The Operational and Financial Hedging Strategies of U.S. High Technology Firms

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Abstract

This paper examines the operational hedging strategies of U.S. high technology firms and how this hedging is related to financial hedging. We use a sample of 216 firm observations, which consist of 108 operationally-hedged high technology firms and a size and industry matched sample of 108 non-operationally-hedged firms. We find that derivatives users are larger and are more R&D intensive than non-derivative users. Our regression analysis results show that operational hedging and financial hedging are complementary. Firms that are geographically diversified have more foreign exchange exposure. However, firms that use financial hedging are able to significantly lower their exchange rate exposure. Finally, our results show that financial hedging adds value for our sample of high technology firms, while operational hedging does not.

JEL classification: F23, F21, F31, G32.

Keywords: Financial hedging; Operational hedging; Foreign currency exposure

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I. Introduction

High technology firms represent industries that have traditionally made substantial investment in intangible assets, particularly research and development, relative to the average industry. As these firms expand their global reach, it becomes important for them, among other reasons explained later, to protect their investments in intangible assets primarily because these assets would be difficult to value in situations of financial distress. We would expect that globally diversified technology firms that hedge to reduce volatility and thus the risk of financial distress would enjoy better valuations than comparable firms that do not hedge.

The risk of potential distress for high technology firms operating in foreign markets should impact hedged and non-hedged firms differentially. The purpose of this paper is to test this proposition and to also examine the impact of hedging on firms' financial performance. According to current accounting standards, a firm should report its sales to foreign countries as export sales if it manufactures the products in the U.S. However, when it has foreign facilities or foreign manufacturing operations (foreign assets), sales from these operations to foreign countries should be recorded as foreign sales. Thus, this differential accounting treatment allows us to separate firms into operationally hedged and non-operationally hedged firms. That is, firms reporting foreign sales are classified as operationally hedged firms, while firms reporting only export sales are classified as non-operationally hedged firms. We define a firm's extent of operational hedging as the degree of geographic diversification, measured in four distinct ways: the number of foreign countries where the firm operates, the number of broad regions where a firm has manufacturing operations, and two dispersions measures based on the Hirshman -

Herfindal index. We test these propositions by using a sample of 216 high technology firms, of which 108 are operationally hedged, and 108 are size and industry matched non-hedging firms.

Our results make several contributions to the literature. First, we demonstrate that firms that are financially hedged are more dispersed than non-derivative users, and have a higher amount of foreign sales. At the same time, they face greater negative exchange rate exposure than non-derivative users. Secondly, we demonstrate that greater dispersion, tax loss, and efficiency significantly affect the magnitude of financial hedging. Third, our results show that financial hedging reduces the absolute value of exchange rate exposure, while operational hedging does not. Finally, our results suggest that financial hedging is positively related to Tobin's Q, a measure of firm performance. Taken together, our results support the conditional complement hypothesis and the tax loss hypothesis, although only financial hedging appears to reduce exchange rate risk or contribute significantly to firm performance.

The remainder of the paper is organized as follows. Section 2 discusses previous studies and empirical hypotheses. Section 3 describes the sampling procedure. Section 4 describes the methodology used in this paper. Section 5 presents the results of tests and Section 6 concludes the paper.

II. Literature Review

II.1. The Rationale for Operational Hedging

Researchers argue that operational hedging through geographic diversification is beneficial for MNCs for reducing the volatility of cash flows. MNCs have multiple operations located in countries whose currencies may not vary together. Thus, MNCs may benefit from

offsetting unexpected changes in foreign currency exchange rates due to operational hedges (i.e., natural hedges) associated with geographic diversification.[1]

Chowdhry and Howe (1999), in their model, claim that operational hedging emerges only if a firm faces a combination of exchange rate and demand uncertainty. They predict that firms are likely to use financial instruments to a greater extent to hedge short-term exposure and rely on operational hedging more heavily to hedge long term exposure.

On the other hand, operational hedging can be used to complement financial hedging. Many large MNCs actively use financial derivatives to hedge their various risk exposures while they are geographically diversified (i.e., operationally hedged). For example, Black & Decker Corp., in its 2000 10-K annual report, provides the argument in support of the complementary nature of operational hedging and financial hedging: "the corporation seeks to minimize the risk that cash flows resulting from the sales of products manufactured in a currency different from that of the selling subsidiary will be affected by changes in exchange rates --The corporation hedges its foreign currency transaction exposures, as well as certain forecasted transactions, generally through options and forward exchange contracts. -- Some natural hedges also are used to mitigate transaction and forecasted exposures."

Lim and Wang (2001) develop a model to examine the interaction between financial and operational hedging. Building on a stakeholder-based reason for firm risk management, they show that financial hedging and operational hedging are more often complementary than substitutive. They argue that financial hedging can be used to reduce the common component of

[1] In addition to the exposure of foreign currency, MNCs can use various channels to transfer funds internationally through intracompany loans, and leading and lagging payments of trade credit. Also, MNCs can access segmented capital markets to lower their overall costs of capital, shift profits to lower its taxes, and take advantage of international diversification of markets and production sites to reduce the riskiness of their earnings (Shapiro, 2002).

profit variability while operational hedging (geographic diversification) can reduce firm-specific risk exposures.

Allayannis et al. (2001) examine the relation between financial and operational hedges. Using a sample of 265 U.S. non-financial MNCs between 1996 and 1998, they find that operational hedging is not an effective substitute for financial risk management. In addition, they show that while firms' operational hedges are not associated with higher value, the use of operational hedges, in conjunction with foreign currency derivatives, improves firm value. These results support the conditional complement hypothesis. Consistent with Chowdhry and Howe (1999), Pantzalis et al. (2003) investigate the impact of operational hedges by 220 U.S. MNCs on their foreign currency exposure. They find that the ability to construct operational hedges leads to lower currency exposures for the pooled sample as well as for firms with positive exposure (net importers) and negative exposure (net exporters). In addition, Carter et al. (2001) examine the impact of operational and financial risk management practices on the foreign exchange risk exposures of 208 U.S. MNCs over the period 1994 to 1998. They find that MNCs with dispersed operating networks, as measured by breath and depth of geographic diversification, have lower levels of currency exposure. Also, they find that the combined use of operational and financial hedges is associated with decreased exchange rate exposure. These results support the complementary hypothesis.

Based on the above mentioned literature, we hypothesize that operational hedging is complementary to financial hedging since operational and financial hedging strategies are used for managing different types of risk exposures, i.e., operational hedging for long-term exposure (economic exposure) and financial hedging for short term exposure (transaction exposure).

II. 2. The Rationale for Financial Hedging

In a perfect world, risk management does not have a role in maximizing shareholder wealth (Modigliani and Miller (1958) and Miller and Modigliani (1961)). Previous risk management theory stems from market imperfections and violations of the perfect world assumptions. Financial risk management can add value if it reduces expected tax liabilities (Smith and Stulz (1985)), bankruptcy costs (Myers (1977), Smith and Stulz (1985)), and the underinvestment problem from costly external financing (Froot et al. (1993)). In addition, Smith and Stulz (1985) focus on managerial incentives as a driver of corporate risk management. Related to the managerial motivation for hedging, DeMarzo and Duffie (1992, 1995) and Breeden and Viswanathan (1998) propose an alternative theory in which the manager hedges due to reputation concerns. A number of researchers empirically examine and provide the evidence that corporate uses of financial derivatives are consistent with the extant theories of corporate hedging, in general.[2]

Smith and Stulz (1985) argue that hedging can reduce expected tax liability since volatility is costly for firms with convex tax functions. The convexity of the tax code creates tax advantages that follow from a smoother profit stream through financial hedging (derivatives) and operational hedging (diversification). Most empirical risk management studies use tax loss carry forwards to measure tax function convexity and find mixed results. In this paper, we use the tax measure, TAX LOSS, the book value of net operating tax loss carry forwards divided by total assets, as a proxy for the tax theory.[3] We expect to find a positive relationship between TAX and hedging activities.

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[2] See, e.g., Mian (1996), Tufano (1996), Geczy et al. (1997), Gay and Nam (1998), Allayannis and Ofek (1998), Graham and Rogers (2002), Guay and Kothari (2003), Hentschel and Kothari (2001), Brown (2001), Hagelin and Pramborg (2005) and Haushalter (2000).

[3] Using an explicit measure of tax convexity, Graham and Rogers (2002) find no support for tax incentives to hedge. Although Graham and Rogers' (2002) tax measure is more appropriate to test tax incentives, we use TAX since the focus here is not on tax incentives. Also, TAX permits a larger sample of observations.

The cost of financial distress theory argues that hedging, by reducing the variability of cash flows, reduces the probability of incurring bankruptcy costs (Smith and Stulz (1985)). The increase in firm value comes from the reduction in the deadweight costs of bankruptcy. In addition to financial hedging, Lewellen (1971) suggests that diversification reduces the likelihood of bankruptcy. The proxy for the costs of financial distress is DEBT, the ratio of total debt to total assets. We expect a positive relationship between DEBT and hedging activities.

The reduction in the underinvestment problem theory holds that firms can reduce the need for costly external financing through hedging (Froot et al. (1993)). Consistent with Froot et al. (1993), Geczy et al. (1997) find that firms' use of currency derivatives is positively related to research and development expenditures for a sample of Fortune 500 firms. Also, Stulz (1990) argues that diversification reduces the underinvestment problem by creating larger internal capital markets. High technology firms may be particularly susceptible to the underinvestment problem given their reliance on intangible assets. To test the reduction in the underinvestment problem theory, this study includes RND, the ratio of research and development expenditures to total assets. A positive relationship between RND and derivatives usage is expected.

Stulz (1984) and Smith and Stulz (1985) argue that managers have a significant portion of their wealth tied to the firm and are often unable to diversify firm specific risk. Thus, risk - averse managers have incentives to hedge to manage the firm's risk. Smith and Stulz (1985) show that managerial compensation plans play an important role in the financial hedging decision since managers' risk aversion can lead them to hedge. For example, managers whose compensation is a concave function of firm value have incentive to reduce firm cash flow

variability. Since option based compensation provides the incentive for managers to undertake risky projects, higher levels of option based compensation will result in lower levels of hedging.[4]

The economies of scale involved in establishing a hedging program is a common explanation for the relationship between size and hedging. Using survey data, Bodnar et al. (1996) find that the second most common explanation for not using derivatives is the cost of establishing and maintaining a derivatives program. Previous empirical studies find a strong positive relationship between the size of the firm and the likelihood of hedging activity (Geczy et al. (1997), Mian (1996), Haushalter (2000), Allayannis and Ofek (2001), and Graham and Rogers (2002)). We include SIZE, the logarithm of the sum of the book value of the firm's debt and preferred stock plus the market value of common equity, to control for the size effect. We expect a positive relationship between SIZE and hedging activities.

Many of the past empirical studies on risk management utilize the ratio of the notional amount of total derivatives use to total assets or risk exposure as a proxy for the firm's risk exposure and/or to analyze the dichotomous variable whether to use derivatives.[5] In general, the notional amount does not provide the risk exposure of the firm. Using 425 large U.S. firms from 1992 to 1993, Hentschel and Kothari (2003) find no significant relation between derivatives and volatility of the firm. The findings contradict traditional hedging theory. They argue that financial derivatives are primarily used in short-term contracts to reduce the risks. Thus, risk reduction for these contracts is unlikely to have material effects on overall firm volatility. They

[4] Tufano (1996) finds the supporting evidence for managerial motivation as measured by managerial stock and option holdings. However, Geczy et al. (1997) do not find support and Gay and Nam (1998) find a positive relation between option-based compensation and financial hedging in a larger sample. Also, Knopf et al. (2002) show that the sensitivity and moneyness of option compensation play a role in the financial hedging decision rather than managerial wealth. We do not include these managerial wealth variables since the main focus in this paper is not on managerial issues for financial hedging.

[5] Tufano (1996), and Brown (2001) are the exceptions. They use the hedge ratio based on the firm's risk exposure but they examine only specific industries. Thus, their findings are not generalizeable.

note that this lack of evidence can be attributed to poor data availability. In this paper, we employ both the dichotomous variable and the continuous variable, the ratio of notional amount of derivatives to total foreign currency risk exposure, in the regression models for robustness tests.

II. 3. Why High Technology Firms are Different

Why look at technology companies? We provide five reasons. First, the literature suggests that firms that need to protect cash flows most are those that have the highest level of intangible assets --those whose assets cannot easily be valued and hence cannot be sold at full market value. Technology companies may face higher bankruptcy costs than others. Secondly, managers should hedge when they have information shareholders do not, such as the risk of loss of value on proprietary assets that are difficult to value, as in the case with technology firms. Third, managers should hedge when it is cheaper for them to do so than for shareholders to do so. Technology companies are more likely than other firms to obtain floating rate financing, and hence, will need to manage interest rate risk, so they probably have economies of scale in hedging cost. Fourth, the market for human/managerial capital in highly specialized technology markets is likely relatively small. Hence, managers may hedge due to reputational concerns. Fifth, technology companies are more capital constrained than other firms. If hedging is a substitute for external financing, then we should observe technology companies manage exchange rate risk through derivatives. On the other hand, technology managers are very likely to be paid with options. Hence, their return payoff is consistent with making investments that encourage volatility, which would discourage them from hedging.

III. Sample

III.1. Operational Hedging Data Procedure

In June 1997, the Financial Accounting Standards Board (FASB) issued Statement of Financial Accounting Standards No. 131, "Disclosure about Segments of an Enterprise and Related Information" (SFAS 131), which became effective for fiscal years starting after December 31, 1997. SFAS 131 rules require that enterprises report certain information about operating segments. It also requires that enterprises report certain information about their products and services, the geographic areas in which they operate, and their major customers. This new rule replaces SFAS No. 14 that required firms to disclose a geographical analysis of foreign operations to the extent that foreign operations account for more than 10% of total operations.[6] Under SFAS 131, segment reporting is more consistent with the organizational structure of the firm and provides more detailed information about geographic segments.

The initial sample of the paper is obtained from the COMPUSTAT Geographic Segment files (C.G.S) for 1998. Since firms effectively adopted the new segment rule SFAS 131 in 1998, we use fiscal year end 1998 for the sample. We restrict the sample of high technology firms with total sales greater than $500 million in 1998. For purposes of this paper, firms in the following SIC codes are included in the sample of high technology firms: 2800 (Chemicals), 3500 (Computers), 3600 (Electronics), 3700 (Transportation), 4800 (Communications), and 7300 (Software).

Among these firms, we define firms that report only export sales in the geographic segment file as "non-operationally hedged firms." Export sales represent the amount or percentage of each segment's revenue generated by domestically produced goods or services, sold outside the domestic country. These export sales values prior to 1998 represent aggregate

[6] It is important to note that the FASB has given management wide latitude for interpretation of the distinction between domestic and foreign operations. Also, there is no consistent manner of reporting the countries of foreign sales. Some firms report their foreign sales for regional groups such as Europe, Asia, or South America, while others report for specific countries such as Japan, Germany, or the U.K.

export sales for a geographical segment. Beginning in 1998, aggregate export sales values are included in the domestic geographical segment's export sales. Values for additional segment-level export sales may be included in foreign geographical segments.

We next obtain an export sales sample of firms from the COMPUSTAT geographic segment files in fiscal year end 1998. To examine the effects of operational hedging on firm value and the relation between operational and financial hedging, we collect a sample for "operationally hedged firms," which have foreign assets or operations in foreign countries and report foreign sales. We match the operationally hedged firms with non-operationally hedged firms of similar size (total sales within $\pm$10%) and in the same industry (four digit SIC code) in the COMPUSTAT geographic segment file. We also require that the sample firm's stock returns be available in CRSP. After this size and industry matching procedure, and financial data requirements, we obtain a final sample of 216 firm observations that consists of 108 operationally hedged and 108 non-operationally hedged firms.

For further investigating the operational hedging activities, we collect the number of subsidiaries located in foreign countries, and the number of foreign countries in which a firm operates from the Directory of Corporate Affiliations: U.S. Public Companies, which was prepared by National Register Publishing's Database Publishing Group in 1999.[7] This database provides a company's divisions, subsidiaries, affiliates, joint ventures, and location of units (U.S. and Non U.S.). We count only level 1 non-U.S. subsidiaries, which report directly to the parent company. Based on these foreign subsidiaries and countries information, we calculate the number of foreign subsidiaries, the number of foreign countries, Dispersion Index I (1 minus

[7] Part of the sample for these operational measures is obtained from Allayannis and Weston. We thank these authors for providing this information.

Hirshman-Herfindahl index based on foreign countries), and Dispersion Index II (1 minus Hirshman-Herfindahl index based on the region).

III.2. Financial Hedging Data Procedure

Next, we collect the financial derivatives information using the search term "notional, hedge, forwards, swaps, options, market risk, and derivatives" from the annual proxy statements (EDGAR database) in the fiscal year end of 1998. We identify financial derivatives user as a firm that reports any type of currency derivatives instruments or reports the notional amount of currency derivatives. For our sample, we identify 124 firms that report the use of financial derivatives and 92 firms that do not report any types of financial derivatives. We record the total notional amount of currency derivatives use and the types of currency derivatives including forwards, futures, options, and swaps as well as interest rate derivatives information.

Because derivatives use and the complexity of the products has been increasing over time, the demand for corporate disclosure of positions, strategy, and risk has increased. SFAS No. 119, Disclosure about Derivative Financial Instruments and Fair Value of Financial Instruments, added to and amended two other statements (SFAS No. 105 and SFAS No. 107) and requires firms to disclose their objectives and strategies. Firms must report the contract notional amount of instruments and hedging purpose. Also, SFAS No. 119 recommends that firms disclose quantitative information about the market risks associated with their derivative positions. In an effort to add transparency to the firm's use of derivatives and its risk management practices, the FASB issued Statement of Financial Accounting Standards (SFAS) No.133, Accounting for Derivative Instruments and Hedging Activities in June 1998. The FASB has subsequently issued SFAS No.137 and SFAS No.138 to augment and supersede portions of SFAS No. 133. SFAS No.133 represents the culmination of the FASB's nearly decade-long effort to develop a

comprehensive framework for derivatives and hedge accounting. Starting with all fiscal years after June 15, 2000, SFAS No.133 becomes mandatory for all companies. The main point of SFAS No.133 is that a company is required to show changes in all of its derivatives values as assets or liabilities in the financial statements and measure those instruments at fair value with offsets allocated to current earnings or other comprehensive income (OCI), even if the derivatives remain in an open position. This is a sharp departure from past accounting procedures (SFAS No. 52 and SFAS No. 119) that allowed many types of derivatives, such as forward, futures, options and swaps, to be left off the balance sheets. Other firm characteristics such as TAX, SIZE, DEBT, and RND are collected from the COMPUSTAT annual industrial database.

Appendix 1 summarizes the definitions and sources of the main variables that are used in our empirical analysis: export sales, foreign sales, total foreign activity, total foreign exchange risk exposure, four proxies for operational hedging, and financial hedging, as well as the source of the information used in the paper.

[Appendix 1 About Here]

EXPORT is the amount of goods or services sold outside the domestic country. FSALE is the amount of sales generated in foreign countries from foreign facilities and operations. TOTFOR is the sum of foreign sales and export sales; standardized by total sales, the variable is referred to as the total foreign activity ratio. FXEXP is the beta from the two factor model regression, i.e., the sensitivity of the firm's stock price to changes in the nominal broad trade weighted index. ABSFX is the absolute value of the foreign exchange risk measure and captures the magnitude of the firm's exposure. LNSUBS is the log of the number of foreign subsidiaries in which the firm operates; LNCOUNTRY is the log of the number of countries in which the firm has operations. The Dispersion variables I and II are one minus the Hirshman-Hirfindahl

indices for the number of countries where the subsidiaries are located, and regions where the subsidiaries are located, respectively. NOTIONAL is the total notional amount of foreign currency derivatives, and FINHEDGE is NOTIONAL divided by the total foreign activities. Tobin's Q is the market value of assets to book value of assets ratio, and represents growth opportunities and performance of the firm. FD is the total amount of foreign debt divided by the firm's assets.

IV. Methodology

IV.1. Operational Hedging Measures

Following Allen and Pantzalis (1996) and Allayannis et al. (2001), we use four proxies for operational hedging: (1) the number of countries in which a firm operates (log of the number of countries, LNCNTY), (2) the number of broad regions where the firm is located (log of broad regions, LNSUBS),[8] (3) the geographic dispersion of its subsidiaries across different countries (Dispersion Index I), and (4) the geographic dispersion of its subsidiaries across regions (Dispersion Index II). Dispersion indices I and II are calculated as one minus Hirshman-Herfindahl concentration index based on the number of foreign subsidiaries in country and in geographic region.[9] These dispersion indices are close to zero if a firm has subsidiaries in one country or region and equal to one if a firm has subsidiaries in many countries or regions. Thus, if a firm is more operationally diversified, then this dispersion index measure also increases.

The effects of operational hedging and financial hedging on foreign exchange risk exposure are measured by using the following two-factor model (Jorion, 1990), $R_{it} = \alpha + \beta R_{mt} +$

[8] Following Allayannis et al. (2001), we divide the countries into 9 major regions: NAFTA, Europe, Western Europe, Eastern Europe, East Asia, Other Asia, Central America, South America, and Africa.

[9] Dispersion Index I = $1 - \{ \Sigma_i [\#\text{ of countries}]^2 / [\Sigma_i (\text{Total \# of countries})]^2 \}$ and Dispersion Index II = $1 - \{ \Sigma_j [\#$ of regions$]^2 / [\Sigma_j (\text{Total \# of regions})]^2 \}$ where # of countries = the number of foreign subsidiaries in country i, and # of regions = the number of foreign subsidiaries in geographic region j.

$\gamma\ FX_t + \varepsilon_{it}$, where R_i = monthly rate of return on the i^{th} firm's stock, R_{mt} = monthly rate of return on the value weighted market portfolio, and FX = monthly rate of return on the broad trade weighted foreign exchange rate. We use monthly return data from the CRSP database over the period of 1997 to 1999 to estimate foreign exchange risk exposure (FXEXP, γ). The data for the nominal broad trade weighted index are obtained from the Federal Reserve Board database.[10]

IV.2. Multivariate Regression Model

The level of foreign exchange exposure and financial risk management decisions are endogenous. A firm's hedging policies affect the magnitude of foreign exposure since hedged firms will have lower level of exposure. On the other hand, foreign exposure influences a firm's hedging policies. A firm that views itself as more exposed will have greater incentive to hedge. Thus, the level of foreign exposure and corporate hedging decisions are determined simultaneously and are modeled accordingly. To control for the endogenous nature of the hedging decisions, we use a system of equations using three-stage least squares methodology (3SLS). For the hedging decision, we use the following equation and add the endogenous variable absolute value of foreign exchange exposure in the model. The basic model is as follows:

$$\text{FINHEDGE} = \alpha + + \beta_{\cdot 1}\ \text{OPERHEDGE} + \beta_2\ \text{TOTFOR} + \Sigma\ \text{Control variables} + \varepsilon \quad (1)$$

where OPERHEDGE = operational hedging variables: Dispersion Index I and Dispersion Index II, LNCNTY, and LNSUBS, TOTFOR = total foreign activity as measured by total foreign sales or export sales to total sales, and Control variables = FD, TAX, SIZE, DEBT, RND, QUICK, and SEGN. In this first regression model, we examine whether operational hedging and financial

[10] We also test by using various estimation periods of 48 month, and 60 month, a different market index (equally weighted index), and various currency indices (Major index, OITP index) (Bodnar and Wong, 2003). The results are similar to the findings in this paper.

hedging are substitutes or complements. We expect the positive coefficient of operational hedging variables when both hedging strategies are complements.

Next, we examine the impact of operational hedging and financial hedging on foreign exchange risk exposure in the following model:

$$\text{ABSFX}(|\gamma|) = \alpha + \beta_1 D^*\text{FINHEDGE} + \beta_2 D^*\text{Operational Hedge} + \beta_3 (1\text{-}D)^*\text{FINHEDGE} + \beta_4 (1\text{-}D)^*\text{Operational Hedge} + \Sigma \text{ Control variables} + \varepsilon \quad (2)$$

where ABSFX = absolute value of the foreign exchange risk exposure as measured, by the two factor model (Jorion, 1990).[11] To separate the impact of foreign exposure by net importer and net exporter, we use a dummy variable, D, to indicate a firm that has positive exposure to exchange rates (i.e., a firm that is a net importer). (1-D) represents a firm with negative exposure (i.e., a firm that is a net exporter). We control heteroscedasticity in the estimation of the exposure coefficients by using the weighted least squares (WLS) method and using the inverse of the squared standard error of the foreign exposure coefficient as the weight (see Pantzalis et al., 2001; Carter et al. 2004a; Kim et al. 2005, for details). We hypothesize that both financial hedging and operational hedging are associated with reducing foreign exchange risk exposure.

Finally, we examine the impact of both hedging strategies on firm value. The dependent variable is Tobin's q as measured by the log of the market to book value of assets. Market value of assets is the sum of the market value of equity, preferred stock, and book value of debt following Chung and Pruitt (1994). The regression model is as follows:

$$\text{Tobin's q} = \alpha + \beta_1 \text{ FINHEDGE} + \beta_2 \text{ OPERHEDGE} + \Sigma \text{ Control variables} + \varepsilon \quad (3)$$

[11] The reason that we use the absolute value of foreign exchange risk exposure measure is that the details of import and export activities at the firm level are not available although we obtain export sales information. For this reason, it is not feasible to identify the sign of the currency exposure to the exchange rate change. Since the focus of this paper, however, is how risk management strategies affect foreign exchange risk exposure and firm value, the magnitude of the exposure is more important than the sign of the exposure.

We include the control variables, SIZE, DEBT, RND CAPX, ROA, number of geographic segments, and credit rating in Tobin's q regression. Froot et al. (1993) show that hedgers are more likely to have larger investment opportunities. Geczy et al. (1997), Gay and Nam (1998) support the evidence. Following Allayannis and Weston (2001), we use CAPX, measured as the ratio of capital expenditures to total assets, as a proxy for investment opportunities. We also incorporate five credit rating dummies to represent credit risk of sample firms, as measured by Standard & Poor's long-term debt credit rating. We hypothesize that there should be a positive relationship between financial and operational hedges and firm value.

V. Results

V.1. Univariate Tests

Table 1 summarizes the descriptive statistics for the sample of 216 firm observations. Panel A shows the number of observations, mean, standard deviation, maximum, minimum, and median, for financial hedging measures, and Panel B provides information regarding operational hedging measures (including Dispersion Index I, and Dispersion Index II, number of foreign subsidiaries, number of foreign countries in which a firm operates, export sales, and foreign sales).

[Table1 About Here]

Table 1, Panel A, presents financial derivatives usage information. The notional amounts of foreign currency derivatives as well as the types of instruments are reported. Forward contracts, which lock in a price for future delivery of currency, are used by 119 firms, or 55% of sample firms. Mean (median) forward contract use is $646.60 (47.00) million. Swaps, which allow firms to lock in and exchange a series of sequential payments with counterparty, are used by 12, or about 6% of the sample. Options, which give the firm the right, but not the obligation,

to transact at a previously set strike price, are used by about 17% of the sample. Foreign debt is used by 23 firms, or 10.65% of the sample. Total currency notional mean (median) amount is $814.78 (55.90). For financially hedged firms, FINHEDGE, the total notional amount divided by sales, has a mean (median) value of 0.58 (0.13). For the full sample including operationally hedged firms as well as derivative users, the FINHEDGE ratio is much lower, with a mean (median) value of 0.34 (0.17). Currency notional amount for the full sample is on average $467.74 million, with a median of $55.9 million. Taken together, these results suggest that sample firms rely heavily on financial derivatives instruments to manage exposure to exchange rates.

Panel B provides information regarding operational hedging activity. The mean (median) country based dispersion index, Dispersion I, is 0.370 (0.480); the regional based dispersion index is 0.514 (0.667).Export sales (EXPORT) are on average $366 million, with a median of $0.46 million. FSALE, foreign sales, have a mean (median) of $1,231 (0.00). The foreign activity ratio has a mean (median) of 0.274 (0.242), indicating that approximately 27% of sales on average are comprised of foreign sales and exports. Sample firms have, on average, 14.63 foreign subsidiaries, with a median of 4 subsidiaries. Sample firms have operations in 8.51 countries, with a median of 4. These results suggest that sample firms are broadly dispersed in terms of operating across countries and regions, and heavily involved with foreign sales and operations.

[Table 1 About Here]

Table 2 provides mean and median difference tests for firm characteristic variables and operational hedging proxies by financial derivative users, and presents tests for differences in characteristics for derivatives users versus non-derivative users.

[Table 2 About Here]

Table 2 indicates that firms that use derivatives are significantly larger in terms of both assets and sales than those that do not use derivatives, a result consistent with previous research. They do not differ in terms of leverage (DEBT), though derivatives users are more R&D intensive. However, they face higher tax burdens. Derivatives users do not differ from non-derivatives users in terms of export sales, i.e., the value of revenues domestically produced but sold overseas. They do have significantly higher foreign sales, i.e., amount of sales generated in a foreign country from foreign operations than non-derivatives users.

Mean currency exposure (FXEXP) estimated from the two factor model, is significantly more negative for derivative users than for non-derivative users. However, median currency exposure and the absolute value of currency exposure are not significantly different for derivatives users versus non-derivative users. Derivative users have more foreign subsidiaries, operate in more countries, and are more dispersed geographically using both measures of dispersion. Both mean and median scopes of operations are significant at the 1% level. Comparisons cannot be made regarding financial hedging (FINHEDGE), given that non-derivatives users are defined by this variable being zero. Tobin's Q does not differ significantly for derivatives users and non-derivatives users.

Table 3 presents the Pearson correlation coefficients for financial and operational hedging variables. Table 3 indicates that there are several significant relationships between exposure, hedging, and growth options as measured by Tobin's Q. Size, as measured by log of total assets, is significantly correlated with export sales, total foreign activities, number of subsidiaries and countries in which they operate, as well as geographic dispersion. The number of subsidiaries and countries in which firms operate are significantly correlated with total foreign

activity, export sales, dispersion, and the likelihood of being a derivatives user (CUSER). Foreign exposure (FXEXP) is correlated significantly negatively with CUSER, and the correlation between the absolute value of foreign exposure (ABSFX) is insignificant. The financial hedge ratio (FINHEDGE), the notional amount of derivatives divided by total assets is significantly and negatively correlated with the total exposure ratio (TOTEXPR), but positively related to dispersion (Disp1 and Disp2). The likelihood of being a derivatives user (CSUSER) is significantly and positively correlated with size, total foreign sales, total exposure (TOTEXPR), and the number of subsidiaries and countries in which firms operate. CSUSER is also significantly and positively correlated with both dispersion measures, but, surprisingly, not significantly correlated with the foreign exchange risk sensitivity (FXEXP) or the absolute value (ABSFX).

[Table 3 About Here]

V. 2. Complement vs. Substitute Test

We next investigate whether the relationships revealed in Table 3 between derivative use (CUSER) and operational hedging are significant in a multivariate framework. Table 4 provides the relation between operational and financial hedging using three stage least squares. The dependent variable is the financial hedge ratio. Four regression models are presented in Table 4.

[Table 4 About Here]

Table 4, Model 1 indicates that the country dispersion index (Dispersion Index I) is significantly, and positively, related to the amount of financial hedging. This supports the conditional complement hypothesis, namely, that firms use operational hedges along with financial hedges to manage exposure. Tax loss is also significant and positive, indicating that firms use overseas financial hedging strategies to offset taxable income. R&D expense is significantly and negative.

Total foreign activity is negatively and significantly related to financial hedging. The quick ratio, which proxies for efficiency, is significant and positive, indicating that more efficient firms use financial hedges. The results of Model 2 are quantitatively similar to Model 1, Dispersion II, which is used as a substitute for the Dispersion I variable. Like Dispersion I, Dispersion II is significant and positively related to the probability of using derivatives, consistent with previous hypotheses. Model 3 substitutes the log of the number of foreign subsidiaries (LNSUB) for Dispersion II. While the sign is the same --subsidiary dispersion is positively related to the likelihood of using derivatives-- the coefficient of LNSUB is insignificantly different from zero. Model 4 is quantitatively similar except that LNCNTY, the log of the number of countries in which the firms have operations, is used instead of LNSUB. Again, the coefficient is positive, but insignificant. In all four models, foreign debt is insignificant in determining the use of financial hedging, as are debt to total assets and the number of business segments in which the firm operates.

Taken together, the results provide support for the conditional complement hypothesis. Firms that are dispersed (operationally hedged) are more likely to use financial derivatives. The tax loss hypothesis is also supported in all four models. Finally, size is significant and positive in all regressions, consistent with previous research. The Chi-Square statistic indicates that all four model specifications are significant. Surprisingly, exchange rate exposure estimated from the two factor Jorion model (ABSFX) is not a relevant determinant of derivatives use.

V. 3. Exposure Effect

We next investigate whether financial and/or operational hedging impacts the exchange rate exposure of our sample firms in a multivariate framework. The results of our four regression models are shown in Table 5.

[Table 5 About Here]

Table 5 regresses financial hedging and operational hedging variables on the absolute value of foreign exchange exposure. Four models are presented, corresponding to four operational hedging measures, Dispersion Index 1, Dispersion Index II, LNSUB, and LNCNTY. In these regressions, we use an indicator variable D to represent positive versus negative exposure following He and Ng (1988). For net importers, the interaction between D and financial hedging is negative and significant; indicating that financial hedging significantly reduces exposure. None of the measures of operational hedging, Dispersion Index I, Dispersion Index II, LNSUB, or LNCTY are signficant. Furthermore, for net importers, total foreign activity is insignificant in determining exposure.

For firms with a negative exposure, (1-D), the financial hedging variable is again significant, indicating that financial hedging is effective in controlling exchange rate risk for high tech firms. However, operational hedging variables are insignificant in all but two cases (Dispersion Index II and LNCTY), where it is significant and positive. This indicates that operational hedging actually increases foreign exchange exposure for net importers. Taken together, in contrast to our hypothesis, the regression results suggest that for high tech firms, only financial hedging is effective in combating exchange rate exposure than operational hedging.

V. 4. Firm Value Effect

Our next objective is to examine whether financial and/or operational hedging affects the growth opportunities or performance of the firm. We next present the results of six cross-sectional regressions on Tobin's Q in Table 6.

[Table 6 About Here]

Model 1 indicates that the financial hedge ratio, FINHEDGE, is significant and positively related to Tobin's Q, indicating that financial hedging adds value to the firm. Business segments are insignificant determinants of Tobin's Q, as are assets and capital expenditures. However, leverage and R&D are both significantly related to Tobin's Q; leverage is negatively related to Q, while R&D is significant and positive. Taxloss is negatively and significantly related to Tobin's Q. Thus, in the absence of any operational hedging variables, financial hedging appears to improve firm performance.

Next we examine whether operational hedging impacts performance. Model 2 includes Dispersion I, the country dispersion variable. Dispersion is insignificant in determining financial performance, while all other variables remain significant with the same signs as in Model 1. Model 3 includes DISP2, the regional dispersion measure. It is insignificantly related to Tobin's Q; all other variables retain their previous signs. LNSUB, the number of subsidiaries the firm has, is insignificant as a determinant of Tobin's Q. Consistent with the previous models, the financial hedge ratio is significant and positively related to Tobin's Q; however, LNCNTRY is insignificantly in determining Tobin's Q. Taken together, the results in Table 5 indicate that financial hedging does add value to the firm as exhibited by its significant and positive relationship with Tobin's Q, but operational hedging does not add value. Hence, while operational and financial hedges are complements, firms derive the greatest performance benefits from financial hedging.

[Table 6 About Here]

VI. Conclusions

High technology firms in the U.S. make substantial investments in intangible assets. These firms seek to exploit their unique assets by expanding globally, which increases the

volatility of their cash flows and the risk of financial distress. Thus, high technology firms view hedging as a viable strategy for managing risks. These firms can undertake some combination of operational and financial hedging to manage risk. We use four distinct measures of operational hedging: the number of foreign countries in which a firm operates, the number of broad regions where a firm operates, and two dispersion measures based on the Hirshman-Herfindal concentration index. Financial hedging is defined as the use of foreign currency derivatives including forward and futures contracts, swaps and options.

For 1998, we identify a unique sample of 108 high tech operationally hedged firms, i.e., these firms report foreign operations and foreign sales. We match these firms on the basis of size and four digit SIC codes with a sample of non-operationally hedged high technology firms, i.e., these firms have export sales only. Our results indicate that while financial and operational hedges may be used for complementary purposes, only financial hedging reduces exchange rate risk and contributes positively to firm performance.

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Table 1. Descriptive Statistics

Panel A. Financial Hedging Information (Financial Derivatives Users Only)

Variables	# of obs	Mean	Standard Deviation	Minimum	Median	Maximum
Currency Derivatives Notional Amount						
Forward Contracts	119	646.599	3117.29	1.00	47.00	33100.00
SWAPS	12	795.008	2367.14	1.00	79.90	8300.00
OPTIONS	36	391.4194	847.13	1.00	16.70	4035.00
Foreign Debt	23	63.60	143.35	0.00	54.35	419.00
Currency Notional Amount	124	814.78	3295.09	1.00	55.90	33100.00
FINHEDGE	124	0.58	1.33612	0.00	0.13	6.50
FINHEDGE (All Sample)	216	0.34	1.05130	0.00	0.004	0.17
Currency Notional Amount (All Sample)	216	467.74	2525.0	0.00	1.00	33,100.00

Panel B. Operational Hedging Measures

Variables	Number of observations	Mean	Standard Deviation	Minimum	Median	Maximum
Dispersion Index I (Country based)	199	0.37	0.32	0.00	0.48	0.89
Dispersion Index II (Region based)	199	0.51	0.41	0.00	0.67	0.98
Number of Subsidiaries	216	14.63	34.16	1.00	4.00	402
Number of Foreign Countries	197	8.51	11.47	1.00	4.00	94
Export Sales (EXPORT)	216	366	1,944.09	0.00	0.46	26,530
Foreign Sales (FSALE)	216	1231	4,696	0.00	11.87	43,819
Foreign Activity ratio (TOTFOR)	216	0.27	0.205	0.0004	0.24	0.938
Total Assets	216	6,249	24,305	188	1576	257,389

Note: This table presents the descriptive statistics for operational and financial hedging measures for the sample of 216 observations for fiscal year end 1998. Firm characteristics are obtained from COMPUSTAT and operational hedging measures (the number of subsidiaries and number of foreign countries) are hand collected from the Directory of Corporate Affiliations in 1999. Number of observations, Mean, standard deviation, minimum, median, and maximum are reported.

Table 2. Univariate Tests by Financial Hedging

	Derivatives Non-Users Number of Firms = 92			Derivatives Users Number of Firms = 124			t-statistics	Z-statistics
	Mean	Median	Std	Mean	Median	Std		
Dispersion Index I	0.290	0.197	0.308	0.424	0.541	0.321	-2.95 ***	-3.03 ***
Dispersion Index II	0.429	0.500	0.413	0.571	0.777	0.405	-2.40 **	-2.66 ***
LNSUBS	1.243	0.693	1.413	1.805	1.945	1.453	-2.71 ***	-2.92 ***
LNCNTY	1.093	0.693	1.220	1.572	1.609	1.267	-2.66 ***	-2.75 ***
EXPORT	0.088	0.030	0.149	0.067	0.000	0.117	1.08	1.22
FSALE	0.146	0.000	0.207	0.235	0.220	0.247	-2.89 ***	-2.58 ***
FXEXP (γ)	-0.348	-0.457	1.888	-0.866	-0.560	1.807	2.01 **	1.05
ABSFX	1.402	1.123	1.303	1.390	1.015	1.440	0.06	0.91
Total Assets	2585.9	819.3	6010	8966.1	2101.2	31438	-2.21**	-6.21 ***
Total Sales	2510.0	807.2	6208	7530.7	1972.3	20118	-2.62 ***	-6.09 ***
DEBT	0.224	0.200	0.188	0.193	0.1672	0.155	1.29	0.96
RND	0.046	0.033	0.047	0.065636	0.0384	0.062	-2.59 **	-2.02 **
TAX	0.011	0.000	0.047	0.032	0.0000	0.101	-2.04 **	-2.81 ***
FINHEDGE	0.000	0.000	n.a	0.584	0.128	1.336	-4.19 ***	-12.81***
Tobin's q	1.842	1.463	1.2296	2.058	1.409	1.504	-1.16	-0.22

***, **, * significant at the 1%, 5%, and 10% levels, respectively.

Note: This table presents the univariate tests for operational and financial hedging measures for the sample of 216 observations in fiscal year end 1998. Firm characteristics are obtained from COMPUSTAT and operational hedging measures (the number of subsidiaries and number of foreign countries) are hand collected from the Directory of Corporate Affiliations in 1999. Dispersion Index I (Dispersion Index II) is measured as one minus the Hirshman-Herfindahl index of the number of countries (regions) where the company is located. The Hirshman-Herfindahl index is constructed as the sum of the squared "market shares" for each country where the market share for each country (region) is defined as the proportion of total subsidiaries in each country (region). The number of subsidiaries (LNSUBS) and foreign countries (LNCNTY) are measured as the number of non-U.S. located subsidiaries/foreign countries from the DCA. FXEXP is the foreign exchange exposure coefficient obtained using two factor market model: broad trade weighted exchange rate index and value weighted market portfolio. ABSFX is the absolute value of FXEXP. The TOTFOR is measured as export sales or foreign sales divided by total sales. EXPORT and FSALE are collected from the COMPUSTAT geographic segment files. Total assets are measured as book value of total assets for fiscal year end 1998. Total Sales are measured as the amount of total sales. Debt to Assets is the ratio of total debt divided by total assets. RND is the research and development expenditures to the total assets. Notional is the total notional amount of currency derivatives. FINHEDGE is measured as total notional amount divided by total foreign activities. Tobin's q is the ratio of market to book value of assets. Means, standard deviations, medians, t statistics and Z statistics are reported.

Table 3. Correlation Coefficients

	Assets	Export	Tfsale	Totexpr	LNSUB	LNCTY	DISP1	DISP2	CUSER	FINHEDGE	Q	FXEXP	ABSFX
Assets	1.000												
EXPORT	0.122*	1.000											
TFSALE	0.877***	-0.050	1.000										
TOTEXPR	0.026	0.032	0.197***	1.000									
LNSUB	0.301***	0.150**	0.324***	0.082	1.000								
LNCTY	0.268***	0.138*	0.296***	0.099	0.983***	1.000							
DISP1	0.100***	0.146**	0.213***	0.087	0.863***	0.892***	1.000						
DISP2	0.185***	0.122*	0.208***	0.071	0.913***	0.941***	0.917***	1.000					
CUSER	0.130*	0.100	0.119*	0.167**	0.190***	0.186***	0.206***	0.168**	1.000				
FINHEDGE	0.032	-0.025	-0.007	-0.215***	0.113	0.128	0.171*	0.151**	0.276***	1.000			
Q	-0.046	-0.071	0.027	0.151**	0.005	0.022	0.039	0.005	0.077	0.061	1.000		
FXEXP	0.029	-0.011	0.007	-0.239***	-0.016	-0.016	-0.016	0.018	-0.138**	0.073	-0.037	1.000	
ABSFX	-0.087	-0.054	-0.086	0.142**	-0.080	-0.066	-0.106	-0.108	-0.004	-0.104	-0.024	-0.409	1.000

***, **, * significant at the 1%, 5%, and 10% levels, respectively.

Table 4. Financial Hedging (Dependent variable = Financial hedge ratio)

	Model 1	Model 2	Model 3	Model 4
Intercept	-0.157 -0.23	-0.390 -0.61	-0.522 -0.77	-0.342 -0.51
Dispersion Index I	0.663** 2.03			
Dispersion Index II		0.488** 2.02		
LNSUB			0.059 0.83	
LNCNTY				0.123 1.44
FD	0.140 0.63	0.135 0.62	0.138 0.63	0.130 0.59
Tax loss	4.458** 2.17	4.434** 2.25	4.337** 2.14	4.379** 2.18
Log of Total asset	0.131 1.56	0.157** 1.98	0.189** 2.19	0.160* 1.90
Debt /Total asset	-0.324 -0.47	-0.427 -0.66	-0.583 -0.87	-0.497 -0.74
R&D expense/sales	-5.121** -2.43	-5.444*** -2.61	-5.681*** -2.70	-5.588*** -2.66
Quick ratio	0.351*** 2.69	0.354*** 2.80	0.340*** 2.61	0.349*** 2.69
# of Business Segment	0.003 0.04	-0.022 -0.29	-0.020 -0.26	-0.013 -0.18
Total foreign activity	-1.562*** -3.27	-1.560*** -3.34	-1.553*** -3.33	-1.563*** -3.33
ABSFX	-0.706 -1.58	-0.529 -1.36	-0.399 -0.92	-0.511 -1.22
F-statistics	3.55***	3.65***	3.33***	3.42***
R-square	11.08	11.59	10.34	10.70

Note: This table shows the multiple regression results for the sample of 216 firms for fiscal year end 1998. The dependent variable is the absolute value of foreign exchange risk exposure. We use three stage least squares to control endogeneity between hedging and foreign exchange risk exposure. Also, we use the weighted least square method using one over squared standard error of the coefficient of foreign exposure. Foreign exchange risk exposure is calculated using the two factor model (Jorion, 1990). The financial hedge ratio is measured as total currency derivatives notional amount divided by total foreign activity. Operational hedging is measured by four different proxies: Dispersion index I, Dispersion index II, log of number of subsidiaries and number of foreign countries. Dispersion index I (Dispersion index II) is measured as one minus the Hirshman-Herfindahl index of the number of countries (regions) where the company is located. Total foreign activity ratio is the sum of export sales and foreign sales divided by total sales. Foreign debt is a dummy variable equal to 1 if the company reports the use of foreign debt, otherwise zero. T-statistics are reported in parentheses. Adjusted R-squares and F-statistics are reported.

Table 5. Foreign exchange risk exposure tests (Dependent variable = ABSFX)

	Dispersion index I	Dispersion index II	Log(Number of subsidiaries)	Log(Number of countries)
D	1.338**	1.318**	1.352**	1.330**
	(2.46)	(2.45)	(2.31)	(2.34)
D * financial hedging ratio	-0.242***	-0.204***	-0.177**	-0.202***
	(-3.54)	(-2.97)	(-2.54)	(-2.92)
D * operational hedging	-0.023	-0.160	-0.018	-0.024
	(-0.07)	(-0.63)	(-0.23)	(-0.27)
D * foreign debt	0.087	0.050	0.081	0.079
	(0.33)	(0.19)	(0.30)	(0.30)
D * total foreign activity	-0.337	-0.279	-0.287	-0.302
	(-0.61)	(-0.51)	(-0.52)	(-0.55)
D * log(total assets)	-0.051	-0.042	-0.055	-0.049
	(-0.65)	(-0.56)	(-0.65)	(-0.60)
D * number of segments	-0.014	-0.008	-0.013	-0.013
	(-0.19)	(-0.11)	(-0.18)	(-0.19)
(1-D)	0.995**	1.019**	1.044**	1.071**
	(2.46)	(2.54)	(2.47)	(2.58)
(1-D)* financial hedging ratio	-0.111*	-0.074	-0.028	-0.061
	(-1.89)	(-1.25)	(-0.48)	(-1.03)
(1-D) * operational hedging	0.354	0.352*	0.072	0.106*
	(1.54)	(1.96)	(1.42)	(1.76)
(1-D) * foreign debt	-0.046	-0.078	-0.085	-0.081
	(-0.28)	(-0.47)	(-0.50)	(-0.49)
(1-D)* total foreign activity	0.042	0.108	0.187	0.114
	(0.12)	(0.30)	(0.51)	(0.31)
(1-D) * log(total assets)	-0.072	-0.083	-0.087	-0.088
	(-1.27)	(-1.47)	(-1.44)	(-1.51)
(1-D) * number of segments	0.097	0.093	0.102	0.099
	(1.57)	(1.48)	(1.63)	(1.58)
F-statistics	35.98***	17.98***	17.67***	17.81***
Adjusted R square	0.553	53.9	53.4	53.69

***, **, * significant at the 1%, 5%, and 10% levels, respectively.

Table 6. Firm value effect tests

	Model 1	*Model 2*	*Model 3*	*Mode 4*	*Model 5*	*Model 6*
Intercept	0.971*** (6.03)	0.975*** (5.81)	0.989*** (6.04)	0.985*** (5.96)	0.969*** (5.65)	0.975*** (5.75)
FINHEDGE	0.056** (4.70)		0.058** (5.37)	0.057** (5.26)	0.057** (5.30)	0.057** (5.34)
Dispersion Index I		-0.018 (0.02)	-0.046 (0.12)			
Dispersion Index II				-0.026 (0.06)		
Log Subsidiary					-0.011 (0.14)	
Log Country						-0.011 (0.10)
Log(total assets)	-0.022 (0.32)	-0.009 (0.04)	-0.012 (0.09)	-0.013 (0.10)	-0.011 (0.06)	-0.012 (0.08)
Total debt/ total assets	-0.514* (2.89)	-0.578* (3.14)	-0.552* (2.86)	-0.547* (2.82)	-0.549* (2.85)	-0.550* (2.85)
R&D/ total assets	4.593*** (20.91)	4.913*** (17.77)	5.040*** (18.21)	5.032*** (18.05)	5.027*** (18.05)	5.035*** (18.14)
Capital exp / total assets	-0.564 (0.24)	-0.807 (0.47)	-0.812 (0.47)	-0.813 (0.48)	-0.816 (0.48)	-0.816 (0.48)
Return on assets	2.872*** (24.47)	2.859*** (21.39)	2.838*** (21.73)	2.840*** (21.58)	2.837*** (21.63)	2.839*** (21.62)
Number of segments	0.003 (0.01)	-0.018 (0.25)	-0.016 (0.19)	-0.015 (0.18)	-0.015 (0.17)	-0.015 (0.18)
Credit rating	YES	YES	YES	YES	YES	YES
Adjusted R-squares	37.17%	38.18%	38.78%	38.76%	38.79%	38.77%
F-statistics	10.69***	10.36***	9.91***	9.91***	9.92***	9.91***

***, **, * significant at the 1%, 5%, and 10% levels, respectively.

Note: This table shows the multivariate regression results for the sample of 424 firms for fiscal year end 1998. The dependent variable is Tobin's Q, measured as the natural log of the ratio of the market value of assets to book value of assets following Chung and Pruitt (1994). The financial hedge ratio is total currency derivatives notional amount divided by total foreign activity. Operational hedging is measured by four different proxies: Dispersion index I, Dispersion index II, log of number of subsidiaries and log of number of countries. Dispersion Index I (Dispersion Index II) is measured as one minus the Hirshman-Herfindahl index of the number of countries (regions) where the company is located. The interaction variable is financial derivatives user variable multiplied by operational hedging variables. Industry is a dummy variable using the two digit SIC code. White (1980) heteroscedestic corrected chi-squares are reported in parentheses. Adjusted R-squares and F-statistics are reported.

Appendix 1: Variable Description

	Variable	Data Description (Sources)
Export Sales	EXPORT	Export sales represent the amount or percentage of each segment's revenue generated by domestically produced goods or services, sold outside of the domestic country. (Compustat Geographic Segment files, C.G.S.)
Foreign Sales	FSALE	The amount of sales generated in foreign countries from foreign facilities and foreign operations. (C.G.S)
Total Foreign Activity	TOTFOR	Sum of the amount of foreign sales and export sales. The total foreign activity ratio is calculated as foreign activities divided by total sales. (C.G.S.)
Foreign exchange risk exposure	FXEXP	Calculated by two-factor model following the Jorion (1990) methodology: $R_i = \alpha + \beta\ Rm + \gamma\ FX + \varepsilon$, where FX is nominal broad trade weighted index. (CRSP and Federal Reserve Board database)
Absolute Foreign Exchange Risk Exposure	ABSFX	Absolute value of the foreign exchange risk exposure measure (FXEXP)
Number of Subsidiaries	LNSUBS	Log of number of foreign subsidiaries in which a firm operates. (Directory of Corporate Affiliations)
Number of Countries	LNCNTY	Log of number of foreign countries in which a firm operates (Directory of Corporate Affiliations in 1999)
Dispersion Index I	Dispersion Index I	Measured as one minus Hirshman-Herfindahl index for the number of countries where the company's subsidiaries are located. The Hirshman-Herfindahl index is constructed as the sum of the squared "market shares" for each country where the market share for each country is defined as the proportion of total subsidiaries in each country.
Dispersion Index II	Dispersion Index II	Measured as one minus Hirshman-Herfindahl index for the number of countries where the company's subsidiaries are located. The Hirshman-Herfindahl index is constructed as the sum of the squared "market shares" for each region where the market share for each region is defined as the proportion of total subsidiaries in each region.
Notional Amount	NOTIONAL	Total notional amount of foreign currency derivatives such as forwards, futures, swaps, options, and other financial instruments. (annual proxy statements, EDGAR database)
Financial Hedge Ratio	FINHEDGE	Total notional amount of currency derivatives divided by total amount of foreign activities. (annual proxy statements, COMPUSTAT)
Foreign Debt	FD	Total dollar value of foreign debt divided by assets (annual reports, Securities Data Corporation New Issues database)
Quick Ratio	QUICK	Measure of efficiency; current assets divided by current liabilities (COMPUSTAT)
Tobin's q	Tobin's q	Market to Book ratio. Market value of asset is calculated by the sum of the market value of equity, book value of preferred stock, and book value of debt. (COMPUSTAT)