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Abstract

We examine whether firms use foreign currency derivatives for hedging or for speculative purposes. Using a sample of S&P 500 nonfinancial firms for 1993, we find evidence that firms use currency derivatives for hedging, as their use, significantly reduces the exchange-rate exposure firms face. We also find that, while the decision to use derivatives depends on exposure factors (i.e., foreign sales and foreign trade) and on variables largely associated with theories of optimal hedging (i.e., size and R&D expenditures), the level of derivatives used depends only on a firm's exposure through foreign sales and trade.

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1. Introduction

Exchange-rate movements affect expected future cash flows, and therefore the value, of large multinationals, small exporters (importers) and import competitors, by changing the home currency value of foreign revenues (costs) and the terms of competition. In light of this, it is surprising that previous research in the area [Jorion (1990), Amihud (1993) and Bodnar and Gentry (1993)] finds that U.S. multinationals, exporters, and manufacturing industries are not significantly affected by exchange-rate movements.

One possible explanation is the fact that corporations make extensive use of foreign currency derivatives and other hedging instruments (e.g., foreign debt) to protect themselves from unexpected movements of exchange rates.[1] To the extent that U.S. multinationals, exporters, and importers fully cover their exposure to exchange-rate movements, we should not expect to find any effect of exchange-rate movements on firms' values. However, derivatives can also be used for speculative purposes, as alleged in the much publicized stories of Procter & Gamble and Metallgesellschaft. This creates a genuine concern for investors and regulators as to what role derivatives play in a corporation.

In this paper, we examine whether firms use foreign currency derivatives for hedging or for speculative purposes. In particular, to identify a firm's hedging or speculative behavior in the data, we examine a) the effect of foreign currency derivative use on its exchange-rate exposure and b) the determinants of the amount of derivative use. We measure exchange-rate exposure as the sensitivity of the value of the firm, proxied by the firm's stock return, to an unanticipated change in an exchange rate, as defined in Adler and Dumas (1984). We test the hypothesis that using foreign currency derivatives for hedging reduces a firm's foreign exchange-rate exposure, and that the degree to which firms use derivatives is related to its

[1]There are several theories that suggest why it may be optimal for a firm to hedge [e.g., Stulz (1984), Smith and Stulz (1985), Froot et al. (1993) and DeMarzo and Duffie (1995)].

exposure through foreign sales and foreign trade.

Many papers examine which theory of optimal hedging is consistent with the use of derivatives that we observe in the data.[2] However, there is no direct evidence that derivatives are actually used to hedge. Hentschel and Kothari (1997) and Simkins and Laux (1997) examine directly firms' use of currency derivatives, but the former does not find any evidence and the latter finds only weak evidence that their use influences exposure. However, given that a firm's exchange-rate exposure is determined by both its real operations (i.e., foreign sales) and its financial hedging activities, we estimate a multivariate regression that links a firm's exposure to both those factors. This contrasts with Hentschel and Kothari, who rely only on univariate tests. We also use a continuous variable for hedging, instead of the dummy variable used by Simkins and Laux. When the dummy is used by itself, it appears to be negatively related to a firm's exposure. However, when the authors use their measure of hedging and foreign sales in the same model, the effect of the hedging dummy is no longer significant and its sign (positive) is inconsistent with the hypothesis that firms use derivatives to hedge.

Using a sample of S&P 500 nonfinancial firms for 1993, we find that a firm's exchange-rate exposure is positively related to its ratio of foreign sales to total sales, and negatively related to its ratio of foreign currency derivatives to total assets.[3] These associations are significant

[2]See, e.g., Nance et al. (1993), Dolde (1993), Francis and Stephan (1990), Mian (1996) for all types of derivatives; Tufano (1996) and Haushalter (1998) for commodity derivatives; and Geczy et al. (1997) for foreign currency derivatives.

[3]Clearly, the effect of exchange rates on share prices should be proportional to *net* revenues denominated in foreign currency -that is, foreign currency denominated revenues minus foreign currency denominated expenses- not, gross revenues. Firms, however, are only required to report foreign revenues (and only if foreign revenues are above 10% of total revenues) and provide no useful information about foreign expenses. Nevertheless, the use of the ratio of foreign sales to total sales should be a good proxy of the *percentage* of net foreign revenues (out of total revenues), if foreign profit margins are similar to domestic margins. In that case, the ratio of foreign sales to total sales is proportional to the ratio of foreign net revenues to total net revenues. Also, the use of gross derivative positions, instead of net positions that we have to use in our tests due to data limitations in the derivatives reporting in the annual reports may introduce noise to our test; however, there is some evidence that firms first net positions in the same currency before aggregating

at the 1% level and robust to alternative time periods, exchange-rate indices, and estimation techniques. We also find this result robust to the use of an alternative sample, which includes all U.S. manufacturing firms with assets above 100 million during 1994 and 1995. Finally, we obtain similar results using individual exchange rates (e.g., the U.S. dollar/Japanese Yen and the U.S./Canadian dollar exchange rate), instead of an exchange-rate index. Our evidence supports the hypothesis that firms use foreign currency derivatives, not to speculate in the foreign exchange markets, but as protection against exchange-rate movements. It also provides an explanation for the lack of significant exchange-rate exposure that has been documented in past studies. In addition, our results confirm and extend those of Jorion (1990), who uses a sample of major U.S. multinationals to show that a firm's exchange-rate exposure is positively related to its ratio of foreign sales to total sales.

We use a two-stage framework (Cragg, 1971), to examine what determines corporations' level of derivative use. This two-stage process allows us to examine separately a firm's decision to hedge from its decision of how much to hedge. Similar to Geczy et al. (1997), we find that firms with larger size, R&D expenditures, and exposure to exchange rates through foreign sales or foreign trade are more likely to use currency derivatives. These results are consistent with the Froot et al. (1993) theory of optimal hedging, and also high fixed start-up costs of hedging explanations. While these tests reveal the factors that prompt corporations to hedge, they do not answer the question of what determines the extent of hedging. Using –in the second stage of the estimation– the notional amount of currency derivatives for those firms that chose to hedge, we find that exposure factors (foreign sales and foreign

them. In other words, a long yen and a short yen forward position will first be netted out. Note also that our hypothesis predicts a relationship between the absolute value of derivatives and the absolute value of exposure; that is, a higher level of derivatives should be associated with a lower level of exposure in absolute value, if derivatives are used for hedging. Therefore, the lack of a sign in the derivatives data due to reporting limitations should not introduce any specific systematic bias. Also, to the degree that there are other sources of exposure, direct or indirect that are omitted in the regression, this would cause bias towards insignificance. Therefore, our finding that hedging is associated with lower exposure is despite the fact that hedgers had initially larger exposures than nonhedgers–exposures that may not exactly be captured through our proxies.

trade) are the sole determinants of the degree of hedging. In other words, given that a firm decides to hedge, the decision of how much to hedge is affected solely by its exposure to foreign currency movements through foreign sales and trade. This result provides additional support to our hypothesis that firms use currency derivatives for hedging purposes.

Finally, foreign debt can be another way to hedge foreign currency exposure. As in the case of foreign currency derivatives, we examine separately a firm's decision to issue foreign debt and its decision of how much foreign debt to issue. Again, we find that exposure through foreign sales is positively and significantly related to a firm's decision to issue foreign debt and to the level of foreign debt. Overall, these findings are consistent with our hypothesis that firms use foreign debt to hedge their exchange-rate exposure.

The paper is organized as follows: Section 2 describes our sample; section 3 presents the tests of the relation between exchange-rate exposure and foreign currency derivatives; section 4 presents the tests on the use and amount of foreign currency derivatives; and section 5 concludes.

2. Sample description

SFAS 105 requires firms to report information on financial instruments with off-balance sheet risk (e.g., futures, forwards, options, and swaps) for fiscal years ending after June 15, 1990. In particular, firms must report the face, contract, or notional amount of the financial instrument, and information on the credit and market risk of those instruments, the cash requirements, and the related accounting policy. With the exception of futures contracts, disclosure was very limited for other off-balance sheet risk financial instruments prior to SFAS 105.

We obtain data on year-end notional value of forward contracts reported in the footnotes

of the annual reports of all the S&P 500 nonfinancial firms in 1993. We exclude S&P 500 financial firms, because most of them are also market-makers in foreign currency derivatives; hence, their motivation for using derivatives could be very different from that of the nonfinancial firms. Our sample's notional values of foreign currency derivatives also include foreign currency options, if a firm disclosed a combined number. However, these values do not include foreign currency swaps. Currency swaps are mainly used by corporations in conjunction with foreign debt, effectively translating foreign debt into domestic liability. In the Bodnar et al. (1995) report of a survey on the use of derivatives of a large sample of U.S. nonfinancial corporations, the instrument used by 48% of the firms in the sample to manage exchange-rate risk was forwards.

Using the dollar notional value of foreign currency derivatives has several advantages over using a binary variable to indicate whether or not a firm uses foreign currency derivatives. For example, by using this continuous variable, we can test hypotheses on the determinants of the amount of hedging and examine the impact of a firm's currency derivative use on its exchange-rate exposure. However, a disadvantage of this measure is that since firms were not required to disclose the direction of the hedge during the period of our tests, we do not know whether the amounts of foreign currency derivatives represent a short or a long position in the underlying currency. This drawback in the data should not introduce any specific systematic bias though, as our hypothesis relates the absolute value of derivatives used with the absolute value of exposure. Also, with the exception of a handful of firms, firms do not break down derivatives amounts by individual currency. However, they seem to first net positions in individual currencies before aggregating them. Despite the possible measurement error introduced by such aggregation, our continuous variable nevertheless provides valuable insights.

Table 1 presents summary statistics of our main variables. Our total sample consists

of 378 firms with a mean value of sales of $7345 million. Approximately 42.6% of the 378 firms in our sample that have complete foreign currency derivatives data use foreign currency derivatives. In all of our tests we use the ratio of foreign currency derivatives to total assets. However, we obtain similar results when we use the ratio of foreign currency derivatives to foreign sales as our independent variable.

For all the firms in our sample, we also obtained data from the DISCLOSURE database on year-end foreign revenues (sales) from operations abroad. FASB 14 requires firms to report geographical segment information for fiscal years ending after December 15, 1977. Firms must report information on segments with sales, assets, or profits above 10% of total. Approximately 59% of the firms in our sample report revenues from foreign operations. These revenues represent 19.8% of their total sales. On average, a firm covers 14.5% of its foreign sales with foreign currency derivatives. Where foreign revenues are missing, we assume that they are zero. However, we also check the robustness of our results by assuming them to be missing. This assumption does not materially affect our results.

3. Exchange-rate exposure and currency derivatives

In this section, we examine the impact of the use of derivatives on exchange-rate exposure. Our hypothesis is that if firms use foreign currency derivatives to protect themselves from exchange-rate movements (i.e., as a hedge), then we should expect that derivatives will reduce exchange-rate exposure. We first present our methodology, and then our tests and results.

3.1 Estimation framework

Dumas (1978), Adler and Dumas (1984), and Hodder (1982) define economic exposure to exchange-rate movement as the regression coefficient of the value of the firm on the exchange rate across states of nature. However, the definition does not imply that exchange-rate fluctuations cause changes in firms' values. Indeed, in Adler and Dumas, stock prices and exchange rates are both endogenous variables and determined simultaneously. However, for an individual firm, we can safely assume that exchange rates are exogenous.

In line with the definition above, previous research in this area[4] uses the following model to estimate a firm's exchange-rate exposure:

$$R_{it} = \beta_{0i} + \beta_{1i} R_{mt} + \beta_{2i} FXI_t + \epsilon_{it},\ t = 1, ...T \tag{1}$$

where

R_{it} is the rate of return on the ith firm's common stock in period t

R_{mt} is the rate of return on the market portfolio in period t

FXI_t is the rate of return on a moving, trade-weighted exchange rate index, measured in U.S. dollars per unit of foreign currencies in period t[5]

In Equation (1), β_{2i} represents the exchange-rate exposure. Similar to a market beta, the exchange-rate exposure measures the percentage change in the rate of return on a firm's common stock against a 1% change in the exchange rate. Because we are interested in examining the relation between exchange-rate exposure and currency derivative use, we use

[4]See, e.g., Jorion (1990), Amihud (1993), and Allayannis (1996).

[5]This specification assumes that exchange rates and stock returns follow a random walk process, hence the rate of return captures the unanticipated movements. In this framework, there is little difference between nominal and real exposure, since the largest percentage of variation comes from exchange rates, rather than inflation. Similarly, there is little difference in using excess returns (returns over the risk-free rate), since the variation in interest rates is also relatively small compared to the variation in exchange rates.

J.P Morgan's "narrow," trade-weighted, nominal exchange-rate index, which measures the strength of the dollar relative to a basket of 18 other OECD currencies.[6] We choose this index because firms are more likely to use derivatives in those currencies and derivatives are generally hedges against nominal exposure. However, we also examine the sensitivity of our results by using a real, much broader index (RX-101) published by the Federal Reserve Bank of Dallas, which measures the strength of the dollar against 101 of the U.S.'s trading partners. Finally, to control for the market movements, we use the CRSP monthly value-weighted market index.

We estimate the exchange-rate exposure of the firms in our sample using model 1. We estimate each firm's exposure in our 1993 sample using monthly return data during the three years surrounding 1993 (1992-94). This is appropriate, since we want to measure the contemporaneous impact of foreign currency derivatives on a firm's exchange-rate exposure. However, we also use a longer time interval (five years) to estimate exposures between 1991 and 1995. Finally, we use monthly data instead of daily or weekly, since daily and weekly exchange rate indices are noisier and usually suffer from nonsynchroneity problems (non-alignment of stock-return and exchange-rate series).

In the second stage, we examine the potential impact of a firm's currency derivative use on its exchange-rate exposure. Exchange-rate exposure is simultaneously determined by a firm's real operations (which we proxy through foreign sales) and its financial hedging. Therefore, we include both factors in the cross-sectional regression equation shown below:

$$\hat{\beta_{2i}} = \alpha_{1i} + \alpha_{2i}(FS/TS)_i + \alpha_{3i}(FCD/TA)_i + \eta_i,\ i = 1, ...N \tag{2}$$

where

[6]The index is weighted to reflect bilateral trade in manufactures in 1990.

$\hat{\beta}_{2i}$ is a firm's exchange-rate exposure estimated in (1)

$(FS/TS)_i$ is a firm's ratio of foreign sales to total sales

$(FCD/TA)_i$ is a firm's ratio of foreign currency derivatives to total assets

3.2 Tests and results

Given the definition of our index in U.S. dollars per unit of foreign currency, an appreciation of the dollar would decrease the index. We expect an exporter or a firm with revenues from operations abroad to be hurt by an exchange-rate appreciation (i.e., the return on its stock should decrease), thus producing a *positive* exchange-rate exposure. However, if a firm is an importer, then an appreciation of the dollar should benefit it (i.e., the return on its stock should increase), producing a *negative* exposure.[7] For a given exposure, an increase in revenues from foreign operations should increase exposure. Hence, our hypothesis suggests that exchange-rate exposure should be positively related to the ratio of foreign sales to total sales.

On the other hand, if firms use foreign currency derivatives to hedge against exchange-rate movements, then the use of derivatives should reduce their foreign exchange exposure. That is, the use of derivatives should decrease exchange-rate exposure for firms with positive exposures and increase (decrease in absolute value) exchange-rate exposure for firms with negative exposures. Therefore, if firms use derivatives as a hedge against exchange-rate movements, the absolute values of derivatives used should be negatively related to the absolute values of the exchange-rate exposures. If, on the other hand, firms use derivatives to speculate in the foreign exchange market, we should expect a positive relation between

[7]For theoretical models predicting this relation between a dollar appreciation and an exporter's/importer's value, see e.g., Levi (1990) and Shapiro (1975).

the absolute values of derivatives used and the absolute values of exchange-rate exposures. Hence, we need a two-tail test. We cannot hypothesize any relation between the absolute value of foreign currency exposure and the ratio of foreign sales to total sales, or between foreign currency exposure and (absolute value of) currency derivative used.

Table 2 presents the coefficient estimates of model 2, which links a firm's exchange-rate exposure (estimated from model 1) with its determinants, namely the percentage of foreign sales and the percentage of foreign currency derivatives used. In the first regression (first column in Table 2), we consider all exposures, both positive and negative. Consistent with our hypothesis, we find a strong positive relation between exchange-rate exposure and the ratio of foreign sales to total sales. In the second regression (second column in Table 2), we examine the relation between exchange-rate exposure and firms' foreign currency derivative use, using the absolute value of the exposures. Consistent with a firm's hedging motive for the use of foreign currency derivatives, we find a negative, statistically significant association between the absolute value of the exposures and the (absolute value) of the percentage use of foreign currency derivatives.

However, the drawback of these regressions is that they only test predictions of how either foreign sales or currency derivatives affect exchange-rate exposure. Since we observe an ex-post exposure (beta) that is determined by both foreign operations and financial hedging, the regression that does not include both factors suffers from an omitted variables problem. This problem could be more severe in this case, because the two factors, foreign sales and currency derivative use, are positively correlated. To include both variables in the regression, we must focus either on the positive or the negative exposures. Because the presence of foreign sales creates a positive exposure, we chose to perform our multivariate tests by using the sample of positive exposures. In addition, foreign sales is an exposure factor for which firm-level data is available, in contrast to imports and exports, for which only industry-level data is

available.

We present results for the sample of firms with positive exposures in the third column of Table 2. Consistent with our hypothesis that firms use currency derivatives as a hedge, we find evidence that exchange-rate exposure increases with the percentage of foreign sales and decreases with the percentage of foreign currency derivatives. Our results on both the use of foreign currency derivatives and foreign sales are statistically significant at the 1% level.[8]

3.2.1 Robustness tests

We perform several additional tests on the sample of positive exposures to examine the robustness of our results. First, we examine whether our results depend on the three-year time interval (1992-94) that we use to estimate firm exposures. We therefore estimate exposures using a longer (five-year) time interval (1991-95). Regression 1 in Table 3 presents the results of this test. The results are very similar to those of the base-case regression (Regression 3, Table 2). Consistent with our hypothesis, we find a positive and significant relation between foreign sales and exposure, and a negative and significant relation between foreign currency derivative use and currency exposure.

Next, we examine whether our results are robust to the use of an alternative exchange-rate index to estimate a firm's exposure in the first stage of the estimation. Instead of using J.P Morgan's narrow, nominal dollar index (against 18 currencies), we use the broad, real, dollar index published by the Dallas Fed (against 101 currencies). Although firm exposure might be captured better using a broader currency index, the impact of derivative use might be captured better using a narrow, nominal currency index. However, the choice of index does not affect our results (Regression 2, Table 3), since the use of derivatives (foreign sales) is

[8]We obtain similar results when we use White-adjusted errors. Our results also do not change, when we eliminate firms with large exposures (estimates that are above 2).

also significantly negatively (positively) related to a firm's exchange-rate exposure estimated based on the Dallas Fed exchange-rate index.

We also re-estimate the relation between exchange-rate exposure and currency derivative use for the sample of S&P 500 nonfinancial firms that disclosed currency derivative use in their 1992 annual reports (Regression 3, Table 3). Similar to our base-case regression, we estimate firms' exposures using a three-year period (1991-1993) and the J.P Morgan dollar index. Our results, which suggest that currency derivatives are used for hedging, extend to the 1992 sample, as the use of currency derivatives significantly reduces firm exchange-rate exposure. In this sample, the ratio of foreign sales to total sales is also positively related to a firm's exchange-rate exposure, but is not statistically significant.

Our last two alternative tests examine different estimation methods. First, we re-estimate model 2 by using weighted least squares. In this case, the weighting factor is the inverse of the standard error of the exposure coefficients estimated by model 1. Weighted least squares assigns more weight to the more precise estimates and therefore can increase the accuracy of our second-stage regression. The results, presented in Regression 4, remain unchanged. Again, consistent with our hypothesis, the use of currency derivatives significantly reduces a firm's exchange-rate exposure.

Finally, we re-estimate model 2, using a probit estimation, in which the dependent variable is a binary variable which equals one if a firm's exposure is statistically significant at the 10% level, and zero otherwise (Regression 5, Table 3). This procedure could be viewed as an extreme weighting scheme under which only statistically significant estimates are considered. Approximately 22% of the firms in our sample with positive exposures have statistically significant exposures. Again, the results are consistent with our hypothesis.

3.2.2 Robustness tests: alternative samples

So far, we have found our results to be robust to alternative time intervals, exchange-rate indices (JP Morgan and Dallas Fed), and estimation techniques (weighted least squares or probit). While our robustness tests are not independent, they nevertheless strongly support our hypothesis that firms use currency derivatives as a hedge. In this section, we use an alternative sample –a much larger cross-section of firms– that allows us to examine the robustness of our results in later years (1994 and 1995), to the inclusion of smaller firms, and to the use of individual exchange rates (instead of indices).

Specifically, we collect data on the use of currency derivatives for all U.S. manufacturing firms (i.e., all firms with primary 4-digit SIC between 2000 and 4000) with available data in Compustat, which have assets above 100 million in 1994 and 1995. There is a total of 916 firms that meet the criteria (thus a total of 1832 firm-year observations). As before, data on currency derivatives are collected from the footnotes to firms' annual reports. The mean value of assets (sales) in this sample is $3868 ($3577) million compared to $8199 ($7345) for the sample of S&P 500 nonfinancial firms used earlier.[9] It is clear that this sample contains a lot of smaller firms; this should make an investigation of the effectiveness of derivatives for such firms possible. Approximately 68% of the sample observations have foreign sales from operations abroad and for the entire sample, foreign sales account for 23% of total sales. However, for multinational firms (firms with foreign sales), foreign sales account for 33% of total sales. Approximately 34% of the firms in the sample use currency derivatives, and 41% of the firms in the sample of multinationals. For firms that use currency derivatives, currency derivatives are on average 7% of their total assets. As in the previous tests, we use returns for the three-year period surrounding the particular year of interest (i.e., we use returns for the 1993-95 period to estimate exposures and match them with derivative positions in 1994).

[9]This sample contains 204 firms that also belong to the S&P 500 nonfinancial firms.

Our first test examines our hypothesis using the absolute value of exposures. If firms use derivatives for hedging, then the (absolute value of) currency derivatives used should be negatively related to the absolute value of currency exposure. As explained earlier, we do not expect any relationship between the ratio of foreign sales to total sales and the absolute value of exposure. Regression 1, Table 3a (Table 3b) presents the results for 1994 (1995). Consistent with our hypothesis that firms use derivatives as a hedge, we find a negative and significant relationship between the use of derivatives and the absolute value of exposure both in 1994 and 1995.

Next, we examine whether our result that exposure is negatively related to the use of currency derivatives holds using all firms with positive exposures. Regression 2, Table 3a (Table 3b) presents results for this test for 1994 (1995). Consistent with our hypothesis, we find that the percentage use of currency derivatives is negatively and significantly related to a firm's currency exposure, suggesting that firms use derivatives as a hedge. The coefficient on the ratio of foreign sales to total sales is positive both in 1994 and in 1995, but is not statistically significant.[10] We also examine whether small firms use derivatives as effectively as large firms. Regressions 3 and 4 show results for the firms in the sample that have assets above and below 500 million respectively. We find similarly that small firms significantly reduce their exposure through the use of derivatives. In general, we find that the coefficient values on the use of currency derivatives vary from year to year, although they are always negative and highly significant.

Finally, we examine the robustness of our results to the use of an alternative European index and two individual exchange rates (the U.S./Canadian dollar exchange rate and the

[10]We also examine whether outliers in the estimates of exposures affect our results, by eliminating large exposure estimates (estimates that are above 2). Consistent with our hypothesis, the coefficient on the percent of currency derivatives used is negatively and significantly related to exposure. Moreover, the coefficient on the percent of foreign sales in 1995 (0.364) is also statistically significant at the 1% level (results not reported).

U.S. dollar/Japanese Yen exchange rate). One of the drawbacks of using a common exchange-rate index for all firms, as we have done in the previous section, is that different firms have different patterns of global sales and hence the weights may be inappropriately applied to exchange rates that are not relevant for a given firm. Unfortunately, it is not possible to construct firm-specific exchange-rate indices, since that would require a breakdown of firm-sales on a country basis. Many firms only report sales broken down by continents, however, this information is also not harmonized across firms. An alternative is to use individual exchange rates, which, at the minimum, alleviates the problem of index-weighting. Clearly, several firms may not be affected by the individual exchange rates that we use here, if, for example, they have no foreign sales to those countries (Japan and Canada). However, as our results show (regressions (5-7)), both during 1994 (Table 3a) and 1995 (Table 3b), the use of currency derivatives is on average negatively and significantly related to a firm's exposure to the Canadian dollar, the Japanese Yen as well as to the European index. Note that foreign sales is not significantly related to exposure in these tests.

In addition to the above tests, we have also performed the following tests using this alternative sample: a) estimate exposures based on the index put forth by the Dallas Fed; b) use five-year return data, instead of three-year return data, (i.e., returns between 1993-1997 for 1995 regressions); c) use weighted least squares and probit estimation techniques, similar to those shown in Table 3 for the 1993 sample. Our results are robust to these alternative tests and continue to support the hypothesis that firms' use of currency derivatives significantly reduces their exchange-rate exposure (results not reported).

Our last test uses the orthogonalized JP Morgan index, instead of the index itself, to estimate exposures. It is possible that, if the market return and the exchange rate are collinear, exposures will be biased. To avoid this problem, we first run a model in which we regress the exchange-rate index on the market and assume the residuals as the new

–orthogonalized– index. Clearly, the orthogonalized index is uncorrelated to the market by construction. We find that the regression of the JP Morgan exchange-rate index on the market index is insignificant and that the market is not significantly related to the JP Morgan exchange-rate index. Nonetheless, we also examined our hypothesis using the exposures based on the orthogonalized index. The results are virtually identical to those using the original index (results not reported).

Overall, our results are robust to sample, year, estimation technique, exchange-rate index (or individual currency) and size and show support for our hypothesis that firms' use of currency derivatives reduces their exchange-rate exposure. In addition, our results complement and extend those in Jorion (1990), in which exchange-rate exposures of U.S. multinationals are shown as positively related to the ratio of foreign sales to total sales. By introducing the firms' percentage of foreign currency derivatives in our tests, we can examine the role of derivatives by corporations. Our results strongly confirm our hypothesis that firms use foreign currency derivatives to hedge against exchange-rate movements, rather than to speculate in foreign exchange markets. Our results also provide an explanation for the lack of significant exposure documented in past studies.

4. The determinants of the extent of hedging

4.1 Related literature

There are several theories of optimal hedging, most of which rely on the introduction of some friction to the classical Modigliani and Miller paradigm. For example, in Stulz (1984), corporate hedging arises as a result of managerial risk aversion. In Smith and Stulz (1985), the structure of the tax code (i.e., if taxes are progressive) or the transaction costs of financial distress could prompt firms to undertake hedging activities. In Froot et al. (1993), hedging

mitigates the underinvestment problem that would result when cash flow is volatile and access to external financing is costly. Finally, in DeMarzo and Duffie (1995), corporate hedging is optimal when managers have private information on the firm's expected payoff despite shareholders' ability to hedge by themselves.

Empirical examination of hedging theories has been difficult due to the general unavailability of data on hedging activities. Until the beginning of the 1990s, a firm's exact position in derivatives was privately held information, and was considered a very important component of strategic competitiveness. It is only recently that corporations have been required to disclose in footnotes in their annual reports, the notional amount of derivatives they are using.

In the absence of reported information on derivatives, most of the earlier studies used survey data to examine why firms use derivatives. For example, Nance et al. (1993) used survey data on Fortune 500 firms' use of forwards, futures, swaps, and options and found that firms that hedged faced more convex tax functions, had less coverage of fixed claims, were larger, and had more growth options in their investment opportunity set.

Recently, studies have focused on the type of hedging (commodity, interest rate, or currency), recognizing that different factors can be important for each type of hedging. In particular, Geczy et al. (1997) examine currency hedging activities for a sample of Fortune 500 firms. They find that firms' use of currency derivatives is positively related to the amount of R&D expenditures, which is consistent with the use of hedging to reduce underinvestment (e.g., Froot et al., 1993); size, which is consistent with fixed-costs of hedging explanations; and exposure factors (foreign income and trade). Tufano (1996) examines commodity hedging activities in the gold mining industry. He finds that firms' use of commodity derivatives is negatively related to the number of options their managers and directors hold, and positively

related to the value of their stock holdings, evidence consistent with theories of managerial risk aversion (e.g., Stulz, 1984). Haushalter (1998) examines the hedging activities of oil and gas producers. He finds that total debt ratio is positively related to the percentage of production hedged, which is consistent with theories of transaction costs of financial distress. Visvanathan (1998) examines the use of interest rate swaps by S&P 500 nonfinancial firms, and also finds evidence supporting theories of transaction costs of financial distress (e.g., Smith and Stulz, 1985).[11] Finally, Mian (1996) investigates all three types of hedging activities for a sample of 3,022 firms and finds mixed evidence for theories of managerial risk aversion and taxes and evidence that strongly supports the hypothesis that hedging activities exhibit economies of scale (i.e., that larger firms hedge more).

All of the studies cited above have examined which factors could be associated with the probability that a firm hedges. With the exception of Tufano (1996) and Haushalter (1998), who also examine the level of hedging in a particular industry (gold, and oil and gas respectively), no other study in the general derivatives area has looked for the factors that are associated with the extent of hedging.

In this paper, we examine this question in the context of foreign currency hedging and for a large cross-section of industries. Testing the determinants of the amount of hedging can provide additional evidence for the use of foreign currency derivatives as a hedge. In particular, if a firm uses such hedges, we expect its decision on how much to hedge to depend on its exposure through foreign sales and foreign trade. Our findings would add to the evidence of the previous section, suggesting that firms use currency derivatives to hedge.

[11] Earlier studies which examined interest rate hedging include Booth et al. (1984); Block and Gallagher (1986); and Wall and Pringle (1989).

4.2 Tests and results

A firm can make its hedging decision in one step, deciding whether or not to hedge and how much to hedge; or in two steps, deciding how much to hedge only *after* it has decided to hedge. Ultimately, this is an empirical question. We test it here in the context of foreign currency derivative use by firms. We model a firm's one-step hedging decision using a Tobit method, because the continuous dependent variable that we use on the percentage of foreign currency derivatives is censored at zero (i.e., there are a significant number of zero observations). To model separately a firm's decision to hedge from its decision of how much to hedge, and identify the relevant factors for each decision, we implement a two-stage process originally suggested by Cragg (1971).

In contrast to the simple Tobit model which constraints the coefficients on the factors associated with the decisions to hedge and how much to hedge to be the same, the Cragg model allows these two decisions to be independent. In the first stage, using all firms, we estimate a binomial probit model in which the decision to hedge is related to variables that are broadly consistent with theories of optimal hedging and controls for exchange-rate exposure.[12] In the second stage, using only those firms that chose to engage in hedging, we estimate a truncated regression using the *amount* of derivative use as a dependent variable. We find that a two-step decision process fits the data better. Therefore, we examine further only the Cragg model's tests and results. Haushalter (1998) used a similar approach to examine the extent of oil and gas derivatives.

We first present the variables that proxy for optimal hedging theories and exposure to exchange-rate movements. We then proceed with the results of the Cragg model. We use similar variables to those used by Geczy et al. (1997). Specifically, to test theories of hedging

[12]The dependent variable is a binary variable which equals one if the firm hedges and zero if it does not.

related to agency costs (underinvestment), we use the R&D expenditures, defined as the ratio of R&D to total sales; dividend yield, defined as the ratio of total dividend paid to share price; and the ratio of market to book, defined as the ratio of the sum of market value of equity and book value of debt to total assets, as proxies for growth options in the firm's investment opportunity. We use a tax dummy variable set equal to one if the firm has a tax-loss carryforward or investment tax credits, and zero otherwise, to test theories related to the reduction in expected taxes. We use ROA, defined as the ratio of earnings before interest, taxes, and dividends (EBITD) to total assets and leverage, defined as the ratio of total debt to total assets, to test theories related to expected costs of financial distress.[13] Finally, we control for the size of the firm (the logarithm of total assets), a factor that most previous studies found was positively related to a firm's decision to hedge. This is consistent with arguments related to the existence of large fixed start-up costs of hedging. We also incorporated the total number of options held at the beginning of the year by the CEO and the total number of shares (both variables scaled by total shares outstanding), which we obtained from the Compustat ExecuComp database, to test theories related to managerial risk aversion. Since neither variable is significant, and because they substantially reduce the number of observations, we do not include them here.

To control for exposure factors, we introduce the ratio of foreign sales to total sales and the share of total trade (imports and exports) in total production. Exports produce the same exposure to exchange rates as do foreign sales. An appreciation of the dollar hurts firms with foreign revenues or exports by reducing the dollar value of foreign-currency-denominated revenues. In contrast, an appreciation of the dollar benefits importers by reducing the dollar value of the costs of imports. However, given that we only have the absolute value of foreign

[13] We also use other measures of predictability of bankruptcy [e.g., Altman's z-score, Altman (1968)] and liquidity, defined as the ratio of cash and marketable securities net of current liabilities to total assets. These are not significant and do not materially alter our results.

currency derivatives, we expect that both the import and export factors should be positively associated to the use of foreign currency derivatives. The decision to hedge should depend on the total foreign trade (imports plus exports) if they are in uncorrelated currencies or firms hedge them separately.

Information on imports and exports is not available at the firm level. However, the U.S. Department of Commerce compiles annual import and export shares at the industry level, for both the two and four-digit SIC classification, for the main U.S. manufacturing industries.[14] In our tests, we match firms with their industry import (export) share at the four-digit SIC where available, otherwise at the two-digit.[15]

Regression 1 in Table 4, presents the results of the first-stage binomial probit model. Our findings are similar to those obtained by Geczy et al. (1997): firm size, R&D expenditures, and controls for exposure (foreign income and trade) are important determinants in a firm's decision to use foreign currency derivatives. The size of the firm is positively related to the decision to hedge, indicating that larger firms are more likely to hedge than smaller firms. R&D expenditures can proxy for the growth options in the firm's investment opportunity set. In the absence of hedging, firms with high R&D expenditures could be more prone to underinvest than those with low R&D expenditures. Hence, firms with higher R&D expenditures benefit more from the use of derivatives. Finally, both exposure factors (foreign sales and foreign trade) are significantly and positively related to a firm's decision to hedge, indicating that firms with higher exposure are more likely to hedge. None of the other variables are important in explaining a firm's decision to hedge.[16]

[14]This dataset is available in the USDC publication, *U.S. Commodity Exports and Imports as Related to Output.*

[15]We have data on import and export shares on 59 industries at the 4-digit SIC and on 25 industries at the 2-digit SIC. At the 2-digit, we have data on the main U.S manufacturing industries (SICs 20-39) as well as on industries related to mineral commodities (SICs 10, 12, 13, 15, 16).

[16]Leverage is significantly related to the decision to hedge, but its sign (negative) is the opposite from what theories of optimal hedging would predict.

Regression 2, Table 4, presents the results of the second-stage, truncated model. This regression identifies the factors that are important determinants of the amount of hedging, once a firm has decided to hedge. We find that the exposure factors (foreign sales and foreign trade) are the sole determinants of the amount of hedging. Both factors are positively associated with the level of hedging, indicating that firms use their exposure to decide on how much to hedge. Hence, exposure factors not only prompt corporations to use derivatives, as suggested by the first-stage results, they also guide a firm's decision on the level of hedging, as suggested by the second-stage results. Note that no other factor is important for a firm's decision on the extent of hedging.[17] This result adds to our evidence of the previous section that firms use currency derivatives to hedge their exchange-rate exposure, rather than to speculate in the foreign exchange markets.[18]

4.3 The determinants of the level of foreign debt

In addition to foreign currency derivatives, firms can also use foreign debt to protect themselves from exposure to exchange rate movements. A firm with revenues denominated in foreign currencies (cash inflows) can issue foreign debt, since this creates a stream of cash outflows in a foreign currency.

We examine separately a firm's decision to issue foreign debt and its decision on how much foreign debt to issue. Our hypothesis suggests that if firms use foreign debt as a hedge, then exposure factors (i.e., foreign sales and trade) should be important in the firm's

[17]The importance of size only in the firm's decision to hedge but not on the level of hedging is consistent with the argument related to high fixed start-up costs of hedging.

[18]We also explore possible nonlinearities in a firm's use of foreign currency derivatives. In particular, we examine a log-linear model in which we regress the log of foreign currency derivatives against the log of foreign sales. This test allows us to quantify the change in the derivative use when foreign sales change by 1%. We find that a 1% increase in foreign sales increases the use of foreign currency derivatives by 0.83%. Hence, firms tend to increase their foreign currency derivatives use as their foreign sales increase, but in smaller proportions than the corresponding increase in foreign sales (results not reported).

decision to issue debt and in its decision on how much debt to issue. Finally, we test a model of choice of hedging instrument, comparing foreign currency derivatives and foreign debt.

We obtain the year-end data on foreign debt for 1993 from the long-term debt footnote in firms' annual reports. Where a firm has used foreign currency swaps to effectively translate foreign debt into a domestic liability, we use the *net* amount of foreign debt. Similarly, swaps that are identified with a domestic loan (which has converted domestic debt into foreign debt) are captured by the measurement of foreign debt. However, in our sample we do not account for swaps that were not associated with a particular loan. Compared to the relatively large percentage of firms that use foreign currency derivatives (42.6%), only 21.8% of the firms in our sample use foreign debt.

Table 5 presents the results of our tests on foreign debt. In the first stage (Regression 1), we use all the variables that we used in the previous tests on the use of foreign currency derivatives. Again, the dependent variable is a binary indicating whether or not a firm uses foreign debt. We note that since foreign debt represents a cash outflow in a foreign currency, it can only be used as a hedge when a firm has foreign revenues (cash inflows), either from operations abroad or from exports. By contrast, imports, which also represent a cash outflow in a foreign currency, cannot be hedged through foreign debt. Therefore we do not use them in these tests.

We find a significant positive relation between the ratio of foreign sales to total sales and a firm's decision to use foreign debt. We also find that larger firms are more prone to use foreign debt. Finally, we do not find any evidence that exporters are more likely to issue foreign debt, nor that any of the remaining variables are significantly associated with the firm's decision to issue debt. This result is generally consistent with our hypothesis.

In the second stage (Regression 2), using only those firms that chose to issue foreign

debt, we examine the determinants of the amount of foreign debt issue. To preserve our observations, we use only those factors that are important in the first stage. We find that as in the case of foreign currency derivatives, exposure through foreign sales is an important determinant of a firm's decision on how much foreign debt to issue. This, too, is consistent with our hypothesis. We also find that while larger firms are more likely to issue foreign debt, of those that do, smaller firms issue larger amounts of foreign debt. This is consistent with high fixed start-up costs of issuing foreign debt.

Finally, we investigate further why exporters are not likely to issue foreign debt, as suggested by Regression 1, Table 5. We use a logit model (Regression 3, Table 5) to test a model of choice that compares the use of foreign currency derivatives and foreign debt. Our dependent variable is a binary equal to one if the firm uses only foreign currency derivatives, and zero if the firm uses only foreign debt.

We find no significant evidence that multinationals prefer to use foreign currency derivatives or debt to hedge foreign currency exposure (the coefficient on foreign sales is insignificant). However, we do find significant evidence that exporters prefer the use of foreign currency derivatives over the use of foreign currency debt. This might be explained by the nature of exporting, which can require customized, short-term contracts that are better served by derivatives rather than by long-term foreign debt. Alternatively, it might be the lack of foreign institutional details that keeps exporters away from issuing foreign debt.

Overall, our results suggest that exposure through foreign sales is an important determinant of both a firm's decision to issue foreign debt and its decision on how much foreign debt to issue. These results are consistent with our hypothesis that firms use both foreign debt and foreign currency derivatives to hedge their exchange-rate exposure. In addition, while firms with operations abroad do not prefer one hedging instrument over another, exporters

prefer the use of currency derivatives.

5. Conclusions

This paper examines whether firms use currency derivatives for hedging or for speculative purposes. Using a sample of S&P 500 nonfinancial firms for 1993, we examine the impact of currency derivatives on firm exchange-rate exposure, the factors that prompt corporations to hedge, and the factors that affect their decision on how much to hedge.

We find a strong negative association between foreign currency derivative use and firm exchange-rate exposure, suggesting that firms use derivatives as a hedge rather than to speculate in the foreign exchange markets. This relation is robust to alternative time intervals and exchange-rate indices to estimate exposure and estimation methods (e.g., weighted least squares and probit) that we use to examine the relation between exchange rate exposure and currency derivative use. It is also robust to the use of a larger, alternative sample that includes all U.S. manufacturing firms that have total assets above 100 million during 1994 and 1995 and to the use of individual exchange rates instead of trade-weighted exchange-rate indices.

We find additional supportive evidence on the firm's hedging behavior, when we examine separately, using a two-stage framework, the factors that are associated with a firm's decision to hedge and its decision on the level of hedging. We find evidence that a firm's exposure through foreign sales and foreign trade is a very important factor that both prompts corporations to hedge and guides their decision on how much to hedge.

Firms can also use foreign debt to protect themselves from exchange-rate movements. Similarly, we find that a firm's exposure through foreign sales is an important determinant of its decision to use foreign debt and on its decision on the level of foreign debt. Collectively,

our results suggest that firms use currency derivatives and foreign debt as a hedge.

Our paper has important implications for managers and financial regulators. A firm's exposure to exchange-rate movements is mitigated through the use of foreign currency derivatives. This finding suggests that an intervention in the derivatives markets may not be warranted, and provides an explanation for the lack of significant exposure documented in past studies.

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Table 1
Descriptive statistics

	Mean	Std	Q3	Median	Q1
Total sales (millions)	7345	15652	7533	3312	1530
Total assets (millions)	8199	20985	7745	3242	1427
Foreign sales/total sales[a]	0.198	0.231	0.329	0.125	0.000
FCD/total assets[b]	0.030	0.057	0.040	0.000	0.000
FCD/foreign sales	0.140	0.211	0.206	0.075	0.000
Foreign currency exposure (β_2)[c]	-0.077	1.009	0.557	-0.072	-0.673
Industry import share[d]	0.158	0.142	0.230	0.100	0.060
Industry export share[d]	0.156	0.115	0.230	0.120	0.050
Foreign debt/total assets[e]	0.007	0.034	0.000	0.000	0.000
R&D/sales	0.024	0.041	0.030	0.004	0.000

[a] Foreign sales are sales by foreign operations of the firm, as reported in the geographical segment footnote.
[b] The dollar value in foreign currency derivatives scaled by total assets.
[c] The sensitivity of the returns of the firm's common stock to an unexpected change in the J.P. Morgan exchange-rate index. The index is defined in U.S. dollars per unit of foreign currency.
[d] Total imports (exports) by the industry scaled by industry total product shipments. Industry is matched at the 4-digit SIC code when available and at the 2-digit SIC otherwise.
[e] Percentage of total debt denominated in foreign currency (that is not swapped to U.S. dollar) to total assets.

The sample includes all nonfinancial S&P 500 firms with data available for 1993, for 378 firms.

Table 2
FX exposure and the use of derivatives

Sample		All Firms		All Firms		$\beta_2 > 0$
Dependent Variable	Predict	β_2	Predict	$abs(\beta_2)$	Predict	β_2
Observations		358		358		169
R^2		0.034		0.016		0.069
Intercept		-0.220[a]		0.753[a]		0.671[a]
		(3.16)		(16.64)		(10.52)
Foreign sales/total sales	+	0.964[a]	None	0.351[c]	+	0.695[a]
		(3.49)		(1.95)		(3.12)
FX Derivatives value /total assets	None	-1.531	-	-1.584[b]	-	-2.735[a]
		(1.42)		(2.26)		(3.04)

[a,b,c] denotes significance at the 1%, 5%, and 10% levels, respectively.

The table provides parameter estimates for the model specified by the following equation,

$$\hat{\beta_{2i}} = \alpha_{1i} + \alpha_{2i}(FS/TS)_i + \alpha_{3i}(FCD/TA)_i + \eta_i,\ i = 1, ...N$$

where the dependent variable is estimated by the following equation,

$$R_{it} = \beta_{0i} + \beta_{1i}R_{mt} + \beta_{2i}FXI_t + \epsilon_{it},\ t = 1, ...T$$

where R_{it} is firm's i common stock return, R_{mt} is the return on the CRSP value-weighted market index and FXI_t is the rate of return on an exchange-rate index (J.P Morgan's dollar index). We use the sample of S&P 500 nonfinancial firms in 1993 and return data for 1992-94. We present the estimates (top) and the corresponding t-statistics (bottom) for the intercept α_{1i}, the coefficient of the ratio of foreign sales to total sales α_{2i}, and the coefficient of the ratio of foreign currency derivatives to total assets α_{3i}, for all firms (Regression 1), using the absolute values of the exposures (Regression 2) and using the sample of the positive exposures (Regression 3).

Table 3
FX exposure and the use of derivatives

Sample	Positive Foreign Currency Exposure $\beta_2 > 0$				
Regression Type	OLS	OLS	OLS	WLS	Probit
Dependent Variable	β_2 estimated over 5 years	RX-101 as FX index	1992 sample	weighted by $\frac{1}{STD(\beta_2)}$	$t-stat > 1.648 = 1$ otherwise=0
Observations	174	172	131	169	169
R^2	0.041	0.076	0.025	0.088	0.067
Intercept	0.466[a]	0.822[a]	0.633[a]	0.703[a]	-0.905[a]
	(10.65)	(10.27)	(11.45)	(10.00)	(5.87)
Foreign sales/total sales	0.321[b]	1.059[a]	0.096	0.856[a]	1.345[a]
	(2.23)	(3.65)	(0.55)	(3.52)	(2.65)
FX Derivatives value /total assets	-1.274[b]	-3.156[b]	-0.886[c]	-3.383[a]	-5.900[b]
	(2.40)	(2.57)	(1.78)	(3.50)	(2.43)

[a,b,c] denotes significance at the 1%, 5%, and 10% levels, respectively.

The table provides parameter estimates for the model specified by the following equation

$$\hat{\beta_{2i}} = \alpha_{1i} + \alpha_{2i}(FS/TS)_i + \alpha_{3i}(FCD/TA)_i + \eta_i,\ i = 1,...N$$

where the dependent variable is estimated by the following equation

$$R_{it} = \beta_{0i} + \beta_{1i}R_{mt} + \beta_{2i}FXI_t + \epsilon_{it},\ t = 1,...T$$

where R_{it} is firm's i common stock return, R_{mt} is the return on the CRSP value-weighted market index and FXI_t is the rate of return on an exchange-rate index (J.P Morgan's dollar index). We present the estimates (top) and the corresponding t-statistics (bottom) for the intercept α_{1i}, the coefficient of the ratio of foreign sales to total sales α_{2i}, and the coefficient of the ratio of foreign currency derivatives to total assets α_{3i}, for the cases in which we estimate exposure. We use a five-year interval (Regression 1), an alternative exchange-rate index (Dallas Fed RX-101) (Regression 2), the S&P 500 firms that report currency derivative data in their 1992 annual reports (Regression 3), and for two alternative estimation techniques (weighted least squares and probit) (Regressions 4 and 5).

Table 3a
FX exposure and the use of derivatives

Sample	All Firms		Positive Foreign Currency Exposure $\beta_2 > 0$				
Dependent Variable	**1994** $abs(\beta_2)$	**1994** sample	Assets >500 mil.	Assets <500 mil.	European index	Canadian dollar	Japan Yen
Observations	646	326	151	175	312	317	341
R^2	0.004	0.005	0.020	0.015	0.003	0.016	0.003
Intercept	0.973[a]	1.024[a]	0.712[a]	1.152[a]	0.839[a]	1.221[a]	0.489[a]
	(20.90)	(14.34)	(8.22)	(12.16)	(11.04)	(13.03)	(14.47)
For. sales/total sales	-0.074	0.009	0.357	0.423	-0.027	0.404	0.056
	(0.38)	(0.04)	(1.32)	(0.68)	(0.07)	(1.06)	(0.51)
FX Der./total assets	-0.238[a]	-0.228[a]	-0.166[a]	-6.620[a]	-0.183[a]	-2.116[a]	-0.079[a]
	(2.98)	(3.81)	(6.38)	(2.40)	(2.66)	(2.64)	(3.75)

[a,b,c] denotes significance at the 1%, 5%, and 10% levels, respectively.

The table provides parameter estimates for the model specified by the following equation

$$\hat{\beta_{2i}} = \alpha_{1i} + \alpha_{2i}(FS/TS)_i + \alpha_{3i}(FCD/TA)_i + \eta_i,\ i = 1, ...N$$

where the dependent variable is estimated by the following equation

$$R_{it} = \beta_{0i} + \beta_{1i}R_{mt} + \beta_{2i}FXI_t + \epsilon_{it},\ t = 1, ...T$$

where R_{it} is firm's i common stock return, R_{mt} is the return on the CRSP value-weighted market index and FXI_t is the rate of return on an exchange-rate index (J.P Morgan's dollar index) or a simple exchange-rate (i.e., US dollar/Yen). The sample includes all U.S. manufacturing firms listed in COMPUSTAT with assets above 100 million in 1994 and 1995. Results in this table are for the *1994* sample. For this sample, we estimate exposure using returns between 1993-1995. We present the estimates (top) and the corresponding t-statistics (bottom) for the intercept α_{1i}, the coefficient of the ratio of foreign sales to total sales α_{2i}, and the coefficient of the ratio of foreign currency derivatives to total assets α_{3i}, for the cases in which we estimate exposure. We use the JP Morgan index and estimate exposure using the absolute values of the exposures (Regression 1), all positive exposures (Regression 2), the subsample of large firms (above 500 million in assets) (Regression 3) and small firms (below 500 million in assets) (Regression 4), and using betas estimated with respect to a European index (Regression 5), the US/Canadian dollar exchange rate (Regression 6) and the US dollar/Japanese Yen exchange rate (Regression 7).

Table 3b
FX exposure and the use of derivatives

Sample	All Firms		Positive Foreign Currency Exposure $\beta_2 > 0$				
Dependent Variable	**1995** $abs(\beta_2)$	**1995** sample	Assets >500 mil.	Assets <500 mil.	European index	Canadian dollar	Japan Yen
Observations	629	319	168	151	269	277	379
R^2	0.016	0.025	0.061	0.008	0.018	0.018	0.012
Intercept	1.215[a]	1.098[a]	0.715[a]	1.348[a]	0.982[a]	1.225[a]	0.741[a]
	(14.57)	(10.52)	(7.03)	(8.56)	(10.08)	(11.47)	(7.94)
For. sales/total sales	-0.004	0.339	0.810[a]	0.228	-0.033	-0.137	-0.154
	(0.02)	(1.10)	(2.21)	(0.47)	(0.11)	(0.41)	(0.64)
FX Der./total assets	-3.292[a]	-3.348[a]	-2.347[a]	-3.962[a]	-2.434[a]	-2.164[a]	-1.864[a]
	(5.03)	(4.95)	(3.01)	(2.50)	(3.31)	(2.60)	(3.19)

[a,b,c] denotes significance at the 1%, 5%, and 10% levels, respectively.

The table provides parameter estimates for the model specified by the following equation

$$\hat{\beta_{2i}} = \alpha_{1i} + \alpha_{2i}(FS/TS)_i + \alpha_{3i}(FCD/TA)_i + \eta_i,\ i = 1, ...N$$

where the dependent variable is estimated by the following equation

$$R_{it} = \beta_{0i} + \beta_{1i}R_{mt} + \beta_{2i}FXI_t + \epsilon_{it},\ t = 1, ...T$$

where R_{it} is firm's i common stock return, R_{mt} is the return on the CRSP value-weighted market index and FXI_t is the rate of return on an exchange-rate index (J.P Morgan's dollar index) or a simple exchange-rate (i.e., US dollar/Yen). The sample includes all U.S. manufacturing firms listed in COMPUSTAT with assets above 100 million in 1994 and 1995. Results in this table are for the *1995* sample. For this sample, we estimate exposure using returns between 1994-1996. We present the estimates (top) and the corresponding t-statistics (bottom) for the intercept α_{1i}, the coefficient of the ratio of foreign sales to total sales α_{2i}, and the coefficient of the ratio of foreign currency derivatives to total assets α_{3i}, for the cases in which we estimate exposure. We use the JP Morgan index and estimate exposure using the absolute values of the exposures (Regression 1), all positive exposures (Regression 2), the subsample of large firms (above 500 million in assets) (Regression 3) and small firms (below 500 million in assets) (Regression 4), and using betas estimated with respect to a European index (Regression 5), the US/Canadian dollar exchange rate (Regression 6) and the US dollar/Japanese Yen exchange rate (Regression 7).

Table 4
Factors explaining the use and level of FX derivatives

Regression Dependent Variable	Probit Use FCD=1 Otherwise=0	Truncated FCD/Total Assets $FCD > 0$
Observations	245	145
R^2	0.433	0.176
Intercept	-4.490[a]	0.039
	(4.17)	(0.52)
Foreign sales/total sales	2.366[a]	0.094[b]
	(4.50)	(2.48)
Industry import + export share	1.254[c]	0.058[c]
	(1.65)	(1.79)
Firm size	0.495[a]	-0.002
	(4.21)	(0.31)
R&D/sales	8.890[b]	-0.007
	(2.33)	(0.04)
Market value of assets/book	-0.334	0.005
	(1.62)	(0.43)
Dividend yield	-1.833	-0.173
	(0.47)	(0.35)
Leverage	-1.855[b]	-0.020
	(1.96)	(0.32)
ROA	1.660	0.036
	(0.66)	(0.29)
Tax dummy	0.153	0.005
	(0.56)	(0.36)
Inverse Mill's ratio		-0.013
		(0.43)
Industry dummies	Yes	No

[a,b,c] denotes significance at the 1%, 5%, and 10% levels, respectively.

The table provides parameter estimates (top) and t-statistics (bottom) using Cragg's (1971) two-stage model. The first stage (Regression 1) is a binomial probit estimation that relates factors proxying for theories of optimal hedging and for exposure to exchange-rate movements to a firm's likelihood of using currency derivatives. The dependent variable is a binary variable equal to 1 if a firm uses currency derivatives, and 0 otherwise. The second stage (Regression 2) is a truncated regression model in which we consider only those firms that chose to hedge for estimating which factors influence a firm's decision on the level of derivative use.

Table 5
Factors explaining the use and level of foreign debt

Regression Dependent variable	Probit Use LT Fr Debt=1 Otherwise=0	Truncated LT Fr Debt/Assets LT Fr Debt> 0	Probit Use Only FCD=1 Only Foreign Debt=0
Observations	214	62	94
R^2	0.279	0.434	0.089
Intercept	-3.957[a] (3.69)	0.064 (0.68)	-0.824 (0.57)
Foreign sales/total sales	1.804[a] (3.32)	0.107[a] (2.81)	-0.475 (0.66)
Industry export share	-1.007 (0.59)		3.111[c] (1.65)
FX Derivatives value /total assets	2.725 (1.53)		
Firm size	0.317[a] (2.65)	-0.018[b] (2.48)	0.140 (0.87)
R&D/sales	-2.538 (0.75)		9.066[c] (1.70)
Market value of assets/book	-0.446 (1.54)		
Dividend yield	-5.791 (0.60)		
Leverage	0.895 (0.82)	0.332 (5.33)	
ROA	3.335 (1.08)		
Tax dummy	-0.081 (0.29)		
Inverse Mill's ratio		0.003 (0.10)	
Industry dummies	Yes	No	No

[a,b,c] denotes significance at the 1%, 5%, and 10% levels, respectively.

The table provides parameter estimates (top) and t-statistics (bottom) using Cragg (1971) two-stage model. The first stage (Regression 1) is a binomial probit estimation which relates factors that proxy for theories of optimal hedging and for exposure to exchange rate movements to a firm's likelihood of issuing foreign debt. The dependent variable is a binary variable equal to 1 if a firm uses foreign debt and 0 otherwise. The second stage (Regression 2) is a truncated regression model where only those firms which chose to issue foreign debt are considered, to estimate which factors influence a firm's decision on the level of foreign debt. Regression 3 presents results of a model of choice between currency derivatives and foreign debt.