrial countries, and most have found only modest exposure. In this paper, we examine the recent experience of firms in East Asian countries. The countries vary in their size, their participation in international trade and borrowing, and their financial development. Just as importantly, there is variation in the exchange rate arrangements both across countries and during the sample period. A country's exchange rate arrangement fundamentally defines the terms on which its economic interactions with the rest of the world are conducted, and it determines the course of domestic monetary policy. Hence, at a most basic level, the arrangement can impact exchange rate exposure. For these reasons, one might expect the exposure of East Asian firms to vary across countries and time, and to differ markedly from that reported for large, western industrialized countries.

The purpose of this paper is to evaluate the extent of foreign exchange exposure among firms in East Asian countries and to examine whether the exposure is linked to exchange rate arrangements.<sup>1</sup> Specifically, we examine the exchange rate exposure of publicly traded firms in nine East Asian countries since 1990; these include Hong Kong, Indonesia, Japan, Korea, Malaysia, the Philippines, Singapore, Taiwan, and Thailand. We compare their exposure to the exposure we find in two benchmark countries, Australia and New Zealand, and to the findings reported in earlier studies of large, western industrialized countries. We also ask whether exposure over the last twelve years has changed and whether measured exposure is linked to the exchange rate arrangements of the home countries. We measure foreign exchange exposure both in terms of the residual exposure that is left after accounting for the aggregate, local market return, and in terms of the total exposure, which includes both the local market exposure and the residual exposure.<sup>2</sup>

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<sup>1</sup> While there have been several recent studies focusing on the macroeconomic effects of currency arrangements (e.g., Ghosh et al., 1996, and Parsley and Popper, 2001), and on the impact of economic integration among economies (e.g., Rose, 2000), we know of only one other study that has examined the potential link between currency arrangements and the extent of firm-level exchange rate exposure, Dahlquist and Robertsson (2001), who examine the exposure of Swedish firms under both a basket peg and under a float.

<sup>2</sup> In emphasizing the distinctions between residual and total exposure, we are following Bodnar and Wong (2000).

Our findings can be summarized easily. First, many East Asian firms show significant exposure to fluctuations in one or more of the four major currencies: the U.S. dollar, the deutschmark, the yen, and the pound. This finding contrasts with the results of past studies, few of which have found much exchange rate exposure at all.<sup>3</sup> Second, we find that the exposure has not diminished over time. Finally, we find no evidence that countries with exchange rates that are fixed against a single currency (as is usual) exhibit less exposure against the other major currencies.

## 2. Gauging Foreign Exchange Exposure

To gauge foreign exchange exposure, we follow in the tradition of Adler and Dumas (1984). They define foreign exchange exposure in terms of a regression of asset value on the exchange rate. Our work also builds closely on that of Dahlquist and Robertsson (2001), Dominguez and Tesar (2001a, 2001b), Wong (2000), Chamberlain, Howe, and Popper (1997), Chow, Lee, and Solt (1997), Bodnar and Gentry (1993), and Jorion (1990) who all take related approaches. In keeping with most of this work, we first estimate the exposure conditional on market returns. This approach allows us to compare our results with the other key studies of exchange rate exposure, and it means that our gauge of exposure will measure what Bodnar and Wong (2000) call “residual” exposure. As Bodnar and Wong stress, estimating conditional exposure using the market return implicitly controls for many of the variables other than exchange rates that affect returns. We include measures of both local and world market returns. This makes the estimates both more stable and more meaningful. Of course, it also means that the exposure measure excludes the local market’s average sensitivity to the exchange rate, as it is reflected in the local market return. To make sure that our findings are not driven by this aspect of our specification, we also estimate exposure leaving out the local market return, and we report those estimates in Section 4.

Our treatment of the exchange rate itself differs somewhat from most of these other studies, however, in that we use individual exchange rates, rather than a trade-weighted exchange rate. In this regard, we take the same approach as Dahlquist and Robertsson, who use individual currencies to examine the exposure of hundreds of Swedish firms. Dahlquist and Robertsson emphasize that the exposure shows up more clearly when the individual exchange rates are used. Furthermore, they argue convincingly that past studies may have missed seeing foreign exchange exposure because it was masked by the aggregation of trade-weighted indices. In our case, the use of individual currencies is also supported by the fact that the currencies in the sample show enough independent variation against the major exchange rates that we are able to distinguish differences in their importance for firm returns.

As mentioned above, our sample includes firms from Hong Kong, Indonesia, Japan, Korea, Malaysia, the Philippines, Singapore, Taiwan, and Thailand, and the benchmark countries, Australia and New Zealand. We examine the exposure of firms in these countries to fluctuations in their currencies against the U.S. dollar, the deutschmark, the yen, and the pound. The sample extends from January 1990 through March 2002 and includes an average of eighty firms per country.

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<sup>3</sup> Most of those studies have focused on firms in the United States or in large European countries. By and large, they have estimated the firm exposure to a weighted-average of exchange rates. One important exception is Dahlquist and Robertsson (2001), who use individual exchange rates and find exposure among Swedish firms. Other exceptions (in terms of finding significant exposure) include Chamberlain, Howe, and Popper (1997) who find exchange rate exposure for U.S. banks using trade-weighted exchange rates, and Chow, Lee, and Solt (1997) who find exposure at long horizons.

The stock return data are taken from DataStream. For each country, we examine the returns of the largest firms included in the major market index. When possible, we use the returns from the largest 100 firms. When returns from fewer than 100 firms are available, we use all of the available firms in the index. The list of firms, and their industry classification and each market value are given in a long Appendix available from the authors.

In Table 1, we report the correlations among weekly observations of the major currencies against the currencies of each of the countries in our sample. As the table shows, the correlations are not uniformly high. In particular, the value of every country's currency against the dollar shows little correlation with its value against the other major currencies. This suggests it may be informative to include the exchange rates separately, rather than using only a trade-weighted exchange rate.

To estimate exchange rate exposure itself, we add fluctuations in all four currencies to a time series regression of each firm's excess return on a constant and on the excess market returns. That is, we estimate the parameters  $\beta_{U.S.\$}$ ,  $\beta_{DM}$ ,  $\beta_{\pounds}$  and  $\beta_{\yen}$  (along with  $\gamma_0$ ,  $\gamma_h$ , and  $\gamma_w$ ) in the following equation:

$$r_{i,t} = \gamma_0 + \gamma_h r_{h,t} + \gamma_w r_{w,t} + \beta_{U.S.\$} s_{U.S.\$,t} + \beta_{DM} s_{DM,t} + \beta_{\yen} s_{\yen,t} + \beta_{\pounds} s_{\pounds,t} + u_{i,t} \quad (1)$$

where time and individual firms are indexed by  $t$  and by  $i$ ; and excess returns and exchange rate changes are defined below.

$r_{i,t}$	≡	Return on equity $i$ , less the return to the local short-term government asset.
$r_{w,t}$	≡	International market return less the U.S. 90 day T-bill return, denominated <i>ex post</i> in local currency.
$r_{h,t}$	≡	Local market return less the local short-term government asset.
$s_{U.S.\$,t}$	≡	Nominal local currency appreciation or depreciation against the U.S. dollar.
$s_{DM,t}$	≡	Nominal local currency appreciation or depreciation against the German mark.
$s_{\yen,t}$	≡	Nominal local currency appreciation or depreciation against the Japanese yen.
$s_{\pounds,t}$	≡	Nominal local currency appreciation or depreciation against the U.K. pound.
$u_{i,t}$	≡	Regression residual.

Table 2 summarizes some of the key results of the estimation of Equation 1 using weekly returns. The estimates suggest that exchange rate fluctuations are important for many of the firms in many, but not all, of the countries. Moreover, the major currencies are not equally important. The first four columns give the fraction of firms that exhibit exposure to the dollar, the deutschmark, the yen, and the pound. That is, for each country, columns 1 through 4 give the fraction of firms for which we can reject at the five per cent significance level the separate hypotheses that  $\beta_{U.S.\$} = 0$ ,  $\beta_{DM} = 0$ ,  $\beta_{\yen} = 0$ , and  $\beta_{\pounds} = 0$ . As shown in the first column, sizable shares of firms in most of the countries appear to be exposed to fluctuations in the U.S. dollar. Over half of the Korean, Philippine, and Indonesian firms exhibit significant exposure to the dollar. The mark and yen appear to be important to a notable share of firms in only a few countries – the yen in Hong Kong and Singapore, and the mark in Taiwan. Fluctuations in the pound do not appear to matter much at all. Most notably, the pound matters not a whit in Hong Kong.

We also test the hypothesis that all the exchange rate coefficients equal zero. That is, for each firm, we test the joint hypothesis,  $H_0: \beta_{U.S.\$} = \beta_{DM} = \beta_{¥} = \beta_{£} = 0$ . Column 5 of Table 2 gives the fraction of firms in each country for which the hypothesis is rejected at the five per cent significance level. That fraction is well above five per cent in most of the countries. In those countries with many of their firms exposed to individual currencies – Indonesia, Korea, Malaysia, and the Philippines – the fraction is quite high, above 40 per cent. Column 6 gives the median  $\bar{R}^2$  of the regressions in each country; and column 7 gives the number of firms we observe in each country. Of course, as mentioned above, these exposures are “residual” exposures. That is, because they are conditioned on the local excess return, they do not reflect aggregate exposure experienced by the local market as a whole. We estimate the exposure inclusive of the aggregate local effect in Section 4.

Before proceeding to an analysis of exposure over time we address one potentially important issue. Namely, we would like to know whether the results in Table 2 are spurious. In particular, it is possible that we would find ‘significance’ in similar regressions using four purely random variables in place of the returns on the dollar, the mark, the yen, and the pound. That is, since we include all four exchange rates in the regressions, we may be biasing upward our chances of statistical significance. To address this concern we conduct a series of monte-carlo simulations by substituting pseudo-exchange rate changes in each regression. These simulations, reported in Appendix Table 1, confirm that the evidence in Table 2 is not spurious. Using simulated data we fail to find abnormal levels of ‘exposure’. We now turn to an examination of changes over time in measured exposure.

The sample period, 1990 to 2002, spans many important changes in the economic environment of these countries. In addition to the dramatic macroeconomic changes of the nineties, there have been sweeping financial reforms in many of the countries, including a liberalization of the regulation of foreign exchange derivatives, which can be used to hedge some exposure.<sup>4</sup> Therefore, we also examine how the foreign exchange exposure has varied over time. We split the full sample into four periods. Each period is three years long: 1990 to 1992, 1993 to 1995, 1996 to 1998, and 1999 to 2002. Notice that the third period, 1996 to 1998 includes the Asian Crisis and its immediate aftermath. We add interactive time dummies to Equation 1 to capture the period-by-period exposure.<sup>5</sup> This gives us the following regression equation:

$$r_{i,t} = \gamma_0 + \gamma_h r_{h,t} + \gamma_w r_{w,t} + \sum_{j=1}^4 \beta_{j,U.S.\$} D_{j,t} s_{U.S.\$,t} + \sum_{j=1}^4 \beta_{j,DM} D_{j,t} s_{DM,t} + \sum_{j=1}^4 \beta_{j,¥} D_{j,t} s_{¥,t} + \sum_{j=1}^4 \beta_{j,£} D_{j,t} s_{£,t} + v_{i,t} \quad (2)$$

where each  $D_j$  is a dummy variable:

$$D_j = \begin{cases} 1, & \text{January 1, 1990 through December 31, 1992} \\ 0, & \text{otherwise} \end{cases}$$

<sup>4</sup> If firms have increased their use of derivatives to hedge their foreign exchange exposure, we might expect to find that exposure has fallen over time. Chamberlain, Howe, and Popper (1997) find that U.S. firms that report using foreign exchange derivatives indeed do exhibit lower foreign exchange exposure than the firms that do not. Chiao and Hung (2000) consider the timing of financial liberalizations in Taiwan, and link the liberalizations to changes in the foreign exchange exposure of exporting firms.

<sup>5</sup> Allowing the parameters  $\gamma_0$ ,  $\gamma_h$ , and  $\gamma_w$  to vary as well (see Appendix Table 2) does not qualitatively affect our conclusions.

$D_2$  = 1, January 1, 1993 through December 31, 1995  
 = 0, otherwise

$D_3$  = 1, January 1, 1996 through December 31, 1998  
 = 0, otherwise

$D_4$  = 1, January 1, 1999 through March 7, 2002  
 = 0, otherwise

Table 3 summarizes the estimation results. We again report the fraction of firms for which we can reject the hypothesis that the coefficient on the exchange rate change is zero. Here, we report the fraction for each of the major currencies in each period. As might be expected, for many countries and sub-periods, the hypothesis is rejected for fewer firms than when the entire period is used. Overall, we find nothing to suggest that foreign exchange exposure has fallen over the sample period. The third period, the one encompassing the Asian Crisis, shows the most exposure – particularly to fluctuations in the dollar; and in many countries exposure is substantial in the final period as well.

As shown in the first column, only Japan and Hong Kong provide very many rejections during the first period, 1990 to 1992. Just over a quarter of the firms in Hong Kong appear to have been exposed to the yen; and 18 per cent of the Japanese firms appear to have been exposed to the dollar. In the second period, shown in column 2, more than half of the Japanese firms show some exposure to the dollar, and about a third of the Taiwanese firms appear to be exposed to the pound. During the third period, more than half of the firms in Indonesia, Korea, Malaysia, and the Philippines appear to be exposed to the dollar. About a quarter of the Japanese firms appear to be exposed to the dollar, but nearly a third exhibit exposure to the mark. In the most recent period, shown in column 4, many of the firms in Korea, Taiwan, and Thailand appear to be exposed to fluctuations in the dollar; and about a third of the Malaysian firms appear to be exposed to fluctuations in the yen. Finally, few firms in our benchmark countries, Australia and New Zealand, show significant exposure to any of the major currencies during any of the periods.

Together, Tables 2 and 3 suggest that residual exchange rate exposure is significant for many firms in East Asia and in many periods. While not restricted either to the dollar or to the crisis period, evidence of exposure is strongest against the dollar, and it is strongest around the time of the crisis.

### 3. Exposure and Exchange Rate Arrangements

Having gauged the residual foreign exchange exposure, we next examine its empirical link to exchange rate arrangements. It is sometimes argued that a fixed exchange rate regime offers a hospitable environment for business by providing stability and removing the need for expensive hedging. However, even in the rare case of a stable exchange rate peg, the exchange rate cannot be fixed independently against more than one currency. If it is fixed against, say, the U.S. dollar, it is left to fluctuate freely



against the yen and the euro. So, firms remain exposed to foreign exchange risk even when their currency officially is fixed. A firm's value may be quite sensitive to exchange rate fluctuations in this setting. In contrast, firms in countries with freely floating currencies may be accustomed to hedging, and hedging may be less costly in such countries. Thus, it is not clear which arrangement will see more foreign exchange exposure overall.

The exchange rate arrangements themselves entail mixtures of various monetary instruments. While in the countries that we study the arrangement is identified easily, it is nevertheless indivisible from the monetary conditions that surround it. That is, an exchange rate arrangement represents a monetary environment, not a single policy instrument. This fact has implications for our empirical work. It precludes us from separating the role of the exchange rate arrangement from the role of the supporting monetary variables. What we examine, then, is the empirical link between foreign exchange exposure and the monetary environment, the signature of which is the exchange rate arrangement.

We look separately at exposure under the alternative arrangements that exist in our sample. Specifically, we look at the exposure under an exchange rate peg, and we look at the exposure without one. To do so, we estimate the following regression:

$$r_{i,t} = \gamma_0 + \gamma_h r_{h,t} + \gamma_w r_{w,t} + \sum_{m=1}^4 \beta_{p,m} D_{p,t} s_{m,t} + \sum_{m=1}^4 \beta_{n,m} (1 - D_{p,t}) s_{m,t} + w_{i,t} \quad (3)$$

where  $D_{p,t}$  equals one when the firm's home currency is pegged against another currency and equals zero otherwise; and, the subscript  $m$  indexes the major currencies. We are interested in the parameters  $\beta_p$  and  $\beta_n$ , which provide separate pegged and nonpegged exposure estimates for the firms in countries that have had experience both with and without a peg during the sample period.

To be useful, this specification requires that the firm's home country have experience with both pegged and nonpegged arrangements. This limits the estimation to Indonesia, Korea, Malaysia, the Philippines, Taiwan, and Thailand. We use the *de facto* exchange rate arrangements; that is, we identify the dates of the exchange rate peg by observing the behavior of the exchange rates, not by observing the officially reported arrangement. This results in the dates given in the notes to Table 4. The table itself summarizes the findings from estimating Equation 3.

As shown in the first column, far more firms show statistically significant exposure to the dollar with a peg than without one in Malaysia, the Philippines, and Thailand. This exposure arises despite the fact that the pegs themselves are essentially tied to the dollar in these countries. As shown in the third column, exposure to the yen is even more evident, with widespread yen exposure occurring in all of the countries under their pegs. Under a peg, more than half the firms in Indonesia, Korea, Malaysia and the Philippines, and nearly a third of the firms in Taiwan and Thailand, show significant exposure to fluctuations in the yen. Without a peg, only Taiwanese firms exhibit a notable yen exposure. With or without a peg, there is much less exposure against the mark and the pound, shown in columns 2 and 4. Overall, the table illustrates that the extent of foreign exchange exposure has been much more widespread with a peg than without one. This suggests that an exchange rate peg does not mitigate the effects of exchange rate fluctuations on firm profitability.

## 4. Total Exposure

Bodnar and Wong (2000) emphasize that “residual” exposure estimates – such as those we’ve just described and those that now are conventionally reported – measure the deviation of the firms’ exposure from the exposure of the market portfolio as a whole. Even when a firm shows no significant exposure in the specifications we have used so far, the firm nevertheless may be exposed to exchange rate fluctuations if the market return covaries with the exchange rate. In order to measure the firm’s exposure as a whole, we drop the local and world returns from Equation 1. That is, we estimate the exchange rate coefficients in the following regression:

$$r_{i,t} = \gamma_0 + \beta_{U.S.} S_{U.S.,t} + \beta_{DM} S_{DM,t} + \beta_{¥} S_{¥,t} + \beta_{£} S_{£,t} + u_{i,t}. \quad (4)$$

The results are reported in Table 5.

In most ways, the results are very similar to the findings for residual exposure. Of the four major currencies, the dollar is still the most important for returns. More than half of the firms in Korea, Malaysia, the Philippines, and Singapore still appear to be exposed to the dollar. The results for Hong Kong are little changed: as before, about a quarter of the firms show significant exposure to the yen, and none appear to be exposed to the pound.

On the other hand, there are some differences. Even more firms in Singapore appear to be exposed to the dollar, while their exposure to the yen has disappeared. Surprisingly, most Japanese firms now appear to be exposed to the pound (many more than are exposed to the dollar). Taiwan’s firms no longer exhibit exposure to the dollar.

A more uniform, but less meaningful, difference in the results is that  $\bar{R}^2$ s are much lower. That is, variations in the market return, now out of the regression, had accounted for much of the explained variability of individual excess returns. The exchange rates themselves, while extremely volatile and often significant, nevertheless do not explain very much of the variation in individual returns. This is consistent with the bulk of empirical work on asset returns, which in general is unable to explain much of the variation in returns beyond that explained by their comovement with the market. Even where significant, exchange rate variation by itself contributes only slightly to the explained variation of returns.

## 5. Summary and Directions for Future Research

This paper has shown that many East Asian firms are exposed to foreign exchange rate risk, particularly to fluctuations in the value of the U.S. dollar. Their exposure shows no signs of abating, and it does not appear to diminish under an exchange rate peg. The exposure among the East Asian firms is much more widespread than typically has been reported for firms in the large, western industrialized economies. It also is more widespread than we find among firms in our benchmark countries, Australia and New Zealand.<sup>6</sup>

<sup>6</sup> However, the extent of exposure we report here is on par with that reported by Dahlquist and Robertsson (2001) for a large sample of Swedish firms.

We have not investigated whether or not firms should care about this exposure – whether the exposure is actually priced in the market and whether it should be hedged. However, economic theory (see e.g. Adler and Dumas, 1983) tells us that foreign exchange exposure is important when goods markets, not just financial markets, have barriers. Goods market segmentation implies a kind of financial market segmentation: when investors' consumption opportunities differ internationally, the exchange rate will affect the way they evaluate the random returns to financial assets. The East Asian countries studied here vary a great deal in terms of the openness of both their capital markets and their goods markets. Thus, the foreign exchange exposure that we document may matter very much in some of them and very little in others. We leave the exploration of the pricing of exposure and its implications for the development of these markets to future research.

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Table 1: Weekly Exchange Rate Correlations, 1990-2002

	U.S. Dollar	DM	Yen	Pound
<b>Hong Kong</b>				
U.S. Dollar	1.000			
DM	0.019	1.000		
Yen	0.002	0.403	1.000	
Pound	0.037	0.665	0.312	1.000
<b>Indonesia</b>				
U.S. Dollar	1.000			
DM	0.191	1.000		
Yen	0.190	0.933	1.000	
Pound	0.198	0.969	0.929	1.000
<b>Japan</b>				
U.S. Dollar	1.000			
DM	0.125	1.000		
Pound	0.140	0.772	—	1.000
<b>Korea</b>				
U.S. Dollar	1.000			
DM	0.149	1.000		
Yen	0.149	0.776	1.000	
Pound	0.157	0.890	0.753	1.000
<b>Malaysia</b>				
U.S. Dollar	1.000			
DM	0.133	1.000		
Yen	0.117	0.599	1.000	
Pound	0.143	0.801	0.557	1.000
<b>The Philippines</b>				
U.S. Dollar	1.000			
DM	0.160	1.000		
Yen	0.173	0.698	1.000	
Pound	0.152	0.853	0.669	1.000
<b>Singapore</b>				
U.S. Dollar	1.000			
DM	0.066	1.000		
Yen	0.024	0.358	1.000	
Pound	0.092	0.687	0.288	1.000
<b>Taiwan</b>				
U.S. Dollar	1.000			
DM	0.090	1.000		
Yen	0.052	0.484	1.000	
Pound	0.100	0.724	0.421	1.000
<b>Thailand</b>				
U.S. Dollar	1.000			
DM	0.146	1.000		
Yen	0.151	0.665	1.000	
Pound	0.154	0.840	0.636	1.000
<b>Australia</b>				
U.S. Dollar	1.000			
DM	0.233	1.000		
Yen	0.243	0.592	1.000	
Pound	0.238	0.808	0.524	1.000
<b>New Zealand</b>				
U.S. Dollar	1.000			
DM	0.095	1.000		
Yen	0.095	0.554	1.000	
Pound	0.106	0.767	0.508	1.000

Table 2: Residual Foreign Exchange Exposure

$$r_{i,t} = \gamma_0 + \gamma_h r_{h,t} + \gamma_w r_{w,t} + \beta_{U.S.\$} s_{U.S.\$,t} + \beta_{DM} s_{DM,t} + \beta_{¥} s_{¥,t} + \beta_{£} s_{£,t} + u_{i,t}$$

	Per cent of firms rejecting:					Median $\bar{R}^2$	# of firms
	H <sub>0</sub> : $\beta_j = 0$ at the 5% level				H <sub>0</sub> : $\beta_j = 0$		
	$j =$ U.S.\$	DM	¥	£	$\forall_j$		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	
Hong Kong	—	12	27	0	24	.74	33
Indonesia	55	13	7	1	46	.53	100
Japan	31	8	—	0	26	.69	100
Korea	69	4	2	1	54	.28	100
Malaysia	59	2	12	0	44	.31	98
The Philippines	61	3	6	0	42	.31	33
Singapore	44	4	29	2	42	.95	45
Taiwan	43	25	2	11	35	.59	100
Thailand	2	1	4	11	7	.56	100
Australia	11	9	6	6	12	.27	100
New Zealand	10	3	5	0	15	.57	40

Notes: Observations are taken weekly from January 1990, to March 2002.

Table 3: Residual Foreign Exchange Exposure by Period

$$r_{i,t} = \gamma_0 + \gamma_h r_{h,t} + \gamma_w r_{w,t} + \sum_{j=1}^4 \beta_{j,U.S.\$} D_{j,t} S_{U.S.\$,t} + \sum_{j=1}^4 \beta_{j,DM} D_{j,t} S_{DM,t} + \sum_{j=1}^4 \beta_{j,\yen} D_{j,t} S_{\yen,t} + \sum_{j=1}^4 \beta_{j,\pounds} D_{j,t} S_{\pounds,t} + v_{i,t}$$

	Median $\bar{R}^2$	Exposure to:	1990-92	1993-95	1996-98	1999-02
<b>Hong Kong:</b>	0.74	Mark	3	0	0	9
		Yen	27	3	15	3
		Pound	0	9	0	3
<b>Indonesia:</b>	0.52	U.S. Dollar	1	4	58	10
		Mark	5	5	6	7
		Yen	0	1	11	11
		Pound	5	3	2	2
<b>Japan:</b>	0.69	U.S. Dollar	18	56	26	15
		Mark	4	5	31	4
		Pound	2	13	2	0
<b>Korea:</b>	0.29	U.S. Dollar	—	7	65	56
		Mark	—	4	2	8
		Yen	—	1	18	2
		Pound	—	3	3	2
<b>Malaysia:</b>	0.38	U.S. Dollar	—	1	60	13
		Mark	—	1	1	4
		Yen	—	2	1	32
		Pound	—	5	0	0
<b>The Philippines:</b>	0.32	U.S. Dollar	12	9	58	12
		Mark	0	6	9	0
		Yen	3	3	3	6
		Pound	3	6	0	0
<b>Singapore:</b>	0.95	U.S. Dollar	0	4	40	7
		Mark	2	2	8	13
		Yen	4	0	16	4
		Pound	4	2	2	13
<b>Taiwan:</b>	0.69	U.S. Dollar	3	15	9	38
		Mark	1	11	14	8
		Yen	0	2	5	2
		Pound	2	32	2	6
<b>Thailand:</b>	0.56	U.S. Dollar	3	6	2	36
		Mark	3	14	1	3
		Yen	1	6	7	5
		Pound	4	1	15	4
<b>Australia:</b>	0.27	U.S. Dollar	5	7	10	7
		Mark	7	6	7	13
		Yen	2	5	7	8
		Pound	12	5	6	2
<b>New Zealand:</b>	0.57	U.S. Dollar	3	10	5	8
		Mark	5	3	3	3
		Yen	0	3	3	10
		Pound	5	0	0	3



Table 4: Foreign Exchange Exposure and Exchange Rate Arrangements

$$r_{i,t} = \gamma_0 + \gamma_h r_{h,t} + \gamma_w r_{w,t} + \sum_{m=1}^4 \beta_{p,m} D_{p,t} s_{m,t} + \sum_{m=1}^4 \beta_{n,m} (1 - D_{p,t}) s_{m,t} + w_{i,t}$$

		Per cent of firms rejecting:					Median $\bar{R}^2$	# of firms
		H <sub>0</sub> : $\beta_j = 0$ at the 5% level			H <sub>0</sub> : $\beta_j = 0$			
$m =$		U.S.\$	DM	¥	£	$\forall_m$		
		(1)	(2)	(3)	(4)	(5)	(6)	(7)
Indonesia	Pegged	0	4	55	8	63	.52	100
	Nonpegged	2	0	10	1	7		
Korea	Pegged	10	0	69	0	39	.28	100
	Nonpegged	4	2	6	2	4		
Malaysia	Pegged	56	6	59	2	3	.40	98
	Nonpegged	27	12	12	9	7		
The Philippines	Pegged	42	6	70	9	15	.31	33
	Nonpegged	0	3	9	0	4		
Taiwan	Pegged	2	4	29	2	42	.59	100
	Nonpegged	4	4	18	2	15		
Thailand	Pegged	73	21	31	9	0	.57	100
	Nonpegged	7	3	2	6	16		

Notes: Observations are taken weekly from January 1990 to March 2002.

Exchange rates are designated pegged during the following periods:

Indonesia – January 1, 1990 to July 1, 1997

Korea – January 1, 1990 to October 22, 1997

Malaysia – January 1, 1990 to July 12, 1997; and September 1, 1998 to March 7, 2002

The Philippines – January 1, 1990 to July 12, 1997

Taiwan – January 1, 1990 to July 28, 1997

Thailand – January 1, 1990 to July 4, 1997

Table 5: Total Foreign Exchange Exposure

$$r_{i,t} = \gamma_0 + \beta_{U.S.\$} s_{U.S.\$,t} + \beta_{DM} s_{DM,t} + \beta_{¥} s_{¥,t} + \beta_{£} s_{£,t} + u_{i,t}.$$

	Per cent of firms rejecting:					Median $\bar{R}^2$	# of firms
	H <sub>0</sub> : $\beta_j = 0$ at the 5% level				H <sub>0</sub> : $\beta_j = 0$		
	$j =$ U.S.\$	DM	¥	£	$\forall_j$		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	
Hong Kong	—	0	39	0	58	.01	33
Indonesia	0	7	8	0	7	.01	100
Japan	5	24	—	74	19	.00	100
Korea	76	5	13	1	67	.08	100
Malaysia	82	0	36	0	65	.06	98
The Philippines	85	0	0	0	58	.03	33
Singapore	89	0	2	0	58	.03	45
Taiwan	1	35	5	2	18	.01	100
Thailand	7	0	1	1	12	.01	100
Australia	8	4	10	3	12	.00	100
New Zealand	69	5	5	1	69	.02	40

Notes: Observations are taken weekly from January 1990 to March 2002.

## Appendix Table 1: Simulated Residual Foreign Exchange Exposure

$$r_{i,t} = \gamma_0 + \gamma_h r_{h,t} + \gamma_w r_{w,t} + \beta_{U.S.\$} s_{U.S.\$,t} + \beta_{DM} s_{DM,t} + \beta_{¥} s_{¥,t} + \beta_{£} s_{£,t} + u_{i,t}$$

	Per cent of firms rejecting:					Median $\bar{R}^2$	# of firms
	H <sub>0</sub> : $\beta_j = 0$ at the 5% level				H <sub>0</sub> : $\beta_j = 0$		
	$j =$ U.S.\$	DM	¥	£	$\forall_j$		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	
Hong Kong	—	3	3	3	3	.71	33
Indonesia	7	6	6	6	9	.28	100
Japan	5	4	—	4	6	.82	100
Korea	5	4	4	5	5	.20	100
Malaysia	3	3	3	3	3	.32	98
The Philippines	3	3	6	3	6	.25	33
Singapore	4	4	4	4	4	.94	45
Taiwan	3	4	4	3	5	.57	100
Thailand	5	6	5	5	7	.54	100
Australia	6	5	5	5	9	.26	100
New Zealand	5	8	8	8	12	.55	40

Notes: This table summarizes 25,470 (the total number of firms times the number of draws) regressions of actual returns series on simulated exchange rate series. For each country, pseudo-exchange rate returns were generated as mean zero normal random variables with standard deviations matching the original exchange rate return series. These pseudo-returns were included in each firm-level time-series regression, and the number of coefficients statistically different from zero was recorded for each pseudo-currency. Then, new exchange rate series were drawn, and the process was repeated thirty times before proceeding to the next country. The table reports the median per cent of statistically significant coefficient estimates.

Appendix Table 2: Residual Foreign Exchange Exposure by Period

$$r_{i,t} = \sum_{j=1}^4 \gamma_j D_{j,t} + \sum_{j=1}^4 \gamma_{h,j} D_{j,t} r_{h,t} + \sum_{j=1}^4 \gamma_{w,j} D_{j,t} r_{w,t} + \sum_{j=1}^4 \beta_{j,U.S.} D_{j,t} S_{U.S.,t} \\ + \sum_{j=1}^4 \beta_{j,DM} D_{j,t} S_{DM,t} + \sum_{j=1}^4 \beta_{j,\pounds} D_{j,t} S_{\pounds,t} + \sum_{j=1}^4 \beta_{j,\text{€}} D_{j,t} S_{\text{€},t} + v_{i,t}$$

	Median $\bar{R}^2$	Exposure to:	1990-92	1993-95	1996-98	1999-02
<b>Hong Kong:</b>	0.74	Mark	3	3	0	9
		Yen	21	3	12	3
		Pound	3	9	0	3
<b>Indonesia:</b>	0.53	U.S. Dollar	7	5	3	20
		Mark	7	12	8	6
		Yen	7	0	1	13
		Pound	11	5	3	3
<b>Japan:</b>	0.70	U.S. Dollar	4	58	44	8
		Mark	1	3	39	5
		Pound	1	12	2	1
<b>Korea:</b>	0.29	U.S. Dollar	—	5	40	53
		Mark	—	3	2	7
		Yen	—	4	15	5
		Pound	—	5	1	3
<b>Malaysia:</b>	0.39	U.S. Dollar	—	4	39	14
		Mark	—	4	1	4
		Yen	—	3	2	32
		Pound	—	6	2	1
<b>The Philippines:</b>	0.34	U.S. Dollar	3	9	33	9
		Mark	0	6	9	3
		Yen	0	0	6	6
		Pound	3	9	0	3
<b>Singapore:</b>	0.95	U.S. Dollar	24	4	20	18
		Mark	2	2	9	13
		Yen	4	4	13	7
		Pound	7	4	0	20
<b>Taiwan:</b>	0.59	U.S. Dollar	1	21	4	42
		Mark	0	17	17	11
		Yen	0	0	6	2
		Pound	2	40	3	6
<b>Thailand:</b>	0.56	U.S. Dollar	4	7	5	47
		Mark	3	16	1	3
		Yen	5	8	4	6
		Pound	7	1	8	4
<b>Australia:</b>	0.27	U.S. Dollar	5	7	10	7
		Mark	6	6	8	13
		Yen	2	4	6	7
		Pound	13	6	7	2
<b>New Zealand:</b>	0.58	U.S. Dollar	0	0	10	7
		Mark	5	0	0	3
		Yen	3	3	3	10
		Pound	10	0	0	3