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ASYMMETRIC CORPORATE EXPOSURES TO FOREIGN EXCHANGE RATES

Research examining firms' economic exposures to exchange rate movements has not differentiated periods of foreign currency appreciation and depreciation when estimating exposure coefficients. Recent theoretical developments regarding real options and pricing-to-market suggest corporate exposures may be asymmetric (i.e., the financial performance impact of a foreign currency appreciation may not be offset by the currency's depreciation). Through an empirical examination of manufacturing firms' economic exposures to exchange rate movements, this paper furnishes evidence on exposure asymmetries.

Economic exposure is the sensitivity of the real value of the firm to fluctuations in real foreign exchange rates (Shapiro, 1992). This focus on economic valuation contrasts with accounting-based transaction and translation exposures defined in terms of the book values of assets and liabilities denominated in foreign currencies. In a simple single-currency model, the economic exposure of a firm can be estimated from time series data as the coefficient computed by regressing real shareholder returns on the percentage change in a real foreign exchange rate (e.g., Booth & Rotenberg, 1990). Computing economic exposure as a single regression coefficient assumes the firm valuation effects associated with exchange rate appreciation and depreciation are symmetric. That is, in all previous research estimating economic exposure coefficients, a single exposure coefficient was estimated from time series data with no distinction made between periods of real currency appreciation and depreciation.

Recent theoretical developments in finance and economics challenge the assumption that the financial performance effects associated with exchange rate appreciation and depreciation are symmetric. Research applying option theory to strategic decisions views investments enhancing strategic flexibility as "real options" (Myers, 1977). Since the firm will choose to exercise a real option only when such action would result in a positive payoff, options provide nonlinear payoff functions allowing for potential gains while limiting downside risk. If firms use real options to hedge economic exposure to foreign exchange rate movements, we would observe different exposure coefficients for periods of foreign currency appreciation and depreciation.

A second theoretical perspective suggesting differential payoffs associated with upward and downward movements in real exchange rates is found in the pricing-to-market research in economics. Pricing-to-market refers to the corporate practice of not fully passing through movements in foreign exchange rates when pricing a product in international markets. As such, the corporation allows its home currency denominated margins on foreign sales to fluctuate. For export firms this may mean improved margins on sales as the home country currency depreciates since the resulting reduction in costs is not fully reflected in foreign currency denominated prices. Alternatively, if the home country currency of an exporter appreciates, margins earned on foreign sales may be adversely affected. These effects on sales margins may not be symmetric, however, if firms face sales constraints in international markets or if they seek to exploit currency fluctuations to build market share. Research

on pricing-to-market identifies plausible conditions under which firm pricing decisions in international markets may result in asymmetric payoffs.

This study examines whether U.S. corporations experience asymmetric exposures to foreign exchange rate movements (i.e., different exposure coefficients when foreign currencies appreciate than when they depreciate). The initial section of the paper discusses economic exposure to foreign exchange rates and the implications of options theory and pricing-to-market theory for corporate economic exposures. The empirical portion of the study examines exposure patterns in U.S. manufacturing firms. In contrast to previous empirical work assuming symmetric exposures to foreign exchange rate movements, the analysis differentiates periods of foreign currency appreciation and depreciation. The empirical evidence indicates the extent to which U.S. corporations exhibit patterns of asymmetric exposures consistent with option theory and pricing-to-market behavior.

THEORETICAL BACKGROUND

Economic Exposure

While economic exposure refers to the sensitivity of the real value of a company to fluctuations in any environmental contingency, it has been most frequently addressed in the context of real movements in foreign exchange rates (e.g., Adler & Dumas, 1984; Garner & Shapiro, 1984; Shapiro, 1992). While accounting exposure is a function of nominal movements in foreign exchange rates, economic exposure focuses on real changes in foreign exchange rates. Real, rather than nominal exchange rate movements, have an impact on the competitive position of a company, affecting expected cash flows and, hence, the market valuation of the firm. As such, economic exposure is a forward-looking concept considering future cash flows rather than historical accounting values.

A simple bivariate linear model for estimating the economic exposure of a firm to movements in the real spot dollar price of the Deutsche mark takes the form:

$$(1) \qquad R_j(t) = \beta_{0j} + \beta_{1j} R_{DM}(t) + \varepsilon_j(t),$$

where $R_j(t)$ is the real rate of return in period t to firm j shareholders and $R_{DM}(t)$ is the rate of change in the real dollar spot price of the Deutsche mark over the same period. The coefficient β_{1j} measures the elasticity of firm value with respect to movements in the dollar spot price of the Deutsche mark.

Booth and Rotenberg (1990), Amihud (1994), Bodnar and Gentry (1993), and Jorion (1990) have contributed empirical research on the estimation of corporate economic exposures to foreign exchange rate movements using simple bivariate models. Booth and Rotenberg (1990) considered the effects of movements in the Canadian dollar relative to the U.S. dollar on stock returns of Canadian companies. Amihud (1994), Bodnar and Gentry (1993), and Jorion (1990) estimated economic exposure coefficients for U.S. corporations using trade-weighted sums of major currencies as their foreign exchange proxies. In constructing their indices, Jorion (1990) and Bodnar and Gentry (1993) aggregated nominal exchange rates while Amihud (1994) used real exchange rates.

Miller and Reuer (1994) criticized the methodologies used in these studies and implemented an alternative approach to estimating corporate economic exposures. Following the theoretical arguments of Oxelheim and Wihlborg (1987), Miller and Reuer (1994) estimated exposure to foreign exchange rate movements using a multiple currency model which controlled for other macroeconomic variables correlated with real exchange rates. We discuss their approach in the methodology section.

No previous research has differentiated the exposure coefficients for foreign currency appreciation and depreciation. The methodology section provides an approach for estimating firms' exposure coefficients without imposing an assumption of exposure coefficient symmetry.

Option Theory

An option grants its owner a right which may be exercised at the owner's discretion. For example, the owner of a call option has the right to acquire an asset at a specified exercise (strike) price. The top portion of Figure 1 indicates the payoff profile for a call option on an asset which changes in value with movements in the spot dollar price of the Deutsche mark, S_{DM}. The owner of a call option will exercise the option only if it has a positive payoff. Such discretion eliminates potential downside outcomes for the option holder. That is, in the event that the payoff would be negative, the option will not be exercised.

A put option confers the right to sell an asset at a specified price. The value of a put option rises as the price of the underlying asset drops in value. The lower portion of Figure 1 indicates the payoff profile of a put option on an asset which changes in value with movements in the spot dollar price of the Deutsche mark, S_{DM}. The key characteristic of options is their asymmetric payoff profiles illustrated in Figure 1.

Insert Figure 1 about here

Real options are analogous to financial options and share the same asymmetric payoff characteristics. Myers (1977) coined the term "real options" to refer to the growth opportunities available to a firm. An initial entry investment, analogous to the purchase price of a financial option, confers the flexibility to engage in future expansion within this line of business. Such call options grant managers the right, but not the obligation, to grow the business. Such options provide a contribution to firm value beyond expected cash flows because they enable the firm to exploit favorable outcomes of uncertain environmental contingencies (e.g., unexpected demand or the resolution of technological uncertainty). Subsequent research has expanded the concept of real options to include other opportunities associated with corporate strategic flexibility (Bowman & Hurry, 1993; Hurry, Miller, & Bowman, 1992; Kogut, 1991; Sanchez, 1993). Real options may take either the form of expansion (call) or abandonment (put) options.

Kogut (1983) observed that, by virtue of their network of geographically-dispersed subsidiaries, multinational corporations (MNCs) possess valuable options. Option characteristics are evident in the flexibility of MNCs to shift input sourcing, production, and marketing from one country to another. Kogut and Kulatilaka (1994) modeled the option value associated with managing a geographically-dispersed set of subsidiaries as a coordinated network. In their model, a MNC shifts production between manufacturing plants in different countries in response to movements in foreign exchange rates. Such production flexibility constitutes a real option which adds value to a MNC. Recent corporate reactions to the Mexican peso devaluation evidence the importance of production location decisions for managing foreign exchange rate movements.

Real options theory suggests that flexibility allows the firm to selectively exploit currency movements to its advantage while also sheltering the firm during periods when exposure would adversely impact firm value. For

firms with real or financial options on assets with real valuations tied to movements in the real value of the Deutsche mark, option theory predicts corporate exposure coefficients differ depending on whether the Deutsche mark appreciates or depreciates. Having a call option on an asset that appreciates with the real value of the Deutsche mark would be consistent with a positive exposure coefficient ($\beta_{1j} > 0$) when the Deutsche mark appreciates but no exposure ($\beta_{1j} = 0$) when the Deutsche mark depreciates. Alternatively, having a put option on an asset that appreciates with the real value of the Deutsche mark would be consistent with a negative exposure coefficient ($\beta_{1j} < 0$) when the Deutsche mark depreciates but no exposure ($\beta_{1j} = 0$) when the Deutsche mark appreciates. Such asymmetric exposure coefficients are consistent with the call and put option payoff profiles depicted in Figure 1.

If firms do not possess options for managing foreign exchange exposure, we would observe symmetric exposures for both appreciation and depreciation of the Deutsche mark. Hence, for firms with symmetric (non-zero) exposure coefficients, we might observe either positive ($\beta_{1j} > 0$) or negative ($\beta_{1j} < 0$) exposures and the sign of the exposure coefficients would be the same for periods of Deutsche mark appreciation and depreciation. We might also observe many firms with no exposure (i.e., β_{1j} not significantly different from zero) regardless of whether the Deutsche mark appreciates or depreciates. Since previous research on economic exposure to foreign exchange movements has not differentiated between periods of currency appreciation and depreciation, these studies made an implicit assumption of exposure symmetry.

Splitting time series data into periods of Deutsche mark appreciation and periods of depreciation, we can estimate a firm's two exposure coefficients using equation (1). Given three possible exposure coefficient values for Deutsche mark appreciation ($R_{DM}(t) > 0$) and Deutsche mark depreciation ($R_{DM}(t) < 0$), there are nine possible exposure coefficient combinations. Table 1 summarizes these nine combinations. Of these nine combinations, two (cells II and VI) are consistent with the use of options to hedge exposures, two indicate symmetric exposures (cells I and IX), and one combination indicates no significant exposures for either Deutsche mark appreciation or depreciation (cell V). Based on previous research on economic exposure to foreign exchange rates using the assumption of symmetric exposures (Miller & Reuer, 1994), we would expect most firms to fall in the center box, indicating no significant exposure. Option theory provides no basis for finding firms in the remaining cells. The

upper right-hand box (III) indicates a firm that benefits from any movement in the Deutsche mark away from its current real value. Such a position, referred to as a "straddle," is unlikely to be feasible because of the associated high costs. The three lower left-hand cells (IV, VII, and VIII) indicate firms that are adversely affected by exchange rates but fail to realize any symmetric benefit when exchange rates move in the opposite direction. This would indicate particularly poor management of currency risk.

Insert Table 1 about here

Pricing-to-Market

The economics literature on pricing-to-market presents alternative hypotheses regarding expected patterns of corporate exposures to foreign exchange rate movements. In contrast to option theory which stresses the value of flexibility associated with relocating input sourcing and production within a multinational network, pricing-to-market theory focuses on product pricing decisions in international markets. While theoretical work on pricing-to-market considers firm-level marketing constraints and international marketing strategies, empirical research has been conducted at the industry or nation level of analysis. Similar to option theory, pricing-to-market theory examines the dynamics of firms' responses to currency shifts and, under certain conditions, predicts asymmetric patterns in corporate exposures.

The decline in the dollar during the latter half of the 1980s drew economists' attention to the question of the balance of payment implications of such currency movements. Krugman (1987) considered the possibility that firms supplying foreign markets seek to maintain local currency price stability rather than maintain constant margins in home currency terms. For a U.S. corporation, maintaining constant dollar denominated margins implies fully passing through movements in the dollar to its international customers. Partial pass-through of currency movements to international customers (i.e., pricing-to-market) suggests that local demand and competitive conditions influence pricing decisions. Some research evidence indicates Japanese and German exporters have a greater propensity to price-to-market than do U.S. exporters, which more fully pass through movements in the dollar (Mann, 1986; Krugman, 1987; Knetter, 1989, 1993; Ohno, 1989; Kasa, 1992; Marston, 1990).

Much of the pricing-to-market literature has addressed the pricing practices of export firms. It is generally expected that exporters increase their profits during periods of foreign currency appreciation. Appreciation of foreign currencies makes domestic companies more cost competitive in international markets. Conversely, during periods of foreign currency depreciation, foreign profit margins drop. The variability in home currency-denominated profit margins when exchange rates move is a geographic form of price discrimination. The ability to engage in such discriminatory pricing is conditioned by the extent to which a product has a unique product-market positioning, reducing the substitutability for other competing products. There must also be sufficient barriers to arbitrage across country borders due, for example, to transportation costs and trade barriers. A multidomestic strategy of product tailoring to local markets also reduces the potential for cross-border arbitrage.

Baldwin (1988) and Dixit (1989) developed models in which sunk costs give rise to asymmetric pricing responses to exchange rate movements. While all foreign market entry modes have some associated sunk costs, we would expect sunk costs to increase as firms move from export and contractual entry modes to foreign direct investment. According to these models, real appreciation of a foreign currency induces entry to supply the foreign market. The presence of new entrants in the country alters industry structure and increases price competition. When the real exchange rate depreciates back to its pre-shock level, sufficient exits may not occur to restore the prior industry structure because of sunk entry costs. Due to the asymmetry of entry and exit decisions, margin increases associated with foreign currency appreciation are truncated relative to margin reductions associated with foreign currency depreciation.

Rangan and Lawrence (1993) found U.S. MNCs' price-cost margins increased with the nominal dollar value of a weighted average of exchange rates for nine countries. This evidence was consistent with pricing-to-market. While the positive coefficient was significant during the period of dollar depreciation (1986-1989), it was not significant during the period of dollar appreciation (1983-1985). Their empirical results provide evidence for asymmetric pricing behavior and, contrary to Baldwin (1988) and Dixit (1989), indicate U.S. firms generally benefit from dollar depreciation but are unharmed by dollar appreciation.

Knetter (1994) examined the question of whether exporters' destination-specific markups were asymmetric for currency appreciation versus currency depreciation. Knetter considered two alternative scenarios that could give rise to asymmetric markups on exported goods. Unlike the models presented by Baldwin (1988)

and Dixit (1989) in which industry structural changes give rise to asymmetric pricing responses to currency movements, Knetter's explanations allow for managerial discretion in pricing behavior.

One possibility is that the marketing capacity of exporters in international markets is limited. Limitations of available distribution channels or quotas in export markets could present a binding constraint on sales volume. Due to this sales volume constraint, export managers choose higher (home currency) margins during periods of foreign currency appreciation than during periods of foreign currency depreciation. While Knetter (1994) developed this argument in the context of sales and distribution constraints, his argument for asymmetric pass-through is equally applicable to other types of capacity constraints such as limited access to inputs and manufacturing capacity.

A second explanation for asymmetric pricing responses considered by Knetter (1994) is that exporters may seek to protect their market shares by reducing home-currency margins during periods of foreign currency depreciation. Also consistent with a strategy of building market share would be relatively constant home-currency margins during periods of foreign currency appreciation, thereby allowing the local currency price of the product to fall.

These two explanations for asymmetric markups give rise to differing patterns of firm exposure coefficients. In the presence of a binding sales volume constraint, home-currency margins will be constant during periods of foreign currency depreciation and rise during periods of foreign currency appreciation. Hence, accounting returns would be constant during periods of foreign currency depreciation but rise during periods of currency appreciation. We can translate these contentions into their implications for exposure coefficients as presented in model (1) assuming stock market returns respond to varying patterns of accounting returns. We would observe no significant exposure ($\beta_{1j} = 0$) to decreases in the dollar price of a foreign currency. During periods of increasing dollar prices of the foreign currency, we would observe a positive exposure coefficient ($\beta_{1j} > 0$). This corresponds with combination of exposure coefficients in cell II of Table 1.

The market share explanation predicts exporters maintain constant margins during periods of foreign currency appreciation and decrease their margins during periods of foreign currency depreciation. Hence, accounting returns are constant during periods of foreign currency appreciation but fall during periods of currency

depreciation. If the stock market responds to these changing margins on foreign sales, we would observe no significant exposure to appreciation in the dollar value of a foreign currency ($\beta_{1j} = 0$) and a positive exposure coefficient ($\beta_{1j} > 0$) during periods of depreciation of the foreign currency. These asymmetric exposure coefficients correspond with cell VIII in Table 1.

While the empirical research on pricing-to-market is informative, this work has focused on aggregate trade data at the industry or country level. Such research designs mask differences in individual corporate pricing strategies which give rise to heterogeneous corporate exposures within industries. No prior empirical research has looked at pricing-to-market as a firm-specific strategic choice. Furthermore, the present research is unique in looking at the firm valuation effects rather than changes in accounting margins associated with real foreign exchange rate movements. While we might expect significant effects on accounting margins when real exchange rates move, it is not clear whether equity markets reflect such effects in stock prices. From an investor perspective, movements in accounting profits are irrelevant if they have no long-term affects on future cash flows.

From the standpoint of this research, the pricing-to-market literature suggests two alternative explanations for asymmetric corporate exposures focusing on pricing in international markets. By contrast, real option theory speaks more directly to sourcing and production location decisions within a multinational network. In either case, it seems much more consistent with the underlying theoretical perspectives to adopt the firm level of analysis when examining foreign exchange exposures rather than the industry or country level.

METHODOLOGY

As noted earlier, the concept of economic exposure refers to the sensitivity of the real value of the firm to volatility in real foreign exchange rates (Shapiro, 1992). Empirical work examining the exposures of individual firms has measured economic exposure as the regression coefficient obtained by regressing real stock returns on a proxy for exchange rates. This proxy has been a single exchange rate (e.g., Booth & Rotenberg, 1990) or a trade-weighted index of exchange rates (e.g., Jorion, 1990).

Given the large number of currencies for which such bivariate models could be estimated, we first sought to identify a small number of representative currencies of major U.S. trading partners for inclusion in the analysis.

Miller and Reuer (1994) performed a factor analysis of twelve currencies for major U.S. trading partners, and found that three currencies -- the Deutsche mark, Canadian dollar, and Japanese yen -- captured an adequate proportion of the variance in real foreign exchange rates for twelve of the major U.S. trading partners. As such, in addition to the Deutsche mark bivariate regression model expressed in equation (1) above, we used two other bivariate models to measure firms' economic exposures to foreign exchange rate movements:

$$(2) \qquad R_j(t) = \beta_{0j} + \beta_{1j} R_{C\$}(t) + \varepsilon_j(t)$$

$$(3) \qquad R_j(t) = \beta_{0j} + \beta_{1j} R_{¥}(t) + \varepsilon_j(t)$$

where $R_j(t)$ is the real stock return of firm j in month t; $R_{C\$}(t)$ and $R_{¥}(t)$ represent the percentage change in the real dollar spot price of the Canadian dollar and Japanese yen in month t; and $\varepsilon_j(t)$ is the error term assumed to be normally distributed with mean zero and constant variance. In order to assess possible asymmetries in firms' foreign exchange rate exposures, equations (1) through (3) were estimated for all months in which the regressor currency appreciated relative to the U.S. dollar for the years 1988-1992. These same equations were then estimated for all months in which the regressor currency depreciated vis-à-vis the U.S. dollar for the years 1988-1992. Let β_{1j}^{up} and β_{1j}^{down} refer to the parameter estimates for economic exposure for periods of real currency appreciation and real currency depreciation, respectively. By assessing the sign and significance of β_{1j}^{up} and β_{1j}^{down} for each firm through the use of t-tests, matrices like Table 1 can be constructed for each of the three currencies to determine the relative frequency of firms displaying the nine possible exposure profiles discussed earlier.

Nominal monthly holding period stock returns were obtained from the Center for Research in Security Prices (CRSP) data files. Stock returns were obtained for all manufacturing firms with SIC codes in the range 3000-3999. Firms which had any missing returns over the five-year estimation period 1988-1992 were eliminated from the analysis, providing a sample size of 249 companies. Monthly data on the dollar price of the three currencies were obtained form the International Monetary Fund's International Financial Statistics CD-ROM package. The real dollar value of each exchange rate was obtained by adjusting for the monthly consumer price index (CPI) in the foreign country relative to the CPI in the U.S.. U.S. price level data provided by the IFS

database were used to convert nominal monthly holding period stock returns to real holding period returns. The appendix provides further details on variable specifications.

The three simple bivariate regression models reflect the specifications found in most finance research. Oxelheim and Wihlborg (1987), however, point out that such simple bivariate models may yield biased exposure coefficient estimates since movements in exchange rates are correlated. They argue that models estimating firms' economic exposures to exchange rates should not only consider the correlations among exchange rates, but also other relevant macroeconomic variables that covary with exchange rates. Failure to include macroeconomic variables in models of economic exposure could result in incorrect attributions regarding the determinants of stock returns.

Hence, in addition to estimating the three simple bivariate models, we considered a multivariate macroeconomic model that includes the three foreign currencies and controls for real market returns and real interest rates. This approach is consistent with research on the pricing of interest rate risk that controls for movements in the market portfolio (e.g., Flannery & James, 1984; Sweeney & Warga 1986). Research on economic exposure to foreign exchange rate movements has used models including (e.g., Amihud, 1994; Bodnar & Gentry, 1993) and excluding (e.g., Booth & Rotenberg, 1990) a market return control variable. The estimated macroeconomic three-currency model of economic exposure was:

$$(4) \qquad R_j(t) = \beta_{0j} + \beta_{1j}R_m(t) + \beta_{2j}R_r(t) + \beta_{3j}R_{DM}(t) + \beta_{4j}R_{C\$}(t) + \beta_{5j}R_{¥}(t) + \varepsilon_j(t),$$

where $R_m(t)$ is a value-weighted market portfolio return in month t, $R_r(t)$ is the percentage change in the real U.S. treasury bill rate in month t, and $\varepsilon_j(t)$ is the error term assumed to be normally distributed with mean zero and constant variance. Nominal monthly value-weighted market portfolio returns were obtained from the CRSP data files. The value-weighted portfolio returns include all distributions and exclude American Depository Receipts (ADRs). CPI data from the IFS dataset were used to deflate the monthly market portfolio returns to real returns, and the IFS dataset also provided the necessary data to calculate the percentage change in the real U.S. Treasury bill rate (see appendix).

Equation (4) was used to calculate six parameter estimates for each firm to assess the possibility of asymmetric exposures to each of the three currencies. For example, β_{3j}^{up} and β_{3j}^{down} were calculated by

estimating equation (4) for all months in the period 1988-1992 in which the Deutsche mark appreciated and for all months in which it depreciated, respectively. Real percentage changes in the Canadian dollar and Japanese yen served as control variables, as did the real market return and the real percentage change in the U.S. Treasury bill rate. A similar technique was used to obtain β_{4j}^{up}, β_{4j}^{down}, β_{5j}^{up}, and β_{5j}^{down} for each firm, using the appropriate currency, market, and interest rate control variables. As in the case of the bivariate estimation models discussed earlier, matrices analogous to Table 1 can be constructed for each of the currencies by assessing the sign and significance of the parameter estimates through the use of simple t-tests.

RESULTS

Table 2 summarizes the results from estimating the bivariate models given by equations (1) through (3). As anticipated, the vast majority of firms are not exposed to either currency appreciations or depreciations. At the .05 level, the proportions of firms exposed to either appreciations or depreciations of the Deutsche mark, Canadian dollar, and Japanese yen are 9.1 percent, 9.6 percent, and 12.9 percent, respectively.

Insert Table 2 about here

The table provides evidence that manufacturing firms' economic exposures to foreign exchange rate movements are rarely symmetric for currency appreciations and depreciations. No firms are symmetrically exposed to Deutsche mark or Canadian dollar appreciations and depreciations, and only one firm is symmetrically exposed to Japanese yen appreciations and depreciations. Of the firms with asymmetric exposures, only one has an asymmetric exposure not accommodated by either the real options theory or pricing-to-market predictions.

The results also indicate that the general pattern of asymmetry varies by the focal currency. 3.2 percent of the sample is exposed to Deutsche mark appreciations, and 6.0 percent is exposed to Deutsche mark depreciations. For the Japanese yen, 3.2 percent of the firms are exposed to appreciations, and 10.0 percent are exposed to yen depreciations. The pattern of asymmetric exposures is more balanced for the Canadian dollar. We find 8.0 percent of the sample is exposed to Canadian dollar appreciations, while 6.8 percent of firms are exposed to Canadian dollar depreciations.

The results presented in Table 2 suggest that where asymmetries in economic exposures to foreign exchange rate movements exist, these asymmetries frequently correspond with the predictions of option theory and pricing-to-market behavior. The proportions of firms falling into the Table 1 null set (i.e., cells III, IV, or VII) are 0 percent, 0.4 percent, and 0 percent for the Deutsche mark, Canadian dollar, and Japanese yen, respectively. By contrast, the number of firms in the "option" cells (i.e., cells II or VI) are 21, 23, and 25 for the Deutsche mark, Canadian dollar, and Japanese yen, respectively. These absolute numbers correspond to proportions of 8.4 percent, 9.2 percent, and 10.0 percent, respectively, for the entire sample of 249 firms. The predominance of exposure profiles consistent with option theory becomes more striking when one considers only the number of firms which are exposed to either appreciations or depreciations in the currency of interest as the denominator. The proportions are 91.3 percent, 95.8 percent, 78.1 percent for the Deutsche mark, Canadian dollar, and Japanese yen, respectively. These proportions indicate most U.S. firms with significant exposures to foreign exchange rate movements manage their exposures in such a way as to take advantage of movements that increase shareholder returns but adequately hedge exchange movements detrimental to shareholder returns.

Table 2 also indicates that several firms have exposure profiles consistent with the two pricing-to-market explanations for asymmetric exposures. There is, of course, some confounding in cell II in that it is not possible to differentiate whether option theory or pricing-to-market behavior accounts for firms in this cell. Eight firms fall into the pricing-to-market cells (i.e., cells II or VIII) for the Deutsche mark, representing 3.2 percent of the entire sample or 34.8 percent of the firms exposed to mark fluctuations. Twenty firms fall into the pricing-to-market cells for the Canadian dollar, constituting 8 percent of the entire sample or 83.3 percent of the exposed firms. For the firms exhibiting exposures to the Canadian dollar consistent with the pricing-to-market rationale, all firms fall in the cell indicating sales constraints rather than market share expansion or preservation objectives. For the Japanese yen, 7 firms fall into the pricing-to-market cells (6 of which are in cell II), representing 2.8 percent of the overall sample and 21.9 percent of the exposed group of firms.

Table 3 provides the results for the three-currency macroeconomic model given by equation (4). Again, as expected, the vast majority of firms are not exposed to foreign exchange rate fluctuations. The proportions of firms exposed to foreign exchange rate movements are somewhat higher than those for the simple bivariate regression

models discussed above. 16.9 percent of the firms are exposed to appreciations or depreciations in the Deutsche mark, 12.4 percent to the Canadian dollar, and 10.0 percent to the Japanese yen.

Insert Table 3 about here

The results for the multivariate estimation technique provide further evidence that firms are not symmetrically exposed to currency appreciations and depreciations. Only one firm is symmetrically exposed to Deutsche mark appreciations and depreciations, and no firms are symmetrically exposed to appreciations and depreciations in the Canadian dollar or Japanese yen. Of those firms that are asymmetrically exposed to the currencies, very few exhibit exposures not accommodated by the real options perspective or pricing to market behavior.

The general pattern of asymmetric exposures is different for the multivariate estimation approach relative to the simple regression models. For example, Table 3 indicates that 11.6 percent of the sample is exposed to Deutsche mark appreciations, and 6.4 percent of the firms are exposed to Deutsche mark depreciations. Table 2 indicates that 3.2 percent of the firms are exposed to Deutsche mark appreciations, and 6.0 percent were exposed to Deutsche mark depreciations. By moving from the bivariate to the multivariate approach, we see that 8.4 percent more firms are considered exposed to mark appreciations, and exposure to mark depreciations becomes less significant on a relative basis. Table 3 indicates that 8 percent of the firms are exposed to Canadian dollar appreciations, and 4.4 percent of the sample is exposed to Canadian dollar depreciations, which is fairly consistent with the bivariate estimation approach. Finally, 7.2 percent of the firms are exposed to Japanese yen appreciations, and 2.8 percent of the sample is exposed to yen depreciations. Relative to the bivariate case, the multivariate estimation method yields 4.0 percent more firms exposed to yen appreciations, and 7.2 less firms exposed to yen depreciations. These results suggest that the choice between bivariate and multivariate estimation techniques is important in discerning magnitudes and patterns of economic exposures to foreign exchange rate fluctuations.

The results provided in Table 3 illustrate that firms exhibit exposure patterns consistent with option theory. The pattern of exposures to the Canadian dollar is quite similar for the multivariate and bivariate models. Twenty-seven firms (10.8 percent of the entire sample, or 87.1 percent of the firms which are exposed to Canadian dollar appreciations or depreciations) exhibit exposure profiles consistent with option theory. Twelve firms

(4.8%) exhibit an option-type exposure profile vis-à-vis the Deutsche mark, and only 5 firms (2%) exhibit an option-type exposure profile relative to the Japanese yen.

Table 3 also reveals a number of firms exhibiting asymmetric exposures consistent with pricing-to-market explanations. Twenty-six firms fall into pricing-to-market cells for the Deutsche mark, 20 firms for the Canadian dollar, and 18 firms for the Japanese yen. More firms fall into cell II than cell VIII for the Canadian dollar (19 versus 1), while more firms fall into cell VIII than cell II for the Deutsche mark (25 versus 1) and for the Japanese yen (15 versus 3). Given this pattern of exposure asymmetries, U.S. firms engaging in pricing-to-market appear to increase margins when the Canadian dollar appreciates and focus on building market share in Germany and Japan.

One of the key questions in this research was whether particular firms have distinct strategies for managing foreign exchange exposures. We sought to determine whether a consistent set of firms exhibited exposure profiles consistent with option theory and pricing-to-market across the three currencies. We identified each firm falling into cells 2, 6, and 9 across the matrices in Tables 2 and 3. For the bivariate estimation approach, only three pairwise matches were found. Three firms were classified into cell 6 for both the Deutsche mark and the Japanese yen. No matches existed for cell 2 or cell 9 classifications across the three currencies. For the multivariate macroeconomic model, no matches were found for any of the cells consistent with option or pricing-to-market theory. These findings indicate currency-specific foreign exchange risk management practices. The evidence does not support the contention that firms' pricing-to-market strategies affect shareholder returns uniformly across countries.

DISCUSSION

Previous work measuring the impact of foreign exchange rate fluctuations on firm value has assumed that economic exposures to such risks are symmetric for foreign currency appreciations and depreciations. This study marks the first attempt to link the concept of economic exposure to recent theoretical advances in the option theory and pricing-to-market literatures. Both of these theoretical perspectives challenge the assumption of symmetric economic exposures for firms operating in integrated international markets.

Real option theory posits that firms can selectively exploit foreign exchange rate movements while hedging detrimental contingencies by altering input sourcing, manufacturing, and marketing activities. Kogut (1983) was the first to note that multinational network flexibility in the context of multiple currency domains

provides firms with a portfolio of options unavailable to firms with single-country or multidomestic strategies (i.e., firms controlling subsidiaries as a loosely-coupled collection of independent units). Underlying real options theory is the view that firms can manage downside outcomes through the use of real, strategic decisions. Such real hedging of corporate risks may nevertheless be used in conjunction with widely available financial hedging tools. Because corporate strategies are seen as having important consequences for firms' risks in general, financial and strategic hedging policies can potentially operate at cross purposes with one another and reduce the effectiveness of overall risk management if developed and executed in isolation from each other (Miller, 1994).

The pricing-to-market literature offers two explanations of asymmetric pricing responses for exporters--sales constraints and pricing strategies to build market share--yet the theory has not been tested at the firm level of analysis. In contrast to real options theory which provides a rationale for asymmetric exposures that focuses primarily on the supply side (e.g., input sourcing and manufacturing location changes), pricing-to-market theory provides emphasizes the demand side (e.g., pricing responses to foreign exchange rate shifts). Both theories emphasize the dynamics of firm behavior in response to foreign exchange rate movements and predict that economic exposures to foreign exchange rate movements can be asymmetric.

The empirical investigation of potential asymmetries in firms' economic exposures to foreign exchange rate movements is the second contribution of the present study. The empirical evidence provided earlier suggests that rarely are manufacturing firms exposed to foreign exchange rates in a symmetric fashion. This finding challenges the specifications of symmetric regression models of foreign exchange exposure found in all prior finance research. Further, the preliminary findings provided by this study suggest that firms asymmetrically exposed to foreign exchange rate movements exhibit exposure profiles that are generally consistent with those predicted by options theory and pricing-to-market theory as opposed to exposure profiles that evidence poor exchange risk management.

The empirical results provided in Tables 2 and 3 suggest that model specification is an important concern for corporate assessment of economic exposures. When moving from the bivariate to the multivariate approach, our results indicate that the pattern of asymmetric exposures changed. Failure to control for other foreign exchange rate movements and other macroeconomic or market variables can result in different exposure patterns, as the two tables reveal. In general, Table 2 presents a more favorable picture of the capabilities of U.S. firms to

take advantage of exchange rate movements and limit the impact of detrimental movements than does Table 3. This may indicate firms' assessment and hedging strategies focus on currencies in isolation from one another. Isolating individual currencies for purposes of exposure assessment and hedging is suboptimal when the environmental contingencies affecting returns are interrelated (Oxelheim & Wihlborg, 1987). Hence, it would be advisable for firms to move toward multivariate assessment and management of risk exposures.

The empirical results did not support the contention that particular firms possess foreign exchange risk management capabilities allowing them to benefit from movements in all three foreign currencies. There was virtually no evidence that firms have similar asymmetric exposure profiles across the three major currencies. In evaluating this result, it is important to keep in mind the rigorous nature of the tests for asymmetric exposures imposed by the models in this research. In all of the models, the data were subdivided into monthly periods for classification as either periods of appreciation or depreciation. Hence, finding significant asymmetric exposures indicates firms with the ability to exercise real options or engage in pricing-to-market with very short response times. While our model constitutes a very rigorous test of the real option and pricing-to-market hypotheses, future research may consider longer periods for adjustments to exchange rate movements. Alternatively, it may be reasonable to model firm behaviors as a function of expectations, as reflected in foreign exchange rate futures, rather than ex post exchange rate movements.

The paper's results indicate that a promising avenue for future research would be developing and testing hypotheses from option theory and pricing-to-market theory which relate firms' international strategies to the economic exposure profiles presented in Table 1. While the present study's results generally agree with the asymmetric exposure patterns predicted by options theory and pricing-to-market behavior, this study has not attempted to empirically establish causal connections between firms' strategies and economic exposure profiles. Such research would be useful to distinguish the different rationales that real options theory and pricing-to-market theory provide for Cell II. Are such exposures explained by supply side flexibility, demand side pricing behavior, or are both perspectives necessary? Additional theoretical and empirical work could also aid in determining the relative importance of firm strategies and infrastructural or institutional characteristics of the host country which may result in the types of exposure profiles predicted by pricing-to-market discussions. The finding that exposure patterns are not uniform across focal currencies alerts future researchers to consider the country-specific nature of

corporate exchange risk management practices. Finally, further theoretical and empirical work will also be required to bring these two theoretical perspectives to bear on samples containing non-manufacturing and non-U.S. firms.

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APPENDIX

1. The real dollar price of a currency at time t is given by: $e'(t) = e_t[P_f(t) / P_h(t)]$, where e_t is the nominal dollar price of the currency at time t, $P_f(t)$ is the foreign country's consumer price level at time t, and $P_h(t)$ is the U.S. consumer price level at time t (Shapiro, 1992: 155).

2. Real stock returns (R_j) and market returns (R_m) are given by: R_j (or R_m) = $[(1+r_n) / (1+i_h)] - 1$, where r_n is the nominal stock (or market holding period return), and i_h is the inflation rate given by the percentage change in the U.S. consumer price level (Brealey & Myers, 1991: 559).

3. The real U.S. Treasury bill rate is given by: $r_r = [(1 + r_n) / (1 + i_h)] - 1$, where r_n is the nominal U.S. Treasury bill rate, and i_h is the inflation rate given by the percentage change in the U.S. consumer price level (Brealey & Myers, 1991: 559). The percentage change in the real U.S. Treasury bill rate is given by: $R_r = [r_r(t) - r_r(t-1)] / r_r(t-1)$.

Table 1
Possible Combinations of Foreign Exchange Exposures

	$R_{DM}(t) < 0$		
$R_{DM}(t) > 0$	$\beta_{1j} > 0$	$\beta_{1j} = 0$	$\beta_{1j} < 0$
$\beta_{1j} > 0$	I. Symmetric Exposure	II. Option P-T-M (sales constraint)	III. ∅
$\beta_{1j} = 0$	IV. ∅	V. No Exposure	VI. Option
$\beta_{1j} < 0$	VII. ∅	VIII. P-T-M (build market share)	IX. Symmetric Exposure

Table 2
Combinations of Foreign Exchange Exposures
for Bivariate Estimation Models[a]

Deutsche mark:

	$R_{DM}(t) < 0$			
$R_{DM}(t) > 0$	$\beta_{1i} > 0$	$\beta_{1i} = 0$	$\beta_{1i} < 0$	Row Total
$\beta_{1i} > 0$	0 (0)	6 (.024)	0 (0)	6 (.024)
$\beta_{1i} = 0$	0 (0)	226 (.909)	15 (.060)	241 (.968)
$\beta_{1i} < 0$	0 (0)	2 (.008)	0 (0)	2 (.008)
Column Total	0 (0)	234 (.940)	15 (.060)	249 (1)

Canadian dollar:

	$R_{C\$}(t) < 0$			
$R_{C\$}(t) > 0$	$\beta_{1i} > 0$	$\beta_{1i} = 0$	$\beta_{1i} < 0$	Row Total
$\beta_{1i} > 0$	0 (0)	20 (.080)	0 (0)	20 (.080)
$\beta_{1i} = 0$	1 (.004)	225 (.904)	3 (.012)	229 (.920)
$\beta_{1i} < 0$	0 (0)	0 (0)	0 (0)	0 (0)
Column Total	1 (.004)	245 (.984)	3 (.012)	249 (1)

Japanese yen:

	$R_{¥}(t) < 0$			
$R_{¥}(t) > 0$	$\beta_{1i} > 0$	$\beta_{1i} = 0$	$\beta_{1i} < 0$	Row Total
$\beta_{1i} > 0$	0 (0)	1 (.004)	0 (0)	1 (.004)
$\beta_{1i} = 0$	0 (0)	217 (.871)	24 (.096)	241 (.968)
$\beta_{1i} < 0$	0 (0)	6 (.024)	1 (.004)	7 (.028)
Column Total	0 (0)	224 (.900)	25 (.100)	249 (1)

[a]The first cell entry denotes the cell frequency when $\alpha = .05$. The entry in parentheses denotes the relative cell frequency when $\alpha = .05$. Column and row totals, as well as grand totals, may not add due to rounding.

Table 3
Combinations of Foreign Exchange Exposures
for the Multivariate Estimation Model[b]

Deutsche mark:

	$R_{DM}(t) < 0$			
$R_{DM}(t) > 0$	$\beta_{3j} > 0$	$\beta_{3j} = 0$	$\beta_{3j} < 0$	Row Total
$\beta_{3j} > 0$	0 (0)	1 (.004)	0 (0)	1 (.004)
$\beta_{3j} = 0$	2 (.008)	207 (.831)	11 (.044)	220 (.884)
$\beta_{3j} < 0$	2 (.008)	25 (.100)	1 (.004)	28 (.112)
Column Total	4 (.016)	233 (.936)	12 (.048)	249 (1)

Canadian dollar:

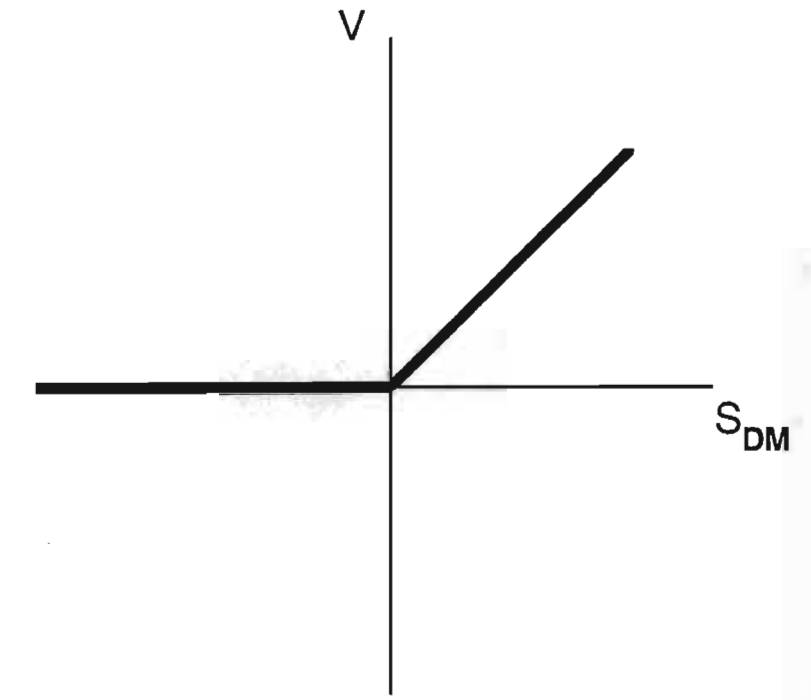
	$R_{C\$}(t) < 0$			
$R_{C\$}(t) > 0$	$\beta_{4j} > 0$	$\beta_{4j} = 0$	$\beta_{4j} < 0$	Row Total
$\beta_{4j} > 0$	0 (0)	19 (.076)	0 (0)	19 (.076)
$\beta_{4j} = 0$	3 (.012)	218 (.876)	8 (.032)	229 (.920)
$\beta_{4j} < 0$	0 (0)	1 (.004)	0 (0)	1 (.004)
Column Total	3 (.012)	238 (.956)	8 (.032)	249 (1)

Japanese yen:

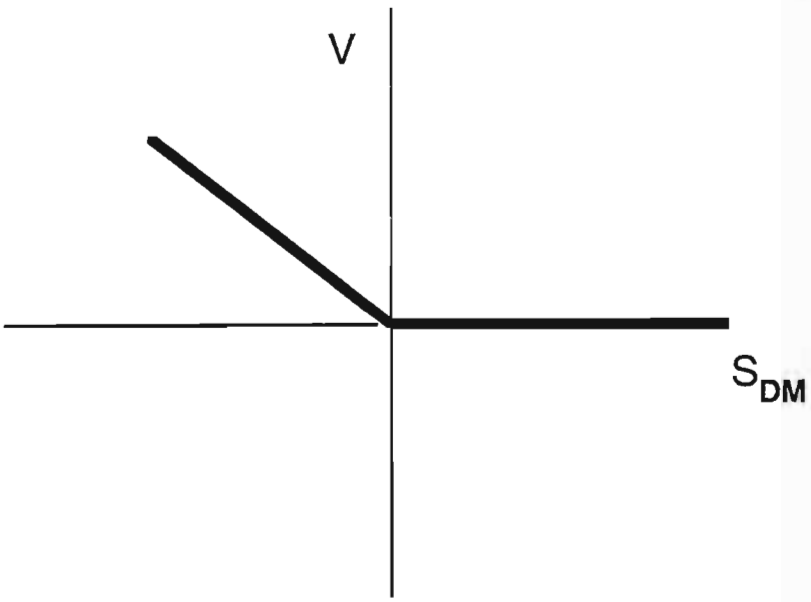
	$R_{¥}(t) < 0$			
$R_{¥}(t) > 0$	$\beta_{5j} > 0$	$\beta_{5j} = 0$	$\beta_{5j} < 0$	Row Total
$\beta_{5j} > 0$	0 (0)	3 (.012)	0 (0)	3 (.012)
$\beta_{5j} = 0$	5 (.020)	224 (.900)	2 (.008)	231 (.928)
$\beta_{5j} < 0$	0 (0)	15 (.060)	0 (0)	15 (.060)
Column Total	5 (.020)	242 (.972)	2 (.008)	249 (1)

[b]The first call entry denotes the cell frequency when $\alpha = .05$. The entry in parentheses denotes the relative cell frequency when $\alpha = .05$. Column and row totals, as well as grand totals, may not add due to rounding.

Figure 1
Payoff Profiles for Call and Put Options



(a) Call Option



(b) Put Option