MANAGING FOREIGN EXCHANGE RISK WITH DERIVATIVES

by

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Abstract

This study investigates the foreign exchange risk management program of HDG Inc. (pseudonym), an industry leading manufacturer of durable equipment with sales in more than 50 countries. The analysis relies primarily on a three month field study in the treasury of HDG. Precise examination of factors affecting why and how the firm manages its foreign exchange exposure are explored through the use of internal firm documents, discussions with managers, and data on 3110 foreign-exchange derivative transactions over a three and a half year period. Results indicate that several commonly cited reasons for corporate hedging are probably not the primary motivation for *why* HDG undertakes a risk management program. Instead, informational asymmetries, facilitation of internal contracting, and competitive pricing concerns seem to motivate hedging. *How* HDG hedges depends on accounting treatment, derivative market liquidity, foreign exchange volatility, exposure volatility, technical factors, and recent hedging outcomes.

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1 Introduction

While the risk management strategy of non-financial firms has been the subject of intense theoretical and empirical research, very little is known about the actual hedging practices of multinational firms. Using a field study and proprietary data, this paper conducts a detailed investigation of a firm's hedging operations and of its motivation for engaging in financial risk management. In the spring of 1998, I spent approximately three months in the treasury department of HDG Inc. (pseudonym).[1] During this period, I observed the implementation of foreign exchange (forex) risk-management decisions. I conducted extensive discussions with treasury personnel and senior management, reviewed internal

[1] As a condition for undertaking this study HDG required that I enter into a non-disclosure agreement. Specifically, I am not able to expose the true identity of the firm. I can only describe the firm as an "industry-leading manufacturer of durable equipment." In regards to specific data, I am not able to identify particular currencies nor can I report disaggregated data (e.g., sales by country by quarter, though "average sales in currency X" is permitted). A general restriction prevents me from disclosing any information that would allow a resourceful person to identify the company.

documents, and collected historical data on all 3,110 individual foreign currency derivative transactions for the 14 quarters from 1995:Q1 to 1998:Q2.[2]

Using this information, I address three general research questions. First, *how* does HDG structure its foreign exchange hedging program? Since existing literature contains little on how non-financial corporations structure their internal risk management programs, answering this question provides insights into the operations of the hedging program and affords a framework for more in-depth analysis of HDG. In general, HDG's policies and practices are consistent with the guidelines proposed by the Group of Thirty (1993) for derivative end-users and with the risk management practices of large multinational corporations (see, for example, Lewent and Kearney (1990), Davis and Militello (1995), Callinicos (1999), and Pearl, Aprati, and Moore (1999)).

Second, I explore the economic reasons *why* HDG manages foreign exchange risk. By observing the daily operations of the group and their interaction with senior treasury and foreign managers, I am able to report on observed motivations for the firm's risk management program. Traditional academic explanations for why a firm would manage hedgable risks (such as minimizing taxes and avoiding financial distress) do not capture the primary motivations of HDG. Instead, hedging appears to be motivated by more subtle explanations relating to information asymmetries between investors and management, competitive strategies involving pricing decisions, and efficiency gains through improved internal decision making and evaluation. For example, the primary focus of the forex hedging group is the determination and management of a foreign exchange rate termed the "hedge rate" used in *ex ante* planning decisions (e.g., in determining annual budgets, sales targets, and strategic decisions) and *ex post* evaluation and reporting.

Third, I investigate the precise structure of the foreign currency hedges with the 14 quarters of transaction data, internal exposure forecasts, and realized foreign exchange revenues. Attention is paid to cross-sectional differences between currencies, the dynamic properties of derivative positions, and the choice of hedging contract types. I find that HDG has a strong preference for hedging with put options primarily because of more favorable accounting treatment and competitive pricing concerns. Other factors that appear to

[2] The derivatives are written on 24 different currencies. Of these, 15 are hedged for the whole sample period (full-sample currencies) and 9 enter the sample during the observation period (partial-sample currencies).

determine the characteristics of the hedge portfolios (i.e., notional values, deltas, and gammas) include exchange rate volatility, underlying exposure volatility, technical factors that may be associated with market views, and recent hedging outcomes.

In one sense, the findings of this research are consistent with the composite of other empirical studies of corporate risk management in that a single, clear, and value-maximizing policy for risk management is not obvious.[3] Even in this ideal case of complete transaction data, it is difficult to determine if risk management increases firm value. Instead, a primary contribution of this study is to use this detailed look at a specific organization to suggest *new* mechanisms by which risk management may add value. In addition, the results aid in posing specific empirical questions that subsequent cross-sectional studies can explore. Similarly, the factors explaining variation in hedging behavior account for, at best, only half the variation in hedge ratios. Again, this indicates a need for further research that can more adequately explain how firms implement hedges.

The remainder of the paper is organized as follows: Section 2 describes the operations of the forex risk management group. Section 3 describes the reasons why HDG undertakes forex risk management and tries to reconcile stated objectives and actual practice with economic theory. Section 4 presents an analysis of the transaction data and factors that explain variation in hedge ratios. Section 5 examines the impact on firm value of foreign exchange risk and its management. This section also presents some new avenues for subsequent research motivated by the project's findings. Section 6 concludes.

2 HDG and Risk Management Operations

United States based HDG Inc. is an industry-leading manufacturer of durable equipment with sales in more than 50 countries. Foreign sales account for just under half of HDG's more than $10 Billion in 1997 gross revenue. The firm actively manages much of its non-US Dollar

[3] Generally, cross-sectional tests attempting to determine why firms use derivatives have not consistently supported theoretical explanations for value-maximizing objectives. Some findings include: larger firms are more likely to use derivatives (Dolde, 1993), firms with more growth options are more likely to use derivatives (Nance, Smith, and Smithson, 1993 and Geczy, Minton, and Shrand, 1997), and hedging increases with leverage (Block and Gallagher, 1986, and Wall and Pringle, 1989). Tufano (1996) finds that management incentives and tenure are important determinants for the cross-sectional differences in gold mining firms' risk management decisions. Even these results are not found in all samples though (see Haushalter, 1999).

(USD) currency exposures with financial derivatives. For example, in 1997 the notional value of foreign exchange derivatives held at fiscal year-end totaled approximately $3 billion and the notional value of derivative transactions for the year was over $15 billion.

HDG is a manufacturer of durable goods for consumers, business, and government. The firm operates in a highly competitive industry with numerous large and small competitors. Competition comes from both US-based and foreign manufacturers. HDG is tightly focused in its primary industry which is a growing market and highly dependent on technological innovation. "Flexibility in all aspects of the business has enabled [HDG] to quickly adapt to the changing competitive landscape. Likewise, [HDG's] financial strategy values financial flexibility" (internal memorandum).[4]

The HDG-specific numerical data for this study are obtained directly from the HDG treasury database and archives. Although HDG has sales in over 50 countries, only 24 of these are local currency business units (IBUs) that give rise to direct foreign exchange exposures.[5] Table 1 shows the countries and functional currencies of 40 of the largest foreign entities. Most foreign operations in developed and newly-developed countries are foreign currency functionals. Together the non-USD entities account for the vast majority of foreign revenues.

The data include the details of all derivative transactions in each currency and the assigned quarter of each position. Forecasted foreign currency exposures were obtained from the tax accounting group as of three dates: 9, 6, and 3 months prior to the target quarter's end. Where available, spot and forward exchange rates are collected from DataStream. Forward rates not available from DataStream are calculated using appropriate-maturity US Treasury Bill rates and short-term interest rates reported by foreign central banks. Volatilities used to mark positions to market are from currency options traded on the Philadelphia Stock Exchange (PHLX) when available and are calculated from the past three months of daily spot

[4] Throughout the paper direct quotes from HDG employees or documents will be presented between quotation marks. If the source of the quote is not clear from the context, the citation will be followed by a description of the document (e.g., internal memorandum) or title of the employee (e.g., Manager of Foreign Exchange) in parentheses. Any items paraphrased or changed to protect the identity of HDG are isolated between square brackets (e.g., [industry] instead of the original description of HDG's industry).

[5] Legally, HDG is structured as a conglomerate of international business units (IBUs). Each of these foreign subsidiaries reports in a "functional" currency (as defined in SFAS 52). In practice, the determination of the functional currency depends on many factors including local legal restrictions, tax treatment, and currency liquidity. Most of the analysis in this paper deals with IBUs whose functional currencies are not US dollars.

prices when unavailable.[6] The combination of these data allows for the calculation of most interesting quantitative features of HDG's derivative positions for each currency-quarter in the sample.[7]

2.1 The Structure of Foreign Exchange Risk Management

HDG "uses foreign currency purchased option contracts and forward contracts to reduce its exposure to currency fluctuations involving probable anticipated, but not firmly committed, transactions and transactions with firm foreign currency commitments" (government filing). Due to unexpected losses and loose controls in foreign currency derivatives transactions prior to the study period, HDG put in place a very precise forex risk-management policy.[8] This policy is described in the official corporate document *Treasury Policy and Procedure Manual*. In effect, the policy limits the types, sizes, and timing of derivative positions. It also specifies the precise procedures followed by all employees involved with foreign exchange transactions.

Figure 1 shows an abbreviated organizational chart for forex risk management as specified by the official policy document. Most generally, functions are assigned to three broad groups: oversight, accounting and control, and operations. The policy states that "the Board of Directors has ultimate responsibility for approval of [HDG's] foreign exchange policy." Specifically, the Finance Committee has direct responsibility for "approval of policy revisions, quarterly performance review, and the annual policy review." In practice, the Foreign Exchange Management Committee (FXMC) provides most of the oversight function. The members of the FXMC are the Chief Financial Officer (CFO), Corporate Controller, Treasurer, regional Vice-Presidents (Americas, Asia-Pacific, Europe, Japan), and the Manager of Foreign Exchange. *Ex Officio* members include most other senior treasury managers.

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[6] These may be poor estimates of implied volatilities in some cases, for example, Asian currencies during the Asian crises of 1997 and 1998. Fortunately, there are only a few option transactions in these Asian currencies during this period (most hedges were constructed with forward contracts). The PHLX data provide implied volatilities for a variety of maturities and strike prices. To approximate the appropriate value as closely as possible, I average implied volatilities from four put options: the two with closest strike prices and closest expiration before the relevant option and the two with closest strike prices and expiration after the relevant option.

[7] A "currency-quarter" is defined as the exposure in a given currency for one (future) quarter, e.g., the expected foreign exchange exposure for 1998:Q1.

The FXMC is chaired by the CFO. The committee is responsible for quarterly reports on foreign exchange performance, hedging strategy, and accounting issues. It also must prepare an annual performance review and report on foreign exchange controls. Typically, the FXMC meets monthly. The primary function of the monthly meeting is to review the existing foreign exchange position and formally approve the *hedging strategy* of the firm. While not specifically defined in the *Treasury Policy and Procedure Manual*, a hedging strategy amounts to a decision to use derivatives to hedge a foreign currency exposure and specific guidelines concerning the type, notional value, and maturity of derivative contracts.

The second group of tasks defined by the policy statement is best described as accounting and control functions. The Treasury Accounting Group is assigned the responsibilities of confirming all foreign exchange transactions, determining the accounting treatment of derivative positions, and "monitoring compliance with exposure management guidelines" (*Treasury Policy and Procedure Manual*). In short, accounting verifies hedging activity is consistent with firm policy and GAAP. For example, only seven employees at HDG, all in the accounting group, are allowed to confirm foreign exchange transactions including derivative trades. By design, none of these individuals are allowed to enter into foreign exchange trades on the firm's behalf. This, now standard, separation of responsibilities lessens the potential for fraud or "rogue" trading.

The Foreign Exchange Group has the operational responsibilities for forex risk management. Members of this group execute the hedging strategy approved by the FXMC. This includes compiling data on underlying exposures, proposing appropriate derivative transactions, executing approved transactions, and monitoring the ongoing status of foreign exchange exposures and contract positions. The next subsection investigates their day-to-day operations in more detail.

HDG recognizes three types of foreign currency exposures: "Exposures arising from transactions denominated in currencies other than the functional currency of each legal entity (transaction exposure), exposure arising from the translation of foreign currency financial statements into US dollars (translation exposure), and exposure to anticipated foreign currency flows that are currently not reflected in accounting systems or other records

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[8] Despite some negative publicity associated with these derivative transactions, HDG decided to maintain its foreign exchange hedging program. This could be interpreted as indirect evidence of the program having a

(economic exposures)." HDG does not actively hedge its translation exposure, although the policy allows for this. Transaction exposure is typically hedged in a very mechanical fashion. As economic exposures become transaction exposures (almost always in the current quarter), forward or spot transactions are used to hedge the full, anticipated amount of foreign currency. Consequently, the subsequent analysis, as well as the effort of the foreign exchange group, derives mainly from the management of economic exposures.

What HDG considers an economic exposure would be considered by many academics as more typical of a transaction exposure. Academics typically define economic exposures as risks to firm value arising from macroeconomic shocks, competitive forces, or strategic concerns. For HDG, the cashflows to be hedged are typically the result of anticipated, but not firmly committed, transactions. Specifically, HDG's "economic" exposures arise primarily from the following four sources: "(1) Anticipated sales, (2) anticipated procurement, (3) anticipated operating expenses, and (4) anticipated third-party sales" (*Treasury Policy and Procedure Manual*). As will be shown later, there is still a large degree of uncertainty with regard to these exposures, but they are forecasted in the budgeting process. In other businesses with longer contracting periods, these exposures might be classified as transaction exposures. As a consequence, at HDG economic exposures are somewhere between the academic definition of "economic" and the accounting definition of "transaction."

The policy statement defines a set of "approved hedging instruments." These are foreign exchange spot and forward contracts, currency put options, and currency call options. "Long-term currency swaps and futures are explicitly not allowed as hedge instruments." The policy does not restrict the use of exotic contracts such as derivatives with average price (Asian), barrier or basket features.

Minimum and maximum degrees of hedging (notional value as a percent of exposure) are specified in the policy and are determined by the expected time to exposure realization:

Expected Time to Exposure	Minimum Hedge	Maximum Hedge
Current quarter	60%	90%
1 quarter	40%	90%
2 quarters	25%	85%
3 quarters	0%	85%
4 quarters	0%	85%

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significant economic value.

Hedging anticipated economic exposures more than four quarters in the future requires approval of the Finance Committee. Exceptions to the minimums and maximums in this policy can be granted by the CFO. Furthermore, hedge ratios exceeding these bounds (to a maximum hedge ratio of 100%) are allowed if the deviation is due to a revision in the forecasted exposure. The maximums and minimums were determined by the board of directors as part of the original adoption of official foreign exchange risk management policies.

2.2 The Practice of Foreign Exchange Risk Management

Most duties related to forex hedging are carried out by four members of the forex group: three Treasury Analysts with responsibilities for distinct global regions (Europe/Africa, Asia-Pacific, and the Americas) and the Manager of Foreign Exchange. These employees interact on a daily basis with the regional treasury managers (based abroad), the Director of Global Treasury, and the Treasurer (both based in the US). Approximately 11 full-time employees are dedicated to foreign exchange risk management: US-based foreign exchange group (4), regional treasury managers (2), senior treasury management (1), treasury accounting (2), and support (2).[9] An estimate by the Manager of Foreign Exchange puts the total cost of the forex risk management program at about $1.5 million annually (roughly half employee compensation and half other overhead such as systems and office space). The group does not have a set budget for derivative premiums and can transact in whatever instruments are deemed appropriate (and approved by the FXMC). A rough calculation suggests that transaction costs, assumed to be half of bid-ask spreads, averaged $2.3 million annually (these costs are included in the subsequent analysis).

Positions related to forex risk management are typically permanent assignments but employee experience varies considerably. For example, the tenure of analysts ranges from a new MBA hire to approximately 10 years in forex hedging (with an average of about 4 years). The compensation and evaluation of the forex group and its members is based almost entirely on qualitative review by senior US-based management (e.g., the CFO) and regional managers. Feedback on performance is provided on an ongoing basis with formal semi-annual reviews. In general, the forex group is viewed as a service provider to the regional businesses.

[9] I aggregate across employees with responsibilities beyond forex hedging, e.g., senior treasury management.

Compensation is not based on trading profit and loss (P&L) for either individuals or for the group.

The physical working area for the FX Group is similar to the areas for the other treasury groups (i.e., there is not a separate "trading floor"). Regional treasury analysts are not considered traders and spend the majority of their time with tasks other than following the currency markets. In fact, HDG does not maintain a record of P&L for the treasury analysts. Their desks do not have live market feeds and they do not monitor derivative positions intra-day. Instead, the group has a table in the center of the work area with one each of the Bloomberg and Bridge terminals for checking markets. Any proposed trades initiated by the treasury analysts must be approved by the Manager of Foreign Exchange or the Director of Global Treasury Operations prior to execution.

The process of implementing a hedge is complex, but it centers around the determination of a foreign exchange rate termed the *hedge rate.*[10] The hedge rate is used as the basis for internal planning and evaluation. Figure 2 provides a flow chart of this process. Initially, the forex group provides a *hedge rate indicator* which amounts to a rough estimate of the final hedge rate based on current spot, forward, and option prices.[11] Foreign business units use this exchange rate to prepare a preliminary business plan. This plan is passed on to the Tax Accounting Group which determines the forecasted foreign exchange exposure.

At this point, the forex group prepares a hedging strategy. Through discussions with the domestic and foreign treasury managers, the forex group prepares a hedge analysis comparing alternatives and recommends a specific hedging strategy to the FXMC. For example, a hedging strategy might be to purchase an at-the-money put option on 50 million GBP with an expiration date at the end of the quarter being hedged. This process is usually routine for currently-hedged currencies. Atypical situations, such as the Asian crises or the addition of a new currency exposure, involve a more careful consideration of alternative hedging strategies. If the hedging strategy is approved by the FXMC, the forex group executes the hedge trades.

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[10] The following description draws primarily from personal observations and internal training documents.

[11] The forex group quotes a "market achievable" rate which denotes that under current market conditions there is a high probability of obtaining the quote as a final hedge rate using the typical hedging strategy. The fourth quarter hedge rate (or indicator) is used for budgeting and planning beyond four quarters.

After executing the trades, the forex group calculates the new hedge rate. This is disseminated to operations and the international business unit (IBU) who use it to update the business plan and consequently the exposure forecast. This is a dynamic process; exposure forecasts and hedge strategies are updated at approximately monthly intervals though derivative transactions in any given currency may be more or less frequent.

Foreign currency exposures are not aggregated across quarters, currencies, or regions. Instead, each quarter's foreign currency is treated independently. For example, at any given time, HDG will have up to five separate "hedges" in place for the Japanese Yen (JPY): one for the current quarter and one for each of the next four quarters. Consequently, each currency-quarter has a separate hedge rate. The primary motivation for this approach is to facilitate the use of the hedge rate by management. Hedging each currency separately may result in larger transaction costs than alternatives like basket options that hedge many currencies in one transaction. However, HDG prefers the liquidity, accounting treatment, and tractability of single currency derivatives. Section 4.2 describes the choice of hedging instruments in detail.

The hedge rate is calculated as a function of current market rates and the cost of derivatives used to hedge for that quarter. Specifically, it is the sum of the current "effective hedge rate times the percent hedged and the all-in cost of adding at-the-money options up to 100% of forecast times the percent unhedged" (treasury training manual).[12] For example, assume the current spot rate for German Marks is 1.6617 and the forward rate is 1.6517. Also, derivatives with notional value equal to 71% of the forecasted exposure with an effective hedge rate of 1.6258 have already been entered into, and the cost of the at-the-money-forward option required to bring the hedge to 100% of the forecasted exposure is 0.0220. Then, the current hedge rate is 0.29*(1.6517 + 0.220) + 0.71*(1.6258) or 1.6397. This method for calculating the hedge rate biases the result toward lower anticipated USD revenues (for a net positive foreign currency exposure). Specifically, the cost of the option should not enter into the calculation. If derivatives are fairly priced, then the risk-neutral expectation of the option's net payoff is zero, and the risk-neutral hedge rate should be 1.6333

[12] The calculation can be more complex in practice because the upper limit of the current percent hedged is 100% (which can occur if exposure forecasts are revised downward) and net proceeds from previous transactions are also included in the calculation to the extent that the exposure was not overhedged. Also, options are used to

(assuming the current effective hedge rate is calculated in the same manner). Treasury managers are aware that this bias, or "expected positive variance," exists and believe it is a desirable attribute of the hedge rate. Since the hedge rate varies with market exchange rates, this provides a "buffer to potential unhedged adverse market movements" (interview with Manager of Foreign Exchange).

In summary, two observations are worth noting. First, it is clear that the foreign exchange hedging operations of HDG are an integral part of firm-wide operations. Hedging affects everything from initial planning to final reporting. Second, the process of determining the exchange rate to use for ongoing business activities is complex and includes systematic biases.

3 Motivations for Foreign Exchange Risk Management

3.1 Hedging or Speculating?

The *Treasury Policy and Procedure Manual* provides little indication of the motivations for foreign currency risk management. It states, "The goal of [HDG]'s economic and transaction hedging programs is to minimize the effects of exchange rate movements on these exposures, accomplished by maximizing the dollar cashflow to [HDG]." Despite being somewhat ambiguous, in an efficient capital market and without firm-specific economic imperfections, this statement is incongruent. Specifically, for this goal to be achievable, HDG must be able to trade profitably in foreign exchange derivatives *and/or* there exists some unspecified economic cost to not hedging.

One possibility is that HDG seeks to trade foreign currency derivatives for profit regardless of underlying exposure. In other words, risk management could be a smoke screen for speculative trading.[13] Evidence indicates that treasury management does not have a clear position on whether or not it can trade profitably in the foreign exchange markets. This is reflected in an electronic mail message to the treasury analyst covering Europe-Africa from

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calculate the hedge rate because they are guaranteed hedge accounting treatment. An at-the-money-forward option is chosen as a benchmark to make the process objective.

[13] Before the sample period started HDG acknowledged that it traded foreign currency derivatives for profit. After some unexpected losses, the current policy was put into place. Since this policy requires identification of an underlying foreign currency exposure before a derivative could be entered into, this would not be viewed as speculative trading from an accounting perspective.

the Director of Global Treasury regarding a technical model used by the analyst to forecast exchange rates: "The results from the model look good so far. Remember that we do not speculate, but [if] we can improve our trade timing, we could use this model." This and conversations with members of the forex group reveal that, to varying degrees, most individuals believe they have the ability to adjust hedge parameters so as to increase the expected net cashflow from derivative transactions. As the Manager of Foreign Exchange explained, "We do not take speculative positions, but the extent we are hedged depends on our views."

This aspect of the risk management program at HDG is not unique. For example, Bodnar et al. (1998) reports that the majority of US firms responding to the Wharton Survey indicate that their market views impact the size or timing of their hedges. Stulz (1996) provides economic arguments for this behavior. However, a close inspection of trading activity reveals that it is unlikely HDG is actively trading derivatives for profit. The average number of transactions per currency-quarter is only 11.8.[14] Since derivative positions are initiated on average 10 months prior to the currency-quarter's end, this implies just over one trade per month in a currency-quarter. The largest number of trades in a currency-quarter is 42 and in no instance was a derivative held for less than one-week. Consistent with official policy, almost all trades increase or keep constant the notional position of derivatives.[15]

Evidence (presented in Section 3.3) illustrates that the variation in earnings and cashflow is decreased by the use of derivatives. These features of the forex risk management program suggest HDG is hedging rather than speculating. However, current financial theory does not provide a consensus view on optimal hedge ratios, so any impact of views on hedging behavior might be viewed as speculative. In other words, in the absence of theory, it is hard to know if a "partial hedge" is motivated by speculation or hedging. In the next section, I explore the impact market views have on how HDG structures its derivative positions.

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[14] Recall, a currency-quarter is an exposure in one currency for a given quarter, so this means there were on average 11.8 trades from the time a hedge for a quarter was initiated until the close of the quarter.

[15] Some positions exceed the recorded exposure size (i.e., hedge ratios over 100%) this may be attributable to nonsyncronous exposure and derivative data in the sample, downward revisions in the exposure forecast, or speculation. This only occurs in a small percentage of currency-quarters and the most serious violations are for smaller, more-volatile currencies. None of the full-sample currency-quarters have average hedge ratios greater than 100%.

It is more likely that HDG believes it can increase firm value with foreign exchange hedging in some way besides actively trading in derivatives for profit. While the official policy statement does not explicitly state potential sources of value, other internal documents provide more insight into possible economic benefits. A treasury training manual states, "the primary currency risk management directives are (1) to increase the certainty of operating margins by supporting planning and pricing decisions with expected rates and by hedging forecasted exposures (2) to reduce negative impacts from currency movements on competitiveness by continuously managing forecasted transactions and by providing competitive information to senior management." In the same document, a somewhat tongue-in-cheek example proposes the reason for hedging (in the example) is "a weaker DEM makes [HDG] Germany's revenues less in USD terms and [the regional manager's] compensation is based on a USD P&L." This suggests, if lightheartedly, that there may exist internal agency issues similar to those described by Tufano (1996) providing a motive to hedge. In a briefing to the Worldwide Executive Finance Meeting the Manager of Foreign Exchange stated the "current FX objectives" as "reducing spot volatility, reducing FX uncertainty on planning, and enhancing competitiveness." In essence, these are equivalent to the objectives stated in the training manual. Other company documents also repeat these objectives.

These objectives do not make plain the source of benefits from foreign exchange hedging. However, HDG may not be explicitly aware of the fundamental economic rationale behind its risk management program but it could nonetheless be acting in a value-maximizing manner by undertaking its forex hedging activities. The next subsection investigates "traditional motivations" which amount to the most commonly cited violations of the Modigliani and Miller (1958) assumptions. Subsequently, I suggest several alternative motivations inspired by HDG's stated objectives. Variations on these have appeared in the academic literature but are explored here in detail as they pertain to forex hedging at HDG.

3.2 Traditional Motivations

A firm facing a convex tax schedule can minimize its expected tax liability by reducing the volatility of its expected taxable earnings (Smith and Stulz, 1985). Graham and

Smith (1999) show that many, but not all, firms face an effectively-convex tax schedule.[16] Their method uses a simulation technique to measure the effective convexity of a firm's tax function and allows for the inclusion of uncertainty in taxable income, tax-loss carrybacks and carryforwards, investment tax credits, and the alternative minimum tax. Of these, uncertainty in taxable income is the most important for HDG.[17] To estimate the effective convexity of HDG's tax function, I calculate the standard deviation of quarterly pre-tax income growth excluding the P&L attributed to derivative transactions using the annual effective tax rate for each year. I annualize this figure and calculate pre-tax income for a six standard deviation interval centered at four times each quarterly earnings value. Assuming normally distributed pre-tax income, this yields fourteen estimates of (approximately) a 99% confidence interval for annual pre-tax income. The lowest value from this procedure is $220 million, more than ten times the value of the final change in the US corporate tax schedule ($18.3 million). Direct questioning of HDG treasury management and tax experts also indicates that reducing expected US taxes is not a motivation for currency hedging. I therefore conclude that the probability of HDG's pre-tax derivative-adjusted income being in a convex region of the tax code is negligible.[18]

Smith and Stulz (1985) and Shapiro and Titman (1986) show that direct and indirect costs of financial distress lead to optimal hedging strategies. For example, Smith and Stulz (1985) show that a levered firm that hedges can lower expected bankruptcy costs and increase firm value. Shapiro and Titman (1986) suggest that the firm can lower costs in a number of indirect ways by hedging. Specifically, if hedging lowers the probability of financial distress, then risk-averse stakeholders with undiversified claims, such as employees, suppliers, and customers, will require a lower risk-premium for contracting with the firm. These savings increase firm value.

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[16] However, Graham and Rogers (1998) find that convexity of the tax schedule does not explain the degree of hedging in a large sample of US firms.

[17] HDG had no significant carrybacks or carryforwards, investment tax credits, nor was subject to the alternative minimum tax during the sample.

[18] As additional indirect evidence of the lack of concern for tax implications no (potential or existing) derivative dealers suggested tax arbitrage strategies for HDG. This is telling because the dealers would discuss hedging objectives with forex management, prepare a "pitch," and then visit HDG to meet with forex management to sell their idea. Of the four pitches I attended, none of the dealers mentioned tax implications. Reviews of material from previous pitches also showed no mention of taxes. Over the sample period, HDG fits the description of the "second-quartile" firm described in Graham and Smith (1999).

Potential costs of financial distress do not seem to be an explanation for HDG's foreign currency hedging activity since the probability of financial distress for HDG is close to zero in the near-term. As noted above, even a very low realization of pre-tax income would still be large in nominal terms. HDG had very little debt over the sample period and an average interest coverage ratio of over 100. At no point during the sample period did the level of long-term debt plus debt in current liabilities exceed 30% of cash and short-term investments. Cash and short-term investments exceeded the level of all current liabilities for each quarter in the sample period.

It is possible that HDG uses its large cash and low debt positions as a crude form of risk management. However, HDG was intentionally, and voluntarily, increasing its leverage during the sample period by repurchasing more than $1.5 billion in common stock and issuing long-term debt. In short, it seems unlikely the forex risk management program can be justified as significantly reducing the probability of financial distress over this sample period.

The low debt level of HDG also suggests that agency models that explain risk management, such as Campbell and Kracaw (1990), are less likely to be relevant. Also, the sample period may not contain realizations of low income states. HDG does not appear specifically concerned with the possibility of financial distress coming about from a "worst-case scenario" of a massive USD appreciation. (I did not observe any scenario analysis or "stress testing" related to major exchange-rate changes.) However, without a longer or different sample of profit realizations, it is impossible to completely rule out potential financial distress as a motivation for hedging.

Another possibility is that the managers or shareholders themselves hold non-diversified positions and wish to reduce the volatility of their aggregate wealth by hedging (see Stulz, 1984, Smith and Stulz, 1985, Tufano, 1996, and Chang, 1997). In the case of HDG, many individuals appear to have a large part of their personal wealth as equity stakes in the company. One individual holds more than 10% of shares outstanding. As of the second quarter of 1998, several directors and executive officers of the company hold pure equity positions worth over $10 million. However, there are reasons these undiversified positions are probably not the motivation for forex hedging. First, HDG has an extensive employee stock option plan in which all members of management (and most treasury employees) receive call options as part of their compensation package. Prior research has shown that call

options provide incentives for managers to increase the volatility of the share price rather than reduce it.[19] More specifically, Smith and Stulz (1985) show that a sufficiently convex compensation contract can completely offset a manager's desire to hedge personal wealth. Second, the general attitude of the senior executives at HDG is better described as bold risk-takers than as risk-averse bureaucrats. Anecdotal evidence and corporate behavior, such as HDG's rapid overseas expansion, supports this claim. It seems unlikely that senior management would seek to insure their wealth with foreign exchange hedging while at the same time risking it by aggressively expanding into very competitive new markets.[20]

Froot et al. (1993) suggest that, if procuring external capital is costly, a firm should use its risk management policy to coordinate internal cashflows with investment needs. To a large extent, HDG has a natural hedge. In its industry, and for HDG in particular, investment needs are likely to be positively correlated with cashflows. For HDG the correlation between investment (defined as capital expenditures plus research and development expenditures) and unhedged free cashflow is 0.69.[21] The correlation with hedged cashflows is an insignificantly different 0.71. It is possible that the high correlation is due to financing constraints, however it seems unlikely that the investment needs of HDG would be constrained by external funding issues. As noted above, HDG has significant liquid assets, has almost no debt, and undertook a large share repurchase during the study period. From 1994 to 1998, annual investment was never more than 52.0% of operating cashflow and averaged only 13.3% of cash and short-term investments. Unless the observed sample does not accurately represent the potential unhedged cashflow and investment outcomes (e.g., a major shock where cashflow from hedging allows for better or cheaper investment), the Froot, et al. theory appears not to provide a good explanation for HDG's hedging.

In conclusion, the evidence indicates that minimizing expected tax liabilities, reducing expected costs associated with financial distress, managerial risk-aversion, and equating

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[19] A general theoretical model of this possibility is presented by Haugen and Senbet (1981). Empirical evidence supporting this claim is provided by DeFusco, Johnson, and Zorn (1990). As related to hedging specifically, see Tufano (1996), Shrand and Unal (1998), and Haushalter (2000).

[20] In addition, in interviews with senior management I inquired specifically as to whether this was an incentive to hedge and none indicated that it was. I did not interview the largest stockholder.

[21] Quarterly for the 14 quarters from 1995:Q1 to 1998:Q2. The correlation of hedged cashflows and investment can be calculated over a longer period. For the 22 quarters from 1993:Q1 to 1998:Q2 the correlation is 0.82. I define free cashflow available for investment as operating cashflow plus R&D expenditures. If I define free cashflow as excluding investment the unhedged and hedged correlations drop to 0.57 and 0.60, respectively. Lagging cashflow by one quarter yields similar results.

cashflow with investment are probably not the primary motivations for managing foreign currency risk at HDG.

3.3 Earnings Smoothing

A stated goal of the hedging program at HDG is "to increase the certainty of operating margins." In practice, this translates into minimizing the impact of changes in foreign exchange rates on cashflow and reported earnings. A mantra at HDG is "linear earnings growth" or a consistent growth rate for quarterly earnings announcements. In a perfect markets setting, reducing earnings volatility by hedging is not value-enhancing. However, theoretical and empirical research (beyond that discussed in the previous section), has suggested possible value-increasing explanations for this behavior. For example, Dye (1988) presents a model where current owners wishing to sell shares use accounting reports to signal a higher value of the company. Trueman and Titman (1988), among others, show that a value-maximizing manager may smooth a firm's income stream as the result of information asymmetries between management and investors. Smith and Stulz (1985) and DeMarzo and Duffie (1991, 1995) suggest similar possibilities as they relate to corporate hedging.

Consistent with these theories, the concern for "linearity" at HDG stems from a perceived adverse impact on the share price from volatility in reported accounting numbers. Specifically, senior management's view is that the market reaction to lower-than-expected earnings is more negative than the positive reaction to higher-than-expected earnings; consequently, lower volatility in earnings increases HDG's share price. More generally, HDG treasury management believes that analysts expect the company to manage the impact of foreign exchange on earnings. For example, the Manager of Foreign Exchange notes that HDG would be "[penalized] if we did not hedge and [penalized] if we hedge incorrectly. To analysts, hedging foreign exchange risk is a box that must be checked. If you do not do it they will [penalize] you with a higher discount rate."

My conversations with outside analysts that cover HDG support this view. One of HDG's leading analysts states that "if HDG didn't hedge, this could effect earnings on a large scale so we definitely would pay attention. In general, all large international companies need to hedge." However this same analyst admits to not following the forex risk management program closely noting that "FX risk is not something which we have a focus on.

[Competitor] sometimes has earnings affected. … I haven't heard a mention of it affecting [HDG's] earnings in the last three years. I don't know about [HDG's] program in detail." Analysts also confirm the importance of smooth earnings. One analyst explains that "the [industry] generally trades based on P/E ratio, with points added to the multiple for higher growth, earnings and revenue consistency, etc. [HDG] has had a solid track record for about the last 5 years on its hedging and we don't factor their FX positions into our thinking. Of course, if it appeared that it would soon affect earnings, it would become more important to us." The concern over potential negative affects on earnings is not limited to equity analysts. The Standard and Poor's debt analyst for HDG notes that "HDG can not afford to not have some risk management program. If foreign exchange had a big impact on earnings we would want to know what happened, and if it could have been managed, why wasn't it." Without exception, the analysts with whom I spoke indicated that they expect HDG to manage their foreign exchange exposure, and that any material impact on earnings from foreign exchange would be viewed negatively. However, none of the analysts indicated being familiar with the specifics of the hedging program. A review of research reports by several leading analysts published during the sample period did not uncover any comments specific to HDG's foreign exchange risk management program.

Personal observations make clear that HDG is very concerned with the earnings impact of foreign exchange, and its risk management. A revealing example comes from a memo to the CFO and Treasurer from the Manager of Foreign Exchange concerning the impact of marking-to-market forward contracts used to hedge forex exposures in Asia: "While we recognize that this strategy has been economically beneficial to the company, the positive results are not easily identified [in the earnings release]. We will be working with Corporate Communications to craft the right message for the [quarter's] earning release as we anticipate a noticeable negative mark-to-market impact in F&O [Financing and Other] from these currencies."

If earnings volatility does have an impact on firm valuation, one would expect HDG to use foreign exchange risk management to reduce earnings volatility. Table 2 shows the aggregate impact of foreign currency derivatives on reported earnings and operating

cashflow.[22] The effect of hedging was calculated by taking the sum of trading profit and losses (P&L) for all foreign currency contracts assigned to a particular quarter and the net proceeds of positions held to maturity. The first column shows values for reported (hedged) earnings and the second column shows values excluding the after-tax aggregate derivative profit and loss (unhedged earnings).[23] The first row reports the mean values. Derivatives have a positive impact ($6.2M) on average quarterly earnings. To measure the impact of derivatives on earnings volatility, the next five rows of Table 2 depict statistics based on changes in earnings.[24] Hedging increases the mean change in earnings by $1.5M (or 0.9% for the earnings growth rate). The impact of hedging on the standard deviation of earnings changes is more interesting. Hedging decreases the standard deviation from $20.1M to $15.7M, a 22.0% decrease. However, HDG's line of business is seasonal and analysts typically compare earnings to the same quarter from the previous year (year-over-year). Measuring the impact of hedging in this way shows a similar effect; the standard deviation of reported earnings decreases by about $4.0M, only a 10.2% decrease because of the larger basis.

Standard deviation may not be the appropriate metric for evaluating the impact of HDG's foreign exchange hedging activities. Management's and analysts' comments indicate that HDG is more concerned with downside risk (e.g., lower than expected earnings) than upside risk. To address this possibility, I estimate downside "semi-deviations" by computing the square root of the second lower partial moment (i.e., $\sum_i \left|\min\left(\Delta E_i - \Delta\bar{E}, 0\right)\right| / N$, where E_i is quarterly earnings). The results are similar to those for standard deviations of earnings but less pronounced. On a quarterly basis, hedging decreases semi-deviations from $7.8M to $6.7M, and on a year-over-year basis the decline is negligible, from $15.6M to $15.5M.

The last two columns of Table 2 show similar calculations for operating cashflow. As compared to earnings, the results are similar only somewhat stronger: the reduction in

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[22] Earnings are calculated from primary EPS including extraordinary items. Substituting fully diluted earnings and/or excluding extraordinary items does not significantly alter the results. Operating cashflow is defined as sales minus costs of goods sold minus operating expenses plus depreciation minus income taxes. I look at the two separately because cashflows provide a better economic indicator of business activities whereas earnings are inclusive of any additional factors and are followed closely by outside analysts.

[23] After-tax derivative P&L is calculated using average effective tax rates as recorded in annual report footnotes.

quarterly standard (semi-) deviation is 38.4% (33.4%). The volatility calculations are based on only 13 quarterly observations and 10 year-over-year observations; F-tests indicate that none of the differences are significant at the 10% level. Interpreting the economic magnitude of these declines is complicated by the fact that HDG's earnings are large and grew rapidly over the sample period. For example, one might consider a 22.0% decrease in standard deviation large, but when mean quarterly earnings are $170M, a $4M reduction in standard deviation seems much less substantial. The Manager of Foreign Exchange indicates that these reductions are in line with expectations, noting that less than half of revenues are foreign, and underlying business risk can not be hedged directly with derivatives.

The last row of Table 2 reports the correlation between quarterly changes in earnings (or cashflow) and the derivative P&L. The negative values are consistent with the already reported results and confirm that HDG is, in fact, hedging. However, the relatively small correlations (-0.37 and -0.39) reveal that much of the variation in earnings and cashflow are not hedged with derivatives. This may be because HDG is not fully hedged, or some risks are not hedgable like domestic sales. Because derivative data are available at the transaction level, the impact of foreign exchange hedging can also be analyzed by currency. This approach has the advantage of removing variation due to USD-based sales. In Appendix A, I compare the unhedged USD exposure (assuming exposures are translated at the end of quarter spot exchange rate) with the actual hedged exposure. While some of the evidence is mixed, the bulk of it indicates that the foreign exchange hedging activities at HDG do reduce the variation in aggregate USD exposures at the year-over-year frequency.

On the whole, it appears that foreign exchange hedging is an effective means of decreasing variation in reported financial numbers. Two other items shed some light on this potential motivation for hedging. First, HDG is concerned about the impact on earnings of SFAS 133 which may require corporations to mark-to-market many derivatives that now qualify for hedge accounting. A limited internal evaluation of the impact of SFAS 133 suggested that there would be a notable increase in reported-earnings volatility. This caused substantial concern on the part of HDG senior management and may impact the company's hedging strategies. The second item suggests that the impact of hedging on earnings is not as

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[24] Because HDG's earnings are growing rapidly during the sample. Standard (and semi-) deviations of the level of earnings would not be particularly informative. Specifically, HDG's quarterly earnings grew from about $50

important as has already been suggested. While there is substantial evidence that the earnings impact of particular transactions, events, or types of derivatives are closely examined, I am not aware of any internal analysis such as that provided in Table 2 and Appendix A.

3.4 Competitive Impacts

Another stated goal of the hedging program is "to reduce negative impacts from currency movements on competitiveness … by providing competitive information to senior management" (treasury training manual). In practice, this goal is viewed as the hedging program allowing the firm to undertake competitive pricing in the output market without significantly reducing margins. Maintaining margins is viewed as a primary strategic goal of the firm, taking precedence over sales volume.[25] Consequently, short-run adverse foreign exchange movements would, in turn, adversely affect sales through higher prices in foreign markets. Hedging could allow the firm to smooth through exchange rate fluctuations. This would be economically meaningful if maintaining relationships with customers requires consistently competitive product pricing. Similarly, there may be other costs associated with adjusting prices in foreign markets (e.g., updating pricing information or the loss of a "value reputation"). Finally, there may exist economies of scale, a tendency for repeat business, or other strategic issues that make competitive factors important in the long-term. This brings into question whether HDG's hedging horizon is sufficient to act as a smoothing mechanism for exchange rates.[26] However, hedging in the near-term may allow for the simultaneous stabilization of margins and preservation of competitive standing while longer-term competitive solutions are implemented, e.g., changing suppliers, relocating operations. This would be consistent with Mello, Parsons, and Triantis (1995) and Chowdhry and Howe (1999) who show that a multinational firm with international production flexibility will implement a financial hedging program as part of its optimal operating strategy.[27]

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million to over $350 million over the 14 quarter sample period.

[25] This is consistent with the previous findings of a preference for "linear earnings growth."

[26] Time-series evidence (for example, Mark and Choi, 1997) indicates that exchange rates are often mean-reverting but also very persistent. The first-order autocorrelation for the monthly trade-weighted US dollar exchange rate from 1973 to 1998 is 0.98.

[27] Other theoretical work suggests that competitive and strategic factors can lead to optimal hedging strategies. For example, recent theoretical work by Downie and Nosal (1998) shows that under certain conditions a firm that possesses market power in the product market can achieve a first-mover advantage over rival firms through the use of risk management products. Froot, Scharfstein, and Stein (1993) suggest that hedging can be an important part of the optimal investment strategy of multinational corporations, particularly for firms facing

Senior treasury management strongly believes that its foreign exchange risk management strategy provides an important competitive advantage in the product market.[28] (This belief, in part, motivates their desire to keep their identity hidden.) As a result, HDG tracks the hedging programs of its major US-based competitors. The forex group makes a quarterly report to the FXMC detailing publicly-available information on the forex hedging programs of its four main competitors.[29] The forex group interprets the information in an attempt to determine the exposures of its competitors. For example, the report on one competitor reads, "[Competitor's] hedging practice should leave them exposed to a strengthening USD. At December 31, 1996, [competitor] had forward contracts designated to hedge transaction exposures but there was no disclosure of anticipatory hedges."

In the opinion of the treasury management, the competitive benefits of a risk management program are primarily short lived. Larger strategic decisions, such as expansion into new markets and location of manufacturing facilities, are based primarily on other factors. Once a major strategic decision has been made, the decisions regarding foreign currency and risk management are undertaken (e.g., functional currency and hedging strategy). However, forex risk management enters indirectly into strategic decisions, because the 3-year strategic plan uses the longest-term hedge rate extrapolated for the second and third year.

If foreign exchange rates impact the competitive position of HDG in its foreign markets, this could be reflected in the company's market share. Alternatively, to the extent that HDG's hedging program neutralizes the effects on market share, exchange rate changes may not impact market share. Table 3 reports coefficient estimates from fixed-effects panel regressions with HDG's market share (first column) and change in market share (second

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product-market competition where investment is a "strategic substitute." Allayannis and Ihrig (1998) develop a model showing the competitive impact of foreign exchange exposure and test the implications on a set of US manufacturing firms. They show that firms in more competitive industries (such as HDG's) have an increased exposure to exchange rates. Géczy, Minton, and Shrand (1997) find that users of currency derivatives are more likely to face import competition and that these hedgers are more likely to use short-term (dynamic) hedging strategies instead of longer-term strategies. Finally, Allayannis and Weston (1999) find that multinational firms in more competitive industries are more likely to use currency derivatives.

[28] It is also a determinant of how the firm structures its hedges (i.e., a preference for put options). This is explored in the next section.

[29] Most of this information is collected from government filings (10-Q, 10-K, and annual reports).

column) as the dependent variables.[30] The data are for the 15 full-sample currencies for all 14 sample quarters (13 quarters for changes). The estimation includes 3 explanatory variables. The 3-month change in the spot exchange rate for each currency[31] is included to capture the near-term impact of exchange rate movements. The positive coefficients (significant at the 5% level for changes in market share) indicate that as foreign currencies strengthen against the USD, HDG's market share tends to increase. Conversely, this suggests that HDG is exposed to adverse exchange rate movements.

The relative position of the spot rate to the previous 12-month high is included to measure the exchange rate status relative to the most favorable condition in the previous 12 months. The significantly positive coefficients for this variable suggest that in countries with a relatively weak foreign currency, which should be bad news for HDG if they are not properly hedged, both the level and changes in market share increase. This is the expected result if hedging lets HDG improve its competitive position when exchange rates movements are adverse.

Derivative P&L (as a percent of the actual exposure) and derivative P&L squared are included to measure the direct relationship between market share and hedging outcomes. If profits from derivatives are used to gain a competitive advantage, an overall positive relationship should be observed between derivative P&L and market share. The coefficients for derivative P&L are significantly positive. The negative coefficients on derivative P&L squared indicate decreasing returns to hedging. (If this were not the case, HDG might wish to take on arbitrarily large "hedges.") The implied economic impact of these estimates is also substantial. For Derivative P&L one standard deviation larger than the mean, market share is 0.65% higher (14% larger than mean market share) and changes in market share are 0.21% higher (49% larger than the mean change in market share). All together, the evidence from these statistical tests supports the hypothesis that HDG obtains competitive advantages from managing foreign exchange risk.

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[30] The market share data were obtained from an independent source that provides such data commercially. Because HDG's market share appears to trend upwards in some currencies the model is specified using both levels and changes.

[31] USD/FCU measured one quarter before the beginning of the observation quarter.

3.5 Facilitation of Internal Contracting

As previously noted, the day-to-day operations of the forex group are centered around the hedge rate. The importance of this rate in internal decision making is enormous since the hedge rate is used to set product prices in local currency, forecast sales and consequently production, and set goals for divisions and managers. HDG has two opposing objectives in determining the hedge rate. First, senior treasury and foreign managers wish to have as constant a rate as possible. It is believed that variation in the hedge rate induces undesirable variation in other business forecasts. Second, foreign managers desire as "favorable" a rate as possible. If a foreign currency strengthens against the USD and HDG has locked into an unfavorable hedge rate, this is viewed as undesirable for business operations in the foreign country.

Hedging with foreign exchange derivatives to establish a hedge rate with low variance has several potential benefits. For one, it may improve the senior manager's ability to make value-maximizing pricing decisions. If foreign managers feel more certain of the final USD margins they will obtain, this could induce them to undertake a more aggressive, and value-increasing, pricing policy. Likewise, if forex hedging allows the firm to more closely follow its optimal operating policy, this will increase firm value. For example, it may be beneficial for HDG to expand its operations in a particular country, but uncertainty surrounding the decision process increases the chance of rejecting this beneficial project. The ability to use a hedge rate decreases the uncertainty surrounding the project decision and increases the chance of accepting the project.[32] This concept is consistent with the findings of Minton and Schrand (1999) which show that firms with lower cashflow volatility have higher levels of investment. For HDG, an impact would be observed in the 3-year strategic plan that uses extrapolated hedge rates.[33]

Consistency in the hedge rate may allow for more efficient internal contracting. Decreasing the uncertainty surrounding the terms of contracts can provide for incentives that are more closely related to the variables under the control of the agents. For example, if using a hedge rate prevents a well-performing manager from being penalized by changes in the

[32] Intuitively, forex hedging can decrease the variance of NPV calculations. Stulz (1999) argues that total project risk is important in capital budgeting.

[33] Since HDG does not separately consider forex, I can not provide specific examples of decisions where using the hedge rate versus forward rates made a difference.

exchange rate over which she has no control, then this could be in the best interest of the firm (for related analysis, see Stulz, 1984).[34] Likewise, risk-averse managers will require less total expected compensation if hedging reduces the volatility of their expected earnings.

In practice, the forex group must balance opposing factors when determining the hedge rate. Using put options eliminates downside risk while leaving room for upside potential but does not reduce the variation as much as using forward contracts. Locking in a rate with forward contracts may later turn out to be unfavorable. This problem is not lost on regional managers whose operations and compensation are materially affected by the hedge rate. The forex risk management program has ended up producing some undesirable side effects. For example, regional managers lobby the central treasury for a better hedge rate. Apparently, the problem can be quite severe. In the words of the Manager of Foreign Exchange, "I spend more time managing managers than I do managing currencies."[35] A second potential drawback is the extreme amount of attention paid by senior treasury managers to "hedge rate variance," or time-series variation in the hedge-rate. For example, considerable regard is paid to the difference between the spot rate and the hedge rate. In practice, this often results in attempts by the FX Group to have a hedge rate better than the spot rate or "beat the spot rate." (The pressure to outperform the spot rate comes from both senior and foreign managers.)

These drawbacks are of interest since most existing research indicates agency problems may result in risk management, whereas this evidence suggests that risk management can be the source of internal agency problems. These findings are similar to a model proposed by Tufano (1998) in which risk management leads to agency costs when hedging replaces the need to raise funds in the external capital markets (see also Chang, 1997).[36]

All of this analysis presumes that there is no other way to achieve the same end. In fact, a similar hedge rate system could be achieved by using internal bookkeeping to create hedge rates since all of these benefits are internal to HDG. For example, the hedge rate could

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[34] On the other hand, it may be optimal for the manager to react to changes in the exchange rate and the optimal response could be hampered by using a hedge rate (see Tufano, 1998).

[35] In response to the problem, a proposed reorganization of the program was under consideration at the time my study concluded.

be replaced with an average of forward rates at different horizons. A more complex system could include fictitious options or other features. This would prevent HDG from having to pay transaction costs on derivatives and could also reduce accounting costs. There are two potential drawbacks to this type of system. First, it will not address other reasons to hedge since it does not involve any actual transactions outside the company. Second, it may be easier to give in to foreign managers (and adjust fictitious hedge rates) if all of the transactions are done with internal record keeping. Overall, it is difficult to determine if potential gains from more efficient internal contracting outweigh the costs of implementing a hedging program and any internal agency costs.

In summary, the motivations for hedging at HDG do not seem to be the result of simple violations of the traditional model of the firm. Instead, earnings management (perhaps to lessen informational asymmetries), competitive concerns in the product market, and improved internal contracting are explanations for hedging more consistent with the risk management program at HDG. The largely unanswered question is whether or not hedging, for any or all of these reasons, actually results in higher firm value. This question is explored in Section 5.

4 The Structure of Derivative Portfolios

The hedging problem of an industrial company like HDG differs fundamentally from the hedging problem of a financial institution. For example, consider a derivatives dealer that acts as the counter-party for one of HDG's option transactions. The financial institution has a well-defined exposure and a dedicated research group with sophisticated financial models which allow it to easily quantify and hedge its risk. Furthermore, the number of risk factors that the financial institution must consider are limited (e.g., models with two sources of uncertainty are usually sufficient for hedging derivatives on a single asset) and the objective of hedging is straightforward (e.g., hedge the derivative position so as to minimize net value variation). In contrast, an industrial company is often faced with an ill-defined exposure, multiple and perhaps conflicting objectives, and few quantitative models for constructing an

[36] In the case of foreign managers at HDG, the "external market" could be the US-based parent. For example, foreign managers at HDG using a hedge rate *they helped to set* may undertake sub-optimal operational decisions

optimal hedge with derivatives. For these reasons it is interesting to explore factors which may determine how corporations structure hedge portfolios. Little research has attempted to explain variation in hedge ratios especially across exposures within a corporation. In the case of HDG, this variation through time and across currencies can be quite large.

Most previous studies have not been able to precisely measure the derivative positions of non-financial corporations, because transaction-level data are rarely available. One notable exception is Tufano (1996) who is able to calculate position deltas and implied gammas for firms in the gold mining industry. I take an approach similar to Tufano's, but concentrate on factors specific to HDG that determine cross-sectional and time-series variation in hedging strategies. First, I calculate aggregate hedge parameters for each currency-quarter for each of the three forecast horizons and compare these to the firm's official policy. Next, I discuss general determinants of hedging strategies and factors that could affect the hedging decision. Finally, I statistically test the impact on hedge parameters of factors suggested by my observations and existing theoretical work.

4.1 Characteristics of Hedge Portfolios

Marking-to-market the derivatives allows for the calculation of hedge portfolio properties at the 3-, 6-, and 9-month forecast horizons. Specifically, I calculate the notional value, delta, and gamma of each hedge for each currency in the sample. I assume a Garman and Kohlhagen (1983) economy and use interest rates and volatilities as described in Section 2. Table 4 reports the mean, maximum, and minimum of these values for the full-sample, partial-sample, and all currencies. The values have been normalized to an underlying exposure of 1.0 to facilitate comparison across currencies. Appendix B describes the methodology.

On average, the degree of hedging is consistent with HDG policy.[37] Average notional values are within the bounds prescribed by the official *Treasury Policy and Procedure Manual*. Hedging as measured by portfolio notional value increases as the exposure draws closer for all but two countries' exposures which have a mean notional value of zero for all

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so as to acquire private benefits from their own foreign operations.

[37] Recall, notional values less than 25% at the 6-month horizon and less than 40% at the 3-month horizon violate the policy's lower bound. Values greater than the upper bounds but less than 100% do not violate official policy if due to forecast revisions. Hedge ratios greater than 100% always violate policy.

forecast horizons (results for individual currencies are not reported).[38] The average full-sample hedge ratios are fairly similar across currencies; however, there is substantial variation through time and across currencies in a given quarter. (The next subsection discusses this variation in detail.) In contrast, the partial-sample hedge ratios are very low for longer horizons and are in many cases zero. Individual hedge ratios for partial-sample currencies vary significantly and reveal some possible violations of the policy statement (e.g., values exceeding 100%). The minimum notional values show that in at least one quarter all partial-sample currencies were under-hedged. For most of the partial-sample currencies, the mean hedge ratio is zero at the 9-month horizon. Notional values in excess of 100% of the exposure could be due to data errors associated with stale exposure forecasts.[39]

As one would expect, average portfolio deltas follow a similar pattern. Average deltas become increasingly negative as the hedge horizon shortens. However, the correlation between average quarterly notional values and deltas varies substantially. As the forecast horizon drops from 9 to 6 to 3 months the correlations decrease in magnitude significantly, from –0.89 to -0.60 to –0.39, respectively. This reveals substantial variation in the moneyness of the option portion of the average hedge portfolios.

Delta provides a better measure of the economic significance of a hedge than does notional value. For example, hedging with very out-of-the-money put options can result in a large notional value but insignificant delta. For this reason, it is interesting to note that for some quarters the average delta was close to zero at all forecast horizons. For example, in one quarter the overall delta was never lower than –0.16 at any horizon. The corresponding average notional value (49.5% at the 3-month horizon) indicates that the aggregate hedge portfolio for this quarter contained somewhat out-of-the-money options.

A better measure of the optionality of the average hedge portfolios is the normalized portfolio gamma. Portfolio gammas increase as the time horizon decreases for all full-sample currencies. This is expected of a hedge portfolio that holds primarily near-the-money options. The results for the partial-sample currencies are notably different. In only 3 of the 9 currencies are any options used in the hedge portfolio, and only one of these uses options for

[38] Although all hedge parameters at the three forecast horizons are zero for two currencies, HDG still used derivatives to hedge exposures in the currencies for horizons of less than 3 months.

all horizons. This results in an average convexity near zero for all horizons in the partial-sample currencies.

The optionality of the typical hedge portfolio increases substantially as the hedging horizon decreases for two reasons: First, as an at-the-money put option approaches maturity its gamma increases.[40] HDG often trades options so as to maintain positions near-the-money. Second, the average increase in notional value of the hedge will increase portfolio gamma if this increase is the result of a larger long position in options. Although it is not captured in the reported figures, the gamma frequently drops to zero, even for full-sample currencies, as the options are replaced by forward contracts in the current quarter. As was suggested by the variation in average notional values and deltas, there is also substantial variation in the average gammas. For all of these measures, aggregate minimum and maximum values differ by factors of roughly 2 to 5. What explains this time variation, as well as variation across currencies, is the subject of the next section.

4.2 Determinants of Hedging Strategies

At HDG's disposal is a vast arsenal of foreign exchange risk management tools offered by derivative dealers. Very few of these are specifically ruled out by the *Treasury Policy and Procedure Manual*. Long-dated swaps are not allowed because HDG only hedges with a one-year horizon. Futures are forbidden by the policy since such contracts are marked-to-market. The Manager of Foreign Exchange notes that even if futures were allowed, the contracts would be undesirable because of a lack of liquidity and the inability to customize specifications such as the maturity date. Adjustments in the futures margin account can result in significant cashflows and hence earnings volatility since the underlying exposures are not marked-to-market. This is undesirable since one of HDG's goals is to reduce earnings volatility. This still leaves HDG with the ability to use vanilla forward and option contracts as well as exotic derivatives (e.g., contracts with average rate, barrier, or basket features). During my study, HDG regularly met with derivative dealers promoting various exotic

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[39] Exposure forecasts were recorded as the last forecast before the observation date and may therefore not be exactly contemporaneous with the reported forecast horizon. I do not have data on whether or not these potential violations were approved by the FXMC.

[40] For comparison, a Garman-Kohlhagen at-the-money put option on a unit of foreign currency with a 20% volatility, domestic and foreign risk-free rates of zero, and time to maturity of 9, 6, and 3 months have gammas of 2.3, 2.8, and 4.0 respectively.

instruments as static hedges. Dealers also suggested dynamic trading strategies that would lower expected premium outlays. Nonetheless, with only a few exceptions, HDG prefers static hedges with vanilla forward and option contracts.

The preference appears to stem from two main sources. First, the goal of minimizing the variation in earnings due to foreign exchange has a side effect that favors options. Because accounting treatment differs by type of derivative, using vanilla options for economic hedges is preferable to using forward or exotic contracts (see SFAS 52). Forward and exotic contracts used to hedge economic exposures for future quarters must be marked-to-market and can therefore increase volatility in reported earnings. These concerns may help explain why Bodnar, et al. (1998) find that 80% of the Wharton Survey respondents express moderate or high concern regarding accounting treatment of derivatives.

HDG also prefers options for the competitive reasons discussed in the previous section. Option premiums will have only a limited impact on the hedge rate when the dollar weakens, whereas the hedge rate can be significantly better than the spot rate when the dollar strengthens. Specifically, HDG can take advantage of hedged adverse currency movements to "pick up market share by aggressively pricing relative to competitors or let the added revenue flow through to margin. It's really up to the regional managers. Either way, [HDG] benefits. If the currency moves in our favor we are only out the put premium" (Manager of Foreign Exchange). The Manager of Foreign Exchange suggests that competitors do not follow a similar strategy because of either a lack of sophistication or a hesitancy to spend on option premiums.

HDG occasionally uses forwards and options with average-rate (Asian) features. The use of Asian forwards is typically motivated by an interaction between market conditions and accounting treatment. During the Asian crisis, some of the Southeast Asian foreign currency markets in which HDG hedges became extremely volatile and illiquid. Consequently, option premiums and bid-ask spreads were considered excessive. Since forwards will not qualify for hedge accounting, the lower mark-to-market volatility induced by Asian features would reduce the impact of hedging on reported earnings relative to vanilla forwards.

Since HDG hedges exposures in many currencies, several dealers have suggested basket options as a method of lowering premiums. HDG has rejected these arguments for three reasons. First, because basket options would not qualify for hedge accounting, they will

have adverse accounting treatment. Second, treasury management believes it would be difficult to incorporate basket features into the hedge rate calculations which ignore correlations among currencies. Third, it is felt that any savings in premiums is illusory. Specifically, if options are priced in a fair market (e.g., no volatility premium), transaction costs are an important measure of value. Bid-ask spreads on basket options are typically greater than spreads on vanilla options suggesting that these instruments could be more costly. In general, HDG has a preference for liquidity and transparency in its choice of derivatives. For example, many exotics would limit transparency because of the need for more accurate and complex models (e.g., for barrier options) and the estimation of unobserved parameters (e.g., cross-currency correlations).

Because forwards and put options are used almost exclusively, HDG usually has three parameters to choose. First, HDG must determine what percentage of the exposure it wishes to hedge for each currency-quarter. Second, HDG must decide on the mix of forward and option contracts. Third, HDG must chose the strike price(s) for any option component of the hedge. As discussed in the previous section, the combination of these decisions results in a portfolio of derivatives used to hedge a particular currency-quarter (henceforth, hedge portfolio) that can be characterized by the local sensitivities of the portfolio, e.g., delta and gamma.[41] Of interest is identification of factors that determine the variation in the characteristics of the hedge portfolios.

Several factors explain the features of the partial-sample hedge portfolios. First, these currencies are generally less liquid, and therefore hedging with derivatives is more costly in terms of bid-ask spreads. The Manager of Foreign Exchange notes that forwards and options in these currencies are frequently "too expensive" (though these remarks also applied to implied volatilities that were viewed as unreasonably large). Second, HDG limits hedging because of the greater exposure uncertainty of the partial-sample currencies (discussed below). Third, because of the strong preference for options when structuring hedge

[41] Since the vast majority of HDG's options are put options with more than 3 months to maturity struck near-the-money (+/- 5% of the forward rate) local hedge parameters are reasonable measures of overall hedge characteristics. The three most common types of trades are increasing the notional value of the aggregate position by adding forwards or options, replacing options with forwards of a similar notional amount, and "rolling strikes" (or replacing in-the-money options with at-the-money options). The process of rolling strikes is justified by the Manager of Foreign Exchange as providing a better hedge for the competitive reasons discussed previously.

portfolios, HDG often prefers to leave an exposure underhedged (or even unhedged) rather than use forward contracts extensively.

Quantifying the foreign currency exposure facing HDG is a fundamental part of the hedging process. Exposure forecast error is important to HDG for a variety of reasons. First, the policy limits the size of positions as a percent of the forecasted exposure. In effect, the forex group tracks hedge positions in terms of percent hedged, so the exposure forecast is crucial in determining the notional value of positions. Second, exposure forecast error implies a risk for HDG. If HDG uses forwards to hedge an uncertain exposure, it leaves open the possibility of the exposure not materializing and also realizing a loss on a forward transaction. Intuitively, this also provides a rationale for using long positions in options because the loss from an option position is capped at the premium.

The effect of exposure uncertainty (or quantity risk) on optimal hedging strategy has been studied extensively in the agricultural hedging literature (for example, see Moschini and Lapan, 1995). Chowdhry (1995) investigates the role of uncertain foreign cashflows on hedging and capital structure policies. In a more general setting, Brown and Toft (1999) show that quantity risk can have a significant impact on the optimal degree and type of hedging. Empirical research has also identified risks relating to the underlying exposure as significant determinants of hedge ratios. For example, Haushalter (1999) finds that basis risk is an important factor in explaining the hedging practices of oil and gas producers.

To estimate the degree of quantity risk in the foreign currency exposures of HDG, I calculate the mean and standard deviation of exposure forecast errors for 3-, 6-, and 9-month forecasts (see Table 5). There are not large or systematic biases in the exposure forecasts for aggregate exposures for most individual currencies;[42] overall, exposure forecast errors are only slightly negative which indicates that all of HDG's rapid growth was anticipated. Also of note, the average error does not increase with the hedge horizon.

Variation in forecast errors is measured by the standard deviation for each forecast horizon (STD). As would be expected, the quality of forecasts improves as the forecast horizon decreases. To adjust for this time-horizon effect, I annualize these figures by dividing by the square root of the forecast horizon in years (An. STD). The volatility of exposure forecasts is large (greater than 25%) for most individual currencies. Most individual partial-

[42] The results for individual currencies are not reported but are available from the author on request.

sample currencies reveal extreme annual exposure forecast volatility—over 100% in some cases. However, much of this error is currency specific; the annual volatility for full-sample currencies is only 14.2%, and for partial-sample currencies, only 21.8%. The annualized standard deviations tend to increase at the 9-month forecast horizon. This suggests that even the relative quality of exposure forecasts deteriorates as the forecast period lengthens perhaps indicating why HDG hedges with only a one-year horizon.[43]

To see if exposure forecast uncertainty affects the degree of hedging, I calculate the correlation between the average annualized standard deviation of forecast errors and hedge portfolio notional value using all 24 currencies. The resulting correlation is significantly negative at the 5% level for all forecast horizons (-0.56, -0.52, and –0.42 at the 9-, 6-, and 3-month horizons, respectively), suggesting that greater exposure uncertainty is associated with less hedging.

Theoretical work by Campbell and Kracaw (1990), Froot, Scharfstein, and Stein (1993), Moschini and Lapan (1995), and Brown and Toft (1999), among others indicates that the correlation between an uncertain exposure and the marketable risk factor is an important determinant of the optimal hedging strategy. For HDG, the correlation is expected to be positive; as the USD/FCU exchange rate increases, sales (and therefore foreign currency exposure) should increase. Table 5 also reports correlations between HDG's foreign currency exposures and exchange rates calculated using several different approaches.[44] The results are difficult to interpret. Different methods yield dramatically different results for both individual currencies and for the aggregates. In part, this may be the result of the small number of observations used in the calculations, but it points out a potential weakness in hedging models that require an estimate of correlation between exposure quantity and the exchange rate. With 14 quarterly observations, only correlations with absolute values greater than 0.47 are significantly different from zero at the 10% level (assuming a bivariate normal distribution).[45]

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[43] Conversely, HDG might expend less effort forecasting since they hedge less at longer horizons.

[44] The first column shows the correlation between changes in the exposure forecasts and changes in the exchange rate at 3-month intervals. The next column shows a similar calculation for updates from the 9-month forecast to the actual realized exposure. The next three columns report correlations from the time series of realized exposures and the realized exchange rate. This is done at the quarterly frequency for levels and changes and on a year-over-year basis for percent changes only.

[45] Correlations estimated using revisions to exposure forecasts are almost all insignificant and never both significant and consistently of the same sign. Correlations between the level of exposure and the level of the exchange rate are consistently negative and significant. This is due to the large average growth in HDG's overseas exposure and the general weakening of foreign currencies against the USD during the sample period

In general, there is not a clear or consistent correlation between exposure changes and the exchange rate for HDG in the sample period. This may explain why HDG does not explicitly incorporate an estimate of the correlation in its hedging decisions. Altogether, it appears that HDG is faced with a high degree of uncertainty with regard to the statistical properties of its underlying foreign exchange exposures. This uncertainty could have a measurable impact on the hedging strategy.

Since hedge portfolio characteristics are available for each currency-quarter, it is possible to study their determinants in a multivariate setting. As suggested by theory and the prior evidence, numerous factors may simultaneously impact hedging strategies. For example, exchange rate uncertainty, exposure volatility, and other factors identified in previous research and conversations with managers (e.g., market views) could all effect hedge ratios. I estimate a set of fixed-effect panel regressions using the hedge portfolio deltas and gammas as the dependent variables.[46] As explanatory variables, I use three types of factors:

1. Current foreign-exchange market factors
    - Exchange rate implied volatility, labeled *FX Volatility*, is used to capture the effect of price risk.
    - The difference between the 6-month forward exchange rate and the spot exchange rate in percent, labeled *Forward Points (%)*, is a measure of the current forward point spread.
2. An underlying exposure factor
    - The absolute difference between the exposure forecast and the actual exposure, labeled *Exposure Volatility*, is used as a crude proxy for quantity risk.
3. Factors that proxy for "market views" and possible behavioral influences
    - The percentage difference between the current spot exchange rate and the highest (lowest) level of the spot exchange rate in the previous 12 months, labeled *Spot % Below (Above) 12 Month High (Low)*, are used as proxies for market views since

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(exchange rates are calculated on a USD per FCU basis). When correlations are calculated on changes in quarterly values or on a year-over-year basis, the correlations are typically closer to zero though there are a substantial number of significant positive correlations for individual currencies on a year-over-year basis.

[46] Hausman specification tests for random effects vs. fixed effects did not consistently choose one model over the other. However, the size and significance of parameter estimates from the two models did not differ dramatically. For brevity, I only report the results of the fixed-effects estimation. The estimation is made using only full-sample currencies because of the previously noted differences between the samples due to factors not modeled here. This excludes 50 of the 260 currency-quarters.

these technical variables are employed by HDG analysts to estimate market tops and bottoms.

- The percentage change in the spot exchange rate over the previous 60 trading days, labeled *3 Month Change in Spot*, is used to capture trend-following behavior.
- The actual profit or loss on the hedge in the previous quarter (relative to the forecast horizon) as a percent of exposure, labeled *Derivative P&L (t-1)*, is included to measure the impact of recent hedging results. This variable may capture the effect of regret from under-hedging or over-hedging in the most recent completed quarter.[47]

Table 6 shows the results of estimating these panel regressions at the 3-, 6-, and 9-month forecast horizons.

A negative relationship between portfolio delta and FX volatility implies that HDG hedges more as exchange rate volatility increases. Intuitively, as forex volatility increases, HDG's nominal USD risk increases, which in turn increases the incentive to hedge. However, HDG's preference for options implies that the up-front cost of hedging will also be greater which may limit the degree of hedging. The significantly negative coefficient on FX volatility at the 9-month horizon suggests the former. However, the lack of a significant relationship at the 6- and 3-month horizons indicates that as the exposure draws closer and the degree of hedging tends to increase, the up-front costs may temper this effect. Moschini and Lapan (1995) and Brown and Toft (1999) predict that as price risk increases relative to other business risks an increasingly linear payoff will provide a better hedge. Results (significant at the 6- and 3-month horizons) using the portfolio gamma as the dependent variable are consistent with this hypothesis – convexity of hedge portfolios tends to be lower when FX volatilities are larger.

The magnitude of *Forward Points (%)* is perceived by the FX group at HDG as a cost of hedging. For example, a forward rate (in USD/FCU) that is less than the spot rate is considered unfavorable and vice versa. This is not a valid consideration if forward rates are an unbiased predictor of realized spot rates. However, empirical evidence suggests that forward rates are biased predictors of realized spot rates.[48] This predicts a negative relation

[47] Absolute pairwise correlations between these variables are typically less than 0.3. All but one are below 0.6 (the correlation between *Derivative P&L (t-1)* at the 9-month horizon and *Spot % Below 12 Month High* is 0.81).
[48] If forward rates are a biased predictor of realized spot rates, but derivative prices are generated under the risk-neutral measure, *Forward Points (%)* proxies for an incremental cost of hedging. Previous research (see, for

between *Forward Points (%)* and hedge portfolio delta. Consistent with this hypothesis, the coefficient estimate is significantly negative at the 3-month horizon. That the estimates at the 6- and 9-month horizons are also negative, but not significantly different from zero, suggests this effect may only be worth considering when constructing near-term hedges.[49]

The results from Table 5 reveal the substantial uncertainty HDG faces with regard to its underlying foreign currency exposure. Various theoretical models, noted previously, have predicted this will lead to less hedging (a less negative delta) but a more convex hedge (a greater gamma). In support of this hypothesis, a significant positive relation is observed between exposure volatility and delta at the 9- and 6-month horizons. However, no significant effect is found for hedge portfolio gamma though each of the coefficient estimates is negative as predicted. This may be due to HDG's strong preference for options or the crude nature of the proxy. Specifically, instead of substituting away from options towards forwards as quantity risk decreases, HDG simply hedges less.

As noted already, HDG often incorporates a view on the level of future exchange rates when determining hedging policy. In its analysis, the forex group uses various technical indicators and outside forecasts from financial institutions. Whether or not views significantly or systematically impact the characteristics of the hedge portfolios is difficult to test, since data describing the sentiments of the forex group are not available. Instead, the technical factors noted above are used to proxy for views. The estimated coefficients on the technical variables reveal a significant impact of these factors on the portfolio deltas and gammas. For example, the level of the current spot rate relative to its 12-month high has a significantly positive impact on portfolio delta at the 6- and 3-month horizons. The level of the current spot rate relative to its 12-month *low* has a significantly positive impact on delta (again at the 6- and 3-month horizon). Finally, recent trends in the exchange rate are significantly related to portfolio delta at the 9-month horizon. This positive relationship

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example, Barnhart and Szakmary, 1991) indicates the unbiased predictor of the realized spot rate is between the current spot and forward rates. Hence, a negative value of *Forward Points (%)* implies "expensive" derivatives (and vice-versa). During the sample period the average spot rate (at all three forecast horizons for full sample currencies) was a better predictor of subsequent spot rates than the forward rate. However, the difference in predictive power is not statistically significant.

[49] *Forward Points (%)* has a significantly positive relation to hedge portfolio gamma (again only at the 3-month horizon) signifying a bias toward a more option-like hedge when *Forward Points (%)* is large. This is consistent with intuition since a positive forward bias would have less of a relative impact on option prices.

suggests that if the foreign currency appreciates against the USD then HDG will tend to hedge less. For portfolio gammas, spot relative to the 12-month low is negatively related to convexity (significant at the 6-month horizon) and the 3-month change in spot prices is positively related to convexity (both significant at the 6- and 3-month horizons). While it is interesting to note that these technical variables are often significant factors in explaining hedge portfolio characteristics, without a better understanding of how they determine market views it is difficult to interpret their precise meaning.[50]

Table 6 also shows the impact of the previous quarter's Derivative P&L (as a percent of exposure) on the portfolio delta and gamma. The negative coefficients for portfolio deltas suggest that HDG hedges more in a currency if the profits from the last completed quarter's hedge were large (i.e., the dollar appreciated). This signifies a trend following strategy by HDG[51] which may be explained either as a behavioral response to adverse market conditions or a need for more hedging in these situations. In contrast, the convexity of the hedge portfolios decreases significantly when lagged *Derivative P&L* is large. In other words, HDG uses a less option-like hedge when the gains from hedging last quarter were large. The net effect is a larger and more symmetric hedge when recent hedges paid off. The economic interpretation of these estimates is noteworthy: a one standard deviation increase in *Derivative P&L (t-1)* at the 3-month horizon would be expected to result in a -0.11 change in normalized delta and in a -1.26 change in normalized gamma.

In summary, the evidence for *FX Volatility* and *Exposure Volatility* is consistent with some theoretical predictions for the hedge-portfolio delta and gamma. In addition, the relationship between the technical indicators and hedge parameters suggests that views on exchange rates may impact the type and size of hedges. The strongest and most consistent relationship is between the hedge parameters and the lagged derivative P&L which indicates that recent hedging history has a substantial effect on how HDG hedges. The explanatory power of these regressions, as measured by adjusted R^2, increases as the hedging horizon shortens suggesting that the variables investigated here are relatively more important for determining shorter-run hedging decisions. However, even the largest adjusted R^2 equals

[50] One interpretation of these results is that the degree of hedging depends on market views derived from these technical factors. An alternative explanation is that these factors capture other (perhaps competitive) factors that determine the optimal hedge portfolio.

0.553 indicating that other factors, or better proxies, are needed to fully explain the variation in hedge portfolio composition.

5 Financial Risk and Firm Value

5.1 Risk Management and Stock Returns

The results from the last two sections suggest that HDG takes its forex risk management seriously. HDG manages other financial risks as well. For example, during the sample period the company entered into an interest rate swap to effectively change part of its debt from fixed rate to floating rate. This transaction was motivated by a desire to match interest payments to the cash-flow profile of its short-term investments. HDG also used derivatives to manage equity price risk from its share repurchase program. Specifically, the treasury group entered into OTC and exchange traded derivative contracts to effectively lock-in the current share price. These types of hedging programs support the hypotheses that HDG wishes to smooth earnings and that management prefers lower financial exposure volatility.

Overall, the evidence appears consistent with risk management decreasing earnings and cashflow volatility, improving the company's competitive position, and facilitating decision making. What has not been shown is that (1) foreign exchange risk (and financial risk in general) is economically important and needs to be actively managed with derivatives and (2) forex risk management actually increases firm value (i.e., stock returns).

Measuring the impact of financial risk and its management on firm value is challenging even with access to transaction-level detail on hedging practices. Specifically, for a company like HDG that manages financial risk, it is difficult to overcome the joint hypothesis that financial risk is not priced and that the company eliminates financial risk by hedging. Both can lead to no measurable impact of foreign exchange risk on stock market value. With this caveat in mind, I investigate the relationship between stock returns and foreign exchange by estimating linear regressions with HDG stock returns as the dependent variable. The results are presented in Table 7. The first column uses weekly returns and includes as explanatory variables market returns for the CRSP value-weighted index, an

[51] This behavior is confirmed by interviews with treasury managers. When a currency moves against HDG there is a belief that the company should hedge this exposure more.

industry stock index, and changes in the USD exchange rate for the currencies with the four largest exposures.[52] Only one of the exchange rate changes (*USD/FC3*) is significant at conventional levels. Furthermore, its sign is opposite to what one would naively expect; the negative coefficient suggests that HDG stock appreciates when *FC3* depreciates against the USD. Results in the next column using an exposure-weighted index of all currencies are similar (a negative, but insignificant, coefficient estimate).

Since the exact derivative P&L is known for HDG at the quarterly frequency, it may be possible to isolate the impact of hedging on stock returns. The weekly analysis is repeated using quarterly returns and the exposure-weighted exchange rate as a benchmark.[53] The last column in Table 7 includes *Derivative P&L* (as a percent of total exposure) as an explanatory variable. The coefficient estimate is statistically positive at the 10% level. The estimate of 4.57 implies an increase in derivative P&L of one standard deviation (0.023% or $17.5M) is associated with an increase in market capitalization of approximately $1.42 billion. The estimated coefficient for *Derivative P&L* may be exaggerated since the market value of HDG rose rapidly during the sample period and derivative P&L may be correlated with other firm-specific factors. However, this result is consistent with the findings of Allayannis and Weston (1998) that foreign exchange derivative use is associated with higher market valuation.

As an alternative for measuring the impact of hedging on stock returns, I estimate the regression reported in the second column of Table 7 for each quarter.[54] Next, I calculate the correlation between the coefficient estimate on the foreign exchange variable and the notional value of derivatives for the respective quarter (results not reported). The correlation is significantly negative at both the 6-month and 3-month horizons which is consistent with the hypothesis that hedging more reduces the stock price sensitivity to exchange rates.

Both of these tests assume that the market is aware of the impact of the forex risk management process on an ongoing basis. While this may seem unlikely, it is possible that

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[52] Analysis with daily or monthly data yields very similar results. Including more currencies did not increase the adjusted R^2 and resulted in problems with multicollinearity.

[53] The CRSP value-weighted index is not a significant explanatory variable when industry returns are included and since the number of observations is small (N=14) it is excluded from the specification. This does not materially change the magnitude or significance of estimated coefficients. Likewise, the analysis is limited to only the exposure-weighted index because of the small number of observations. However, the exchange rate is not a significant explanatory variable for HDG's stock market returns at the quarterly frequency either.

[54] The estimate of exchange rate sensitivities is problematic since few of the estimated coefficients from these regressions are statistically different from zero and several are negative

general announcements by the company concerning its current operations include information relevant to currency risk. Overall, the evidence that the share price depends on changes in foreign exchange rates and that hedging has an impact on firm value is weak.

5.2 Unanswered Questions

In general, the analysis of HDG provides only limited, and mostly indirect, evidence that forex risk management increases firm value. Perhaps the most interesting insight of this study is that many of the apparent motivations for HDG's forex risk management are not well developed in the theoretical literature or tested using a broad cross-section of companies. As a consequence, one valuable contribution of this analysis is to suggest areas for subsequent research.

For example, the results regarding earnings smoothing indicate that both HDG's management and outside analysts believe that earnings volatility is priced. This hypothesis can be tested by relating earnings and cashflow volatility to valuations for firms that hedge and do not hedge. Proxies for the degree of information asymmetry can be employed to test if this explanation is actually a source of a priced risk. An alternative hypothesis is that hedging does not increase value in this way or even decreases value by smoothing through informative changes in cashflows.

The evidence also indicates that competitive factors in the product market lead to value-increasing risk management. However, the existing theoretical research in this area does not apply directly to HDG. New theoretical work is needed to determine what underlying economic factors can lead to this motivation for hedging. For example, under what conditions are factors such as differences in production technology, degree of competition, or location of competition (i.e., domestic, foreign, or third country) be sufficient for foreign exchange risk management to increase firm value? Likewise, will all firms use similar hedging strategies in equilibrium?

Foreign exchange hedging at HDG impacts managerial incentives and compensation. This raises the question of how to structure the optimal compensation contract for a regional manager in the presence of hedging. Conversely, under what conditions does the preferred compensation contract imply a role for hedging (e.g., lead to lower total compensation)? In general, when would it make sense to compensate foreign managers in domestic versus

foreign currency, and how does hedging impact the optimal contract? Finally, can hedging improve effort or optimal operating policy when foreign managers have superior information about the local market?

Perhaps the biggest gap in existing research is revealed by investigating how HDG structures its hedges. In particular, the results in Table 7 indicate that many different factors impact the composition of HDG's hedge portfolios, yet very little theoretical or empirical research considers "hedging strategies" for non-financial corporations. Several specific questions are raised by this analysis. First, what additional factors explain variation in hedging strategies? Second, how large is the impact of managerial views on the degree and type of hedging?[55] Third, how important are risk measurement issues, such as exposure uncertainty, correlations, and cash-flow-at-risk, for determining hedging strategies for non-financial corporations? Finally, what are the necessary conditions for HDG's option preference to be based on competitive factors?

6 Conclusions

In contrast to most existing empirical research on risk management, this analysis focuses in detail on foreign exchange risk management at a single, large, multinational corporation. Advantages of this method include a more precise understanding of the risk management process and institutional details, identification of specific motivations and decision factors, and access to otherwise unavailable transaction-level data. The conclusions center around three basic questions.

First, how is the risk management program structured? I show that HDG has a foreign exchange hedging program that is systematic, extensive, and an integral part of foreign operations. The primary mechanism for this interaction is the use of *hedge rates* for budgeting, pricing, and *ex post* evaluation of foreign operations and managers.

Second, what are the motivating factors that determine why the firm manages foreign exchange risk? Many common explanations for risk management (such as minimizing expected taxes, avoiding costs of financial distress, managerial risk aversion, and coordination

[55] As a corollary, since forward rates are biased predictors of subsequent spot rates in many financial markets, should (and if so *how* should) managers incorporate this information in their hedging decisions?

of cashflows and investment) do not mesh with the evidence from HDG nor are they espoused by management. The official hedging policy provides little guidance in trying to answer this question. However, other documents, discussions with management, and statistical tests support alternative reasons for risk management at HDG. These include smoothing earnings (perhaps to lessen informational asymmetries), facilitating internal contracting via the hedge rate, and obtaining competitive pricing advantages in the product market.

Third, how does the firm structure the derivative portfolios used for foreign exchange risk management? Primarily because of accounting treatment and competitive pricing concerns, HDG has a strong preference for using options to structure its hedges. In fact, for some illiquid currencies for which options are less viable, HDG would rather not hedge at all than use forwards. The transaction-level data allow for the examination of cross-sectional and time-series variation in hedge ratios as well as statistical analysis of factors that impact hedging behavior. The results from statistical tests indicate that exchange rate volatility and exposure volatility are important determinants of optimal hedging policies. In addition, it appears managerial views and recent hedging history are also key factors.

All together, these results provide the most detailed examination of a firm's foreign exchange hedging program to date. Still, there are general questions left unanswered. For example, how do the different, and possibly conflicting, risk management goals interact? How do differing goals determine the structure of the hedging strategy? And perhaps most importantly, how do we measure the overall economic impact of risk management? However, one thing is clear; the process of using derivatives to hedge foreign exchange risk at HDG is complex. The evidence indicates that *multiple* factors determine both *why* and *how* foreign exchange risk is managed. While some of these have been discussed in the academic literature, a contribution of this paper is to reveal in detail the mechanisms through which risk management may increase firm value. Hopefully, this will facilitate theoretical work that is consistent with industry practice and motivate knew empirical research with larger samples.

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Appendix A: Currency-Specific Hedged and Unhedged Exposures

Table A reports statistics based on foreign-currency exposures. The table only reports values for aggregate foreign currency positions. The fifteen currencies for which HDG hedged in all quarters of the sample period are denoted as *full-sample currencies*. The nine currencies for which HDG hedged during only part of the sample period are denoted as *partial-sample currencies.*

The first few columns of Table A show some general information concerning the currency-specific exposures and hedges. The size of exposures varies substantially across currency with the full-sample currencies typically having larger exposures. However, all of HDG's exposures are net *inflows* of foreign currency. Consistent with HDG's preference for put option hedging strategies, the derivative P&L is positively skewed, and premiums spent on hedging are generally small when aggregated across currencies but can be substantial for individual currencies. These calculations include any net premium from round-trip transactions, but are not the same as profits and losses from option transactions because they do not include payoffs from positions held to maturity. The goal is to obtain a measure of how much HDG is willing to spend on up-front premiums. The fourth column of Table A reports these figures. The values can be negative indicating that the firm took in more from closing existing long positions in options than it paid out in initial premiums.

The last four columns of Table A calculate the impact of derivative transactions on net USD exposures. At the quarterly frequency, the standard deviation of USD exposures is reduced in only 10 of the 24 currencies. As noted before, HDG's underlying business is seasonal and these seasonal effects are much more pronounced at the country level than at the firm wide level. To adjust for this effect, the last two columns of Table A repeat the volatility calculations using year-over-year changes in USD exposures. In this case, the effect of hedging on volatility is more consistent. Hedging reduces the standard deviation of USD exposure for 12 of the 18 currencies and the semi-deviation for 15 of the 18 currencies. (A minimum of six hedged quarters is required to calculate year-over-year volatilities thus excluding six of the partial-sample currencies from the analysis.) Both the standard and semi-deviations are lowered by hedging for the sub-samples and all currencies together. For example, the all-currencies standard deviation is reduced from 22.9% to 19.5%.

Appendix B: Hedge Ratio Methodology and Currency-Specific Results

The hedge parameters are calculated as follows:

$$\textit{Portfolio Notional Value at Forecast Horizon t (\%)} = N_t = \frac{1}{E_t}\sum_{d=1}^{D} N_{t,d}$$

where E_t is the forecasted exposure at horizon t, and $N_{t,d}$ is the notional value of derivative d assigned to currency-quarter t. The aggregate notional value is the arithmetic average weighted by the forecasted USD exposure (calculated using the forward exchange rate). Portfolio deltas and gammas have been normalized to an underlying exposure of 1.0 USD and an exchange rate of 1.0 USD/FCU to facilitate comparison and aggregation across currencies.

$$\textit{Portfolio Delta at Forecast Horizon t (Normalized)} = \Delta_t = \frac{1}{E_t}\sum_{d=1}^{D} \Delta_{t,d}$$

where $\Delta_{t,d}$ is the dollar delta of derivative d assigned to currency-quarter t.

$$\textit{Portfolio Gamma at Forecast Horizon t (Normalized)} = \Gamma_t = \frac{F_t}{E_t}\sum_{d=1}^{D} \Gamma_{t,d}$$

where $\Gamma_{t,d}$ is the dollar gamma of derivative d assigned to currency-quarter t and F_t is the forward rate for horizon t measured in USD/FCU (to normalize the value).

Figure 1: Organization of Risk Management Functions at HDG

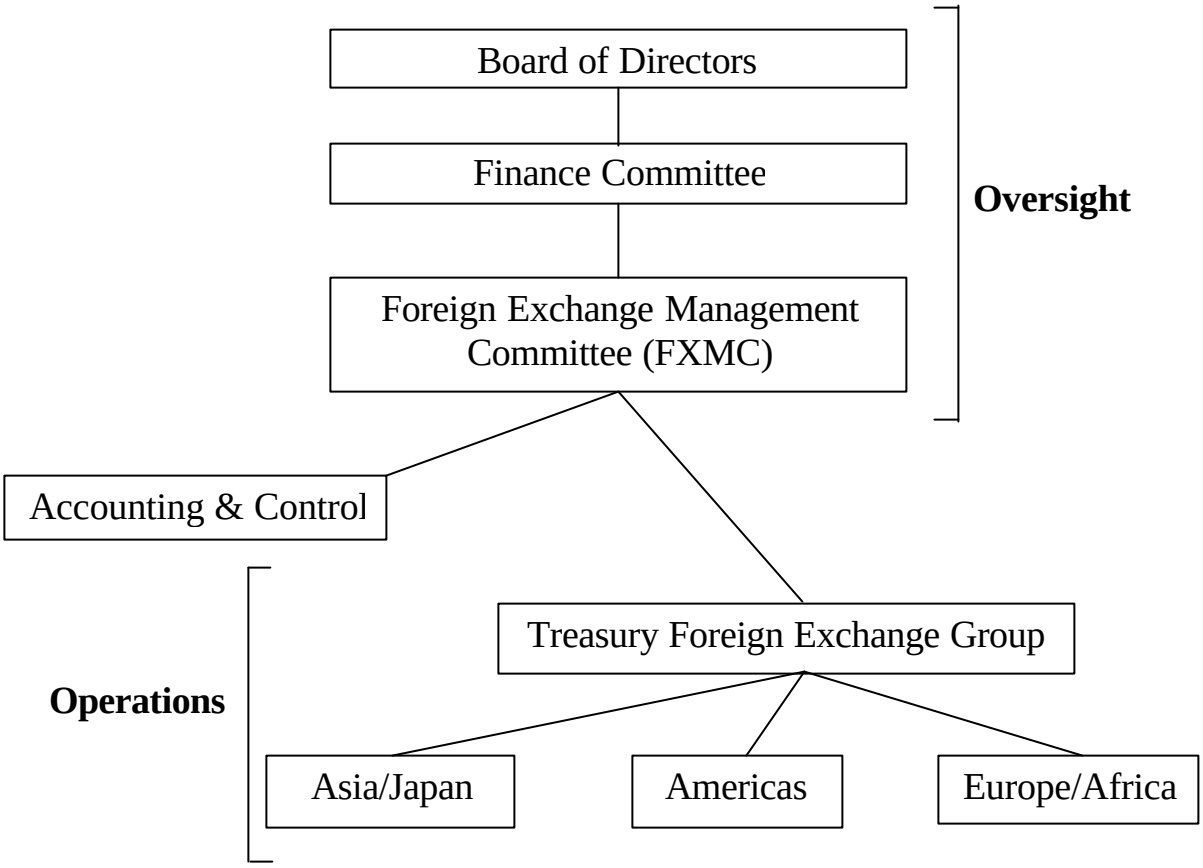

Figure 2: Determination of Foreign Exchange Exposure and Hedge Rate

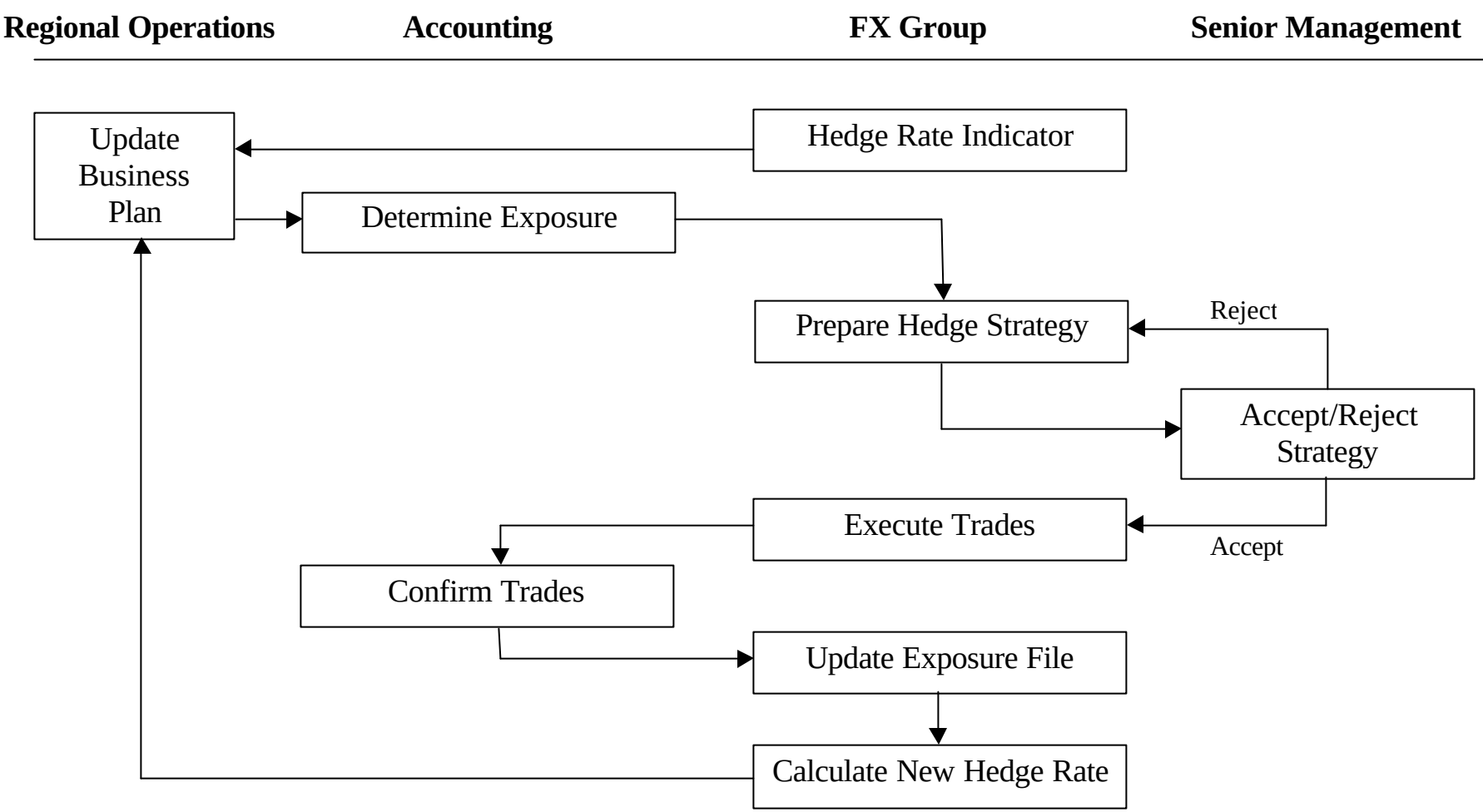

Table 1: Functional Currencies

This table reports country, local currency, and functional currency of the largest foreign markets for HDG. Of the 40 countries listed, 24 are not USD exposures. All of the foreign currency functionals for which HDG hedged with derivatives are listed in the table.

Country	Local Currency (Symbol)	Exposure
Argentina	Argentine Peso (ARS)	USD
Austria	Austrian Schilling (ATS)	ATS
Australia	Australian Dollar (AUD)	AUD
Bangladesh	Bangladesh Taka (BDT)	USD
Belgium	Belgian Franc (BEF)	BEF
Brazil	Brazilian Real (BRL)	USD
Canada	Canadian Dollar (CAD)	CAD
Chile	Chilie Peso (CLP)	USD
China	Chinese Renminbi (CNY)	USD
Colombia	Colombia Peso (COP)	USD
Czech Republic	Czech Koruna (CZK)	USD
Denmark	Danish Kroner (DKK)	DKK
Finland	Finnish Markka (FIM)	FIM
France	French Franc (FRF)	FRF
Germany	German Mark (DEM)	DEM
Great Britain	British Pound Corp (GBP)	GBP
Hong Kong	Hong Kong Dollar (HKD)	HKD
India	India Rupee (INR)	USD
Indonesia	Indonesia Rupiah (IDR)	USD
Ireland	Irish Punt (IEP)	IEP
Italy	Italian Lira (ITL)	USD
Japan	Japanese Yen (JPY)	JPY
Malaysia	Malaysian Ringgit (MYR)	MYR
Mexico	Mexican Peso (MXP)	USD
Netherlands	Dutch Guilder (NLG)	NLG
New Zealand	New Zealand Dollar (NZD)	NZD
Norway	Norwegian Krone (NOK)	NOK
Pakistan	Pakistani Rupee (PKR)	USD
Philippines	Philippine Peso (PHP)	USD
Poland	Poland Zloty (PLZ)	USD
Singapore	Singapore Dollar (SGD)	SGD
South Africa	South African Rand (ZAR)	ZAR
South Korea	S. Korean Won (KRW)	KRW
Spain	Spanish Peseta (ESP)	ESP
Sri Lanka	Sri Lankan Rupee (LKR)	USD
Sweden	Swedish Krona (SEK)	SEK
Switzerland	Swiss Franc (CHF)	CHF
Taiwan	Taiwanese Dollar (TWD)	TWD
Thailand	Thai Baht (THB)	THB
United Arab Emirates	UAE Dirham (AED)	USD

Table 2: The Impact of Hedging on Earnings & Cash Flow

This table reports the effect of foreign exchange derivative profit and losses on reported earnings (net income) and cashflow. The unhedged results are calculated by subtracting after-tax derivative profit and losses (P&L) from reported earnings and cash flow. Both standard deviations and semi-deviations of dollar changes are reported for sequential quarterly results and year-to-year quarterly results. Reported values are based on 14 quarters of data from 1996:Q1 to 1998:Q2. Semi-deviations are calculated as the average of deviations below the mean change or zero whichever is less. Values are in USD millions.

	Earnings		Cashflow	
	Hedged	Unhedged	Hedged	Unhedged
Mean (Quarterly)	$169.4	$163.2	$189.9	$183.7
Mean Change (Quarterly)	$22.9	$21.4	$21.3	$19.8
Standard Deviation (Changes)				
Quarterly	$15.7	$20.1	$14.9	$24.2
Year-over-Year	$34.9	$38.9	$36.6	$41.9
Semi-Deviation (Changes)				
Quarterly	$6.7	$7.8	$6.49	$9.75
Year-over-Year	$15.5	$15.6	$16.0	$16.5
Correlation (Quarterly, Unhedged Changes, Derivative P&L)	-0.37		-0.39	

Table 3: Market Share and Foreign Exchange Risk

This table shows coefficient estimates and t-statistics from fixed-effects panel regressions for 14 quarters (13 for changes) and the 15 full-sample currencies (N=210 and 195). The dependent variables are the market share and change in market share for HDG in each of these currency-quarters. The independent variables are defined as follows: *3-Month Change in Spot* is the percentage change in the spot exchange rate over the previous 60 trading days. *Spot % Below 12 Month High* is the percentage difference between the current spot exchange rate (as measured in USD/FCU) and the highest level of the spot exchange rate in the previous 12 months using daily values. These two variables are recorded six months prior to the end of each currency-quarter. *Derivative P&L* is the actual profit or loss on the derivative portfolio. The asterisks (*, **, ***) represent significance in a two-tailed test at the 10%, 5%, and 1% levels, respectively. Hausman specification tests for random effects vs. fixed effects rejected the random effects models in favor of the fixed effects models. T-statistics are calculated using heteroskedasticity-robust standard errors.

		Market Share	Change in Market Share
3-Month Change in Spot (USD/FCU)	coef.	0.037	0.058 **
	p-val	0.174	0.030
Spot % Below 12-Month High (USD/FCU)	coef.	0.106 ***	0.027 *
	p-val	< .001	0.078
Derivative P&L (% of exposure)	coef.	0.116 ***	0.049 *
	p-val	0.002	0.097
(Derivative P&L)^2 (% of exposure)	coef.	-0.307 **	-0.274
	p-val	0.016	0.168
Adjusted R-squared		0.69	0.26

Table 4: Notional Values and Hedge Parameters of Derivative Holdings

This table presents the average, minimum, and maximum values across 14 quarters for notional value as a percent of exposure, normalized delta, normalized gamma, and normalized vega. Forecast horizon is the number of months before the close of the relevant quarter. Values for delta, gamma and vega are normalized to a notional exposure of 1.0. Values are weighted by forecasted USD exposure. Appendix B provides additional details on the calculations.

		Notional Value			Normalized Delta			Normalized Gamma		
	Forecast Horizon	9-Mo.	6-Mo.	3-Mo.	9-Mo.	6-Mo.	3-Mo.	9-Mo.	6-Mo.	3-Mo.
Full-Sample	Mean	33.4%	59.7%	76.8%	-0.17	-0.31	-0.46	1.38	2.76	4.20
Currencies	Min	9.1%	28.3%	51.0%	-0.26	-0.53	-0.74	0.60	1.62	1.63
	Max	48.8%	78.5%	96.9%	-0.05	-0.15	-0.17	2.05	4.84	7.90
Partial-Sample	Mean	0.6%	5.0%	15.7%	-0.01	-0.05	-0.14	0.01	0.08	0.24
Currencies	Min	0.0%	0.0%	0.0%	-0.07	-0.29	-0.47	0.00	0.00	0.00
	Max	7.7%	30.9%	48.9%	0.00	0.00	0.00	0.08	0.53	1.38
All	Mean	31.8%	56.9%	73.6%	-0.16	-0.30	-0.44	1.31	2.62	4.00
Currencies	Min	8.3%	26.7%	49.5%	-0.25	-0.49	-0.68	0.55	1.59	1.51
	Max	46.5%	73.7%	91.7%	-0.04	-0.15	-0.16	1.88	4.54	7.41

Table 5: Exposure Forecast Errors and Correlations

This table presents the exposure forecast errors and correlations between exposure forecast errors (or revisions) and changes in exchange rates. The mean, standard deviation and annualized standard deviation of forecast errors are reported for forecast horizons of 3, 6, and 9 months. Correlations between exposures and exchange rates are calculated in two ways: The first two columns under correlations show values for forecast updates and changes in rates. The next three columns show quarterly or year-over-year correlations using time series data. The mean correlation is calculated using the previous four columns. Values are calculated using all available data.

		Exposure Forecast Errors				Correlations (Exchange Rate v. Exposure)						
		Forecast Horizon										
		9-Month	6-Month	3-Month	Mean		Sub-periods	Actual - 9 Mo.	Qtrly Levels	Qtrly % Ch.	Yr-Yr % Ch.	Mean
Full-Sample Currencies	Mean	1.22%	-4.61%	-3.92%	-2.43%	6-9 Mo.	0.22	0.43	-0.91	0.33	-0.55	-0.18
	STD	16.51%	7.99%	6.18%		3-6 Mo.	-0.08					
	An. STD	19.07%	11.31%	12.35%	14.24%	Act-3 Mo.	0.05					
Partial-Sample Currencies	Mean	-3.56%	-0.54%	1.00%	-1.03%	6-9 Mo.	0.21	0.34	-0.79	-0.01	0.80	0.08
	STD	21.17%	16.19%	8.98%		3-6 Mo.	-0.20					
	An. STD	24.45%	22.90%	17.96%	21.77%	Act-3 Mo.	0.07					
All Currencies	Mean	1.21%	-4.28%	-3.58%	-2.21%	6-9 Mo.	0.23	0.44	-0.93	0.34	-0.66	-0.20
	STD	15.97%	7.83%	5.75%		3-6 Mo.	-0.06					
	An. STD	18.44%	11.07%	11.51%	13.67%	Act-3 Mo.	0.13					

Table 6: Determinants of Hedge Portfolio Characteristics

This table shows coefficient estimates and p-values from fixed-effects panel regressions for quarterly data and the 15 full-sample currencies. The dependent variables are the normalized hedge portfolio parameters (delta and gamma) for 9-, 6-, and 3-month exposure forecast horizons. The independent variables are defined as follows: *FX Volatility* is the implied volatility for the USD/FCU exchange rate for the appropriate horizon. *Forward Points (%)* is the difference in percent between the 6-month forward exchange rate and the spot exchange rate. *Exposure Volatility* is the absolute percent difference between the exposure forecast and the actual exposure. *Spot % Below (Above) USD/FCU 12 Month High (Low)* is the percentage difference between the current spot exchange rate (as measured in USD/FCU) and the highest (lowest) level of the spot exchange rate in the previous 12 months using daily values. *3-Month Change in Spot* is the percentage change in the spot exchange rate over the previous 60 trading days. *Derivative P&L (t-1)* is the actual profit or loss on the hedge in the previous quarter as a percent of the exposure. The asterisks (*, **, ***) represent significance in a two-tailed test at the 10%, 5%, and 1% levels, respectively. Hausman specification tests for random effects vs. fixed effects did not consistently choose one model over the other. However, the size and significance of coefficient estimates for the two models did not differ dramatically. P-values are calculated using heteroskedasticity-robust standard errors. Estimation for 9-, 6-, and 3-month horizons use 11, 12, and 13 quarters of data respectively (because of the lagged variable *Derivative P&L(t-1)*).

		Dependent Variable: Portfolio Delta			Dependent Variable: Portfolio Gamma		
Independent Variables	Horizon	9-Mo.	6-Mo.	3-Mo.	9-Mo.	6-Mo.	3-Mo.
FX Volatility	coef.	-1.20 ***	-0.64	0.54	-1.98	-18.44 ***	-43.37 ***
	p-val	0.006	0.287	0.501	0.599	0.004	< 0.001
Forward Points (%)	coef.	-2.01	-1.65	-7.22 **	15.26	7.46	60.83 *
	p-val	0.213	0.453	0.017	0.277	0.499	0.071
Exposure Volatility	coef.	0.45 **	0.66 *	0.81	-1.31	-0.83	-0.65
	p-val	0.047	0.068	0.118	0.545	0.828	0.898
Spot % Below 12-Month High	coef.	0.12	0.50 *	0.82 **	0.73	0.88	0.574
(USD/FCU)	p-val	0.565	0.083	0.041	0.688	0.770	0.898
Spot % Above 12-Month Low	coef.	-0.08	1.19 ***	1.78 ***	-2.00	-10.04 **	-10.09 *
(USD/FCU)	p-val	0.787	0.005	0.003	0.444	0.024	0.061
3-Month Change in Spot	coef.	0.36 **	0.10	0.13	-1.61	4.75 *	10.82 **
(USD/FCU)	p-val	0.034	0.725	0.737	0.346	0.502	0.014
Derivative P&L (t-1)	coef.	-0.721 ***	-1.63 ***	-1.96 ***	-8.63 **	-13.71 **	-23.77 ***
(% of exposure)	p-val	0.003	< 0.001	< 0.001	0.038	0.029	< 0.001
Adjusted R-squared		0.376	0.525	0.553	0.290	0.451	0.526

Table 7: The Impact of Foreign Exchange Rates and Hedging on Stock Returns

This table reports the effect of foreign exchange rates and derivative profit and losses on stock returns. Reported values are based on 252 weekly observations from January 1994 to December 1998 and 14 quarterly observations from 1996:Q1 to 1998:Q2. Coefficient estimates and p-values are from linear regressions with HDG quarterly stock returns as the dependent variable. Explanatory variables include, the CRSP value-weighted index (NYSE/AMEX/NASDAQ), S&P industry returns, changes in the USD exchange rate for HDG's four largest forex exposures (*FC1* - *FC4*), changes in the exposure-weighted exchange rate of the USD (all currencies), and derivative P&L. Variables reported as *USD/FCU* are percent changes. Asterisks (***, **, *) represent significance at the 10%, 5%, and 1% level in a two-tailed test. P-values are calculated using heteroskedasticity-robust standard errors.

		Dependent Variable: Stock Returns			
Independent Variables		---- Weekly ----		---- Quarterly ----	
Constant	Coef.	0.012 ***	0.013 ***	0.154	0.102
	p-val	0.003	0.001	0.140	0.327
CRSP Value-Weighted Return	Coef.	0.027 **	0.529 *		
	p-val	0.014	0.057		
Industry Returns	Coef.	0.878 ***	0.891 ***	1.973 ***	1.810 ***
	p-val	< 0.001	< 0.001	0.004	0.007
USD/FC1 (% change)	Coef.	-0.415			
	p-val	0.122			
USD/FC2 (% change)	Coef.	-0.166			
	p-val	0.745			
USD/FC3 (% change)	Coef.	-1.105 *			
	p-val	0.081			
USD/FC4 (% change)	Coef.	0.304			
	p-val	0.502			
Exposure-Weighted % Change	Coef.		-0.597	1.572	-4.297
in USD/FCU	p-val		0.229	0.880	0.349
Derivative P&L (% of exposure)	Coef.				4.569 *
	p-val				0.089
Number of Observations		252	252	14	14

Table A: Exposures, Derivative P&Ls, and the Impact on USD Cash Flows

This table presents the average, minimum, and maximum values across 14 quarters for unhedged USD exposure, derivative P&L, and the total premium as a percent of the USD exposure. Unhedged USD exposures are calculated using realized foreign currency exposures and quarter end spot exchange rates. Derivative P&L is the average net cashflow from derivatives. Total premium (% of exposure) is the net cash spent on option premiums not including the payoff of positions held to maturity. Also shown are standard deviation (in levels and percent) and semi-deviation for quarterly hedged and unhedged exposures and year-over-year exposures. Asterisks denote hedged exposures with a lower volatility measure than unhedged exposure. Dollar figures are in USD 1,000s.

							Quarterly		Year-over-Year		
	Number of Curr.		Unhedged USD Exposure	Derivative P&L (USD)	Total Premium (% of Exp)		Unhedged Exposure Volatility	Hedged Exposure Volatility	Unhedged Exposure Volatility	Hedged Exposure Volatility	
Full-Sample Currencies	15	Ave	$663,085	$7,590	-3.36%	Std Dev.	$313,844	$319,418	--	--	
		Min	$358,071	-$8,569	-8.31%	Std Dev. %	13.52%	13.89%	25.98%	21.80%	*
		Max	$1,336,793	$38,127	0.94%	Semi Dev.	5.43%	5.53%	8.91%	7.42%	*
Partial-Sample Currencies	9	Ave	$41,787	$1,314	0.04%	Std Dev.	$30,622	$32,301	--	--	
		Min	$6,954	-$2,700	-0.16%	Std Dev. %	24.34%	26.30%	122.73%	114.64%	*
		Max	$96,340	$10,850	0.46%	Semi Dev.	9.75%	10.49%	48.41%	45.17%	*
All Currencies	24	Ave	$704,872	$8,905	-2.91%	Std Dev.	$341,725	$348,849	--	--	
		Min	$366,089	-$8,440	-7.79%	Std Dev. %	12.73%	13.19%	22.88%	19.47%	*
		Max	$1,433,132	$40,942	0.70%	Semi Dev.	5.12%	5.25%	7.76%	6.50%	*