Exchange Risk Sensitivity and Its Determinants: A Firm and Industry Analysis of U.S. Multinationals

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We develop a model of firm valuation to examine the exchange risk sensitivity of 409 U.S. multinational firms during the 1978-89 period. In contrast to previous studies, we find that exchange rate fluctuations do affect firm value. More specifically, we find that approximately sixty percent of firms with significant exchange risk exposure gain from a depreciation of the dollar. We also find that cross-sectional differences in exchange risk sensitivity are linked to key firm-specific operational variables (i.e., foreign operating profits, sales, and assets). Although we find limited support for exchange risk sensitivity when we aggregate the data into 20 SIC-based industry groups, we do observe some cross-sectional and inter-temporal variation in the exchange risk coefficients. Subperiod analysis reveals higher number of firms with significant exchange risk sensitivity during the weak-dollar period as compared to the strong-dollar period.

■ Exchange rate variability is a major source of macroeconomic uncertainty affecting firms in an open economy. Exchange rate fluctuations affect operating cash flows and firm value through the translation, transaction, and economic effects of exchange risk exposure. In addition, external shocks may create an interdependence between exchange rates and stock returns. Therefore, it is reasonable to expect a connection between exchange rate changes and firm value. The importance of exchange rate variability is also evidenced by the growing emphasis corporations place on exchange risk measurement and management strategies.

However, compared to other macroeconomic factors, such as inflation and interest rate risk, the research on exchange risk and its impact on firm value is scant. Recent studies based on portfolio data (Bodnar and Gentry, 1993, Jorion, 1990, and Prasad and Rajan, 1995) and market-index data (Ma and Kao, 1990) have found minimal or no evidence of exchange rate fluctuations affecting stock returns. One explanation for these counterintuitive results is the research design used in these studies. We posit that, like any other macroeconomic factor, the exchange risk factor will not have the same affect on all firms. Rather, the exchange risk sensitivity of firms will depend on their operating profiles, financial strategies, and other firm-specific variables. Thus, an aggregate-level analysis may not reveal the true exchange risk sensitivity of firm value. A firm-level study is necessary to understand whether, and why, individual firms display varying sensitivity to exchange risk.

Therefore, we focus our attention on individual firm value and estimate a model of firm valuation under exchange risk exposure using individual stock return data for 409 U.S. multinational firms for the 1978-89 period. We find that firm value is significantly affected by both real and nominal exchange rates. Further, these effects vary in terms of the degree and direction across firms. The degree of effect refers to the percentage change in firm value in response to a one percent change in exchange rates; direction of effect refers to whether a firm gains or loses from a given change in exchange rates. We find a higher percentage of firms with significant exchange risk exposure gain with a depreciation of the dollar. In order to explain this cross-sectional variation, we develop a framework linking exchange risk exposure to firm-specific foreign operational variables; i.e., profits, sales, and assets. Consistent with our expectations,

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we find a positive relationship between these foreign operational variables and the exchange risk sensitivity of firm value.

The intertemporal stability of exchange risk exposure is examined by estimating these coefficients during equally-spaced subperiods and by dividing the sample period into strong and weak-dollar subperiods. For comparability with prior studies, we also examine exchange risk exposure by dividing the 409 firms into 20 SIC-based industry portfolios. Consistent with prior studies, we observe few industry portfolios with significant exchange risk exposure. These results also confirm our suspicion that aggregation of firm data into portfolios, and the resultant loss of information, is an important reason why earlier studies fail to document strong support for exchange risk sensitivity of firm value.

I. Model

This study focuses on the measurement of exchange risk exposure, as opposed to exchange risk pricing.[1] We employ a simple two-factor model to estimate the exchange-risk sensitivity coefficient of individual firms and industry portfolios. Inclusion of the exchange risk factor is recommended by Adler and Dumas (1984), and a similar equation is employed by Bodnar and Gentry (1993) and by Jorion (1990).

A. Exchange Exposure

A two-factor model, where R_{it}, the return on company i's stock at time t, is a linear function of the return on a market factor, R_{mt}, and the exchange risk factor, e_t, is described below:

$$R_{it} = \alpha_i + \beta_i R_{mt} + \gamma_i e_t + v_{it} . \quad (1)$$

The coefficients β_i and γ_i provide a measure of market-risk and exchange risk sensitivity of firm i; v_{it} is the idiosyncratic error term. Equation (1) is not a model of asset pricing but a factor model that allows measurement of factor sensitivities. A potential problem in estimating such a two-factor model arises from the possibility that the market and exchange risk factors may be correlated or jointly influenced by some external shocks. To avoid any bias due to factor correlations, we orthogonalize the exchange risk factor. We follow the standard approach (e.g., Elton and Gruber, 1991) and run a side regression of exchange rates on the market factor.[2]

We use Equation (1) to examine the null hypothesis that the exchange rate fluctuations have no effect on stock returns, i.e., H_0: $\gamma_i = 0$. The alternate hypothesis is H_1: $\gamma_i \neq 0$. The sign of the exchange rate coefficient can be either positive or negative depending on the net exposed asset and liability positions of the firm. For example, firms that use their foreign subsidiaries principally to import finished goods and sell them in the U.S. will benefit from an appreciation of the dollar. This benefit arises due to a reduction in the dollar value of foreign costs. In contrast, firms that incur most of their cost of production in the U.S. and sell in foreign markets have exposed foreign sales revenue. They find that their products become less competitive in overseas markets, and their foreign sales revenues decline with any appreciation of the dollar. Similarly, multinational firms with net exposed assets abroad will lose with a strengthening dollar, while firms with net exposed liabilities gain.

B. Firm-Specific Determinants

In this section, we develop a framework for incorporating the role of firm-specific variables in explaining the cross-sectional variations in exchange risk exposure of individual firms. We begin by defining the value of a U.S.-based multinational firm (V_i) as the sum of its domestic value (V^d_i) and its foreign value (V^f_i) components:

$$V_i = V^d_i + V^f_i \quad (2)$$

where each component is expressed in dollars (the home currency of the multinational firm). These component values, in turn, are the present values of their respective net operating dollar cash flows (π^d and π^f):

$$V^d_i = \int_0^\infty \pi^d_{it} \exp(-k_{it}) d_t ; \quad (3)$$

$$V^f_i = \int_0^\infty \pi^f_{it} \exp(-k_{it}) d_t .$$

By definition, R_{it}, the rate of return on a firm's stock, is the percentage change in the firm value, V_{it},

$$R_{it} = (V_{it} - V_{it-1})/(V_{it-1}) . \quad (4)$$

Similarly, the exchange-risk-sensitivity coefficient, γ_i, in Equation (1) can be expressed as:

[1]The issue of exchange risk pricing in the U.S. markets is examined in Choi and Prasad (1992) and in Jorion (1991).

[2]During our sample period of 1978-89, the correlation between the exchange risk factor and the market factor is statistically insignificant at the 0.05 level. Estimations were done with and without orthogonalization, and the results were similar. However, following the suggestions of an anonymous referee, we use orthogonalized variables in all the estimations reported here.

$$\gamma_i = \text{cov}(R_{it}, e_t)/\text{var}(e_t) . \quad (5)$$

Applying Equations (2) and (3) to Equation (4) and substituting the resulting value of R_{it} in Equation (5) enables us to express the exchange risk exposure of stock returns in terms of the firm's net operational cash flows from domestic and foreign sources:

$$\gamma_i = \text{cov}(\pi^d_{it} + \pi^f_{it}, e_t)/\text{var}(e_t) . \quad (6)$$

To establish the connection between the exchange exposure coefficient and firm-specific variables, we decompose the net operating cash flows from domestic and foreign sources as:

$$\pi^d_{it} = (S^d_{it} - VC^d_{it} - FC^d_{it})(1 - T^d); \quad (7)$$
$$\pi^f_{it} = (S^f_{it} - VC^f_{it} - FC^f_{it})(1 - T^f)$$

where S_{it} is firm i's sales revenue at time t, VC_{it} is the variable cost, FC_{it} is the fixed cost, and T is the effective tax rate (the superscripts d and f denote domestic and foreign variables, respectively). Substitution of Equation (7) in Equation (6) gives us the exchange exposure coefficient in terms of revenue and cost variables:

$$\gamma_i = [S_{it}\,\text{cov}(S^f_{it}/S_{it}, e_t) - VC_{it}\,\text{cov}(VC^f_{it}/VC_{it}, e_t)]\,/\,\text{var}(e_t) \quad (8)$$

where $S_{it} = S^d_{it} + S^f_{it}$ and $Vc_{it} = VC^d_{it} + VC^f_{it}$.[3]

Alternatively, following Hodder (1982), the firm value can also be expressed as a function of the firm's assets and liabilities. For this purpose, we may write operating cash flows as:

$$\pi^d_{it} = r^d_{it}A^d_{it};\ \pi^f_{it} = r^f_{it}A^f_{it} \quad (9)$$

where r^d_{it} and r^f_{it} are the rate of returns on domestic (A^d_{it}) and foreign assets (A^f_{it}) respectively. Substitution of Equation (9) in Equation (6) allows us to explain the exchange risk exposure in terms of the firm's identifiable assets:

$$\gamma_i = A_{it}\,\text{cov}(A^f_{it}/A_{it}, e_t)\,/\,\text{var}(e_t) \quad (10)$$

where $A_{it} = A^d_{it} + A^f_{it}$. Equations (6), (8), and (10) are now summarized in functional form as:

$$\gamma_i = f(\pi^d_i, \pi^f_i) = g(S^d_i, S^f_i, VC^d_i, VC^f_i = h(A^d_i, A^f_i) . \quad (11)$$

For empirical tests, we express the exchange risk exposure in Equation (11) as a function of domestic and foreign operating profits, sales, costs, and assets.

Note that foreign and domestic variables are all stated in dollars. Thus, the stated covariances would reflect not only the economic effects on foreign-currency-denominated operational cash flows but also the translation impact of restating cash flows, assets, and liabilities in U.S. dollars. Equation (11) is a general specification that subsumes different operational characteristics and market conditions in the firm's output and input markets.[4] The existence of a positive relationship between exchange risk exposure and firm-specific variables is tested based on the null hypothesis, H_0: $a_1 > 0$, against the alternate, H_1: $a_1 \leq 0$.

Characterization of exchange risk exposure as a function of these firm-specific variables presumes that the exchange risk faced by the firm is not fully eliminated by operational or hedging strategies.[5] Given imperfect hedging, we can expect the exchange exposure of firms to increase with an increase in the firm's overseas assets, sales revenues, or profits. For example, if a firm generates a higher proportion of its revenues from foreign markets, it may face a higher level of exchange rate risk because a larger percentage of its revenues is denominated in foreign currencies. Consequently, *ceteris paribus*, the higher the foreign sales, the greater will be the effect of exchange rate fluctuations on firm value. The sensitivity of the firm's cost structure to exchange rate changes also affects the exchange risk exposure of a firm. Here, we capture this possibility by the inclusion of foreign operating profits in the estimations. Similarly, a firm's ownership of exposed assets abroad affects its value in dollars through the translation effect.[6]

[3]To simplify covariance calculations, the domestic and foreign revenue and cost variables are assumed to be exogenous and independent of each other. In a more general setting, a more complicated expression is obtained. For example, fixed costs become variable in a continuous time framework. A violation of the assumption that domestic and foreign costs and revenues are independent would yield additional covariance terms. These additional covariance terms, however, do not materially change the nature of firm-specific variables used in the empirical work here. Finally, it is also possible to have a covariance involving financial leverage, as in Hamada (1972), by including domestic and foreign debt expenses in Equation (7). This extension, however, is not pursued here because of the difficulty in obtaining the necessary data on the breakdown between domestic and foreign debt and interest expenses.

[4]See Choi (1986) and Errunza and Senbet (1981) for further discussion of exchange rates and firm valuation.

[5]The assumption of imperfect exchange risk hedging has been observed by Grammatikos, Saunders, and Swary (1986) in the case of commercial banking. It is also consistent with the results obtained by Eun and Resnick (1988) for major industrial countries based on aggregate market indices.

[6]Eaker (1980) examines the choice of the currency of denomination for multinational transactions and its effect on exchange risk exposure.

II. Data

Monthly time-series of stock returns (inclusive of dividends) were obtained from the University of Chicago Center for Research in Security Prices (CRSP) tapes for the period of January 1978 to December 1989. Four hundred and nine multinational firms that had complete price and dividend information during the entire sample period are included in the study. A multinational firm is defined as a firm that has production facilities located in more than two countries (Dunning, 1973). Consistent with this definition, we determine the multinationality of a firm using firm-specific information in the COMPUSTAT database. A firm is considered a multinational if its foreign sales, net operating profits, and identifiable physical assets are all 25% or more of their respective corporate totals and exceed U.S. $1 million in 1989.[7] This method of defining multinational firms according to all three foreign operational variables simultaneously is similar to that used in the international business literature. It is also more stringent than using an arbitrary cutoff point for one of these variables on the basis of segment data reported under SFAS No. 14.

The nominal exchange rate variable is the U.S. dollar value of one unit of foreign currency, where foreign currency is the multilateral trade-weighted basket of ten major currencies as published in the *Federal Reserve Bulletin*.[8] An increase in the exchange rate implies an appreciation of the foreign currency and a depreciation of the dollar. We calculate the real exchange rate by adjusting the nominal exchange rate for the U.S. and foreign monthly consumer inflation rates obtained from the appropriate *Federal Reserve Bulletin*. The inflation rates for the foreign country are calculated based on the same trade-weights as used in the multilateral-exchange rate series. The exchange risk factor used in Equation (1) is calculated as the percentage change in the nominal and real exchange rates orthogonalized to the market factor. We also used unexpected exchange rate changes, defined as the difference between actual and expected exchange rates. Expected exchange rates were proxied by the forward rate or based on lagged spot rates. The results in the latter case are consistent with those reported here. The market factor is proxied by the percentage change in the value-weighted, dividend-adjusted CRSP market index. Firm-specific variables used in the study are obtained from the COMPUSTAT database, which contains information from firm 10-K reports.

III. Exchange Risk Sensitivity of Individual Firms

We estimate Equation (1) using the ordinary least squares (OLS) method to obtain exchange risk sensitivity coefficients for the 409 multinational firms.[9] From an econometric standpoint, the generalized least square (GLS) approach, which accounts for the cross-sectional correlation in residuals, is superior to OLS. However, GLS limits the number of firms (cross-sectional series), which must be smaller than the number of observations (time-series). Therefore, rather than grouping data and losing valuable information, we use OLS on individual firms, achieving greater economic information at the potential expense of econometric inefficiency. We apply the GLS approach, in the form of seemingly unrelated regression, to industry data later in this paper.

Table 1 presents the results for the nominal and real exchange risk exposures of individual firms. The results are summarized in terms of the sign and significance of the exposure coefficient. Panel A shows that 61 firms have significant exchange risk sensitivities at the 0.10 level (two-tailed test). Of the firms with significant exchange exposure, 64% benefit from a depreciation of the dollar. The others have a negative exchange exposure coefficient. A positive (negative) coefficient indicates that firms experience an increase (decrease) in stock returns when the dollar depreciates against the foreign currency. The null hypothesis—that exchange rate exposures are zero for all firms ($\gamma_i = 0$)—is rejected at the 0.01 level ($F = 372.57$), thus establishing the existence of exchange risk sensitivity at the firm level.

The nominal and real exchange risk sensitivities of our sample firms are very similar; we observe only a marginal difference in the exact value of the nominal and real exchange risk sensitivity coefficient. The firms that are exposed significantly to nominal exchange risk are also the ones that exhibit significant real exchange risk coefficients. Of the 63 firms with a significant real exchange risk coefficient, 59% have a positive coefficient. Given these

[7]We recognize that given our arbitrary classification date of 1989, there is no control for firms that may have changed classification during the sample period. Lack of data availability and incomplete data during the earlier periods are the principal reasons we base our classifications on the last year in our sample period.

[8]The weights of each currency are: 0.064 Belgian franc, 0.091 Canadian dollar, 0.131 French franc, 0.208 German mark, 0.090 Italian lira, 0.136 Japanese yen, 0.083 Dutch guilder, 0.042 Swedish krona, 0.036 Swiss franc, and 0.119 British pound. These weights are based on the average trade shares of the 10 countries for a five-year period: 1972-1976. (*Federal Reserve Bulletin*, August 1978, p. 700).

[9]We examined the original stock return data and the residuals from the regression procedure to detect outliers. Forty-two of the 409 firms exhibited one to three outliers (3 deviations from the mean) from a total of 140 observations per firm. In reestimating the regressions for these 42 firms, we excluded the outliers.

Table 1. Exchange Risk Exposure of Individual Firms: 1978-89

$$R_{it} = \alpha_i + \beta_j R_{mt} + \gamma_i e_t + v_{it}$$

The exchange risk exposure coefficient, γ_i, is estimated individually for 409 multinational firms using monthly time-series data for the 1978-89 period. Estimations use the OLS approach. R_{it} is the rate of return on stock i, R_{mt} is the percentage change in the CRSP value-weighted market index, and e_t is the percentage change in dollar value of one unit of a trade-weighted basket of currencies. The exchange rate factor is orthogonal to the market factor. The real exchange rate is calculated by adjusting the nominal data for the U.S. and foreign inflation rates. Panel A provides information about the nominal and real exchange risk exposure coefficients. Panel B tests for the overall exchange risk exposure of all 409 firms.

Panel A. Exchange Risk Exposures

Total Firms	Significant Exposure (% Total Firms)	Positive Exposure (% Significant)[a]	Negative Exposure (% Significant)[a]
(i) The Nominal Exchange Exposure Estimations			
409	61 (15%)	39 (64%)	22 (36%)
(ii) The Real Exchange Exposure Estimations			
409	63 (15%)	37 (59%)	26 (41%)

Panel B. Test of Overall Exchange Risk Exposures

H_0: No exchange exposure exists. ($\gamma_i = 0$) F value = 372.57***

***Significant at the 0.01 level.

[a]The exchange exposure coefficients in Panel A are evaluated at the 0.10 level using a two-tailed test.

Table 2. Exchange Risk Sensitivity Coefficients Based on Nominal Data for the 1978-1989 Period

This table reports summary statistics based on nominal exchange risk exposure coefficients reported in Panel A of Table 1. Only the 61 firms with significant nominal exchange risk exposures are included in this analysis. Quartiles are formed by ranking the exposure coefficients in descending order.

	Mean	Std. Deviation	Maximum	Minimum
1. All 61 Firms with Significant Exposure	0.1567	0.7350	1.6677	-1.1965
2. First Quartile	0.9043	0.2653	1.6677	0.6764
3. Second Quartile	0.5565	0.0522	0.6711	0.4981
4. Third Quartile	-0.0057	0.4756	0.4905	-0.5998
5. Fourth Quartile	-0.8780	0.1608	-0.6758	-1.1965

results, and the fact that it is the nominal exposure that is reported in financial statements, the following estimations use only nominal data.

We observe cross-sectional variations in the exchange risk sensitivity of individual firms. As reported in Table 1, some of the sample firms gain, while others lose, when the dollar depreciates. These variations, and their relationship to firm-specific variables, is examined in detail in the following section. Table 2 provides summary statistics on the exchange exposure coefficients of the 61 firms with significant

nominal exchange exposures. In addition to the benefits or loss (direction) effect, the information in Table 2 reflects differences in the degree of exchange risk sensitivity of firms. The nominal exchange risk coefficients vary from -1.1965 to 1.6677, with a mean of 0.1567 for the group of 61 firms. Thus, on average, a 1% depreciation of the dollar is accompanied by a 0.15% increase in the stock return. Examination by quartiles provides a better understanding of the distribution of these coefficient values. The 61 coefficients are ranked in descending order and grouped into quartiles. The first quartile, which includes the firms with the highest positive-exposure coefficients, has an average coefficient of 0.9043, while the fourth quartile, with lowest negative-coefficient values, has a mean coefficient of -0.8780.

The fact that we do not find a large percentage of firms with significant exchange risk sensitivity is not inconsistent with the theory posited in the paper. A fundamental motivation for our study is grounded in the insight that exchange rate fluctuations, like any other macroeconomic factor, should have varying effects on firm value. We argue that variations in exchange risk sensitivity of firm value are a reflection of differences in firm-specific economic, operational, and policy variables.[10] For example, the impact of exchange rate fluctuations on firm value should depend on whether the firm has net exposure on the foreign cost side (cash outflow) or on the foreign revenue side (cash inflow). Firms with net cash outflow exposure (import-oriented firms) should benefit, while firms with net cash inflow exposure should lose from appreciation of the dollar. Similarly, some firms may have foreign cash inflows almost offsetting foreign cash outflows. The value of these firms will be unaffected by changes in exchange rates even if they have extensive foreign operations. For example, Hewlett Packard, a representative firm, derives a significant portion of its revenues from foreign markets (approximately 50% in 1994) and has production facilities in several countries (more than ten in 1994) but displays an insignificant exchange risk sensitivity coefficient.[11]

Another firm-specific operational variable affecting exchange risk sensitivity of a firm is its policy regarding the degree of risk aversion and its hedging strategies. Such hedging decisions can effectively disguise the potential exchange risk exposure of a firm by sheltering cash flows from exchange rate fluctuations. For example, Eastman Kodak, known to be innovative and sometimes aggressive in its exchange risk management strategies, displays a significant exposure of -0.4386, while Polaroid, a firm in the same SIC classification, is more conservative and has an insignificant exchange risk exposure.

Bartov and Bodnar (1994) provide an additional justification for finding insignificant exchange risk exposure. They suggest that firms that can respond to exchange rate changes and overall international market conditions at low cost will tend to have insignificant exchange risk exposure. Consistent with our arguments, we find evidence suggesting that foreign cash inflows (revenues) and outflows (costs) are exposed to exchange rate fluctuations. However, offsetting cash flows can minimize the exposure to exchange risk. Supporting empirical evidence is presented in the following section, where we examine the effect of several firm-specific international-business operational variables on the exchange risk sensitivity of a firm. However, due to the lack of detailed information, the effect of management profiles and exchange risk hedging strategies is left for future investigation.

Before moving on to firm-specific estimation, a caveat is in order. Given the possibility that estimations based on the two-factor model may be biased due to the existence of omitted variables, the robustness of the results presented here is evaluated using an alternative model specification. We specify a three-factor model where interest rate risk augments the market and exchange risk factors.[12] Use of the interest rate variable is well-supported in the existing literature (for example, Choi, Elyasiani, and Kopecky, 1992, and Sweeny and Warga, 1986). The interest-rate risk factor is calculated as the change in the three-month U.S. Treasury bill rate. Results obtained reveal 61 firms with significant exchange risk exposures. These are the same firms that were significantly exposed to exchange risk according to the two-factor model. The sign of the exchange risk coefficient is also consistent with the two-factor model; 59% of the significant exposures are positive and 41% negative.

IV. Firm-Specific Determinants of Exchange Risk Sensitivity

Based on Equation (11), we estimate the following linearized equation to test the null hypothesis that exchange risk coefficients are positively correlated with variables that indicate the extent of a firm's international operations:

$$\gamma_i = a_0 + a_1 X_{it}; \quad (12)$$
$$X_{it} = S^f_{it}, A^f_{it}, \text{ or } \pi^f_{it}$$

[10]Bartov and Bodnar (1994) present similar arguments in their recent study on the relationship between exchange rate changes and firm performance.

[11]Quantitative information about specific firms was obtained from annual reports and documents submitted to the SEC.

[12]We recognize that the use of a three-factor model does not preclude the possibility of the existence of other fundamental economic factors.

where S^f_{it} is the foreign sales revenue, A^f_{it} is the foreign identifiable assets, and π^f_{it} is the foreign operating profit. All firm-specific variables are measured in billions of U.S. dollars. Data on firm-specific variables are plagued with problems, such as missing data items, and observations are missing in the series that are available. This limitation forces us to drop the cost variable in Equation (11) from the empirical tests. The effects of the cost variable on the exchange risk sensitivity, however, should be reflected in the operating profit variable. We find usable information for the three variables listed in Equation (12) for the five-year period 1985 to 1989. Cross-sectional estimations are carried out for each of these five years and for the average data during 1985-89.

Prior studies have defined firm-specific variables either as ratios or as levels in evaluating the multinationality of a firm. However, high foreign sales ratios generally do not indicate greater exchange exposure across firms of different sizes. For example, a firm with $200 million in total sales and a 20% foreign sales ratio will have a larger cash flow exposed to exchange rate risk than a firm with $100 million in total sales and a 20% foreign sales ratio. Therefore, we use the *level* of foreign variables rather than *ratios* of foreign to domestic variables. To avoid multicollinearity, each of these variables is estimated separately.

Following Fama and French (1992), estimations are carried out in two steps, using non-overlapping periods. Exchange risk betas are estimated using time-series data for 1978-84, while cross-sectional estimates use the 1985-89 time period. These estimations are based on the 61 firms with significant exchange exposure coefficients. Firms with insignificant exposures are excluded from the present analysis. If the exposure coefficient is insignificant, we cannot use it to derive any reliable conclusion about its relationship with firm-specific variables. Initial estimations based on the absolute value of the exchange risk coefficient, γ_i, show that foreign sales and foreign assets are significant during the overall sample period of 1985-89 (Panel A of Table 3). Foreign sales and assets also yield significant results for three of the five individual years—1987, 1988, and 1989. Foreign operating profits are significant for the first three years.

Next, we separate the data based on the sign of the exchange exposure coefficient. Estimations based on firms with a positive coefficient (Panel B) and those with a negative coefficient (Panel C) yield similar results. For the sample of firms with positive coefficients, all three foreign variables are significant for the overall sample period and for two of the five individual years. We observe some sensitivity to the particular firm-specific variable selected; the foreign sales variable shows superior performance relative to the other two variables. Foreign operating profits are significant for two years for the sample of firms with positive coefficients and for three years for the sample of firms with negative coefficients. Overall, all three firm-specific variables have positive coefficients supporting a positive association between foreign operations and exchange risk exposure.

V. Exchange Risk Sensitivity of Firms During Sub-Periods

The overall sample period of 1978-89 reveals subperiods with different secular trends. There is a steep increase in the value of the dollar until March 1985. The following period, characterized by the Plaza Accord in 1985 and the Louvre Accord in 1987, indicates a declining trend until early 1987, followed by a relatively mixed pattern. For example, a dollar depreciation implies an increase in domestic prices of foreign goods, while a dollar appreciation portends a decrease in domestic prices. The falling value of the dollar makes exporters more price competitive, while a rising dollar benefits importers. However, given the short-run downward price rigidity in the economy, a price decrease is not as likely as a price increase. Therefore, a dollar depreciation and a dollar appreciation may not bring about symmetric changes in firm value. Thus, we test for any variations in the exchange risk sensitivity during different dollar regimes. The overall sample period is divided into the strong-dollar period of January 1978 to March 1985 and the weak-dollar period of April 1985 to December 1989.

Estimation results in Panel A of Table 4 indicate that exchange rate effects vary during the two dollar regimes; the number of firms with significant exchange risk sensitivity is higher during the weak-dollar period. The exposure coefficients range from 1.832 to -1.255 for the strong-dollar period and from 1.702 to -2.044 for the weak-dollar period. The direction of exchange rate effects for both subperiods is consistent with that for the overall sample period; the majority of firms (68%-71%) gain from a depreciation in the value of the dollar. The falling value of the dollar makes exporters more price competitive, while a rising dollar benefits importers. However, given the downward price rigidity, both changes do not have symmetrical effects. Estimations based on equally-spaced subperiods yield similar results. However, these results need to be interpreted with caution, given that each subperiod is too small for broad generalizations.

Table 3. Firm-Specific Determinants of Exchange Exposure

$$\gamma_{it} = a_0 + a_1 X_{it}; \qquad X_{it} = S^f_{it}, A^f_{it}, \pi^f_{it}$$

The exchange risk sensitivity coefficient, γ_{it}, is estimated for individual firms over the 1978-84 period, using the two-factor model (Equation 1). The effect of the firm-specific variables on the exchange risk sensitivity is examined using cross-sectional data for the 1985-89 period. Separate estimations are conducted for each of the five years, 1985 to 1989, and on average data for the combined five-year period. Panel A reports results based on the 61 firms with significant exchange risk exposures. Given that firms exhibit both positive and negative coefficients, Panel B evaluates the 39 firms with positive coefficients, and Panel C examines the 22 firms with negative exposure coefficients. We expect to find positive correlation between firm-specific variables and the exchange exposure coefficient. Therefore, a one-tail test is used to test the null hypothesis of $a_1 > 0$ against the alternate of $a_1 \leq 0$. All firm-specific variables are measured in billions of U.S. dollars. S^f is the foreign sales revenue of firm i of dollars, A^f is the foreign identifiable assets of firm i, and π^f is the foreign operating profits of firm i.

Panel A. Estimations Using Absolute Exchange Rate Exposure Coefficients[a]

	1985	1986	1987	1988	1989	1985-1989
S^f	-0.007	-0.015	0.0192**	0.0114*	0.0100*	0.0112*
	(-0.29)	(-0.71)	(1.722)	(1.514)	(1.469)	(1.520)
A^f	0.0018	-0.004	0.0185**	0.0117**	0.0114*	0.0159*
	(0.067)	(-0.19)	(1.824)	(1.688)	(1.626)	(1.438)
π^f	-0.292*	-0.219*	0.1671*	0.0745	0.0724	0.0810
	(-1.48)	(-1.47)	(1.641)	(1.276)	(1.222)	(1.193)

Panel B. Estimation Using Positive Exchange Rate Exposure Coefficients[a]

	1985	1986	1987	1988	1989	1985-1989
S^f	0.0156*	0.0059	0.0133**	0.0129*	0.0119**	0.0131**
	(1.615)	(0.243)	(1.650)	(1.638)	(1.664)	(1.739)
A^f	0.0266	0.0183	0.0129**	0.0130**	0.0133**	0.0209**
	(0.915)	(0.702)	(1.782)	(1.787)	(1.860)	(1.810)
π^f	-0.215	-0.150	0.0881*	0.0847*	0.0814	0.0954*
	(-1.06)	(-0.91)	(1.277)	(1.362)	(1.280)	(1.357)

Panel C. Estimations Using Negative Exchange Rate Exposure Coefficients[a]

	1985	1986	1987	1988	1989	1985-1989
S^f	0.0079*	0.0061*	0.0538*	0.0037**	0.0027**	0.0053*
	(1.352)	(1.520)	(1.569)	(1.663)	(1.660)	(1.631)
A^f	0.0067	0.0065*	0.0047*	0.0244	0.0018	0.0041
	(1.195)	(1.334)	(1.285)	(0.920)	(0.868)	(1.200)
π^f	0.8710*	0.4561*	0.4275*	0.2180	0.1732	0.4175*
	(1.489)	(1.391)	(1.408)	(1.060)	(0.827)	(1.382)

**Significant at the 0.05 level.
*Significant at the 0.10 level.

[a]Numbers in parentheses are t values.

Table 4. Exchange Risk Exposure of Individual Firms During the Subperiods

$$R_{it} = \alpha_i + \beta_i R_{mt} + \gamma_i e_t + v_{it}$$

This table reports the variability in the nominal exchange risk exposure coefficients during various subperiods. The overall sample period is segmented based on the trends in the dollar and then into equally-spaced subperiods. Estimations are based on the two-factor model for the 409 multinational firms. R_{it} is the rate of return on stock i, R_{mt} is the percentage change in the CRSP value-weighted market index, and e_t is the percentage change in exchange rates. The exchange rate factor is orthogonal to the market factor.

Panel A. Subperiods Based on Dollar Value

Firms with Significant Exposure	Average Value of γ_i	Positive Exposure (% Significant)[a]	Negative Exposure (% Significant)[a]
(i) Strong-Dollar Period (1/78-3/85)			
34 (8%)	0.4042	23 (68%)	11 (32%)
(ii) Weak-Dollar Period (4/85-12/89)			
55 (13%)	0.3950	39 (71%)	16 (29%)

Panel B. Equally-Spaced Subperiods

Firms with Significant Exposure	Average Value of γ_i	Positive Exposure (% Significant)[a]	Negative Exposure (% Significant)[a]
(i) First Subperiod (1/78-12/83)			
31 (8%)	0.3826	20 (65%)	11 (35%)
(ii) Second Subperiod (1/84-12/89)			
44 (11%)	0.6401	38 (86%)	6 (14%)

[a]The significance of exchange exposure is evaluated at the 0.10 level using a two-tailed test.

VI. Exchange Risk Sensitivity of Industry Groups

In this section, we shift our focus from individual firms to industry groups. We explore the possibility that the exchange risk exposure patterns are industry-specific. We recognize that exchange exposure patterns may be examined by using other classification schemes, such as capitalization-ranked portfolios or the export- or import-orientation of firms. However, given our focus on examining industry-specific exchange risk sensitivity, and to facilitate comparison with Jorion's (1990) results, we use two-digit SIC codes to group the 409 firms into 20 industry portfolios.

Table 5 provides the SIC-codes and the number of firms per industry portfolio. Once the industry portfolios are formed, we employ the seemingly unrelated regressions (SUR) technique to estimate exchange rate sensitivity for each of these industry portfolios. This method incorporates the cross-sectional interdependency of residuals. Results from the two-factor model during the 1978-89 period reveal only two industries, mining and other retail, with positive exchange exposure coefficients that are significant at the 0.10 level (two-tailed test). These results are consistent with Jorion (1990). The exchange exposure coefficients range from -0.270 for department stores to 0.361 for mining. In terms of absolute-values, the high end of exposure coefficients is dominated by textiles and apparel, retail, and department stores. The sign of the coefficient is negative for each of these groups. This suggests that as a group, firms in these industries face a greater exposure on their cost side and, thus, lose when the dollar depreciates. The low degree of exchange risk exposure for utilities is explained by the fact that firms in this industry are protected by dollar pricing of energy products and by government regulations. The F statistic of 5.128 rejects the null hypothesis of equal exposures across industries at the 0.02 level.

The fact that a lot of variation is lost in the aggregation process provides an econometric justification for finding few industries with significant exchange risk sensitivity. Another explanation is that firms within an industry group are not necessarily homogeneous in their operational

Table 5. Exchange Risk Exposure of Industry Portfolios

$$\text{Two-Factor Model: } R_{it} = \alpha_i + \beta_i R_{mt} + \gamma_i e_t + v_{it}$$

$$\text{Three-Factor Model: } R_{it} = \alpha_i + \beta_i R_{mt} + \gamma_i e_t + \delta_i g_t + v_{it}$$

A two-factor and a three-factor model are employed to estimate the exchange risk sensitivity of 20 SIC-based portfolios. Estimations use the SUR approach to allow for cross-sectional correlations in the residuals. R_{it} is the rate of return on stock i, R_{mt} is the percentage change in the CRSP value-weighted market index, e_t is the percentage change in exchange rates, and δ_t is the change in the three-month treasury bill rate. The interest rate and exchange rate factors are orthogonal to the market factor.[a]

Industry	SIC	No. of Firms	1978-89 (2-Factor) γ_i	1978-89 (3-Factor) γ_i	1/78-3/85 (2-Factor) γ_i	4/85-12/89 (2-Factor) γ_i
Mining	10-14	27	0.361**	0.351*	0.633**	0.048
			(1.98)	(1.87)	(2.56)	(0.17)
Food & Beverages	20	23	-0.091	-0.099	-0.180	-0.011
			(-0.88)	(-0.92)	(-1.34)	(-0.06)
Textile & Apparel Products	22, 23	9	-0.151	-0.0860	0.077	-0.281
			(-0.79)	(-0.44)	(0.31)	(-0.89)
Paper Products	26	11	0.162	0.170	0.011	0.357**
			(1.36)	(1.39)	(0.06)	(2.06)
Chemical	28	50	0.083	0.088	0.022	0.146*
			(1.26)	(1.31)	(0.22)	(1.70)
Petroleum	29	10	0.172	0.159	0.193	0.121
			(0.91)	(0.81)	(0.72)	(0.44)
Stone, Clay & Glass	32	10	-0.061	-0.029	-0.024	-0.072
			(-0.43)	(-0.20)	(-0.14)	(-0.28)
Primary Metals	33	15	0.089	0.128	0.290	-0.042
			(0.49)	(0.70)	(1.31)	(-0.13)
Fabricated Metals	34	18	0.049	0.051	0.112	-0.010
			(0.43)	(0.42)	(0.63)	(-0.06)
Machinery	35	45	0.043	0.072	0.087	0.132
			(0.35)	(0.57)	(0.55)	(0.64)
Electrical Equipment	36	42	-0.032	-0.031	0.035	0.042
			(-0.26)	(-0.24)	(0.19)	(0.25)
Transport Equipment	37	20	-0.180	-0.164	-0.035	-0.204
			(-1.53)	(-1.38)	(-0.21)	(-1.24)
Miscellaneous Manufacture	38, 39	24	-0.036	-0.021	0.036	0.021
			(-0.33)	(-0.18)	(0.02)	(0.14)
Railroads	40	2	0.045	0.036	0.299	-0.146
			(0.24)	(0.19)	(1.12)	(-0.53)
Other Transport	41-47	5	-0.093	-0.111	0.174	-0.405
			(-0.54)	(-0.63)	(0.74)	(-1.52)
Utilities	49	11	0.082	0.073	-0.006	0.197
			(0.85)	(0.73)	(-0.04)	(1.47)
Department Stores	53	5	-0.270	-0.265	-0.258	-0.182
			(-1.53)	(-1.48)	(-0.93)	(-0.82)
Other Retail	50-52, 54-59	18	-0.245*	-0.241*	-0.252	-0.159
			(-1.90)	(-1.83)	(-1.22)	(-1.04)
Finance, Real Estate	60-69	16	0.059	0.058	0.184*	-0.049
			(0.77)	(0.75)	(1.82)	(-0.40)
Other	Other	48	-0.117	-0.084	-0.011	-0.150
			(-1.26)	(-0.90)	(-0.08)	(-1.26)

**Significant at the 0.05 level.

*Significant at the 0.10 level.

[a]Numbers in parentheses are t values, based on a two-tailed test.

characteristics or in their financial strategies.[13] Further study is needed to explain the exchange risk exposure characteristics of various industry groups in a greater detail.

The robustness of these results is examined by estimating a three-factor model that includes interest rate risk (Table 5). Once again, we find that results are consistent with the two-factor model; the same two industry portfolios (mining and other retail) are significantly exposed. The intertemporal behavior of exchange rate exposures for the industry groups is also similar to that of individual firms. We find only two industry groups with significant exchange risk exposures during each of the subperiods. During the strong-dollar period mining and finance and real estate display positive exchange exposure coefficients that are significant at the 0.10 level. Financial firms, part of the finance and real estate industry, appear to gain when the dollar is strong, perhaps due to the increased international capital inflow into dollar-denominated securities. However, subperiod results cannot be generalized because of the limited number of observations in each subperiod.

VII. Summary

In this paper, we estimated a model of firm valuation to examine the exchange risk sensitivity of firm value. The model was estimated for 409 U.S. multinational firms during the 1978-1989 period and for 20 industry portfolios. Results for individual firms indicated that approximately 60% of the firms with significant exchange risk exposure benefited, and 40% lost, with a depreciation of the dollar. The evaluation of exchange rate sensitivity during different dollar regimes revealed a higher percentage of firms with significant exchange exposures during the weak-dollar regime. Downward price rigidity in the short run may be one reason for this exposure pattern.

When we examined exchange risk exposures at the industry level by grouping the firms into 20 portfolios based on two-digit SIC codes, we found limited support for the importance of the exchange rate factor. This may be explained by the fact that although firms in a given industry are in the same primary line of business, they are still heterogeneous in terms of their operational and financial characteristics. Since industry groups include firms with positive and negative exchange risk exposure, aggregating across such firms will result in finding an insignificant exposure coefficient for the industry group.

We also found that the cross-sectional variation in exchange risk sensitivity of individual firms is related to firm-specific operational variables. Our estimations revealed a positive relationship between the scope of the foreign operations of a firm—measured by foreign sales, assets, and operating profits—and its exchange risk sensitivity. Future studies that include additional operational and managerial information collected from survey data should provide further insights into the complex relationship between exchange rate fluctuations and firm value. ■

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[13]We experimented with various grouping procedures based on SIC codes. For example, we combined industry groups with similar characteristics (e.g., textile and apparel, department stores, and other retail), and we also further decomposed an industry group into sub-groups using all four-digits of SIC codes (e.g., electrical equipment (3600-3699) into electrical (3600-3669) and electronic & computers (3670-3699)), in each case without significantly different results. This supports our thesis that exchange risk sensitivity may be more of a firm-specific phenomenon than an industry-specific one.

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