The Effect of Exchange Rate Fluctuations on Multinationals' Returns

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Abstract: This paper examines if the type of exchange rate used or size of the movement in the exchange rate matters in estimating exchange-rate exposure of U.S. manufacturing firms. We find that switching from a broad trade-weighted exchange rate to a 2-digit SIC industry exchange rate increases slightly the number of significantly exposed firms in a simple Jorion (1990) regression. We also find that firms' stock returns may be affected differently in periods of crisis and non-crisis. Although the value of exposure does not change much with the size of the exchange rate movement, we find some firms have significant exposure only in crisis periods while others have significant exposure only during normal fluctuations in exchange rates. All told, we find about 1 in 5 firms' returns is significantly affected by movement in the exchange rate between 1995 and 1999.

Keywords: exposure, crisis indicators, 2-digit SIC industry exchange rate
JEL codes: F23, F31, G120

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Introduction

Estimating exchange-rate exposure began with the simple Jorion model in 1990 and evolved to more sophisticated time-varying models early this decade (e.g., Allayannis and Ihrig (2001) or Bodnar, Dumas and Marston(2002)). In all of these studies, although the question was how does movement in the exchange rate affect the firm's return, no one stepped back and examined whether the type of exchange rate used in the analysis mattered or if the size of the movement in the exchange rate mattered. Here we look at these issues with industry-specific exchange rates.

One often reads or hears media reports of how exchange rate fluctuations are affecting a firm's operations and, hence, stock returns. This observation is somewhat of a puzzle against the backdrop of the simple Jorion model, which only finds about 10 percent of a sample of firms with significant exchange-rate exposure at the 10% level. Researchers have added many terms to this model – from revenue and cost terms, to pass-through and mark-ups – and find evidence of more exposure that we believe is consistent with real world observations. But, perhaps, one could use the simple Jorion model if the exchange rate was just more closely tied to a firm's activities. That is, the trade weights in the broad dollar that are typically used in estimating exposure are the average across all firms in the United States and do not reflect a single firm's activities. What if we replaced the broad exchange rate with an industry-specific exchange rate that is more consistent with a firm's activities? Would this change in the exchange rate be all that is needed to more accurately estimate firm exposure?

We construct 2-digit SIC manufacturing industry exchange rates for this study. These exchange rates are a weighted sum of bilateral exchange rates (foreign currencies/US dollar), where the country weights are the proportion of total imports and exports the 2-digit SIC manufacturing industry has with each country in the rest of the world. One can imagine that the industry-specific exchange rate captures some firm-specific information that past studies have explicitly modeled. That is, the imports and exports used in the weighting may reflect the firm's costs and revenue, respectively, and by separating each 2-digit SIC industry we are acknowledging different market structures (and hence markups and pass-throughs) across industries. So, perhaps, the industry-specific exchange rates can incorporate characteristics of the firm that other studies explicitly model in their exposure framework.

Fraser and Pantzalis (2004) and Ihrig (2001) both create firm-specific exchange rates by using information about U.S. multinationals' foreign subsidiaries locations in their weighting schemes. That is, the exchange rate index in these studies is a sum of bilateral (U.S. dollar/ foreign currency) exchange rates weighted by the number of subsidiaries of an U.S. multinational (MNE) in a given country relative to its total. They find evidence that these firm-specific exchange rates pick up more significant exposure than a broad exchange rate measure. Although these studies use exchange rates that should be more in line with the firm's activities, some argue that a proper weighting scheme should not give equal weight to all subsidiaries but, should focus on the size of the subsidiaries. We address this concern by utilizing the 2-digit SIC industry exchange rates.

Our analysis uses monthly data between 1995 and 1999 on 901 U.S. manufacturing firms, which includes 548 U.S. MNEs and 353 U.S. domestic firms. We use the JPMorgan Broad exchange rate as our benchmark exchange rate in the analysis, and also consider a 2-digit SIC industry exchange rate. For each U.S. firm in our sample we find the 2-digit SIC manufacturing industry that represents the majority of its sales and link this firm with the appropriate 2-digit SIC exchange rate. To make sure the SIC exchange rate fits the business of the firm, we restrict our sample to firms that have the majority of their total sales in a single 2-digit SIC industry.[1]

We estimate a simple Jorion regression with both the broad exchange rate and the 2-digit SIC industry exchange rate. Whether we focus on the entire sample or just the MNEs, the analysis shows a slight increase in the number of firms with significant exposure when we move to the industry-specific exchange rate. The analysis finds 15 percent of MNEs have significant exposure when we use the industry-specific exchange rate. The number of firms with significant exposure is not as large as what is found in studies that add firm-specific characteristics directly to the model, but is an improvement over a broad dollar measure. Perhaps the 2-digit SIC industry exchange rate may pick up some, but not all, the firm characteristics shown to be significant in estimating exposure; it is, by construction, the average across all firms in an SIC industry.

Next we turn to the issue of whether the size of the movement in the exchange rate matters in the estimate of exposure. There are many reasons why exposure can differ between periods of normal exchange rate fluctuations and crises periods. During an exchange-rate crisis, for example, hedging opportunities might be limited and/or the firm may see a sudden change in revenue and/or costs, all of which affect the value of exposure.[2] We test for the possibility that exposure varies with the evolution

[1]We also considered limiting our sample to firms that had 90% of their sales in one 2-digit SIC industry. This reduced the size of our sample, but did not change the findings. As a result, we present the larger sample - where 51% of a firm's total sales are in one 2-digit SIC.

[2]See Allayannis, Brown and Klapper (2002) for more details of derivatives market illiquidity during the East Asian crisis, and Allayannis and Ihrig (2002) for details of how revenue and costs affect exposure.

of a crisis: there is a 'normal' value of exposure associated with 'normal' movements in the exchange rate, and a different value of exposure during periods of stress in the exchange rate market.[3]

Using crisis dates from the early warning system literature (e.g., Kaminsky, Lizondo, and Reinhart (1998)) we construct 2-digit SIC trade-weighted crisis dummies. Incorporating these crisis dates into the exposure model, using the industry-specific exchange rates, we find that about 12 percent of the firms, either domestic firms or U.S. MNEs, have significant exposure during periods of normal movement in the exchange rate and about 7 percent of the firms have significant exposure during crisis periods. Some firms' returns may have significant exposure in one state, but not both. Overall, about 17 percent of the firms are affected by exchange rate movement in at least one of the two states.

We find that the value of exposure does not differ across states of exchange rate fluctuations.[4] Focusing on the MNEs, the median estimate of exposure is -0.47. Of course, the effect of exchange rate movement on returns is influenced by the size of the exchange rate movement. During normal monthly fluctuations in the exchange rate, where the dollar appreciated an average of 4/10th of a percentage point per month between 1995 and 1999, we find monthly returns fell by 0.2 percentage points due to the appreciation of the dollar. During a crisis, where the dollar appreciated 0.9 percent per month, we estimate monthly returns fell by 0.4 percentage point during a crisis month. Focusing solely on the significantly exposed MNEs, the median estimate of exposure quadruples to -1.86. This

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[3]We also tested for the possibility that there was overshooting during the crisis period, so that exposure bounced back immediately following a crisis (as expectations realigned). We did not find support for this hypothesis.

[4]This finding differs from Kiymaz (2003) who finds Turkish firms' exposure is higher in pre-crisis than post-crisis periods.

indicates that during normal exchange rate fluctuations returns fell, on average, 0.74 percentage points per month, and in a crisis period the average return fell by 1.7 percentage points.

Our findings are consistent with other research that examine how firm activity is affected by crisis episodes. Forbes (2002) documents how firms in 41 countries have their annual performance (measured as firm sales, net income, market capitalization and asset value) negatively affected over the span of exchange rate crises. Allayannis and Weston (2002) document monthly abnormally low returns of U.S. MNEs from the East Asian crisis. Forbes (2001) estimates abnormally low returns of 15 (10) percentage points through the duration of the Asian (Russian) crisis. Each of these studies supports the results found here.

Comparing across crisis and non-crisis periods, there are some firms that have significant exposure in crisis periods that do not have significant exposure in non-crisis months, suggesting that these firms might be able to hedge small movement in exchange rates, but can not insulate their cashflow from crisis episodes. This result is consistent with Chow, Lee and Solt (1997) who argue changes in the exchange rate affect short-term and long-term cashflows, but current exchange-rate changes can be hedged or the cashflow effects are offset by interest-rate effects. Since the firms that have significant exposure only in crises, which are periods hedges may not be available, Chow's comments hold. However, we also find many firms have significant exposure during periods of normal movement in the exchange rate and not in crisis months. This contradicts Chow et al.'s hypothesis. Perhaps these firms do not hedge for cost/benefit reasons, and during periods of large fluctuations in foreign currency they expend the energy to operationally hedge. For example, Schering-Plough in its 1995 annual report (page 25) argues in support of exclusive use of operational hedges: "To date, management has not deemed it cost-effective to engage in a formula-based program of hedging the profitability of these operations using derivative financial instruments. Some of the reasons for this conclusion are: The Company operates in a large number of foreign countries; the currencies of these countries generally do not move in the same direction at the same time".

We perform sensitivity analysis on the results using alternative crises indicators, and adding Fama-French (1993) benchmark factors to the model. These tests do not significantly change our results: (1) switching to a 2-digit SIC industry exchange rate we find slightly more significant exposure than what is found with a broad measure; perhaps this industry exchange rate is picking up part of the firm's activities that have been shown in past studies to be significant in explaining exposure, and (2) the size of exchange rate movement does seem to matter for firms.

The remainder of this paper is organized as follows. Section 1 describes the model. Section 2 overviews the data, while section 3 presents the exposure estimates. Section 4 concludes the paper.

I. Model

We estimate a modified Jorion (1990) model. For each MNE, exchange-rate exposure is estimated by regressing the MNE's return on the market return and exchange rate movement, accounting for periods of exchange rate crises. Specifically,

$$R_t^i = a_0^i + a_1^i R_t^m + b_1^i \Delta e_t + b_2^i I_t \Delta e_t + e_t^i \qquad (1)$$

where R^i is firm i's return at date t, R^m is the market return, Δe is the change in the exchange rate and, I is the crisis indicator that is nonzero in a month where there is a crisis.

The structural adjustment to the Jorion model is the inclusion of the I term. In Jorion's framework exposure is β^i_1. In our framework exposure is $\beta^i_1 + \beta^i_2 * I^i_t$. Exposure varies though time as I fluctuates between zero and one. Compared to other recent estimates of exposure, such as in Allayannis and Ihrig (2001) and Bodnar et al. (2002), we are implicitly embedding the effects of trade shares, markups and pass-through in our β's. As shown in this past work, one can find more firms with significant exposure by accounting for these features of the data, so we keep in mind that our results may be a lower bound for the actual number of firms' returns significantly affected by exposure when accounting for the effect of a crisis.

II. Data

In our analysis we estimate monthly time-varying exchange rate exposure for 901 U.S. manufacturing firms in exchange rate crisis and non-crisis months between 1995 and 1999. First we discuss the specifics of the data sources and how we constructed key variables for the analysis. Then we provide some summary statistics.

II.A Data construction and sources

The data for this project mixes the standard return variables with new exchange rate data. The exchange rate data is unique in two respects. First, we use an exchange rate measures more specific to the firms by utilizing monthly 2-digit SIC trade data. Second, we introduce an exchange rate crisis variable in the model to allow for crisis periods to differ from non-crisis months.

The sample contains monthly data on 901 firms, of which 548 are U.S. MNEs and the remaining are U.S. domestic firms. We look at both the entire sample of firms and also break out the MNEs for separate analysis. Exposure is estimated over the 5-year interval 1995-1999, so that there are 54060 firm-year observations in the entire sample. This time period is chosen because it incorporates a period with many crises. Over this period Brazil, Colombia, Indonesia, South Korea, Malaysia, the Philippines, Singapore, South Africa, Spain, Thailand, and Venezuela were flagged by the early warning system indicators as having a crisis.[5]

Returns: Monthly manufacturing firm returns are retrieved from the University of Chicago Center for Research in Security Prices (CRSP) database. Dividends are included in the prices used to calculate firm returns. The CRSP monthly value-weighted market index is used as the market portfolio.

SIC classification: CRSP firm data is matched with a SIC industry using SIC and sales data from Compustat's North American database. A firm is classified as belonging to a given SIC if at least 50 % of its revenues comes from that industry. Our sample contains firms in SIC industries 20-39.

Exchange rate: As a reference exchange rate, we consider the JPMorgan Broad exchange rate index. This "broad" type of exchange rate is consistent with what is used in most other studies of exposure

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[5]This list is based on the Kaminsky, Lizondo, and Reinhart (1998) measure of an exchange-rate crisis. Other countries may have been flagged as crisis countries, but were excluded from the sample because of their low trade weight.

(e.g. Jorion, Allayannis and Ihrig, Bodnar, Dumas and Marston). For this analysis, however, we focus on 2-digit SIC industry exchange rates. Using the trade shares from Goldberg (2004), the monthly 2-digit SIC industry exchange rate for industry i is defined as:

$$e_i = \sum_{j=1}^{N} w_{i,j} ER_j$$

where N is the total number of countries that this industry trades with, $w_{i,j}$ is the percent of trade between the U.S. and country j in industry i, and ER_j is the bilateral exchange rate between the U.S. dollar and the currency of country j. All firms within a given 2-digit classification will have the same exchange rate.[6] Although this exchange rate measure is not firm specific, it does more accurately reflect the currencies that are important to the firm's industry than the broad dollar measure. Across all firms in our sample, the correlation between movement in the 2-digit exchange rate series and the JPMorgan Broad is 0.73. The correlation varied from 0.37 for SIC 29 (petroleum and coal products) to 0.98 for SIC 38 (instruments).

Crisis indicators: Associated with the early warning system literature, various measure of exchange rate crisis dating have emerged. Our primary measure is Kaminsky, Lizondo, and Reinhart (KLR) (1998), however, we also do sensitivity analysis with Frankel and Rose (1996) and Kamin, Schindler and Samuel (2001). Each of the three studies creates monthly country indicators that take on values of

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[6]So there is a trade-off between this exchange rate and the one used by Ihrig (2001) and Faser and Pantzalis (2004). This exchange rate tries to capture the flavor of the flow of funds (associated with revenue and costs),but it is not a firm-specific exchange rate.

zero or one.[7] A zero means that there is no exchange-rate crisis in the country at that date. A one indicates that, based on the authors' criteria, there was above normal exchange rate pressure (i.e., a crisis). Edison (2000) provides a good overview of the research on the early warning systems and, extends the indicators in the earlier studies through the 1990s.

We take the KLR country crisis indicators and create our 2-digit SIC industry's trade-weighted crisis dummy variable as follows:

$$I_i = \sum_{j=1}^{N} w_{i,j} CRISIS_j$$

where N is the total number of countries that this industry trades with, $w_{i,j}$ is the percent of trade between the U.S. and country j in industry i, and $CRISIS_j$ is the crisis indicator (KLR) of country j. I can take on a value between zero and one. If none (all) of the countries where this 2-digit SIC industry has trade flows had a crisis, then I is zero (one).

Since all of our 2-digit SIC industry crises measures are created from the same set of N countries, and no trade-weights are zero, all firms experience the same set of crises. Over our five-year sample period, all industries encountered 51 months without crises, and 9 months with crises. Of course, the value of I depends on the percent of trade in the crises countries. Across all industries and all months, the average value of I is 0.0024 (which reflects the fact that 51 months of our sample see I take on a value of zero). During crises months, the average value of the crises indicator is 0.016,

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[7]The three indicators differ in the variables they use to identify periods of greater than normal exchange-rate pressure. Kaminsky et al. define a crisis by large movement in the nominal exchange rate and/or international reserves.

indicating that about 1.6 percent of trade, on average, is with crises countries. Looking across industries in crises months, I ranges from an average value of 0.009 in industry 37 (transportation equipment) to 0.037 in industry 29 (petroleum and coal products).

II.B. Glance at the data

The exchange rates and crisis dummies we construct use the 2-digit SIC industry trade weights. In an attempt to reveal how these variables are affected by the trade shares, consider SIC 26 - paper and allied products. This industry has 26 firms in our sample, of which we find 7 have significant exposure.

Figure 1 plots the crisis measure, I, for SIC 26 over our sample period. This provides an illustration of how often and how much of the paper industry's operations are located in crisis countries. Recall that the crisis dummy, I, takes on a value between zero (no trade in countries with a crisis) and one (all trade is with countries that are having crises). There are 9 months that the indicator flags as the industry having trade with countries in crisis. In the crisis months, on average, 1.3 percent of trade is associated with crisis countries. The first crisis month is 1995:3, when the central bank of Spain devalued the peseta by 7 percent. The value of I is 0.01, representing Spain's trade share of 1 percent. The larger spikes in 1997:11, 1997:12 and 1999:1 are associated with crises in South Korea (2.5 percent of trade is with South Korea), the East Asian countries of Indonesia (0.7 percent), Phillippines (0.4 percent) and Singapore (0.5 percent), and Brazil (2.4 percent), respectively.

Figure 2 plots the JPMorgan's Broad exchange rate, the series typically used in exposure analysis, and the exchange rate for SIC 26. These two series have a correlation of 0.73. Beginning with the 1995:3 crisis, you can see the SIC 26 exchange rate shows a dollar appreciation (reflecting the depreciation of the peseta), but the Broad dollar actually depreciates, reflecting appreciations of other foreign currencies that the broad dollar puts more weight on than SIC 26. Moving to 1997, you can see the JPMorgan Broad and SIC 26's exchange rates move in parallel, both picking up the crisis at the same time and with about the same magnitude. In 1999, SIC 26 picks up the Brazilian crisis slightly earlier and slightly larger in magnitude than the JPMorgan Broad dollar. So we can see differences in the exchange rate measures resulting from differences in the amount of trade with foreign countries.

Table 1 provides summary statistics of all the variables we use in the analysis. Column 1 reports the average value over the entire sample, column 2 reports the means for crisis periods (I>0) and column 3 reports the average value in non-crisis months (I=0). Starting with the returns, we see that returns are actually higher in exchange-rate crises months than non-crises months. Of course, there are many variables affecting returns (including interest rates, which respond to currency crises and affect the rate of return) so what is really important to us is the difference between the firm's return and the market return. As seen in the third row, R^i-R^m, the difference between the MNE's return and the market return increases during crises months from -0.1 percentage point in non-crises months to -0.6 percentage point in crisis months. The next two rows highlight that the average U.S. dollar appreciation over the whole sample (across all 2-digit SIC industry exchange rates) is 0.2 percent per month using the broad dollar and 0.4 percent per month with the 2-digit SIC industry exchange rate. During crisis months the dollar appreciates more than non crisis months, with an average appreciation of 0.3 percent for the broad dollar and 0.9 percent for the industry-specific exchange rate. Last, the average value of the crisis dummy is quite small, at 0.003 over the entire sample.

We now turn to the estimated model.

III. Exposure Estimates

To begin, we run the standard Jorion (1990) regression using the JPMorgan broad exchange rate and the appropriate 2-digit SIC industry-specific exchange rate for each of the 901 manufacturing firms over 1995:1-1999:12. Recall that past studies using this simple Jorion model with a broad exchange rate do not suggest as much exposure as one would expect from media reports and recent studies that have incorporated firm-specific characteristics. A summary of the exposure estimates is presented in Table 2. Columns 1 and 2 report the results using the JPMorgan Broad exchange rate on the entire sample and solely the MNEs, respectively. Focusing on the entire sample, we find the standard result that about 12 percent of firms' returns are affected by exchange rate movement. The median exposure is -0.24, which translates to a one percent appreciation of the dollar causes monthly returns to fall, on average, by 0.02 percentage points. For the MNEs in the sample, we find a slightly higher percentage of firms with significant exposure and the median exposure is slightly higher as well.

Columns 3 and 4 of Table 2 report the results of the Jorion regression with the 2-digit SIC industry exchange rates. We find 13 percent of the total sample has significant exposure and 15 percent of MNEs' returns are significantly affected by exchange rate movement. Moving from the broad dollar to the industry-specific exchange rate, therefore, we find slightly more firms with significant exposure. Recall that moving to the 2-digit SIC exchange rates we hoped that we were embedding significant firm characteristics into the exchange rate. That is, we hoped that previous studies that focused on U.S. MNEs' foreign revenue and costs, and studies that examined industry structure (through markups and pass-through) were being indirectly incorporated in the industry-specific exchange rate. Comparing the results of the Jorion model with the industry-specific exchange rates to the more sophisticated models that embed firm characteristics directly, we do not find the number of significant firms similar in magnitude to these more sophisticated models of exposure (e.g. Allayannis and Ihrig find approximately 20 percent of the MNEs in their industry groups have significant exposure). The 2-digit SIC industry exchange rates, therefore, do not seem to fully proxy for the firm-specific characteristics embedded in the more sophisticated models.

Fraser and Pantzalis (2004) estimate the Jorion model with a lagged exchange rate term and find their firm-specific exchange rate does slightly better in terms of number of firms with significant exposure than the broad exchange rate in this framework. We estimate this modified-Jorion model (see row 7 in Table 2) and find approximately 20 percent of firms, either domestic or MNEs, have significant exposure, but now the broad dollar finds as many, if not more, significantly exposed firms as the industry exchange rate. Since the lagged term is not standard in the exposure literature, we focus the remainder of the analysis on the model with contemporaneous terms.

We turn to estimating exposure in our model that accounts for exchange-rate crises, equation (1). Exposure is calculated as $\beta^i_1 + \beta^i_2 * I^i_t$. Table 3 reports summary statistics on the values of β_1 in column (1) and β_2 in column (2) for all firms in the sample using the JPMorgan broad dollar. As shown, 110 firms have significant exposure under normal fluctuations in the exchange rate, and 61 firms have significant exposure during crisis months. Some firms' returns, 17 to be exact, are affected by any sized movement in the exchange rate, so that a total of 154 firms' returns are affected by exchange rate fluctuations. This represents 17 percent of the sample.

Firms with significant exposure during a crisis, but not in normal months, could be using exchange rate hedges in normal states but that these hedging opportunities are not available during crises. For those firms that see their returns affected by small exchange rate movements but not during crises, perhaps they are not hedging for cost/benefit reasons, but take the time to operationally hedge large fluctuations in the U.S. dollar.

Turning to the estimated value of exposure, column 3 reports summary statistics. The minimum value is about -9, saying one firm has it's stock return fall, on average, by 0.09 percentage points when the dollar appreciates by one percent. The maximum value of exposure is 6.7, saying one firm has its stock return increase 0.07 percentage points, on average, when the dollar appreciates one percent. Typically one thinks of a negative value of expsoure as suggesting that the revenue term dominates the value of exposure, while a positive estimate of exposure suggests costs are move highly influenced by exchange rate movement. The median exposure is near -0.4, similar to what is found in the Jorion regression.

Note that the movement in the exchange rate is much larger in a crisis than a non-crisis period, so the effect of the exchange rate on returns is much more prominent during a crisis. That is, on average, the dollar appreciates 9 percent per month during the crisis months of our sample, so there is one firm that, on average, saw its return fall by 0.8 percentage points, and another firm whose return rose by 1.3 percentage points during a crisis month.

Turning to the MNEs in our sample, Table 4, we again find some firms that are only significantly exposed to normal fluctuations in the exchange rate, others that are only exposed to large movements in the exchange rate, and others that are affected by any sized movement in the exchange rate. Eighteen percent of the firms' returns are significantly affected by exchange-rate fluctuations, and the minimum and maximum are in line with the full sample. Overall, the MNEs have a higher median value of exposure than the domestic firms in the sample. The median exposure estimate is near -.5, suggesting a one percent appreciation of the dollar causes monthly returns to fall, on average, by 0.05 percentage points. Focusing only on those MNEs that are significantly exposed, the median exposure is much larger, at -1.9.

Figure 3 highlights a significantly exposed firm in our sample: Kimberly-Clark Corporation (KMB) in SIC 26 (exchange rate and crisis dummy variables highlighted in Figures 1 and 2). The figure plots R^i -R^m for KMB. You can see that in 6 of the 9 months identified as a crisis month (when I is nonzero), R^i -R^m is negative. Specifically, looking at 1995:3, when the peseta devalued, the spread between KMB and the market return widened. This was also the case through the East Asian crisis in 1997 and the Brazilian crisis in 1999:1. On average, in crisis periods the spread is -1.2 percentage points.

Looking across SICs, we find each of the 20 SIC industries have at least one firm with significant exposure. Figure 4 shows the distribution of firms across industries, both total number of firms in the industry and the number of significantly exposed firms. As seen, SICs 21 (tobacco manufactures), 22 (textile mill products), 26 (paper and allied products), and 33 (primary metal industries) all have more than a quarter of their firms with significant exposure. This is in stark contrast with SIC 28 (chemicals and allied products), where only 9 (7%) firms with significant exposure out of a total of 122.

Last we test the sensitivity of our results to different crisis indicators and to Fama-French (1993) benchmark control factors. Although not shown here, each sensitivity analysis suggests the results are robust.

IV. Conclusion

This paper takes the standard Jorion (1990) model for estimating exposure and adapted it to incorporate two specific exchange-rate issues. First we introduced a 2-digit SIC industry-specific exchange rate in the analysis. Second, we adjusted the model to allow exposure to differ between periods of normal exchange rate fluctuations and crises.

Estimation results show that there is a slight increase in the number of firms with significant exposure when we move to the industry-specific exchange rate. Although the 2-digit SIC industry exchange rates incorporate firm characteristics that have been shown to significantly affect exchange-rate exposure, the results suggest that one may need to delve into more detailed exchange rates or more specifics about firm's activities in order to get an estimate of exposure that is more consistent with the sophisticated models. Besides looking at firms' activities, our analysis suggests that controlling for the size of the movement in the exchange rate matters. Our analysis shows that firms may only be significantly exposed during crises periods or normal movement in the exchange rate. Overall, we find that nearly 1 in 5 U.S. manufacturing firms had significant exchange rate exposure between 1995 and 1999. On average, exposure is estimated to be near -0.4 across all firms in our sample, and -0.5 for MNEs.

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Table 1 - Summary Statistics

	All months (1)	Crisis months (2)	Non-crisis months (3)
R^m	2.1	3.3	1.9
R^i	1.9	2.7	1.8
R^i-R^m	-0.14	-0.6	-0.06
Δe = JPMorgan	0.2	0.3	0.2
Δe = 2-digit SIC	0.4	0.9	0.4
I	0.003	0.018	0
Observations	54060	8109	45951

Table 2 - Exposure Estimates using Standard Jorion model, 1995:1-1999:12

$$R_t^i = a_0^i + a_1^i R_t^m + b^i \Delta e_t + e_t^i$$

	JPMorgan Broad		2-digit SIC exchange rate	
	ALL (1)	MNEs (2)	ALL (3)	MNEs (4)
Minimum	-8.79	-8.79	-8.64	-6.54
First Quartile	-1.13	-1.28	-1.34	-1.34
Median	-0.24	-0.37	-0.44	-0.50
Third Quartile	0.48	0.33	0.33	0.23
Maximum	11.00	11.00	5.91	3.51
# Significant @ 10%	111	78	117	84
With Δe_{t-1} *	182	122	168	113
# Firms	901	548	901	548

Note: values reported in the table are the estimates of exposure from the standard Jorion model, β
* Estimating $R_t^i = a_0^i + a_1^i R_t^m + b_1^i \Delta e_t + b_2^i \Delta e_{t-1} + e_t^i$ as in Fraser and Pantzalis (2004), where exposure is significant if either β_1 or β_2 is significantly different from zero.

Table 3 - Estimating Exposure with a Crisis Dummy, 1995:1-1999:12, Entire Sample

$R_t^i = a_0^i + a_1^i R_t^m + b_1^i \Delta e_t + b_2^i I_t \Delta e_t + e_t^i$

	All firms			Significantly Exposed Firms		
	β^i_1 (1)	β^i_2 (2)	$\beta^i_1 + \beta^i_2 * I^i_t$ (3)	β^i_1 (4)	β^i_2 (5)	$\beta^i_1 + \beta^i_2 * I^i_t$ (6)
Minimum	-9.51	-602.16	-9.36	-9.51	-533.30	-9.36
First Quartile	-1.34	-51.53	-1.32	-2.70	-70.68	-2.60
Median	-0.39	-9.14	-0.39	-1.77	13.47	-1.59
Third Quartile	0.42	26.06	0.38	0.30	63.08	0.24
Maximum	7.20	646.78	6.73	7.20	646.78	6.73
# Significant @ 10%	110	61	154	110	61	154
# Firms	901	901	901	154	154	154

Note: Exposure is $\beta^i_1 + \beta^i_2 * I^i_t$ and estimated using equation (1).

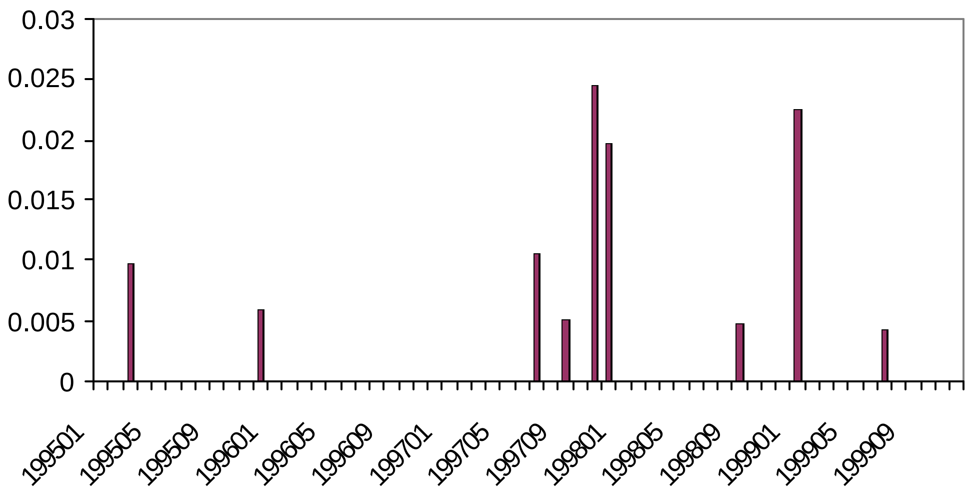
Table 4 - Estimating Exposure with a Crisis Dummy, 1995:1-1999:12, Multinationals

$$R_t^i = a_0^i + a_1^i R_t^m + b_1^i \Delta e_t + b_2^i I_t \Delta e_t + e_t^i$$

	All Multinational			Significantly Exposed MNEs		
	β^i_1 (1)	β^i_2 (2)	$\beta^i_1 + \beta^i_2 * I^i_t$ (3)	β^i_1 (4)	β^i_2 (5)	$\beta^i_1 + \beta^i_2 * I^i_t$ (6)
Minimum	-6.05	-602.16	-6.22	-6.05	-429.53	-6.22
First Quartile	-1.38	-44.04	-1.35	-2.68	-48.01	-2.60
Median	-0.48	-7.16	-0.47	-1.89	13.50	-1.86
Third Quartile	0.30	28.58	0.23	-0.16	60.61	-0.46
Maximum	6.79	511.44	5.43	5.61	511.44	4.89
# Significant @ 10%	71	36	97	71	36	97
# MNEs	548	548	548	97	97	97

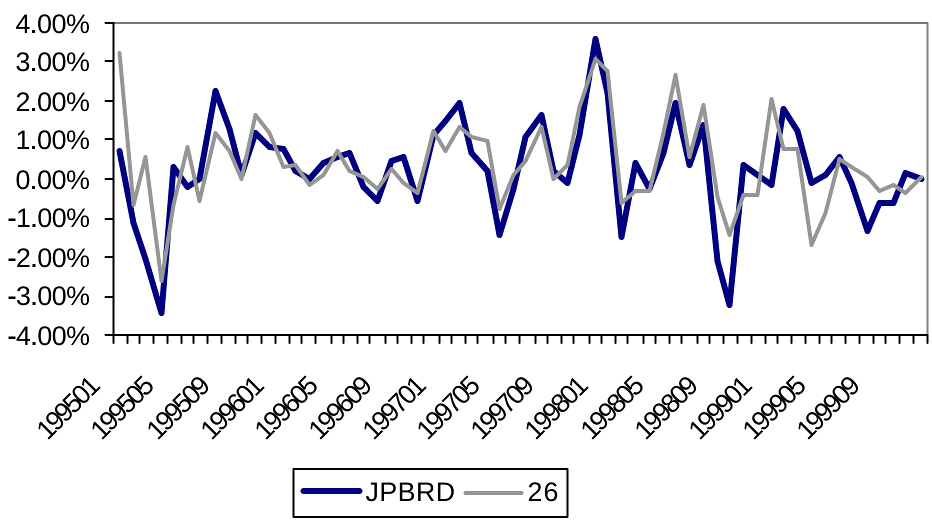
Note: Exposure is $\beta^i_1 + \beta^i_2 * I^i_t$ and estimated using equation (1).

Figure 1 - Crisis Dummy for SIC 26 (Paper and allied products)



Note: I∈[0,1], 0 indicates no trade with crises countries.

Figure 2 - Movement in the Broad dollar versus SIC 26 exchange rate



Notes: Positive numbers represent U.S. dollar appreciations.
Correlation between series is 0.73

Figure 3 - Significantly Exposed firm in SIC 26

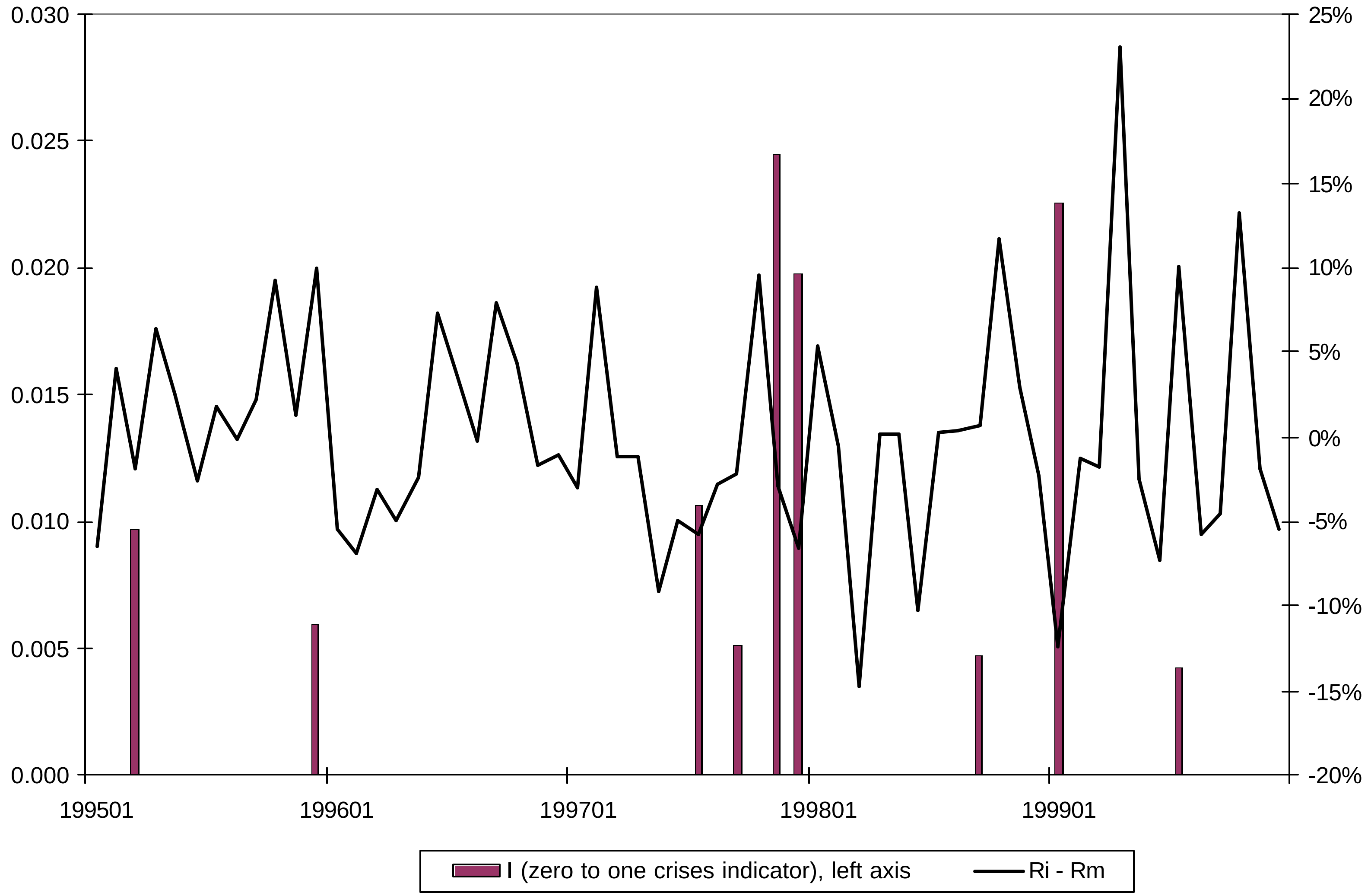


Figure 4 - Distribution of all firms across industries