Exchange rate pegs and foreign exchange exposure in east and south east asia

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Abstract: This paper shows that many Asia-Pacific firms are significantly exposed to foreign exchange risk. Their exposure appears to be much more widespread than is typical for the large, western industrialized economies. The paper also shows that exchange rate pegs appear to do little to alleviate this widespread exposure against currencies other than the peg. The firms studied here are most exposed to fluctuations in the U.S. dollar; the yen and euro are important in a few countries. The extent of their exchange rate exposure has varied but not diminished over the last decade. 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.

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I. 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. In addition, through their effect on foreign competition and domestic macroeconomic

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conditions, exchange rates also can impact the profitability of firms with no foreign currency revenues at all.[1] 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 western industrial countries, and most have found only modest exposure. In contrast, we focus on Asia-Pacific countries, and we find that their experience has been different. Our sample of countries includes some that differ markedly from the large, western economies in terms of their size, participation in international trade and borrowing, and financial development. These countries also differ among themselves in terms of how they experienced the Asian financial crises. Just as importantly, they provide variation in 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 all of these reasons, one might expect the evidence of exposure among East and South East Asian firms to vary across countries and time, and to differ from existing evidence reporting only minimal levels of exchange rate exposure. Our goal in this study is to explore these differences. In particular, this paper evaluates the extent of foreign exchange exposure among firms in Asia-Pacific countries and examines whether the observed exposure is linked to the use of an exchange rate peg.

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 currency arrangements on trade (e.g., Rose, 2000). However, we know of only

[1] Marston (2001) provides a model that focuses carefully on cash flows and industry structure to explain when exposure depends *only* on its net foreign currency revenues and when it depends on other variables. He and Ng (1998) discuss how a firm's imports, exports, and hedging strategies affect exposure.

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), which examines the exposure of Swedish firms. In this paper, we are able to study the link between currency arrangements and exposure both across countries and over time. Specifically, we examine the exchange rate exposure of publicly traded firms in nine Asia-Pacific countries since 1990; these include Hong Kong, Indonesia, Japan, Korea, Malaysia, the Philippines, Singapore, Taiwan, and Thailand. Then, in addition to examining the link between exposure and exchange rate arrangements, we also ask whether their exposure over the last twelve years has changed, and we compare their exposure to that of two benchmark countries, Australia and New Zealand, and to the exposure reported in the earlier studies. 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.[2]

Our findings can be summarized easily. First, many Asia-Pacific firms show significant exposure to fluctuations in one or more of the four major currencies: the U.S. dollar, the euro (deutschmark prior to 1999), 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.[3,4] Second, we find that countries with exchange rates that are fixed against

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[2] In emphasizing the distinctions between residual and total exposure, we are following Bodnar and Wong (2000).

[3] 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.

[4] The absence of observable exposure may reflect hedging by firms. Bodnar and Marston (2004) provide evidence that operational hedging may have been important in reducing the exposure of many U.S. firms. Financial hedges are examined by Allayannis and Ofek (2001), and by Chamberlain, Howe, and Popper (1997). Both studies find the use of derivatives to be associated with reduced exposure. (Allayannis and Ofek examine U.S. nonfinancial firms; while Chamberlain, Howe, and Popper examine U.S. banks.)

a single currency (as is usual) exhibit no less exposure against the other major currencies. Finally, we find that the exchange rate exposure has not diminished over time.

II. 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), Bodnar and Marston (2004), Allayannis and Ofek (2001), 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 IV.

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 do Dahlquist and Robertsson,

who use individual currencies to examine the exposure of hundreds of Swedish firms.[5] 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 Japanese yen, the British pound, and the euro (the deutschmark prior to 1999). The sample extends from January 1990 through March 2002 and includes an average of eighty firms per country.

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 file 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 reaffirms that it may be informative to include the exchange rates

[5] Allayannis and Ofek (2001) also use individual exchange rates to check the robustness of their original results, which use a trade-weighted exchange rate.

separately, rather than using only a trade-weighted exchange rate.[6]

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 $\beta_{US\$}$, $\beta_{€}$, $\beta_{£}$ and $\beta_{¥}$ (along with γ_0, γ_h, and γ_w) in the following equation:

$$r_{i,t} = \gamma_0 + \gamma_h r_{h,t} + \gamma_w r_{w,t} + \beta_{US\$} s_{US\$,t} + \beta_{euro} s_{euro,t} + \beta_{¥} s_{¥,t} + \beta_{£} s_{£,t} + u_{i,t} \qquad (1)$$

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.[7]

$r_{w,t}$ ≡ International market return less the U.S 90 day Treasury bill return, denominated *ex post* in local currency.

$r_{h,t}$ ≡ Local market return less the local short-term government asset.

$s_{US\$,t}$ ≡ Nominal local currency appreciation or depreciation against the U.S. dollar.

$s_{euro,t}$ ≡ Nominal local currency appreciation or depreciation against the euro (prior to 1999 we use the German mark).

$s_{¥,t}$ ≡ Nominal local currency appreciation or depreciation against the Japanese yen.

$s_{£,t}$ ≡ Nominal local currency appreciation or depreciation against the U.K. pound.

$u_{i,t}$ ≡ Regression residual.

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[6] We might have expected multicollinearity to be an important problem. In that case, one might as well look only at a weighted average of exchange rates, as was done in most of the past work mentioned in note 3. A high degree of multicollinearity makes it impossible to sort out the individual effects of the explanatory variables. Too much multicollinearity (while not biasing the coefficient estimates) causes the standard errors on the individual coefficient estimates to be high, thereby misleadingly leaving the individual coefficients statistically insignificant. One then finds only joint significance, without individual significance. Here, multicollinearity turns out not to be a serious problem; while some of the correlations reported in Table 1 are high, there is still enough independent currency variation that we find widespread significance of the individual currencies.

[7] In additional estimates, available from the authors, we define $r_{i,t}$ as a return generated from a portfolio of five stocks. We find that somewhat more of these portfolio returns appear to be sensitive to exchange rates; but the overall picture is roughly similar.

Table 2 summarizes some of the key results of the estimation of Equation 1 for each firm using weekly returns, and where the exchange rate appreciation or depreciation is defined as the percentage change in the exchange rate over the week.[8] Columns one through five give the percent of firms that show significant currency exposure, column 6 gives the median corrected r-squared, and column seven gives the number of firms.[9] The estimates suggest that exchange rate fluctuations are important for many of the firms in most, 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 euro, the yen, and the pound. That is, for each country, Columns 1 though 4 give the fraction of firms for which we can reject at the five percent significance level the separate hypotheses that $\beta_{US\$} = 0$, $\beta_{€} = 0$, $\beta_{£} = 0$, and $\beta_{¥} = 0$.[10] 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.[11] Over half of the Korean, Philippine, and Indonesian firms exhibit significant exposure to the dollar. The euro 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 euro 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

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[8] Definitions and sources of the stock market and government returns are given in Appendix tables 1 and 2. Weekly returns are calculated from Friday to Friday. A list of all company names, their market value (as of March 2002), the time period of the data for each company (including total number of observations), and their DataStream industry code and descriptor – for all countries is available from the authors.

[9] In all, Table 2 summarizes 871 separate regressions.

[10] Significance tests throughout the paper are based on estimated covariance matricies robust to heteroscedasticity and serially correlated residuals (of up to five lags). See, Newey and West (1987).

[11] As emphasized by a referee, the Japanese stock market is very much bigger than the stock markets in the other countries that we examine. Moreover, the top Japanese firms are themselves extremely large, and they may not be as representative of the country's market as a whole. Indeed, looking at a more representative cross-section, we find much less dollar sensitivity. Estimating equation 1 for 1000 Japanese firms, only seven percent of them are significantly exposed to fluctuations in the dollar exchange rate. (Exposure to the euro and pound remains low.) This lower dollar exposure is more in keeping with the findings in our benchmark countries, Australia and New Zealand, and with other work examining large, industrialized countries.

is, for each firm, we test the joint hypothesis, H_0: $\beta_{US\$} = \beta_{euro} = \beta_{¥} = \beta_{£} = 0$.[12] Column 5 of Table 1 gives the fraction of firms in each country for which the hypothesis is rejected at the five percent significance level. That fraction is well above five percent 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 percent. Column 6 gives the median $\overline{R}^2$ 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 euro, 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 3, 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

[12] Normally an F-test, the test of exclusion restrictions is here a χ^2 test since we use a covariance matrix that allows for heteroscedasticity and serial correlation.

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.[13] 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 to1998, 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. This gives us the following regression equation:

$$r_{i,t} = \gamma_0 + \gamma_h r_{h,t} + \gamma_w r_{w,t} + \sum_{j=1}^{4} \beta_{j,US\$} D_{j,t} s_{US\$,t} + \sum_{j=1}^{4} \beta_{j,euro} D_{j,t} s_{euro,t} + \sum_{j=1}^{4} \beta_{j,¥} D_{j,t} s_{¥,t} + \sum_{j=1}^{4} \beta_{j,£} D_{j,t} s_{£,t} + v_{i,t} \qquad (2)$$

where each D_j is a dummy variable:

D_1 = 1, January 1, 1990 through December 31, 1992
= 0, otherwise

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 somewhat 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

[13] 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.

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, there is only a modest amount of exposure 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; 19 percent of the firms in Japan appear to have been exposed to the dollar, and 18 percent of the Australian firms appeared to have been exposed to the pound. In the second period, shown in column 2, more than half of the Japanese firms show some exposure to the dollar, and nearly a third of the Taiwanese firms appear to be exposed to the pound. The next set of columns gives the estimates for the third period, when exposure was highest. During the third period, more than half of the firms in Indonesia, Korea, Malaysia, and the Philippines, and about a third of those in Japan and Singapore appear to be exposed to the dollar; and about a quarter of the firms in Singapore appear to be exposed to the yen. 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.

Together, Tables 2 and 3 suggest that residual exchange rate exposure is significant for many firms in East and South 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.

III. 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.[14] 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:

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[14] As emphasized by an anonymous referee, deviations from purchasing power parity (PPP) may differ across exchange rate arrangements, giving rise to differing degrees of exchange rate exposure for that reason. (See Parsley and Popper, 2001, for an assessment of PPP under alternative exchange rate arrangements.) In this regard, what should matter is the real exchange rate, not the nominal exchange rate, which we use. However, the empirical fact that nominal exchange rates are so much more volatile than prices at frequencies less than one year means that the correlation between nominal and real exchange rate changes is extremely high. This suggests that it is very likely that the results we report here would extend to real exchange rates, were we able to measure them at this frequency. (Price data, hence real exchange rates, are only available monthly.)

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

where $D_{p,t}$ equals one when the firm's home currency is pegged against another currency and equals zero otherwise, and $D_{n,t} = 1 - D_{p,t}$; and, the subscript m indexes the major currencies. We are interested in the parameters β_p and β_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 relying on 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.

The first column shows the fraction of firms that show significant exposure to the dollar. The pegs are imperfect enough that there is sufficient variation even in the dollar exchange rate for exposure to be measurable in these countries.[15] 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.

The third column gives the fraction of firms that show significant exposure to the yen. As shown, there is apparently even greater exposure to the yen. Widespread yen exposure occurs in all of the countries under their pegs. Under a peg, more than half the

[15] All of the pegs except the post-1998 peg of Malaysia (its second peg) and the long-lasting peg of Hong Kong exhibit variation. In the case of Hong Kong, we only estimate the exposure to the non-pegged currencies.

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 apparently less exposure against the euro 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.

The next table helps us explore whether this exposure reflects only the single brief period of the Asian Crisis. Table 5 gives the result from re-estimating the equation excluding the summer of 1997. There are some notable differences for Malaysia and Thailand under a peg. Excluding the Asian Crisis period, most Malaysian firms appear to be exposed only to the yen, not to the dollar, as they where when the crisis period was included. Among the Thai firms, both the dollar and the yen exposure disappear. For the remainder of the countries, the results are little changed: whether the crisis period is included or not, foreign exchange exposure is more striking with a peg than without one.

In an attempt to get some insight into the form of the exposure, we next examine whether the firms appear to be long or short in the major foreign currencies. That is, when they are significant, are the estimated signs of $\beta_{p,\,m}$ and $\beta_{n,\,m}$ in Equation 3 positive or negative? The exchange rate, s, is defined here as the domestic currency per major currency unit (for example baht/yen). So, a positive exchange rate coefficient means that the return tends to increase when the foreign currency appreciates (when the firm's home currency depreciates against the major foreign currency). Thus, a positive coefficient indicates the firm is in essence long in the foreign currency; while a negative coefficient indicates that the firm is essentially short foreign currency.

The first four columns of Table 6 give the percent of firms for which the exchange rate coefficient is both positive and significant for each currency. The last four columns

give the percent of firms that have negative, significant coefficients. Thus, column 1 gives the fraction of firms that are, in effect, long in dollars. Column five gives the fraction of firms that are essentially short dollars. As can be seen from the table, of those firms exposed to the dollar, many more are long dollars than short dollars. They key exception is Malaysia. There, under a peg or not, firms are more likely to be short dollars. One might have argued that a dollar peg would lull firms into taking on too much dollar denominated debt, making them effectively short in dollars. That so many of the exposed firms were essentially long dollars suggests that the peg did not have that effect, except possibly in Malaysia. On the other hand, many of the firms appear to have been essentially short yen. Looking at the yen exposure in columns three and six, one sees that most yen-exposed firms had negative estimated coefficients, except in Indonesia. That is, in most of the countries, when the yen depreciated against the home currencies, returns went up, not down. Overall, the exposed firms tended to be long dollars and short yen under a peg.

In sum, this section has shown that the extent of foreign exchange exposure has been much more widespread with a peg than without one. In effect, firms were less hedged under pegged exchange rates. Of course this may reflect the limitations of local financial market development rather than a resistance to hedging. This section has also shown that the Asia-Pacific firms that are exposed tend to be long dollars and short yen. This implies that dollar denominated debt was not the primary vehicle of exchange rate exposure.

IV. Total Exposure

Bodnar and Wong (2000) emphasize that "residual" exposure estimates – such as those we have 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:

$$r_{i,t} = \gamma_0 + \beta_{US\$} s_{US\$,t} + \beta_{euro} s_{euro,t} + \beta_{¥} s_{¥,t} + \beta_{£} s_{£,t} + u_{i,t} \quad (4)$$

The results are reported in Table 7.

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 in most countries. More than half of the firms in Indonesia, 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 the $\overline{R}^2$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.

V. Summary and Directions for Future Research

This paper has shown that many Asia-Pacific 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 Asia-Pacific 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.[16]

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 Asia-Pacific 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.

[16] However, the extent of exposure we report here is on par with that reported by Dahlquist and Robertsson for a large sample of Swedish firms.

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Table 1
Weekly exchange rate correlations, 1990-2002

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

The equation estimated is

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

	Percent of firms rejecting: H_0: β_j=0 at the 5% level				H_0: $\beta_j = 0$	Median	# of
j =	US$	€	¥	£	$\forall_j$	$\overline{R}^2$	firms
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Hong Kong	--	15	30	0	27	.74	33
Indonesia	54	16	8	1	41	.53	100
Japan	30	7	--	0	26	.69	100
Korea	76	3	6	1	68	.28	100
Malaysia	61	3	13	0	49	.31	98
Philippines	58	3	9	3	42	.31	33
Singapore	47	7	31	2	44	.95	45
Taiwan	41	27	2	12	37	.59	100
Thailand	3	1	5	11	19	.56	100
Australia	9	10	7	8	13	.27	100
New Zealand	10	5	5	0	13	.57	40

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

Table 3
Residual foreign exchange exposure by period

The equation estimated is

$$r_{i,t} = \gamma_0 + \gamma_h r_{h,t} + \gamma_w r_{w,t} + \sum_{j=1}^{4} \beta_{j,US\$} D_j s_{US\$,t} + \sum_{j=1}^{4} \beta_{j,euro} D_j s_{euro,t} + \sum_{j=1}^{4} \beta_{j,¥} D_j s_{¥,t} + \sum_{j=1}^{4} \beta_{j,£} D_j s_{£,t} + v_{i,t} .$$

			Percent of firms rejecting: H_0: β_j=0 at the 5% level			
	Median $\overline{R}^2$	*j=*	*1990-92*	*1993-95*	*1996-98*	*1999-02*
Hong Kong:	0.74	Euro	3	3	0	15
		Yen	27	3	18	6
		Pound	3	12	0	3
Indonesia:	0.52	U.S. Dollar	1	10	59	9
		Euro	10	2	4	7
		Yen	0	3	12	12
		Pound	7	3	4	2
Japan:	0.69	U.S. Dollar	19	54	31	15
		Euro	4	5	17	4
		Pound	5	14	3	0
Korea:	0.29	U.S. Dollar	--	8	70	62
		Euro	--	5	1	7
		Yen	--	4	19	5
		Pound	--	4	2	4
Malaysia:	0.38	U.S. Dollar	--	7	63	10
		Euro	--	1	1	5
		Yen	--	3	2	35
		Pound	--	4	1	2
Philippines:	0.32	U.S. Dollar	12	12	55	12
		Euro	0	9	6	3
		Yen	6	3	3	6
		Pound	3	9	0	0
Singapore:	0.95	U.S. Dollar	2	4	38	13
		Euro	2	2	7	16
		Yen	4	0	24	4
		Pound	4	2	4	13
Taiwan:	0.69	U.S. Dollar	2	15	9	37
		Euro	1	14	12	11
		Yen	0	5	5	3
		Pound	3	31	4	6
Thailand:	0.56	U.S. Dollar	3	6	3	37
		Euro	9	15	1	2
		Yen	4	9	6	7
		Pound	9	2	16	3
Australia:	0.27	U.S. Dollar	7	7	2	7
		Euro	7	5	7	13
		Yen	3	6	12	6
		Pound	18	9	7	4
New Zealand:	0.57	U.S. Dollar	0	8	8	10
		Euro	7	0	3	5
		Yen	0	3	3	8
		Pound	5	0	0	3

Table 4
Foreign exchange exposure and exchange rate arrangements

The equation estimated is

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

			Percent of firms rejecting:						
			H_0:	β_m=0 at the 5% level			H_0: β_m=0	Median	# of
		m =	US$	€	¥	£	$\forall_j$	$\overline{R}^2$	firms
			(1)	(2)	(3)	(4)	(5)	(6)	(7)
Indonesia	Pegged		0	2	54	10	5	.52	100
	Nonpegged		2	0	12	0	42		
Korea	Pegged		11	0	78	3	22	.28	100
	Nonpegged		4	1	4	1	68		
Malaysia	Pegged		56	7	61	2	63	.40	98
	Nonpegged		27	15	11	11	54		
Philippines	Pegged		42	6	63	12	33	.31	33
	Nonpegged		0	6	3	3	64		
Taiwan	Pegged		1	4	30	2	14	.59	100
	Nonpegged		3	4	19	4	34		
Thailand	Pegged		75	21	35	11	81	.57	100
	Nonpegged		10	3	2	5	39		

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
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
Foreign exchange exposure and exchange rate arrangements

This table excludes the Asian crisis period. The equation estimated is

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

			Percent of firms rejecting:						
			H_0:	β_m=0 at the 5% level			H_0: β_m=0	Median	# of
		m =	US$	€	¥	£	$\forall_j$	$\overline{R}^2$	firms
			(1)	(2)	(3)	(4)	(5)	(6)	(7)
Indonesia	Pegged		0	4	55	9	5	.52	100
Korea	Pegged		14	5	78	10	26	.28	100
Malaysia	Pegged		5	2	61	14	11	.38	98
Philippines	Pegged		46	12	64	15	30	.31	33
Taiwan	Pegged		0	6	28	2	15	.59	100
Thailand	Pegged		12	12	5	8	29	.56	100

Notes: Observations are taken weekly from January 1990 to May 1997.
Exchange rates are designated pegged during the following periods:
Indonesia, January 1, 1990 to May 30, 1997
Korea, January 1, 1990 to May 30, 1997
Malaysia, January 1, 1990 to May 30, 1997
Philippines, January 1, 1990 to May 30, 1997
Taiwan, January 1, 1990 to May 30, 1997
Thailand, January 1, 1990 to May 30, 1997

Table 6
Sign of foreign exchange exposure

The equation estimated is

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

			Percent of firms rejecting H_0: β_m=0 at the 5% level							
		m =	US$ (1)	€ (2)	¥ (3)	£ (4)	US$ (1)	€ (2)	¥ (3)	£ (4)
			β Positive				*β Negative*			
Indonesia	Pegged		0	0	54	8	0	2	0	2
	Nonpegged		2	0	0	0	0	0	12	0
Korea	Pegged		11	0	2	2	0	0	76	1
	Nonpegged		4	0	0	1	0	1	4	0
Malaysia	Pegged		13	6	1	1	43	1	60	1
	Nonpegged		0	15	11	0	28	0	0	11
Philippines	Pegged		42	0	0	12	0	6	64	0
	Nonpegged		0	6	3	0	0	0	0	3
Taiwan	Pegged		1	2	0	0	0	2	30	2
	Nonpegged		2	3	0	2	1	1	19	2
Thailand	Pegged		75	1	0	9	0	20	35	2
	Nonpegged		10	0	1	1	0	3	1	4

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
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 7
Total foreign exchange exposure

The equation estimated is

$$r_{i,t} = \gamma_0 + \beta_{US\$} s_{US\$,t} + \beta_{euro} s_{euro,t} + \beta_{¥} s_{¥,t} + \beta_{£} s_{£,t} + u_{i,t}$$

		Percent of firms rejecting:						
		H_0: β_j=0 at the 5% level				H_0: $\beta_j = 0$	Median	# of
	j =	US$	€	¥	£	$\forall_j$	$\overline{R}^2$	firms
		(1)	(2)	(3)	(4)	(5)	(6)	(7)
Hong Kong		--	0	24	0	30	.05	33
Indonesia		54	5	3	0	23	.02	100
Japan		31	28	--	82	66	.01	100
Korea		64	5	15	0	57	.08	100
Malaysia		64	1	36	0	58	.07	98
Philippines		73	3	0	0	46	.03	33
Singapore		76	2	0	0	9	.03	45
Taiwan		1	22	4	3	31	.01	100
Thailand		2	0	2	0	2	.01	100
Australia		22	5	5	5	28	.03	100
New Zealand		26	15	5	3	21	.04	40

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

Appendix 1
Definitions of market indexes, and number of companies

Country	Number of Companies	Local Market Index	DataStream Mnemonic	Average No. Obs per firm
Hong Kong	33	Hang Seng	hngkngi	471
Indonesia	100	Composite	jakcomp	322
Japan	100	Nikkei 225	japdowa	539
Korea	100	Composite	korcomp	457
Malaysia	98	Kuala Lumpur Composite	klpcomp	443
Philippines	33	Manila Composite	mancomp	405
Singapore	45	Singapore Straits	sngpori	467
Taiwan	100	Taiwan Weighted	taiwigh	344
Thailand	100	Bangkok S.E.T.	bngkset	454
Australia	100	Australia All Ordinaries	austall	445
New Zealand	40	SE 40	nz40cap	349
World	1600	Morgan Stanley US dollar World index	mswrld$	--

Note: The average number of observations is the average number of weekly return observations per firm. Weekly returns are calculated from Friday to Friday

Appendix 2
Source for local short-term fixed rates

Country	Series Descriptor	Source
Hong Kong	GHKTB3M Index	Bloomberg
Indonesia	JIIN3M Index	Bloomberg
	SBI 90 Day	DataStream
Japan	JY0003M Index	Bloomberg
Korea	KWCDC Index	Bloomberg
Malaysia	KLIB3M Index	Bloomberg
Philippines	PPTB91D Index	Bloomberg
Singapore	T-Bill 3 Month	Bloomberg
	SIBR3M Index	DataStream
Taiwan	NTRPC Index	Bloomberg
	Money Market 90 Day	DataStream
Thailand	BHSB3M Index	Bloomberg
	Interbank 3 Mth (BB)	DataStream
Australia	ADTN3M Index	Bloomberg
New Zealand	3 Month T-Bill	Bloomberg
	NDTB3M Index	DataStream

Appendix 3
Simulated residual foreign exchange exposure

The equation estimated is

$$r_{i,t} = \gamma_0 + \gamma_h r_{h,t} + \gamma_w r_{w,t} + \beta_{US\$} s_{US\$,t} + \beta_{euro} s_{euro,t} + \beta_{¥} s_{¥,t} + \beta_{£} s_{£,t} + u_{i,t}$$

	Percent of firms rejecting: H_0: β_j=0 at the 5% level				H_0: $\beta_j = 0$	Median	# of
j =	US$	€	¥	£	$\forall_j$	$\overline{R}^2$	firms
	(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
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 percent of statistically significant coefficient estimates.