

30

8 3 6 7 3

U M I
MICROFILMED 2003

INFORMATION TO USERS

This manuscript has been reproduced from the microfilm master. UMI films the text directly from the original or copy submitted. Thus, some thesis and dissertation copies are in typewriter face, while others may be from any type of computer printer.

The quality of this reproduction is dependent upon the quality of the copy submitted. Broken or indistinct print, colored or poor quality illustrations and photographs, print bleedthrough, substandard margins, and improper alignment can adversely affect reproduction.

In the unlikely event that the author did not send UMI a complete manuscript and there are missing pages, these will be noted. Also, if unauthorized copyright material had to be removed, a note will indicate the deletion.

Oversize materials (e.g., maps, drawings, charts) are reproduced by sectioning the original, beginning at the upper left-hand corner and continuing from left to right in equal sections with small overlaps.

ProQuest Information and Learning
300 North Zeeb Road, Ann Arbor, MI 48106-1346 USA
800-521-0600

UMI[®]

A

**THE RETURNS PUZZLE AND NON-FINANCIAL FIRMS' RISK
MANAGEMENT STRATEGIES: EVIDENCE FROM DIVERSE INDUSTRIES**

By

SUSAN R. HUME

**A dissertation submitted to the Graduate Faculty in Business in partial fulfillment of the
requirements for the degree of Doctor of Philosophy, The City University of New York**

2003

UMI Number: 3083673

UMI[®]

UMI Microform 3083673

Copyright 2003 by ProQuest Information and Learning Company.
All rights reserved. This microform edition is protected against
unauthorized copying under Title 17, United States Code.

ProQuest Information and Learning Company
300 North Zeeb Road
P.O. Box 1346
Ann Arbor, MI 48106-1346

This manuscript has been read and accepted for the Graduate Faculty in Business in satisfaction of the dissertation requirements for the degree of Doctor of Philosophy.

April 29, 2003
Date

Jeremy F. Martell
Chair of Examining Committee

April 29, 2003
Date

SA Off
Executive Officer

Turan Bali

Hassan Tehranian

Avner Wolf

Supervisory Committee

THE CITY UNIVERSITY OF NEW YORK

ABSTRACT

THE RETURNS PUZZLE AND NON-FINANCIAL FIRMS' RISK MANAGEMENT STRATEGIES: EVIDENCE FROM DIVERSE INDUSTRIES

by

Susan R. Hume

Advisor: Professor Terrence F. Martell

This paper examines whether non-financial firms of all sizes and from multiple industries use foreign currency, interest rate and commodity derivatives together to hedge financial risk broadly defined. Previous studies have examined the relationship of a firm's stock return and a single category of derivatives use, especially in foreign currencies, to suggest that hedging with derivatives improves a firm's rate of return for those firms that hedge. However, the results have been mixed in terms of explaining a consistent relationship and left researchers with a returns puzzle regarding this inconsistency. Further, these studies do not consider the effects of the three major categories of financial derivatives products using continuous measures of exposures that are used simultaneously by large and small firms over time, as in this study.

This paper considers total enterprise risk as this is the way that firms hedge. From public 10-K and annual report disclosures of derivatives data for U.S. and Canadian non-financial firms in the pharmaceutical, mining, metals and food processing industries during the years 1995 to 1998, this study uses modified Jorion multifactor market (1990) and Allayannis and Ofek models (2001) to estimate the sensitivity of each firm's equity exposure to interest rate, commodity and currency fluctuations.

This study finds some evidence that derivatives use reduces the interest rate, commodity or currency exposure that these firms face in some years, but in other years derivatives hedging had little measurable impact on these firms' exposures and values. These results are based on the use of various statistical methodologies, including Ordinary Least Squares (OLS) adjusted for heteroskedasticity, and Maximum Likelihood Estimation (MLE) with univariate and bivariate distributions. Furthermore, these results utilize firm returns prior to the decision to hedge with derivatives to separate hedging decisions from returns effects.

This study contrasts with prior research that considers only foreign currency or interest rate risk individually, or that considers only large firms, or that uses non-continuous derivatives data, or that examines only one year of hedging. The implications are that hedging with derivatives is not often important to a firm's rate of return

ACKNOWLEDGEMENTS

There are many people who I would like to thank for their guidance and support throughout my doctoral studies. I would like to express my deepest gratitude to my dissertation advisor, Professor Terrence Martell, whose unwavering guidance and devotion to higher education is unmatched. He is an academic role model whose limitless contributions made this dissertation possible. I have benefited greatly from our many discussions, his guidance, encouragement and critical questions, especially regarding the derivatives markets. I will always be indebted to him for all he has done.

I also greatly appreciate the help of my dissertation committee members. I am grateful to Professor Bali for all his invaluable help and willingness to answer my many questions in research. I learned a great deal from him about the nature of derivatives markets, returns and econometric modeling. I thank Professor Wolf for all his valuable suggestions in my dissertation research with his key insights and also his help throughout my studies at Baruch College. Professor Tehranian of Boston College has also been immensely supportive and inspired me with his research knowledge and invaluable insights.

I greatly appreciate Professor Kishore Tandon for his constant support and encouragement during my doctoral studies. I also thank Professor Ashok Vora for his immeasurable support and assistance in the completion of my studies. Professor Gloria Thomas is an invaluable resource for all doctoral students and has given me great encouragement while studying at Baruch College. Many thanks to Sylvia Clark who has always been most helpful even in the most stressful of times.

Lastly, but most importantly, I would like to thank my wonderful family for their unconditional love and support. To my husband John, I am greatly indebted for his sacrifice and contributions of love and kindness. To my sons Phil and Scot, who continue to grow before my eyes, I thank for helping me to become a better human being.

TABLE OF CONTENTS

ABSTRACT	iii
ACKNOWLEDGEMENTS	v
LIST OF TABLES AND FIGURE	ix
CHAPTER ONE – INTRODUCTION	1
CHAPTER TWO – LITERATURE REVIEW	9
2.1 OVERVIEW – RISK MANAGEMENT AND THEORETICAL FOUNDATION	9
2.1.1 RISK MANAGEMENT - MAXIMIZING SHAREHOLDER WEALTH	12
2.1.2 RISK MANAGEMENT – MANAGERIAL MOTIVES	20
2.2 RISK MANAGEMENT AND INDIVIDUAL EXPOSURES	24
2.2.1 FOREIGN CURRENCY EXPOSURE – THEORY AND EMPIRICAL LITERATURE	25
2.2.2 INTEREST RATE EXPOSURE – THEORY AND EMPIRICAL LITERATURE	36
2.2.3 COMMODITY PRICE EXPOSURE – THEORY AND EMPIRICAL LITERATURE	41
2.2.4 EMPIRICAL EVIDENCE – COMBINATION OF EXPOSURES	51
CHAPTER THREE	54
3.1 INTRODUCTION	54
3.2 HYPOTHESIS SPECIFICATIONS	57
3.3 ESTIMATION FRAMEWORK – MEASURING EXPOSURES	59
3.4 IDENTIFICATION OF FIRMS INCLUDED IN THE STUDY	74
3.4.1 THE DATA SET	77
3.4.2 DISCRIMINATOR CRITERIA AND DATA SOURCES	79
3.4.3 CLASSIFICATION OF DERIVATIVES DATA	82
CHAPTER FOUR	84
4.1 ANALYSIS AND INTERPRETATION OF RESEARCH RESULTS	84
4.2 DATA COLLECTION AND MEASUREMENT OF DERIVATIVES USE	88
4.3 TWO-STAGE REGRESSION ANALYSIS – EXPOSURE RISK MODELS	89
4.4 ROBUSTNESS TESTS	109
CHAPTER FIVE	110
5.1 CONCLUSIONS, LIMITATIONS, AND FUTURE RESEARCH ISSUES	110
5.2 THE MODELS FOR EXPOSURES	110
5.3 TWO-STAGE REGRESSION ANALYSIS (TSRA) – EXPOSURE RISK MODELS	112
5.3.1 THE FULL MODEL	112
5.4 FUTURE RESEARCH ISSUES	116

BIBLIOGRAPHY**167**

LIST OF TABLES AND FIGURE

TABLE I - DERIVATIVES INDUSTRY	119
TABLE II - WORLD GOLD SUPPLY / DEMAND BALANCE	120
TABLE III – PANEL A HEDGING CATEGORY DESCRIPTIONS	121
TABLE III – PANEL B EXPECTED COEFFICIENTS OF VARIABLES	122
TABLE IV	123
Test Of Equality Of Means For Betas For Bivariate Usage	123
TABLE V - FIRM CHARACTERISTICS OF USERS AND NONUSERS	125
IR AND FX	125
IR AND CM	128
FX AND CM	130
TABLE VI	132
RELATIONSHIP BETWEEN FX EXPOSURES AND DERIVATIVES USE FOUR-FACTOR MODEL, DAILY DATA, ALL FIRMS	132
RELATIONSHIP BETWEEN IR EXPOSURES AND DERIVATIVES USE FOUR-FACTOR MODEL, DAILY DATA, ALL FIRMS	133
RELATIONSHIP BETWEEN CM EXPOSURES AND DERIVATIVES USE FOUR-FACTOR MODEL, DAILY DATA, ALL FIRMS	134
TABLE VII	135
RELATIONSHIP BETWEEN FX EXPOSURES AND DERIVATIVES USE 3 AND 4-FACTOR MODEL, MONTHLY DATA, ALL FIRMS	135
RELATIONSHIP BETWEEN IR EXPOSURES AND DERIVATIVES USE 3 AND 4-FACTOR MODEL, MONTHLY DATA, ALL FIRMS	137
RELATIONSHIP BETWEEN CM EXPOSURES AND DERIVATIVES USE 3 AND 4-FACTOR MODEL, MONTHLY DATA, ALL FIRMS	139
TABLE VIII	140
RELATIONSHIP BETWEEN FX EXPOSURES AND DERIVATIVES USE THREE-FACTOR MODEL USING MONTHLY DATA, USER FIRMS ONLY	140
RELATIONSHIP BETWEEN IR EXPOSURES AND DERIVATIVES USE THREE-FACTOR MODEL USING MONTHLY DATA, USER FIRMS ONLY	142
RELATIONSHIP BETWEEN CM EXPOSURES AND DERIVATIVES USE FOUR-FACTOR MODEL USING MONTHLY DATA, USER FIRMS ONLY	144

TABLE IX	146
IR AND FX EXPOSURES AND DERIVATIVES USERS	146
THREE-FACTOR MLE MODELS USING MONTHLY DATA, USER FIRMS ONLY	
IR AND CM EXPOSURES AND DERIVATIVES USERS	148
THREE-FACTOR MLE MODELS USING MONTHLY DATA, USER FIRMS ONLY	
FX AND CM EXPOSURES AND DERIVATIVES USERS	150
THREE-FACTOR MLE MODELS USING MONTHLY DATA, USER FIRMS ONLY	
TABLE X	152
BIVARIATE RELATIONSHIP BETWEEN IR AND CM FOR USERS	152
THREE-FACTOR MLE MODELS USING MONTHLY DATA, USER FIRMS ONLY	
BIVARIATE RELATIONSHIP BETWEEN FX AND CM FOR USERS	154
THREE-FACTOR MLE MODELS USING MONTHLY DATA, USER FIRMS ONLY	
BIVARIATE RELATIONSHIP BETWEEN IR AND FX FOR USERS	156
THREE-FACTOR MLE MODELS USING MONTHLY DATA, USER FIRMS ONLY	
TABLE XI	158
UNIVARIATE RELATIONSHIP FOR FX EXPOSURE	158
TWO-FACTOR OLS MODEL USING MONTHLY DATA, USER FIRMS ONLY	
UNIVARIATE RELATIONSHIP FOR IR EXPOSURE	160
TWO-FACTOR OLS MODEL USING MONTHLY DATA, USER FIRMS ONLY	
UNIVARIATE RELATIONSHIP FOR CM EXPOSURE	162
TWO-FACTOR OLS MODEL USING MONTHLY DATA, USER FIRMS ONLY	
TABLE XII	164
PROBABILITIES FROM TEST OF EQUALITY OF MEANS FOR BETAS	
FIGURE 1 – HEDGING AND THE EFFECTS OF AGENCY COSTS AND INFORMATIONAL ASSYMETRY	166

CHAPTER ONE – INTRODUCTION

The primary intention of this research is to consider empirically whether or not derivatives use by non-financial firms is of little value, under the theoretical framework of Modigliani and Miller (1958), or value enhancing under certain conditions as asserted by the modern paradigm for corporate risk management (Froot, Scharfstein, and Stein (1993), Nance, Smith, and Smithson, (1993), Smithson (1993)). The M&M paradigm suggests that under perfect market conditions firm value is created only by a firm's investments (the left hand side of the balance sheet). Any adjustments or changes in financing of a firm's balance sheet (the right-hand side) will not improve value overall under M&M's Proposition I irrelevancy statement. And individual investors can diversify away firm risk when markets are frictionless, under Proposition II, which also makes hedging irrelevant to the firm. This contrasts with the modern paradigm of corporate risk management, which asserts that firms can benefit from a carefully planned derivatives hedging program that improves corporate wealth by providing the firm with cash when needed to make value-enhancing investments. Hedging under this scenario aligns the supply of funds (from financing) with the demand for funds (for investment opportunities), but doesn't change the average supply of funds since hedging is a zero-sum game (Smithson, 1993, and Froot, Scharfstein, and Stein, 1993).¹ Empirical evidence suggests that hedging with

¹ Given the large market for derivatives use by non-financial firms, the extent literature considers the theoretical market imperfections to explain the use of derivatives, such as growth options, financial

derivatives reduces risk exposures and enhances value for single categories of derivatives such as foreign exchange, or specific industries or individual firms (Allayannis and Ofek, 2001, Allayannis and Weston, 2001, Carter, Pantzalis and Simpkins, 2001, Haushalter, 2000, Tufano, 1996, 1998). However, there is no broad-based study of firms of different sizes for all derivatives categories using public statement disclosures that are consistent over time. Such research is essential to determine whether or not the practice of derivatives hedging is value enhancing for the levels undertaken by non-financial firms.

It is important to consider the entire spectrum of derivatives used for risk management based on the way that firms generally view their exposures today. According to the Wharton Survey (Bodnar, Hayt, and Marston, 1998), of firms that use derivatives, foreign exchange risk is the most commonly managed (83% of derivatives users), interest rate risk is the next most common (76%) and commodity risk the third most common (56%). Further, corporate risk management practice has developed since the first currency swap in 1981 from that of a stand-alone transaction basis to a firm-wide approach (Bicksler and Chen, 1986, Mian, 1996, Marshall and Siegel, 1997 and Bodnar, Hayt, and Marston, 1998). This development has changed risk management from a passive one-time arbitrage of rate differentials and comparative advantages in bond markets to more routine transactions centrally

distress, asymmetric information, agency costs, diversification, product competition or internal contracting. These issues are discussed in the literature review, Chapter II.

managed. Risk management activities are centralized in terms of the decision-making process with 89% and 94% of foreign exchange and interest rate users respectively choosing centralized risk management to manage operations (Bodnar, Hayt, and Marston, 1998). Commodity users also manage with centralized operations (67%), although some manage with a decentralized approach coordinated with central oversight (21%) (Bodnar, Hayt, and Marston, 1998). Therefore, it is appropriate and necessary to examine all risks for the individual firm on an enterprise-wide basis to avoid biases (Beatty, 1999).

Reflecting the large corporate derivatives losses in the 1990's and resulting regulatory requirements by the SEC in 1998 to provide quantitative and qualitative information about a firm's market risk exposures, derivatives portfolios are regularly monitored and modeled for exposure against underlying assets or liabilities (Blankley, Lamb, and Schroeder, 2000). While individual transactions are booked to reduce transaction exposures in foreign exchange, for example, the positions are tracked on a firm-wide basis and evaluated as a portfolio. In many firms, sophisticated Value at Risk (VaR) models from third party vendors, such as JP Morgan Chase's RiskMetrics, evaluate the value of a firm's portfolio of derivatives positions with stress and sensitivity tests (Marshall and Siegel, 1997).

A firm may use derivatives for short-term exposure, or hedge known financial exposure in conjunction with other risk management techniques such as operating and tax adjustments, for longer-term exposures, or alternatively not hedge at all.

Operating adjustments can range from changing the source of inputs and/or outputs in production, to pricing changes in marketing products internally and externally. Tax adjustments reflect the decision on dividend repatriation, as well as where to locate capital for physical plants and labor to reflect tax incentives. During the study period articles in contemporary publications indicated that several large firms, such as 3M and Kodak have not hedged or have discontinued hedging large currency exposure, preferring to fund investments by finding operating solutions to risk exposure (Jareka, 1998). Large firms also have substantial capital bases to temporarily withstand negative currency and other risk fluctuations, believing that the wrong hedge can increase volatility. Prior to the bankruptcy of Enron, large non-derivative user firms were generally not viewed favorably by Wall Street investment banks, stock analysts, or institutional investors during the study period as noted in contemporary publications (Jareka, 1998)².

Smith (1995) arrays the risks that affect a firm along a continuum with market-wide risks on one end, to the other end of the spectrum with firm-specific risks. Market-wide risks are evidenced by the unexpected changes in interest rates, foreign exchange rates or oil prices. Firm-specific risks include fire, lawsuits, outcomes from research and development, and exploration and development activities. Given the different risks, a wide variety of risk management tools, either on or off-balance sheet can be chosen by a firm. For example, hedging commodity price exposure can be

² According to one popular business publication, firms that do not hedge “have lost all credibility with Wall Street,” says a Goldman Sachs investment banker. (Jareka, 1998, p.74).

managed by forward contracts (off-balance sheet financial risk management), or through oil-indexed notes (on-balance sheet financial risk management) or through plant sites (on-balance sheet production risk management). Each choice involves a tradeoff between flexibility and cost, as evidenced by off-balance sheet forwards, swaps, or options, which quickly adjust exposure but are expensive, to less flexible brick and mortar plant locations, which are natural hedges for foreign revenue and expenses.

The motivation for this paper is to consider the three primary categories of financial derivatives risk- interest rate, currency and commodity – that are available to a firm to hedge financial risk, in light of the portfolio effects from holding these positions. Each risk has been considered individually but not simultaneously in the extent literature.³ There has been substantial research about the relationship between firm value and currency derivatives using the Jorion multifactor model (1990) for many different categories of firms, from those that are classified as either U.S. multinationals, or exporters, or Fortune 500, or manufacturers. In the Jorion model, empirical tests of derivatives use as value enhancing examine the effects of exchange rate movements on stock returns. It is assumed that economic exposure to exchange rate movements is measured as the regression coefficient of the real value of the firm

³ Two studies, which are not returns-based models, are also consistent with our research. Guay and Kothari (2001) examine the portfolios of large derivatives using firms and their sensitivities to substantial changes in interest rates, currency exchange rates and commodity prices for one year. Their research suggests that these firm's derivatives portfolios do not substantially reduce volatility in operating cash flow or earnings. In Hentschel and Kothari (2001), large corporations that use derivatives do not show a reduction in earnings volatility, based on a univariate analysis with pre-FASB 119 data (1990-1993).

on the exchange rate across states of nature (Dumas, 1978, Adler and Dumas, 1984, and Hodder, 1982). Jorion finds that the relationship between stock returns and exchange rates is positively related to the foreign operations of multinationals. In other studies that consider foreign exchange derivatives, the findings suggest that exchange rate movements affect expected future cash flows and consequently, firm value (Geczy, Minton and Schrand, 1997, Allayannis and Ofek, 2001, Carter, Pantzalis and Simkins, 2001). This is expected since “exchange rate movements...change the home currency value of foreign revenues (costs) and the terms of competition.” (Allayannis and Ofek, 2001, p. 273).

This paper further extends the work of Allayannis and Ofek (2001) based on the Jorion model (1990) for currency derivatives to include interest rate and commodity derivatives as categories for hedging. This paper examines whether firms in selected industries use all categories of derivatives for hedging. Four different industries were used in this study: commodity concentrated (gold and silver mining), derived agricultural (food processing), heavy manufacturing (primary metals processing) and high technology (pharmaceutical and large biotechnology firms). Several of these industries were chosen as it was thought that firms using derivatives would be more likely to use commodity derivatives.⁴ This study considers all categories of derivatives since firms use these hedging vehicles simultaneously to

⁴ Empirical evidence in Mian (1996) shows that the use of commodity derivatives in 1990 for 3,000 firms is more likely in the industries chosen. This is also suggested in Dolde (1995). See Chapter 2.2.3 for further discussion.

reduce overall risk exposure. Currency exposure is defined as the sensitivity of the value of the firm as proxied by the firm's stock return to the unanticipated change in an exchange rate index (currency beta). Interest-rate exposure is defined as the sensitivity of the value of the firm to the unanticipated change in an interest rate index (interest rate beta). Commodity exposure is defined as the sensitivity of the value of firm to the unanticipated change in a commodity index (commodity beta). The impact of hedging is tested by the hypotheses that interest rate, currency and commodity exposures are positively related to the levels of long-term debt, foreign sales and total inventory, respectively and negatively related to derivatives use.

It is argued that firms hold derivatives positions to offset the effects of unexpected currency, interest rate or commodity price movements.⁵ Today's firm operates with many risk management components and the failure to consider all strategies may result in an endogeneity bias when using cross-sectional data, as suggested by Beatty (1999). The results of the current study do not generally support the hypothesis that derivatives positions offset unexpected risk movements for many of the years studied. These results are robust to several of the econometric tests for all of the three derivatives risk categories based on regressions with univariate and bivariate distributions, using both daily and monthly data sets. To the extent that it is observed that there is no change in firm value as measured by risk sensitivities for firms that hedge, then this suggests that firms: 1) use other forms of risk management

⁵ This assumes that hedging is perfectly correlated with the underlying position or that the firm is not speculating on asset prices in the use of derivatives.

to hedge, such as operational hedging that can come from global diversification or other financial hedging using foreign debt, or product pricing or production management, or; 2) do not fully hedge the extent of the effect of exchange rate movements or possibly speculate, or; 3) interest rate, exchange rate and commodity risks are economically insignificant relative to their return, or; 4) do not have an economic justification for derivatives hedging if they are diversified, large and of good credit quality, except in extraordinary cases, or; 5) use derivatives to facilitate internal contracting, or informational asymmetries, or product pricing issues; or, 6) exposures are a non-linear function of returns.

This paper is organized as follows. Chapter II reviews the current literature. Chapter III presents hypotheses specifications and the research methods and designs. Chapter IV contains the analysis of the data and the interpretation of the results. Section V contains concluding remarks.

CHAPTER TWO – LITERATURE REVIEW

2.1 Overview – Risk Management and Theoretical Foundations

The literature on derivatives risk management has grown commensurately with the use of these products since the first currency swap was transacted between the World Bank and IBM in 1981. In Table I, we report the growth in total volume and outstanding dollar amounts for traded options, futures contracts, and global derivatives products. For example, total global derivatives outstanding increased 250% to over \$94 trillion for the four-year period ending 1998, primarily in the category of over-the-counter products. Two products showed declines in the categories of foreign currency options and stock index options.

Traditional asset pricing models such as the capital asset pricing model (CAPM) of Sharpe (1964) and Litner (1965), arbitrage pricing theory (APT) of Ross (1976) and the intertemporal capital asset pricing model (ICAPM) of Merton (1973) examine asset returns to determine what factors are important in explaining those returns. While these models do not explicitly integrate risk management, the factor loadings in these models have been used to empirically explain the relationship between hedging with derivatives and asset returns. The empirical literature has had mixed results in identifying consistent relationships.

More recently, behavioral models have gained in popularity in categorizing return characteristics and are useful for stylized facts or specific markets. For example, Simon (1951) models relational contracts within and between firms and Grossman and Hart (1986) defines the relationship of integration and asset ownership. Hong and Stein (1999) explain market continuums, momentum, and trading for asset returns with a behavioral model, but without consideration of derivatives use. Hong (2000) provides a dynamic behavioral model to explain returns, speculation and volatility in futures markets. However, no general dynamic behavior model considers the overall category of derivatives and risk management to specify the relationship between returns and derivatives use.

Much has been written on the underlying hedge motivations for individual categories of risk, almost exclusively from an empirical perspective and mainly in the field of currency risk.⁶ Theoretical models tell us how important either foreign exchange, interest rate or commodity exposure is in the framework of affecting a firm's value. However, no theoretical model exists to consider the firm's exposure to interest rate, foreign exchange and commodity risk simultaneously and the use of the range of derivatives choices for financial price risk management. Current financial theory needs to be developed to describe the structural form of these equations. This is especially critical in light of the mixed results in using current models to explain a non-financial firm's hedging motivations.

⁶ See sections 2.2.1–2.2.3 in the literature review for a detailed discussion of the individual theoretical and empirical risks in each category.

The discussion of why firms hedge is approached in current literature by specifying hedging policy choice as a function of exogenous variables. This is based on the theoretical argument that the market frictions of transaction costs, financial distress, agency costs, information asymmetry, and tax advantages justify derivatives use. But the very nature of the arbitrage argument that calculates how many copper futures that a copper mining firm such as Phelps Dodge should buy or sell to remain delta neutral also suggests that hedging is of no value. The M&M paradigm (1958) argues that without market imperfections, hedging is irrelevant and will not increase or decrease firm value. Under M&M's Proposition I, the choice of investments by the firm is value enhancing but financing decisions are irrelevant. Thus under this Proposition, managers should seek value enhancing investments but the financing of those investments is irrelevant to their outcomes. Further under M&M's Proposition II, buying and selling derivatives cannot alter the company's value since individual investors can buy and sell derivatives contracts themselves to adjust exposures to underlying risk. Individual investors, however, may be limited in their use of derivatives due to the transactions costs of entering and maintaining a derivatives position. For example, it is not customary for an individual retail non-managerial investor to be approved by a broker or dealer as a bona fide investor with minimum financial threshold to engage in interest rate or currency swaps to hedge investments in a copper producer such as Phelps Dodge. However, those retail investors who hold the company's stock can buy or sell copper option contracts or futures if they care to

adjust their exposure to commodity prices. This compares with institutional investors who hedge to manage mutual, retirement, pension, corporate or hedge funds, and are sufficiently large with personnel dedicated to use all types of derivatives. It is this notion of market frictions that would allow a corporation or institutional investor to span the universe of derivative hedging while a retail investor may be limited in access to all types of derivatives contracts.

Theoretical arguments for financial risk management center on two distinct frameworks: the first, on maximizing shareholder wealth and the second, on maximizing manager's wealth. The choice of risk management activities can: maximize shareholder value due to the impact on financial distress, investment policy, agency costs, transaction costs, or tax incentive. Alternatively, these activities can maximize manager's private utility due to managerial risk aversion, or to signal managerial skill.

2.1.1 Risk Management – Maximizing Shareholder Wealth

The primary paradigm explaining the maximization of shareholder value is cash flow hedging using the model of Froot, Scharfstein and Stein (FSS) (1993). The rationale for hedging according to FSS is to avoid the deadweight costs of external finance and align the supply of funds under all states of nature with the demand for

funds to fund all positive net present value projects. This follows as an extension of Myers (1977) debt overhang effect and Myers (1984) pecking order theory of capital structure. Firms that use debt have bond covenants that can restrict production or investment policy. These covenants are costly to monitor externally since it is impossible to track managers decisions on specific investment projects that are foregone. Myers (1977) suggests that a substantial portion of the firm's value is comprised of intangible assets that represent future investment opportunities. The debt overhang effect suggests that those firms with debt have an incentive to reject positive net present value investments if the benefit of the investment accrues to the bondholders and not to the shareholders. To mitigate the underinvestment problem, debt should be indexed to the exogenous sources of risk of the firm. As an extension of the debt overhang effect, hedging also mitigates the underinvestment problem of risky debt. Firms would like earnings to be smooth so that investment opportunities do not have to be postponed due to costly or difficult to raise external finance.

FSS is also an extension of Myers (1984) pecking order theory for capital structure to derivatives hedging. Firms prefer to use internal wealth, or retained earnings, as the main source of funds for investments. External debt financing is next in order of preference and last is external equity financing. Firms are reluctant to issue equity or other risky securities, such as convertible debt, at a low price for an investment project. A firm that avoids the capital markets in this instance would not be able to finance a value-enhancing project, when available.

The use of derivatives smoothes corporate cash flows so that value-enhancing investments can be made in all states of nature with internal funding sources. Specifically, in FSS (1993) the supply of funds can be observed from cash flows from operations. The internal supply of funds for investment does not equal the desired investment demand for funds at different price levels in the unhedged firm. For example, the unhedged copper firm would find that when market prices for copper are high it would have an excess supply of internal funds to finance new projects, while for low copper prices there would be insufficient internal funds for investment projects. Risk management rations cash for investment projects across a variety of possible price outcomes by transferring cash flow savings from high price states to low price states.

Under FSS (1993, 1994), the firm is averse to funding cash shortfalls with external finance, which is assumed to be costly, and a “deadweight” to shareholder value. The source of these costs from FSS (1993), Warner (1977) and Tufano (1998) are varied from: 1) the costs of bankruptcy and financial distress, which can be direct costs, such as legal costs, or indirect costs, such as the loss of key employees and product suppliers, 2) the informational asymmetries between managers and investors, 3) the agency costs of monitoring managers when external finance is avoided, and 4) the managerial perception that external finance is costly. The FSS (1993) model uses Townscend (1979) and Gale and Hellwig (1985) costly state verification models which assumes that cash flows are costlessly observable to insiders but not to outside

investors. Risk management reduces volatility of cash flows and as Stulz (1990) shows increases firm value when managers tend to overinvest in high price states. Risk management thus reduces agency problems under normal circumstances when agency costs are not too severe.

Tufano (1998), with modifications, illustrates possible outcomes for two firms that have different managerial and shareholder objectives, but both with deadweight external finance costs (Figure 1). One firm, Omega Oil (OO) has managerial and shareholder objectives aligned. The other firm Alpha Omega Oil (AOO) has severe agent problems. For OO, the optimal investment demand for funds from internal financing sources can't be met without hedging at O_{low} . Under O_{high} , the supply of internal funds is more than that demanded for optimal investments when there is no hedging. With hedging, OO's outcome is a straight line $I_{m,1}$ that redistributes excess supply of funds to the low supply outcome states. Both managers and shareholders share equally in expected payoffs.

The other firm, AOO has severe agent problems, which are made worse by the private benefits that managers receive from completed investment projects. Hedging AOO's investment projects provides funds during shortfalls that capital market providers would not finance. The outcome is line $I_{m,2}$, which has a put option profile. Lower oil prices decrease the available supply of funds for projects and hedging is not beneficial to shareholders when a firm faces severe agency problems. The expected payoff to the shareholder is higher for the unhedged firm than in the hedged case.

This is because the managers collect the private benefits from expected payoffs before distribution to shareholders. Shareholders prefer no hedging, while managers prefer hedging for the firm. Managers are reluctant to cut investment and lose their private benefits from investment projects. Under O_{high} , demand for investments is increased to the manager's level of investment to finance their pet projects and increase managerial consumption. Under severe agency conditions derivatives hedging provides cashflow for business investments, which would not cover the costs of capital markets providers, and prevents the firm from releasing cash to shareholders in O_{low} .

Consider the market frictions that give rise to the rationale for derivatives hedging from FSS (1993). Recall that these conditions are:

- A1. information asymmetry
- A2. convex tax schedules
- A3. costly financial distress
- A4. agency problems between owners and managers
- A5. transactions costs

For larger, publicly owned and well-rated firms, A1, A2, A3 and A4 are generally not dominant factors to suggest hedging would be beneficial to outweigh the transaction costs of a hedging program (including control costs). These large firms have institutional investors to mitigate informational asymmetries and few face the

lower end of progressive corporate taxes. Further from A5, without strong controls in place by the firm's board of directors, auditors and overseers of the risk management processes, the cost of hedging may be excessive if not controlled. The list of firms with weak implementation derivatives details- Enron, World Com and Metallgesellschaft, to name a few, demonstrate that the lack of strong controls can seriously impair the firm's survival. Of further concern, A1 and A4 are potentially conflicting conditions as shown by Tufano (1998). If information asymmetry is large and agency problems severe, then management may not be trustworthy to manage shareholder interests. Under this scenario, hedging could be used to finance investment projects that further manager welfare with private benefits, such as career enhancement, salary compensation or empire building. Hedging would provide cash flow to the firm in low states where a trip to the capital market under scrutiny of bankers, investment bankers or private investors would not have financed the project due to the high private benefits required by managers.

Thus we are left to consider the conditions under which hedging with derivatives can be costly to firm value, which is generally not discussed in many papers. These conditions are:

B1. The market imperfections aren't large enough to justify the expenses of derivatives.

B2. Agency conflicts between manager and shareholder are not manageable.

B3. Asymmetric information about the firm type and motive for hedging is costly to shareholders if not monitored.

Given that hedging has benefits and costs to the shareholder, the overall effects of hedging to firm value are measured by the severity of the informational asymmetries, the extent of agency problems due to management's private benefits (M), the project's gross returns (R), and the volatility of the firm's expected cash flow under high and low price states, according to Tufano (1998). Using this model, it can be shown that hedging is beneficial to shareholder value when managers who have private consumption in the project can not consume more than the project's gross returns, where $R > M$. Hedging is beneficial if it smoothes cash flow volatilities providing identical cash flows under all states directly to shareholders, with managers sharing in expected cash flows proportionately. FSS conditions hold here even with large agency costs, as long as the project can be financed through the capital markets. At O_{high} , price levels managers give up excess cash flows to cover hedging commitments.

However, when management and shareholder agency conflicts are large and management has the opportunity to extract project value before cash flows accrue to shareholders, then expected cash flows for the unhedged firm are greater than for the hedged firm ($R < M$). Under this scenario, shareholders would have preferred that projects be financed with costly external finance since the cost of hedging with severe

agency management problems would provide lower cash flows to shareholders. The external capital markets would provide shareholders with the assurances that managers were not extracting unnecessary value from the firm. Managers, however, would prefer hedging with derivatives since under low cash flow states all projects would be funded by cash flows from hedges. The unhedged firm would not be able to fund cash flow projects under low price states since the capital markets would not finance the project due to the high costs extracted by managers.

Another consideration of costly hedging is the possibility of speculation attributable to severe asymmetry as outlined in condition B3. Mozumdar (2001) shows that this is an important cost in the swap market, similar to that of costly external finance. With a multi-period model, he shows that asymmetric information can lead to speculation in the derivatives markets. The adverse effects of speculation can be controlled only by credit enhancement for swaps maintained by diligent dealers. The dealer reviews the credit worthiness of firms and monitors poor credits for their ability to meet swap payments.

Not only does costly external finance motivate managers to hedge with derivatives to improve shareholder wealth, but tax incentives can also encourage similar motives. Firms that realize low or negative pretax income are unable to use tax benefits, such as tax carry forwards or items subject to tax preferences. Hedging smoothes pretax income and increases the probability of a firm using tax incentives according to Mayers and Smith (1982), and Smith and Stulz (1985). Thus, derivatives

can assure cash flows in low states of the world and increase a firm's debt capacity and tax shield. In Smith and Stulz (1985), the authors suggest that nonlinear tax schedules, where taxes are a convex function of earnings, make hedging optimal. Convexity suggests that a firm with more volatile earnings stream has higher expected taxes than a firm with less volatile earnings. Convexity is more likely to exist in firms with a high probability of negative earnings and in firms who can't utilize tax carry forward losses into future periods. Graham and Smith (1999) model the tax savings for selected firms to show that many have an effective convex tax schedule. However, this theoretical construct regarding convexity does not explain the level of hedging for 75% of the firms in their simulations.

2.1.2 Risk Management – Managerial Motives

It has previously been shown how large agency problems and information asymmetries can lead to managers financing pet projects and extracting value from shareholders. The second paradigm focuses on risk management as value enhancing for managers under several theoretical explanations. First, managers may demonstrate risk averse motives when their wealth is poorly diversified and concentrated in the firm's stock as shown by Stulz (1984). Risk management can reduce the undiversified risk that managers bear, which improves their welfare (Smith and Stulz (1985) and Stulz (1984)). This occurs when derivatives use reduces the variance of total firm

value and improves managerial wealth that is concentrated in owning the firm's stock. Outside shareholders are indifferent to a manager hedging with derivatives if shareholders can diversify themselves and the managerial motive to hedge is not overly costly.

The nature of the manager's benefit is related to their underlying compensation contract and can influence hedging decisions (Smith and Stulz, 1985). Those managers that hold only stock of the firm, but no options may be concerned with stock price volatility. This is the undiversified risk that Smith and Stulz (1985) and Stulz (1984) discuss. Further, managers with earnings based compensation could hedge to reduce earnings volatility, which would also be consistent with shareholder motives. Amihud and Lev (1981) show that when a manager's employment income is tied to changes in firm value, then the decision will be made to reduce variability in earnings. This occurs because the increase in the earnings variance reduces the certainty equivalent of the manager's employment income.⁷

Managers who own the firm's common stock and stock options have different incentives with respect to their personal wealth. It is not always clear-cut whether managers will seek value reducing or increasing investments. In Agrawal and Mandelker (1987), they suggest that the investment decisions are influenced by the amounts of equity compensation held by the manager and the correlation of the firm's

⁷ According to Agrawal and Mandelker (1987) a manager's wealth can consist of four components: common stock, option holdings, human capital from the present value of future employment earnings and any assets unrelated to the firm.

stock and options held to their overall personnel wealth. They argue that variance-increasing investments will affect the manager's personal wealth in the following three ways. First, the value of holding the firm's stock and options increases when the firm holds risky debt as shown in option pricing models as in Black and Scholes (1973). The value of the firm's stock price increases because equity in a levered firm is equivalent to holding a call option. Second, the certainty equivalent value of the employment income stream to the manager decreases when firm variability increases to the extent that the manager's employment is directly associated with changes in firm value. Third, the variability of total wealth changes depending on the weights and correlations of the firm in the manager's portfolio. Managers with large stock and options holdings select variance-increasing investments because the first effect dominates. By extension of Agrawal and Mandeker (1987), we can infer that the length of time of a manager's expected employment with the firm would also affect that manager's decision to pursue variance increasing firm investments. Short-term managers would place little emphasis on the second effect and the first effect would dominate. Managers with longer-term employment expectations would be concerned with the second effects on personal wealth and would be less inclined to pursue variance-increasing investments.

If only stock options are given to managers as compensation, then most literature suggests that managers will be more likely to increase risk taking⁸. In Merton (1973), Myers (1977), and Black and Scholes (1973), theoretical models suggest that higher volatility is beneficial to equity owners, which hold call options on firm value, than to debt holders who are sellers of call options. Further, Jensen and Meckling (1976) show that equity holders (managers) have incentives to increase firm cash flow volatility and equity volatility as volatility transfers wealth from bondholders to shareholders. FSS (1993) theorize that greater cash flow volatility is beneficial to managers but detrimental to shareholders when it reduces the present value of tax shields from debt and increases the present value of the costs of financial distress. In the past senior managers have used privately arranged executive swaps to further diversify individual portfolio risk. Bolster, Chance and Rich (1996) show that executive equity swaps allow managers to reduce exposure to their firm's equity holdings. Since cash flow rights are swapped but ownership rights are not, agency costs are imposed. As a result, the manager has reduced the correlation of personal wealth with corporate wealth, but due to the retention of voting and ownership rights increased the likelihood of making self-serving decisions.

⁸ Leland (1999) argues, however, that shareholders are better off overall when firm volatility is reduced and subsequently equity volatility, to utilize debt tax shields. These benefits outweigh the agency costs of debt and can be viewed as an incentive for managers to decrease risk through derivatives use.

Managerial skill is a second theoretical explanation to explain derivatives use that is value enhancing to management. DeMarzo and Duffie (1995) and Breeden and Viswanathan (1996) model an environment where shareholders are uncertain about managerial quality. Managers want to take advantage of competitive short-term labor markets. Shareholders observe the firm's performance and assess the quality of management and the type of projects in which the firm will invest by observing earnings. It is found that hedging reduces noise in earnings and increases the information content of the firm's profits. Thus, firms use derivatives to influence the labor market's perception. The labor market revises its opinions about managers abilities based on the firm's performance. When hedging smoothes earnings volatility, the labor market will favor the management of those firms that uses derivatives.

Finally, managers may use derivatives to reduce the risks associated with short-term contracts (Hentschel and Kothari, 2001). Since cash flows from these contracts are small relative to firm value, risk reduction for these contracts is unlikely to materially affect firm value.

2.2 Risk Management and Individual Exposures

As noted before, there is no current overall theoretical paradigm that incorporates risk management with the underlying exposures for interest rates, foreign exchange and commodities simultaneously. There are theoretical constructs and

empirical literature that considers these exposures individually. This Chapter further considers the empirical and theoretical models explaining the individual components of exposures and derivatives use to a firm's return. We will consider the nature of the theoretical predictions for risk exposures and returns at the firm level. This is an expansion of the work by Bodnar and Wong (2000) for currency exposures, which fails to find a predicted positive relationship between returns and currency exposure. This is referred to as the "currency returns puzzle" in numerous articles. We will explore and extend their model more broadly to consider the returns puzzle for each exposure that the firm faces in addressing the nature of risk management.

2.2.1 Foreign Currency Exposure – Theory and Empirical Literature

We first consider the theoretical models to explain foreign exchange risk. The research models variables that attempt to capture unexpected changes in foreign exchange rates.⁹ Changes in foreign exchange rates impact the return of domestic and international firms by driving the changes in a firm's cash flows that reflect in firm value. According to Levi (1994), the value of the exporting firm is an additive function of the risk adjusted opportunity cost of capital for foreign and domestic

⁹ Expected change in foreign exchange does also occur. Popper (1997) documents that expected changes are already in stock prices. Jorion (1990) notes that the forward premium is a biased predictor of variations in spot rates and explains little of those variations.

profits and the net monetary asset and liability position in foreign currency. This relationship is written as, using Levi's notation:

$$V = \frac{TR - TC}{\rho} (1 - \tau) + \sum_{i=0}^k \pi_i X_i \quad (1)$$

$$\text{where } TR = \sum_{i=0}^k \pi_i p_i q_i . \quad (2)$$

$$TC = c \sum_{i=0}^k q_i \quad (3)$$

The individual variables are:

V = market value of the firm

TR = total revenue

TC = total cost

ρ = risk-adjusted shareholder opportunity cost of capital

X_i = net monetary asset/liability position in currency i

τ = tax rate

π_i = exchange rate in units of home currency per unit of currency i

p_i = product sold in country i

q_i = quantity sold in country i

c = constant marginal cost of production at home

Through algebraic manipulation and consideration of partial derivatives, Levi (1994) identifies the elasticity of firm value for the exporter relative to the exchange rate as:

$$\frac{\pi_j}{V} \frac{\partial V}{\partial \pi_j} = \eta_j \frac{\pi_j q_j \left(p_j - \frac{c}{\pi_j} \right) (1 - \tau) / \rho}{V} + \frac{\pi_j X_j}{V}$$

where η_j = is the elasticity of demand in country j such that:

$$\eta_j = - \frac{p_j dq_j}{q_j dp_j}$$

The assumptions are that marginal costs are fixed and that $\eta > 1$ to ensure positive earnings. The equation tells us that the sensitivity of the exporting firm's value in relation to exchange rates depends directly on both the elasticity of demand for the product in the foreign country and the profit generated in the foreign country. The demand elasticity varies inversely with the tax rate and the opportunity cost of capital. If the profits in market j are positive, then the first term is positive, and the exporting firm's value increases with home currency depreciation. This is also supported in Shapiro's (1975) oligopolistic model for multinationals that finds that the major factors influencing a firm's exchange rate risk are: 1. the distribution of sales between domestic and export markets, 2. the level of import competition faced domestically, and 3. increasing or decreasing cost technologies, which affect the direction and volume of trade as well as import or export demand elasticities.

Several studies examine empirically the relationship between the change in the dollar and firm value using returns data and without examining derivatives use. Adler and Simon (1986) and Adler and Dumas (1984) suggest that foreign exchange elasticity exposure can be expressed in terms of a regression such as:

$$\Delta V_t = \sum_{i=0}^k \beta_i \Delta \pi_{i,t} + \mu_t$$

where exposure is estimated with β , a variable related to a firm's exports and imports, or alternatively foreign profits. Adler and Dumas (1984) model that the currency exposure elasticity of the firm can be determined by a regression of the individual firm's stock return on the coefficient of an exchange rate index on the regression:

$$R_j = \alpha_j + \delta_j XR + \varepsilon_j \quad (4a)$$

where R_j is the stock return for firm j , XR is the percentage change in an exchange rate variable, which is expressed as the home currency price of the foreign currency (HC/FC) and δ_j is the elasticity of firm value to the exchange rate change. This elasticity indicates the firm's average currency exposure over the estimation period in home currency units as a percentage of the firm's market value.

Jorion (1990) extends Adler and Dumas (1984) with a multi-factor model that links a firm's returns with currency exposure and overall market returns. The Jorion model is a two-stage regression model. In the first stage, currency exposure is estimated as:

$$R_{i,t} = \beta_{1,i} + \beta_{2,i} FX_t + \beta_{3,i} R_{m,t} + \varepsilon_{i,t} : t = 1, \dots, T \quad (4b)$$

where:

$R_{i,t}$ is the rate of return on the i th firm's common stock in period t

FX_t is the rate of return on a moving trade-weighted exchange rate index, in US \$ per unit of foreign currency in period t

$R_{m,t}$ is the rate of return on the market index in period t

After each firm's currency exposure is estimated, a second-stage cross-sectional regression is estimated. The form of this equation is:

$$\hat{\beta}_{2,i} = \gamma_{1,i} + \gamma_{2,i}(FS/TS)_i + \xi_i : i = 1, \dots, N \quad (5)$$

where $\hat{\beta}_{2,i}$ is a firm's exchange rate exposure estimated in (4b). Jorion (1990) shows

that the elasticity of exposure of foreign operations is $\left(\frac{dV}{V}\right) / \left(\frac{dS}{S}\right) = \eta \pi^f / \pi$ and

directly related to π^f , foreign profits. Under Jorion's (1990) model, the ratio of foreign sales to total sales proxies for the ratio of foreign profits to total profits since the latter is generally not reported as often in a firm's published financial data. It is expected that the exposure should increase as the proportion of sales exported increases. While Jorion (1990) finds that the foreign sales ratio is significant and positively linked to returns, he finds no evidence that exchange rate exposure is linked to returns. Jorion finds that only 15 of 287 (5.2%) U.S. multinational firms have significant foreign exchange rate exposure at the 5 percent level. Additionally the results show evidence of cross-sectional variation in exposure coefficients.

While uncertain currency cash flows are difficult for a firm, there is little empirical evidence to link exposure to returns in many non-derivatives studies after Jorion (1990). Bartov and Bodnar (1994) regress individual stock returns on percent changes of a trade-weighted exchange rate index using the weights in the Multilateral Exchange Rate Model (MERM). They find no evidence that dollar changes affect a firm's return, but some weak evidence that lagging dollar changes affects a firm's returns. The authors suggest that investors are systematically mispricing the relationship between currency risk and firm value due to the lack of timely information on the firm's performance relative to assets and liabilities. This is weakly supported by the outcome of the regression using the lagging currency index and lagging market returns. These results, however, may suffer from noisy data due to the use of such data. Frazer and Pantzalis (2002) also find weak support, again without considering the effects of derivatives. In this study, several widely used currency indexes were examined: the FRB Major Currencies Index (MMI), narrowly defined with 16 major U.S. trading partners; the FRB Broad Index (BBI), with 35 trading partners; and, a firm specific index weighted by U.S. currency and foreign subsidiary contributions. The firm specific index explains stock returns relationships better than FRB major currencies index, but less effectively than the FRB's Broad-based index. Further, even the most significant currency index, the BBI explains only 12.6% of returns. This is the characteristic outcome in non-derivative studies.

The lack of empirical support for the theoretical predictions for foreign exchange exposure and returns at the firm level is referred to by Bodnar and Wong (2000) as the “returns and currency exposure puzzle.” Theory would predict that a firm’s economic position in foreign currency long or short determines the impact of a change in exchange rates. “U. S. firms with net long economic position in foreign currency will benefit (suffer) from a depreciation (appreciation) of the dollar. If a firm has a long economic position in foreign currency, changes in the exchange rate influence expected future cash in-flows (revenues).” (Bartov and Bodnar 1994, p. 1758). Long economic positions are firms with cash inflows denominated in foreign currency (exporters), while net short positions have cash outflows in foreign currency (importers). Domestic producers with no imports or exports could also be influenced by currency rate changes when their prices for inputs or outputs are determined in international markets due to competition. It is surprising that the exposure puzzle exists, given the theoretical expectations.

When studies consider derivative hedging data with stock returns and exchange rate exposures, the returns effect puzzle continues for most of the studies. Hentschel and Kothari (2001) using a univariate regression model do not find any evidence of a relationship between currency exposure, derivatives use and stock returns. Carter, Pantzalis, and Simpkins (2001) use two-factor regression analysis, but do not find a significant relationship between equity returns and currency exposure, for either nonuser or user firms. These results are also observed when individual

derivatives sub-classifications are analyzed. The two exceptions in their study are that the classifications of currency swap users and other users (caps, collars, and swaptions) are significantly related to returns. As in Jorion (1990), Carter, Pantzalis, and Simpkins (2001), find that foreign sales operations are related directly related to currency exposure and also that firms with diverse international operations rely less on derivatives than firms with less diverse operations abroad.

A recent derivatives study by Allayannis and Ofek (2001) questions the exposure puzzle and finds support for the expected relationships predicted by theoretic models regarding currency exposure. Their study finds a significant positive relationship between foreign sales and currency risk exposure and a negative relationship between derivatives use and currency exposure, using a multivariate two-factor framework. Allayannis and Ofek (2001) extend Jorion (1990) with a two-stage regression model using equation (4b) for the first stage to estimate currency exposure. The second stage regression is:

$$\hat{\beta}_{2,i} = \gamma_{1,i} + \gamma_{2,i}(FS/TS)_i + \gamma_{3,i}(FDER/TA)_i + \xi_i : i = 1, \dots, N \quad (4c)$$

where:

$\hat{\beta}_{2,i}$ is a firm's exchange rate exposure estimated in (4b)

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

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

The model simultaneously considers a firm's real operations, measured by foreign

sales, and financial hedging using derivatives. The decision to use derivatives is related to exposure through foreign sales and trade, which measure the firm's real operations. Exporters are net long in currency exposures and firms with foreign sales are more likely to use derivatives. Allayannis and Ofek (2001) also find that derivatives use is significantly negatively related to currency exposure. Since currency derivatives protect a firm against exchange rate movements, the use of derivatives reduces currency exposure and improves firm value for the Fortune 500 firms in their study. These results may be significant due to the data structure used in their model, which examines only β coefficients of the same sign to show the expected relationships. Further, the definition of derivatives use classifications does not consider all foreign exchange derivatives, but only forwards, options, and futures. A large classification, currency swaps, is excluded.

Why is the evidence mixed? One explanation is that the structure of the foreign exchange econometrics model may significantly impact currency exposure estimates. Bodnar (2000, 2002) suggest that the model structure is important to establish the relationship between currency exposure and derivatives use. Most studies estimate currency exposure using a two-factor model against monthly individual firm stock returns, as in Bartov and Bodnar (1994), Jorion (1990), and Allayannis and Ofek (2001). Recall that the standard model from Jorion (1990) from equation (4b) defines

$$R_{i,t} = \beta_{1,i} + \beta_{2,i} FX_t + \beta_{3,i} R_{m,t} + \varepsilon_{i,t}, t = 1, \dots, T \quad (4b)$$

where $\beta_{2,i}$, or γ_i is the exchange rate elasticity exposure of the firm and $\beta_{3,i}$ is the return on a market index. The exchange rate elasticity γ as Bodnar et al (2002) shows is a residual currency exposure elasticity. It is the difference between the firm's total currency exposure elasticity and the market's exposure elasticity adjusted by the firm's market beta. Using the partitioned regression method in Greene (1997), equation (4b) can be written in matrix notation.

$$\gamma_i = (F'F)^{-1}F'R_i - (F'F)^{-1}(F'M\beta_i) \quad (5)$$

where $F = T \times 2$ matrix of the constant term and the currency rate change variables

$R_i = T \times 1$ vector of stock returns for firm j

$M = T \times 1$ vector of the market return

Because market returns are used in the regression equation in the two-factor model to improve r^2 statistics and to correct for macroeconomic factors that are correlated with the exchange rate for all firms, the matrix is an expansion such that

$$\gamma_j = \delta - \delta_m \beta_i \quad (6)$$

where the first term is the vector coefficient estimates of the intercept term and the total exchange rate exposure elasticity δ . The second term $\delta_m \beta$ is the product of the exposure elasticity of the market and the market beta of the firm. The second term reduces the total currency rate elasticity by the product of the market exposure and the firm's market beta. Bodnar (2002) refers to the exchange rate change coefficient

$\beta_{2,i}$ as the “residual” exposure coefficient. It is not the total currency exposure coefficient of the univariate regression. Bodnar (2002) explains that a firm with a zero coefficient for $\beta_{2,i}$ for the two-factor model indicates that the residual currency exposure is equivalent to the market index exposure. This does not mean that the firm is not affected by exchange rates, as would be the case if the regression equation were a one-factor model with only exchange rates and no market returns. The implications are that the residual exposure is impacted by both currency factors related to a firm’s cash flow and macroeconomic factors unrelated to a firm’s cash flows. The benefits of including the market index in the regression are that the OLS r^2 is improved and that there is no longer the problem of correlations in the error term.¹⁰

The choice of market index is also important to the empirical results. Bodnar (2002, 2000) suggests that the equally-weighted market (EWM) index provides less size bias than the value-weighted (VWM) index. Given that the current study is comprised of firms of small and large size, this suggests that the EWM index would be preferred since a VWM index would give larger firms more weight in the regression model. Further, larger firms are more likely to be geographically diversified multinationals with higher import needs and net foreign currency sellers. This would contribute additionally to undo large firm bias. This distortion would flow through directly to the residual currency exposure.

¹⁰ When the market return is not included in the 1st stage regression, OLS is efficient but $\beta_{2,i}$ is not independent and the standard error is biased. This violates the OLS assumption.

While the choice of market index is important, the choice of currency index has not generally been shown to greatly affect the results, especially regarding derivatives outcomes. Allayannis and Ofek (2001) test both derivatives use and different currency indices with similar outcomes regardless of the choice of index. Fraser and Pantzalis (2002) examine several widely used published indices and a firm specific index weighted by U.S. currency exchange rates vs. each firm's foreign subsidiary, in a currency study that does not consider derivative use. The results indicate that the firm specific index better explains stock returns than the MCI, but is less significant than the BBI. Even the BBI, however, does not explain a large portion of the firm's stock returns. The implication of prior empirical research is that the choice of currency index is not of significant importance to affect outcomes in the regression model.

2.2.2 Interest Rate Exposure – Theory and Empirical Literature

The relationship between stock returns and interest rates also has been the subject of considerable studies primarily in empirical research. Market models regress interest rate factors and market indices on stock returns using two or more factor models similar to the factor models for foreign currencies discussed in the previous section (see Flannery and James (1984), Folger, John and Tipton (1981), and Fama and Schwert (1977). The fundamental notion is that measuring changes in domestic

interest rates captures unanticipated changes in inflation rates. Sweeney and Warga (1986) suggest that “the shape of the yield curve contains optimal forecasts of how yield will shift over time.”(Sweeney and Warga 1986, pp. 394-395). They model changes in yield on long-term government bonds as unexpected interest rate shifts. The slope of the yield curve incorporates information on expected yield changes over time. This suggests that long-term forward rates approximate the long-term spot rates, which implies that expected long-term yield changes are about zero. Thus, changes in long-term yields reflect shifts in the level of interest rates, which are unanticipated. If we examine changes in long-term yields over time for a given maturity, then these changes proxy the height of the yield curve and not shifts along the yield curve. In their study, Sweeney and Warga (1986) used three different time series indices to replicate unanticipated inflation: twenty year U.S. government bond yields, three month U.S. T-bill rates and a composite of short-term and long-term rates. The results were similar for each of these interest rate indices. They show that the change in the short-term rate is 0.95 correlated with the change in the long-term rate.

The β for interest rates may take any positive or negative value and is also a residual exposure relative to market exposure, similar to currency exposures.¹¹ A

¹¹ This is shown through the generating function on a simple market model where $R_{i,t}$ is the i^{th} firm's return, $R_{m,t}$ is the return on a market index, ΔI_t is the change in the interest rate and E_i is the expected return on asset i , such that:

$$R_{i,t} = E_0 + \beta_{i,1}(-E_0) + \beta_{i,2}(E^A - E_0) + \beta_{i,1}R_{m,t} + \beta_{i,2}\Delta I_t + \varepsilon_{i,t}$$

where E_i is the expected return on asset i . The value-weighted sum for t :

positive $\beta_{i,2}$ suggests that a firm is helped by unanticipated increase in interest rates, while a negative $\beta_{i,2}$ suggests that the firm is harmed by unanticipated increases in interest rates. A positive (negative) sign for $\beta_{i,2}$ implies that if expected interest rates rise from month to month, then the stock price of the firm will rise (fall).

According to Sweeney and Warga (1986), there are four explanations for these effects. The first is explained by Alcain and Kessel (1959). Higher inflation results in lower real interest payments on outstanding debts, which raises the firm's stock price and value. The second effect is the replacement of maturing debt at higher interest rates due to inflation. It is unclear what the outcome under this scenario will be since the higher interest costs are paid with dollars of diminished value due to inflation. The third explanation comes from the empirical works of Sweeney and Warga (1986). Increases in inflation bring greater real economic instability, reducing the real return on capital. Fourth, their empirical work suggests that prior to deregulation, utilities output prices lagged the rise in costs, which resulted in a reduction of stock price and firm value.

$$R_{m,t} = E_0 \sum \omega_i + (-E_0) \sum \omega_i \beta_{i,1} + (E^A - E_0) \sum \omega_i \beta_{i,2} + R_{m,t} \sum \omega_i \beta_{i,1} + \Delta I_t \sum \omega_i \beta_{i,2} + \sum \omega_i \varepsilon_{i,t}$$

Given $\sum \omega_i = 1$, then it must be the case that $\sum \omega_i \beta_{i,1} = 1$, $\sum \omega_i \beta_{i,2} = 0$, and $\sum \omega_i \varepsilon_{i,t} = 0$. So while the value-weighted average of $\beta_{i,2}$ is zero, the $\beta_{i,2}$ measures interest rate sensitivity relative to the market's sensitivity.

French, Ruback and Schwert (1983) and Flannery and James (1984) provide another theoretical model to explain the relationship between stock returns and interest rates through their association with the maturity structure of a firm's nominal contracts. This model constructs the "nominal contracting" hypothesis, where a firm's nominal common stock returns consist of two components. The first is the nominal asset returns and the second is real (physical) asset returns. Nominal assets have cash flows that are fixed in nominal terms. Examples of nominal assets are fixed price contracts such as accounts receivables and debt. The cash flows of real assets fluctuate with price levels. Examples of real assets are variable priced contracts, such as most commodity goods, accounts receivable with adjustable pricing and labor agreements tied to the CPI. The cash flows of real assets fluctuate with price levels, which would have no effect on firm value if unexpected inflation rises (falls). The nominal contracting hypothesis predicts that stockholders of firms with nominal assets less than nominal liabilities will benefit from unexpected inflation.¹² This occurs because the nominal interest rate used to discount cash flows varies with the duration of the nominal contract. The effect of an unanticipated change on inflation is greater the longer the maturity of the firm's net nominal assets.

Movements in interest rates reflect changes in inflation expectations according to Fama (1975), Fama and Gibbons (1982) and Nelson and Schwert (1977). Using the nominal contracting hypothesis,

¹² Nominal liabilities can be viewed as negative nominal assets, or alternatively as reducing nominal assets.

“the interest rate sensitivity of a firm’s common stock returns will depend upon the firm’s net nominal assets and the maturity composition of net nominal assets held. The higher the portion of the net nominal assets held, the more sensitive should be the firm’s common stock returns to interest rate changes...The hypothesis predicts that cross-sectional variation in the effect of unanticipated interest rate changes on stock prices should be related to differences in balance sheet composition.” (Flannery and James, 1984, p. 1143).

Using commercial banks and savings and loan returns data, Flannery and James (1984) find support for the nominal contracting hypothesis: the relationship between stock returns and interest rates is positively related to the size of the maturity differences between the net nominal assets for financial institutions. Further, based on weekly data for a five-year period with an AR (3) model and using seven-year bonds to proxy for inflation, β sensitivities are positively significant in explaining the returns of sixty-seven banks in the study. The r^2 of the regression is a good fit of 0.56. The return regression includes the equity market index using the NYSE composite, a value-weighted index. One-year bill prices showed a positive relationship to stock returns, although this was insignificant at the 10% or lower level. Generally the nominal contracting hypothesis is difficult to model for the non-financial firm, as the appropriate data on maturity differences by net nominal assets is not generally available or consistently reported in published financial statements. The implications

are that there will be a positive relationship between the co-movement of returns and interest rates with the maturity composition of the firm's balance sheet. Firms that have a high proportion of net nominal assets with longer maturities will be more sensitive to interest rate changes.

There are no studies that empirically consider only the relationship between interest rate changes and returns for non-financial firms who use derivatives. In Hentschel and Kothari (2001) the study examines interest rate changes and currency changes concurrently for non-financial firms.¹³ Firms are grouped into portfolios based on derivatives holdings before SFAS 119. Exposure to interest rate changes were all negative for the years 1990-1993, but the study does not indicate the number of significant β 's for interest rate users. There is also no indication that derivatives use affects currency exposure for those firms. In Guay and Kothari (2001), interest rate and currency changes were examined and the outcome suggests that firms with greater interest rate and currency exposures have lower derivatives concentration.¹⁴ This study also does not provide detail regarding the number of significant β 's exposures.

2.2.3 Commodity Price Exposure – Theory and Empirical Literature

¹³ See section 2.2.4 for further discussion on their study.

¹⁴ Refer to section 2.2.4 for additional discussion and outcomes.

Theoretical models to explain commodity prices and asset returns are found for mining and extraction firms, primarily gold companies. The estimation of gold exposure in financial literature is also a growing area of research, as in Blose and Shieh (1995), Tufano (1996, 1998), Petersen and Thiagarajan (2000), and Adam (1999). The interest is a response to gold price volatilities attributable in part to the movement of the U.S. to suspend gold convertibility in its exchange rate standard in 1971 (McDonald and Solnick (1977)). Managers and investors became concerned about the impact of gold price fluctuations on firms as the U.S. moved off the gold standard. The models for gold studies are an extension of the approach suggested by Adler and Dumas (1984) for currency exposures and focus on the observable market value of the firm. The primary equation assumption for gold studies is that the market value of the firm is the present value of all future cash flows. Estimating gold exposure is determined by the elasticity of firm value with respect to gold commodity prices, which can be calculated in a regression. Investors who hold gold mining stocks are concerned with the extent to which changes in gold price are reflected in these stock's returns. Changes in commodity price levels cause investors to change their expectations of future cash flows and thus the value of the firm's assets. To the extent that firms use derivatives to reduce gold betas, which is one type of commodity exposure elasticity, the firm would improve its return and value.

Blose and Shieh (1995) examine the impact of gold prices on the firm by modeling its impact on cash flows, but do not consider derivatives use. The value of the mining firm is:

$$V = \sum_{t=1}^n (P_t q_t - C_t) (1+r)^{-t} + V_{ng} \quad (7)$$

where P_t = the expected spot price of gold at time t

q_t = the quantity of gold extracted in period t (production, refining, and inventory available for sale)

C_t = the cost of producing q_t at time t , with $C_t = C_t(q_t)$

r = the market required risk adjusted discount rate for gold related cash flows

n = the number of period until the mine is exhausted n

V_{ng} = the value of the non-gold related assets

The total firm value is the sum of the discounted gold mining cash flows (the first term) plus the discounted non-gold cash flows (the second term).¹⁵ According to their model, the firm's gold price elasticity for the firm that has debt, D , is

$$e_s = \frac{P \sum q_t}{P \sum q_t - \sum C_t (1+r)^{-t} + V_{ng} - D} \quad (8)$$

¹⁵The model makes the following assumptions: The mining company is a price taker in both gold and financial markets; the production plan satisfies $q_t > 0 \forall t \geq n$, i.e. mining operations are always open; forward gold prices are the market's unbiased expectations of future spot prices; buying and holding gold have no storage cost, only the opportunity cost of capital; and $dq_t / P_0 = 0$

According to the Blose and Shieh model (1995), equation (8) relates a firm's gold price elasticity directly to the market value of the firm's gold reserves and the inverse of the market value of stock. The model predicts that lower gold price elasticities are directly related to higher nongold assets. Higher elasticities are related to higher production costs and debt. Firms with primarily gold assets will have elasticities greater than one. Thus, return on gold stock for a firm is a function of the return on gold, gold price levels, production costs, gold reserves, financial leverage and nongold assets.

To empirically examine the model's prediction regarding gold price risk, Blose and Shieh (1995) regress a gold firm's return on a share of stock on changes in gold prices and changes in a market index (CRSP VW index). Using monthly data for ten years (1981-1990), the authors find that the gold price elasticity is greater than one for all firms, or 1.34. About 65% (15 out of 23 firms) have significant gold price elasticities. These results, however, do not consider derivatives use in the model.

In a paper that considers the relationship of derivatives use with gold price elasticities and stock returns, Tufano (1998) considers gold mining risk with a two-factor market model. The study measures stock returns and elasticities of gold prices with the CRSP VW index. Forty-eight North American mining firms are modeled from 1990 to 1994. Of 651 firm quarter observations, 62% (404) have significant gold elasticity at the 10% level of significance and 56% (366) are significant at the 5% level. The mean gold beta was 2.21 with a standard deviation of 2.38 indicating that

the gold elasticities are not stationary from quarter to quarter. Further, there is substantial cross-sectional variation in gold betas among the gold firms studied. Using a fixed production model similar to Bloise and Shieh (1995), Tufano considers taxes and fixed and variable costs, where a firm's value is:

$$V = \sum_{i=1}^N \frac{\{Q(P - C) - F\}(1 - \tau)}{(1 + r)^i} \quad (9)$$

And the elasticity of gold prices is

$$\begin{aligned} \frac{\partial V/V}{\partial P/P} &= \frac{PQ(1 - \tau) \sum_{i=1}^N \frac{1}{(1 + r)^i}}{V} \\ &= \frac{PQ}{Q(P - C) - F} \end{aligned} \quad (10)$$

where Q = fixed annual production, or R/N (total reserves/ years of production); P = market price of gold; C = extraction and processing costs; F = fixed charges (general and administrative, fixed financial charges); r = firm's cost of capital; and τ = corporate tax rate. Unlike Bloise and Shieh (1995), Tufano (1998) does not explicitly specify a variable for diversification from non-mining gold assets. From the comparative statics, Tufano (1998) hypothesizes that the hedging firm's sensitivity to gold prices:

1. decreases as gold prices rise.¹⁶

¹⁶ This theoretical prediction as well as that of Bloise and Shieh (1995) is inconsistent with the commonly observed result that producers hedge less when gold prices are low to avoid locking in low prices. The theoretic outcome suggests that firms hedge less when prices are high: this is also inconsistent with commonly observed results.

2. is inversely related to quantity produced, which is assumed fixed.
3. increases with fixed and variable costs, which are also viewed as financial and operating leverage respectively¹⁷
4. is unaffected by interest rates with level production, increasing with interest rates with rising production, and decreasing with interest rates with declining production.

Petersen and Thiagarajan (2000) conduct a study of two gold mining firms and derivatives use. While these firms operate in the same industry, they have different risk management philosophies. One firm, American Barrick Resources Corporation¹⁸, used derivatives extensively, while the other, Homestake Mining, used changes in operating decisions to manage risk. The gold elasticities are significantly positive for the non-derivatives firm, but not significant for the derivatives firm during the period 1976-1994. However, during the seven-year sub period neither firm had significant elasticities, despite volatile gold prices. This suggests that non-derivatives operating hedging, such as altering the quality of the ore mined, may be effective in managing gold price risk, or that the level of hedging is not significant to exposures for the sub-periods.

Other empirical models study commodities risk in non-gold firms to predict the relationship between a firm's stock return and commodity exposure. The studies have

¹⁷ If the assumption of fixed marginal costs are relaxed to increase with gold prices, elasticity would increase but at a slower rate, as Tufano (1998) points out.

¹⁸ American Barrick Resources Corporation is now Barrick Gold Corporation.

been primarily limited to oil and natural gas firms (Strong (1991), Haushalter (2000), Haushalter, Heron and Lie (2000), Rajgopal and Venkatachalam (1998), and Geczy, Minton, and Schrand (1999)). Strong (1991) and Haushalter (2000) associate a positive relationship between oil stock prices and changes in oil prices. Strong (1991) provides a theoretic model to study oil prices in firms relative to returns and risk exposures. He tests the hypothesis that oil price series follow a martingale, which implies that oil prices are unanticipated with the anticipated component approximately zero. A unit root presence in the price trend implies a martingale in an oil price trend regression series. In Strong, the series confirms a unit root and the assumption that oil price changes are unanticipated. The empirical results show that 13 of 24 (54%) firms had share returns significantly related to oil price changes from 1975 – 1987. However, there is no consideration of the use of derivatives on exposures.

Several studies consider the stock return sensitivity of oil producers. Haushalter, Heron and Lie (2000) find that oil price elasticities are significant and positively related to a firm's stock returns for 1993 – 1995 using adjusted daily stock prices. However, the number of firms that report significant returns is not disclosed and the data are pooled for users and nonusers. This makes it difficult to assess the effects of derivatives use on commodity exposure. Hedging during the study period was not a large factor with the mean fraction of production hedged about 8%-9% for the third quartile. Rajgopal and Venkatachalam (1998) examine stock returns and oil price exposure for 23 petroleum refiners over the ten-year period of 1987 – 1996 in a

two-factor market model. The oil elasticities have a mean of 0.12 and are significantly positive at the 5% level for 74% of the firms. However, the effects of derivatives use are not considered. 87% of the oil betas are positive indicating the extent of variability in the cross-section sample. Haushalter (2000) uses a two-factor model to study derivatives impact on risk exposures for oil and gas firms. The derivatives data are collected from a survey by the author. These firms have exposures to oil volatilities and are most likely to use derivatives when the futures basis risk available to hedge oil price risk is small.

In addition to gold and oil exposures, Geczy, Minton, and Schrand (1999) consider natural gas commodity price exposure and returns with derivatives use. In their empirical study, the authors examine natural gas price elasticities for that industry using a Fama-French (1993) three-factor market model. The model's dependent variable is the difference between the returns portfolio and the rate of return on 3-month treasury bills. The elasticity measures are the excess return on crude oil prices, the returns on corporate bond, and the excess returns on the EWM index. None of the elasticity measures are significant for the commodity hedger firms for 1992 to 1995 at the 15% level. During those years, operating strategies, such as gas storage, holding cash and diversification effectively substituted for derivatives use, according to their study.

Other derivatives studies consider whether or not firms are using derivatives to support the theoretical constructs that arise from market imperfections (Tufano (1996),

Adam (1999), and Pennings and Leuthold (2000)). Tufano(1996) considers gold mining risk and derivatives use for 35-38 firms during the years 1991 – 1993. The approach is to collect a hedging measure, delta percentage, against reserves and production. These data are analyzed on univariate variables predicted to proxy for effects on risk management. The variables studied were shareholder maximization and managerial maximization. The data supports derivatives use for managerial motives. Firms whose managers hold more options manage less gold price risk, while those managers who hold more stock manage more gold price risk. The latter supports the belief that owners with less diversification showed more risk aversion.

Additionally, firms who have CFO's with less tenure use derivatives more, supporting that managerial skill signals the degree of derivatives use. This is an extension of the information asymmetry arguments of DeMarzo and Duffy (1995) and Breeden and Viswanathan (1996) that managers with less tenure hedge more to influence the labor markets.

Adam (1999) studies the gold mining industry to test whether these firms are hedging to reduce dependence on capital markets use due to information asymmetry as hypothesized by FSS (1993, 1994). Adam (1999) finds support that during the period 1989 – 1995 these firms: 1) use risk management to hedge capital expenditures and not operating expenses or sales, 2) derivatives users relied less on external capital sources to finance capital expenses, and, 3) had capital expenditure hedging that was inversely related to the firm's current financial condition and access to external capital

markets. This supports FSS (1993, 1994) hypothesis that financial constraints are an important factor in risk management. However, this study is difficult to apply to other non-gold firms as the derivatives data are not as detailed. Further, Adams (1999) defines capital expenditures as short-term using expenditures of one year or less to estimate expected expenditures. This does not consider the effects of capital expenditures in years beyond one. These expenditures are important for some firms who may hedge 2 to 3 years of production from time to time.

Pennings and Leuthold (2000) develop a commodities behavior approach that does not examine exposures and values, but studies the interaction of the futures market and the firms involved in that market. The model shows how commodity derivatives facilitates contractual relationships between firms and resolves conflicts. The motivations for a firm to use futures contracts are based on the firm's characteristics, the trading environment and the power balances between firms. For example, "if firm A is more powerful than firm B and firm A prefers cash contracts, but firm B prefers forward contracts, a cash contract relationship will occur and firm B buys hedging services to complement the price term of the cash contracts." (Pennings and Leuthold, 2000, p. 876). The model is supported with evidence from a survey that uses data on Dutch pork companies that differ in terms of level of power and type of contract preferred. The behavioral model is an extension of Williams (1986) where the cash and derivatives markets are viewed as interactive trading markets (implicit loan markets).

2.2.4 Empirical Evidence - Combination of Exposures

As discussed before, the theoretical models to explain combinations of exposures and derivatives use have not yet been developed. Further, for non-financial firms there is relatively little empirical evidence that relates two or more risk exposures and derivatives use to stock returns using notional amounts of derivatives outstanding which is referred to as continuous data.¹⁹ Barton (2000) uses a simultaneous equations model for Fortune 500 firms without considering stock returns for 1994 to 1996. The results for interest rate and currency derivatives suggest that managers use accounting discretionary accruals to substitute for financial risk management when markets are imperfect. Bodnar, Hayt, and Marston (1995, 1996, 1998) survey firms on derivatives use. These firms respond that they hedge with derivatives, but not fully. As this is survey data, the results may have a selection bias due to the selective nature of the respondents. Hentschels and Kothari (2001) use pre-SFAS 119 data for interest rate and currency exposures to study whether large firms have different exposures and value. Firms are grouped by derivatives use into portfolios and a three-factor monthly returns model is used. Exposures are estimated by regressing the portfolio returns on a currency index (the FRB trade-weighted G-10

¹⁹ Empirical studies on financial institutions are an exception as they are required to report more detailed derivatives information to regulatory agencies (see Booth, Smith, and Stulz (1986), Eccher, Ramesh, and Thiagarajan (1997), Schrand (1993), and Gorton and Rosen (1995)). Empirical studies on derivatives hedging that use non-continuous data, which are binary yes/no usage variables, are Mian (1996) and Dolde (1992). A discussion of the use of continuous data is presented in Chapter 3.1 and 3.4.

index which is slightly more volatile than the FRB nominal major currencies index), six-month LIBOR, and market returns (VW index from CRSP).²⁰ There is no systematic increase in the portfolios currency or interest rate exposures relative to derivatives holdings. Interest rate elasticities are all negative, while currency elasticities are both positive and negative. The study does not indicate how many of the portfolios have significant exposure elasticities.

Howton and Perfect (1998) study currency and interest rate derivatives use for Fortune and S &P 500 firms using derivatives data that mixes reporting from pre-SFAS 119 with some SFAS 119 data covering the first year of its implementation. Their empirical models use univariate Tobit regressions, with notional principal contract values as the dependent variable. While there is no returns model for stock exposure in their study, the outcomes support that external finance and financial distress, tax-related costs and currency risk exposure (measured by a foreign income dummy) are determinants of derivatives use.

Gay and Nam (1998) use the Swaps Monitor derivatives database, which is a private survey completed by firms to the industry association Swaps Monitor Publications, Inc. The study examines the underinvestment problem and derivatives use. Gay and Nam (1998) also use a univariate Tobit model with the dependent variable defined as notional value of total derivatives contracts. Several proxies in the

²⁰ Volatilities for currency indices are according to the Federal Reserve (Federal Reserve Bulletin, 1998. Chapter 3.3 discusses the different type of indices in greater detail.

regression support the underinvestment explanation for derivatives use. However, a returns model is not used.

Guay and Kothari (2001) examine the importance of hedging for 234 large non-financial firms using published data for 1997. Cash flows and market value sensitivities for derivatives users are found to be insignificant to the magnitude of the firm's operations when examined against operating cash flow, investing cash flow and measures of risk exposure for interest rates and currencies. The exposure puzzle effect continues to show that firm value is relatively unaffected by interest rate and currency exposures for both derivatives and nonuser firms. In their study, the outcomes suggest that the dollar level of hedging is modest relative to a firm's size, operating cash flow and investing cash flow and has very little impact on firm value for firms that use derivatives. The estimates of hedging sensitivities are based upon assumptions about the maximum possible change in derivative inputs for all categories. Also, maturity data and underlying average rate information are not always disclosed or uniform among firms, which may affect the estimates of hedging sensitivities.

CHAPTER THREE

3.1 Introduction

This paper attempts to address a difficult problem in existing research on derivatives use. While studies have examined the use of derivatives, the focus has been on individual risks in currency, interest rate, or commodity exposures. A firm's use of individual derivatives is just one element of their risk management strategy. If this is one component of risk management, then the failure to consider all other strategies may result in endogeneity bias when using cross-sectional data as suggested by Beatty (1999). Therefore, the current study examines the full range of risk management activities with a cross-section of users and nonusers. Enterprise risk should be studied across the full range of risk management activities, as this is the way that firms manage their operations today (Bodnar, Hayt, and Marston (1998)). An increase in the use of derivatives of each risk class should reduce individual risk exposures, if hedging is value enhancing and important to the firm. Additionally, an increase in hedging in one category may reduce the need to hedge in another category and this interrelationship among exposures can be considered as a basis trade, which has not been previously studied. The nature of derivatives use should also consider if its use increases, decreases or has no effect on risk. This is also not generally discussed in many of the studies. While the theoretical arguments suggest that

hedging is beneficial in markets with friction, it has also been shown that hedging costs can be excessive as in Tufano (1998) and Mozumdar (2001).

Previous studies have not considered the exposures of all categories of derivatives usage with continuous values.²¹ Early studies have examined hedging questions with binary, or zero or one variables for derivatives users and nonusers to indicate hedging. At that time, notional values were not consistently reported and difficult to collect, as in Mian (1996), Dolde (1995), and Geczy, Minton, and Schrand (1997). Moreover, there is some evidence that the use of non-continuous data does not adequately measure the extent of hedging and may lead to biased outcomes, as suggested by Haushalter (2001).

Studies that use continuous notional amounts do not consider the effects of all type of derivatives use simultaneously, as in Barton (2000), Allayannis and Ofek (2001), and Allayannis and Weston (2001). In Guay and Kothari (2001), they examine the use of interest-rate and currency derivatives, but not commodities, to determine that the maximum loss from hedging on a firm's cash flows is not significant. Guay (1999) considers volatility and univariate risk exposures individually but only for new derivatives users.

Other derivatives studies have been case studies, special surveys, or focused on a particular firm or industry. Examples of case studies are Brown (2001) and

²¹ Continuous notional data refer to the use of actual notional amounts of derivatives use, which can start at zero and be any positive number. For example, a firm that reported \$25 million notional outstanding of interest rate swaps would have a continuous data value of \$25 million. Early studies captured usage as a binary variable (yes/no for usage). Binary data are also referred to as non-continuous data.

Chacko, Tufano, and Verter (2000). Brown examines the internal foreign exchange transactions of a large durable goods manufacturer to find that hedging is used to limit internal conflict. Chacko, Tufano, and Verter (2000) examine equity derivatives use in the biotech firm Cephalon to find that the hedging outcomes are more costly than the alternatives. Petersen and Thiagarajan (2000) study two gold firms with different hedging philosophies, but which have similar impacts on cash flows. Bodnar et al (1995, 1996, 1998) survey firms in a questionnaire about derivatives usage. Studies that consider single industries and hedging are in gold mining by Tufano (1996, 1998), and Petersen and Thiagarajan (2000); in oil and gas by Haushalter (2000), Geczy, Minton and Schrand (1999), Rajgopal and Pincus (1999), Rajgopal and Venkatachalam (1998), and Haushalter, Heron, and Lie (2000). Studies that consider single exposure in currencies and derivatives usage are by Allayannis and Ofek (2001), Allayannis and Weston (2001), and Carter, Pantzalis and Simkins (2001). Two studies consider more than one type of derivatives use but not in a returns model context, as in Howton and Perfect (1998), and Gay and Nam (1998). Howton and Perfect (1998) use univariate measures to proxy for asymmetric information, financial distress and tax convexity with a Tobit model that uses total currency and interest rate notional derivatives for the dependent variable. Gay and Nam (1998) consider total notional derivatives usage for Fortune 500 firms as a dependent variable in a Tobit model to study underinvestment and growth options in a univariate framework.

The current study is motivated by not only the consideration of total hedging by individual exposures, but considers large and small firm's derivatives use over time. Previous studies using published data have concentrated on large Fortune 500 firms for one year of hedging. There is evidence that a firm's hedging changes from year to year, not only in this study but also in industry data. For example, according to gold industry data in Table II, net forward gold sales for 1995 were 466 metric tonnes due to high gold prices. By 1996, forward gold sales had reversed to net forward purchases of 14 metric tonnes. In the next year, 1997, the industry had returned to a net forward sales position with 329 metric tonnes outstanding.

3.2 Hypotheses Specifications

Prior research provides a rationale for the examination of derivatives use as guidance in the selection of variables and the design of tests. There are two primary determinants for a firm that influence risk exposures; these are derivatives use from financial hedging and the extent of the firm's real operations. Tests in this study are designed to examine the impact of all derivatives use simultaneously on exposures of exchange rate, interest rate and commodity price risk. Further, tests are constructed to determine if exposures depend also on key factors that are important to a firm's operations. The primary objective in this study is to construct a model that considers

financial and real operations risk management concurrently as this represents the determinants used by firms today to manage enterprise risk and manage exposure volatilities.

The general hypotheses to be tested relate exposure levels with the financial hedging associated with derivatives use and with the real operations that make a firm more likely to need derivatives to hedge. The hypotheses in this study are:

For Financial Hedging:

H1a. Cross-sectional variations in a firm's risk exposures reflect the importance of each category of derivatives hedging to a firm's return.

H1b. The more a firm uses derivatives, the less its exposure to the underlying risk.

More explicitly these hypotheses indicate that the magnitude of derivatives notional amounts are negatively associated with the appropriate categories of exchange rate, interest rate and commodity risks.

For Real Operations:

H2a. Cross-sectional variations in a firm's risk exposures also reflect its real operations.

H2b. The more a firm has in selected real operations variables, the greater is its specific risk exposure and the degree to which this firm uses derivatives.

These hypotheses test that key operations are positively associated with a firm's categories of risk exposures and the degree to which a firm hedges with derivatives.

The overall set of hypotheses H1 and H2 regarding financial hedging and real operations are determined simultaneously. This is important to consider in the methodology used in constructing the tests, as firms have a variety of ways to manage risk.

Tests of specific associated hypotheses require the identification and measurement of a number of variables. The design of the study has been divided into six preliminary research tasks. These tasks include the development of: 1) measures of exposure risks, 2) measures of real operations, 3) measures of derivatives use, 4) construction of models over time to separate the decision variables appropriately, 5) the choice of firms in the study, and 6) hypotheses to be tested in multifactor models using the chosen variables which proxy for these measures.

3.3 Estimation Framework – Measuring Exposures

The foundation for this research is to further develop the tradition of earlier works that measure stock price exposures of nonfinancial firms to three macroeconomic forces: foreign exchange, interest rates and commodity prices. Economic exposure to exchange-rate movement has been considered by Allayannis

and Ofek (2001) based upon the works of Dumas (1978), Adler and Dumas (1984) and Hodder (1982) as the regression coefficient of the firm on exchange rates across states of nature. While these studies do not suggest that there is a casual relationship between exchange rates and stock prices since both are jointly determined and endogenous variables, there is empirical evidence to suggest that at the individual firm level, exchange rates are exogenous to asset values.²² This supports the current study's investigation of asset values, market movements and derivatives use.

Prior research on exchange rates used the two-stage Jorion two-factor model (1990) to consider a firm's exchange rate exposure. In the first stage, exposure is estimated as:

$$R_{i,t} = \beta_{1,i} + \beta_{2,i}FX_t + \beta_{3,i}R_{m,t} + \varepsilon_{i,t} : t = 1, \dots, T \quad (11)$$

where:

$R_{i,t}$ is the rate of return on the i th firm's common stock in period t

FX_t is the rate of return on a moving trade-weighted exchange rate index, in US \$ per unit of foreign currency in period t

$R_{m,t}$ is the rate of return on the market index in period t

In the first stage regression, the model is estimating an individual firm's foreign currency exposure, $\beta_{2,i}$, for each year.

²² See e.g. Jorion (1990), Allayannis and Ofek (2001), and Carter, Pantzalis and Simkins (2001).

To consider the other categories of risk exposures, the framework of Jorion (1990), which includes a market index, is extended to consider the three major exposures that a firm faces: interest rate and commodity risk in addition to foreign currency. Thus, the four-factor model for the 1st stage regression becomes:

$$R_{i,t} = \beta_{1,i} + \beta_{2,i}FX_t + \beta_{3,i}IR_t + \beta_{4,i}CM_t + \beta_{5,i}R_{m,t} + \varepsilon_{i,t} : t = 1, \dots, T \quad (12)$$

where:

$R_{i,t}$, FX_t , and $R_{m,t}$ are defined as before, and

IR_t is the rate of return on a short-term interest rate factor in period t

CM_t is the rate of return on a commodity index in period t

In equation (12) each non-intercept term β represents a firm's exposure by category and is comparable to a market β . The coefficient $\beta_{2,i}$ represents exchange rate exposure, or currency elasticity, as measured by the percentage change in the rate of return on a firm's common stock against a 1% change in the exchange rate. The exchange rate index selected is the FRB nominal MCI, which measures the dollar strength relative to 16 major trading partners in Europe, Japan, Canada, and Australia, prior to the creation of the euro in January 1999.²³ This index is appropriate as derivatives usage reflects hedging against nominal exposures. Moreover, other studies suggest that foreign currency exposure is robust to a variety of indices, such as the

²³ The index consists of the euro-area currencies, Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, the Netherlands, Portugal, and Spain, as well as Australia, Sweden, Switzerland and the U.K. With the creation of the euro, this index was accordingly changed.

FRB nominal and real BBI (35 important trading partners), the J.P. Morgan nominal dollar index (18 trading partners), the FRB nominal and real Other Important Trading Partners Indices (OITP) (19 trading partners, some with high inflation), the Dallas FR real RX-101 index (101 currencies), and four individual currencies (the Canadian dollar, the Japanese Yen and a European Index (Brown, 2001, Allayannis and Ofek, 2001, and Carter, Pantzalis and Simkins, 2001)).²⁴ The use of an index is more appropriate than a specific currency as it is not generally possible to construct a firm specific index using published data without losing many observations. While Fraser and Pantzalis (2002) construct an individual firm currency index weighted by U. S. currency and foreign subsidiary contributions, the results are not significantly better at reflecting currency exposure levels than published indices. Moreover, most firms report sales on a geographic area basis, not by individual countries, and the areas are not always uniformly defined. For example, some firms segregate U.S. sales from North American sales. Some firms include Caribbean sales with European operations.

$\beta_{3,i}$ represents the interest rate exposure measured as a percentage change in the rate of return on a firm's common stock against a 1% change in interest rates. Because the study is concerned with the relationship between interest rate exposure and interest rate derivatives usage, which is commonly repriced against short-term rates, three-month LIBOR is used, as published in the Federal Reserve's HR 15.

²⁴ The MCI, BBI and OITP were introduced by the FRB to replace the G-10 index, to better consider the competitiveness of U.S. goods in U.S. and foreign markets and to take into consideration a broader set of currencies (Federal Reserve Bulletin, 1998).

$\beta_{4,i}$ represents commodity exposure as measured by the change in the rate of return on a firm's common stock against a 1% change in the commodity price index. The CRB equally-weighted spot commodity index was selected as a broad-based commodity measure reflecting six major groups of commodities, with equal weighting preferred to value weighting to minimize distortions created with using value. The CRB index is comprised of the six major categories of metals, textiles and fibers, livestock and products, fats and oils, raw industrials, and foodstuffs, covering 23 markets.

$\beta_{5,i}$ represents the rate of return on the CRSP equally-weighted market index for NYSE, AMEX and Nasdaq firms. It was important that the market index include Nasdaq, to avoid size bias, because this study considers smaller firms as well as larger firms. Further, as discussed in Chapter 2, recent studies have suggested that using the equally-weighted index is less biased than using the value-weighted index, which can distort the sign and size of exposures because of the relationship between market capitalization and exposure. According to Bodnar and Wong (2000) using equally-weighted returns provides residual exposures consistent with actual cash flows of firms.

In this study each firm's category of exposure is estimated using equation (12). For a given year, β exposure estimates are computed using two data sets, daily and monthly returns. The daily data sets use one year's daily data for the year leading up to the hedging decision. Regressions for 1995 for instance reflect the daily holding

period returns, including dividends, on daily changes in each exposure category for 1995 for each firm. Since some firms had non-December fiscal year ends, it was necessary to adjust the hedging measures to correspond more accurately to the non-calendar dates. Accordingly, for those firms with fiscal year ends after March, all financial and operating statistics are lagged by one year.²⁵ This means that non-calendar fiscal year end firms would use financial statistics for the prior year. For example, 1995 returns of such a firm are measured against 1994 assets.

Because of the possibility of noisy data from the use of daily data, the study also considers exposure estimates using monthly data.²⁶ For the sample of monthly data, the three years prior to the derivatives hedging decision is used; thus, regressions for 1995 have monthly returns from 1993 to 1995. This methodology is more appropriate than using monthly returns data that surround the derivatives hedging decision. In most prior exposure studies, the derivatives year 1995 regression would model (12) using 3 years of monthly returns data for the period 1994 to 1996. The benefit of the current study methodology is that it avoids considering hedging decision with returns outcomes. This design thus uses the variables in the information set. For

²⁵ Financial data from Compustat generally reports lagging statistics for firms with non-December fiscal year ends. However, this is not always the case for their geographic data set, which is not consistent for all data. Some items were missing, reported in the wrong year, or inaccurate. Accordingly, all Compustat data were verified against published 10-K figures.

²⁶ Scholes and Williams (1977) recommend adjusting daily market returns data with a one period lagging return to provide consistent estimators of the market model. Tufano (1998) finds that gold exposures of mines are nonstationary across time. Accordingly, in Tufano's study daily data are adjusted by corrected Dimson approaches (see Dimson (1979) with corrections by Fowler and Rorke (1983)). The adjustments use one lead and one lag term.

example, to estimate a firm's exposure to currency risk at time t , we use variables until time $t - 1$.

Table IV reports the monthly mean β exposure coefficients for combinations of exposures in regressions. When considering the exposure coefficients for β 's, most are small relative to their standard errors, except for some firms that have significant and large coefficients. For example, nonuser firms had 11 significant β 's for currency exposure and 13 significant β 's for interest rate exposure in 1998. The number of significant currency exposures for nonusers were 8, 7, and 5 for years 1997, 1996, and 1995 respectively. The number of significant interest rate exposures for nonusers were 9, 3, and 5 for years 1997, 1996, and 1995 respectively. The percentages of significant interest rate and currency exposures for nonusers was 26%, 18%, 10% and 10% for 1998, 1997, 1996, and 1995, respectively. Further, the mean β coefficients change over time. This is also shown to be the case in Jorion (1990) and Tufano (1998).

In the second stage regressions, this study extends Allayannis and Ofek's (2001) examination of the impact of a firm's derivatives use on foreign currency exposure to all three exposures: exchange rates, interest rates and commodities. We are interested in the two factors that determine the level of exposure risk for a firm for each category of exposure: one reflecting real operations and the second representing financial hedging. The likelihood of using each category of

derivatives is measured by a firm's real operations. Each of the two determinants of currency, interest rate and commodity exposures included in the cross-sectional regressions are discussed below. Table III, Panels A and B, summarizes the data collected by derivatives categorizes and the expected signs of the financial and real operational coefficients of the regressions.

Exchange rate exposure is simultaneously determined by a firm's real operations proxied by foreign sales and its financial currency hedging with currency derivatives use, according to Allayannis and Ofek (2001). The ratio of foreign sales to total sales has been a standard measure of a firm's real foreign operations since Jorion (1990).²⁷ We hypothesize that this ratio should be positively related to currency exposures. The financial hedging determinant of currency exposure is the ratio of notional foreign currency derivatives to total assets, which adjusts for a firm's size. We predict that this ratio is negatively related to absolute currency exposure. The presence of currency derivatives should reduce exposure if firms are fully covering this exposure.

Interest rate exposure is simultaneously determined by a firm's real operations proxied by a long-term debt ratio and interest rate financial hedging. The ratio of long-term debt to total assets is our real operations measure of net nominal assets since interest rate sensitivity is not available for all non-financial firms (Flannery and James (1984), Haushalter (2000), Barton (2000), and Fama and French (1987)). We

²⁷ The ideal proxy for currency real operations is the percent of foreign after-tax profits to total profits, which is not consistently available for all firms.

hypothesize that the long-term debt ratio is positively related to interest rate exposure. The interest rate determinant of exposure for financial hedging is the ratio of notional interest rate derivatives to total assets, which is predicted to be negatively related to the absolute value of interest rate exposure. The presence of interest rate derivatives should reduce exposure if firms are fully hedging this exposure.

Commodity exposure is simultaneously determined by both a firm's real operations, proxied by an inventory measure, and commodity derivatives financial hedging. The ratio of total inventory to total sales is our measure of the need to hedge commodity risk (Gezy, Minton, and Schrand (1999), Haushalter, Heron, and Lie (2000), and Fama and French (1987)).²⁸ We hypothesize that the inventory ratio is positively related to commodity exposure. The financial hedging determinant of commodity exposure is the ratio of notional commodity derivatives to total assets. We hypothesize that commodity derivatives use is negatively associated with the absolute value of commodity exposure. The presence of this category of derivatives should reduce commodity exposure when a firm is fully hedging.

We test our hypotheses with second stage cross-sectional regressions. We use the exposure estimates for each category from equation (12) for the four-factor model. The second stage regressions are:

for exchange rate exposure:

²⁸ We would prefer using raw materials for the numerator to more closely measure the need to hedge commodities, but this was not available for all firms.

$$\hat{\beta}_{2,i} = \gamma_{1,i} + \gamma_{2,i}(FS/TS)_i + \gamma_{3,i}(FDER/TA)_i + \xi_i : i = 1, \dots, N \quad (13)$$

where:

$\hat{\beta}_{2,i}$ is a firm's exchange rate exposure estimated in (12)

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

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

for interest rate exposure:

$$\hat{\beta}_{3,i} = \theta_{1,i} + \theta_{2,i}(LTD/TA)_i + \theta_{3,i}(DDER/TA)_i + v_i : i = 1, \dots, N \quad (14)$$

where:

$\hat{\beta}_{3,i}$ is a firm's interest rate exposure estimated in (12)

$(LTD/TA)_i$ is a firm's ratio of long-term debt to total sales

$(DDER/TA)_i$ is a firm's ratio of total dollar derivatives to total assets

for commodity exposure:

$$\hat{\beta}_{4,i} = \lambda_{1,i} + \lambda_{2,i}(TI/TS)_i + \lambda_{3,i}(CDER/TA)_i + \mu_i : i = 1, \dots, N \quad (15)$$

where:

$\hat{\beta}_{4,i}$ is a firm's commodity exposure estimated in (12)

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

$(CDER/TA)_i$ is a firm's ratio of commodity derivatives to total assets

Consistent with the hypothesis that derivatives management and the determinants of operational exposure occur simultaneously with economic exposures, the study investigates the coordinated use of these hedges to reduce exposures. Accordingly, the study models the interaction of exposures as three and four-factor regressions for the second stage. The relationships are combinations of foreign exchange and interest rate exposures, foreign exchange and commodity exposures, and interest rate and commodity exposures. The four-factor model includes all exposures for the first-stage regression including commodities with a market return. The four-factor model uses equation (12) for the first stage and either equation (13), (14), or (15) for the second stage cross-sectional regression. The three-factor model considers only the two exposure factors that will be used in the second stage regression. For example, the three-factor model for interest rate and currency exposures allows us to examine how the exclusion of commodity exposure and general commodity price level changes impacts exposure determinants.

The equations for the two-stage three-factor regression models are:

For foreign currencies and interest rates:

$$R_{i,t} = \beta_{1,i} + \beta_{2,i}FX_t + \beta_{3,i}IR_t + \beta_{4,i}R_{m,t} + \varepsilon_{i,t} : t = 1, \dots, T$$

(12a)

$$\hat{\beta}_{2,i} = \gamma_{1,i} + \gamma_{2,i}(FS/TS)_i + \gamma_{3,i}(FDER/TA)_i + \xi_i : i = 1, \dots, N \quad (16)$$

$$\hat{\beta}_{3,i} = \theta_{1,i} + \theta_{2,i}(LTD/TA)_i + \theta_{3,i}(DDER/TA)_i + \nu_i : i = 1, \dots, N \quad (17)$$

with $f(\xi_i, \nu_i) = \frac{1}{2\pi\sigma_\xi\sigma_\nu\sqrt{1-\rho^2}} e^{-\frac{1}{2(1-\rho^2)}[\xi_i^2 + \nu_i^2 - 2\rho\xi_i\nu_i]}$, the bivariate normal density

function. ρ is the correlation between ξ and ν .

For foreign currencies and commodities:

$$R_{i,t} = \beta_{1,i} + \beta_{2,i}FX_t + \beta_{4,i}CM_t + \beta_{5,i}R_{m,t} + \varepsilon_{i,t} : t = 1, \dots, T$$

(12b)

$$\hat{\beta}_{2,i} = \gamma_{1,i} + \gamma_{2,i}(FS/TS)_i + \gamma_{3,i}(FDER/TA)_i + \xi_i : i = 1, \dots, N \quad (16)$$

$$\hat{\beta}_{4,i} = \lambda_{1,i} + \lambda_{2,i}(TI/TS)_i + \lambda_{3,i}(CDER/TA)_i + \mu_i : i = 1, \dots, N \quad (17)$$

with $f(\xi_i, \mu_i) = \frac{1}{2\pi\sigma_\xi\sigma_\mu\sqrt{1-\rho^2}} e^{-\frac{1}{2(1-\rho^2)}[\xi_i^2 + \mu_i^2 - 2\rho\xi_i\mu_i]}$ is also a bivariate normal density

function. ρ is the correlation between ξ and μ .

For interest rates and commodities:

$$R_{i,t} = \beta_{1,i} + \beta_{3,i}IR_t + \beta_{4,i}CM_t + \beta_{5,i}R_{m,t} + \varepsilon_{i,t} : t = 1, \dots, T$$

(12c)

$$\beta_{3,i} = \theta_{1,i} + \theta_{2,i}(LTD/TA)_i + \theta_{3,i}(DDER/TA)_i + v_i : i = 1, \dots, N$$

$$\hat{\beta}_{3,i} = \theta_{1,i} + \theta_{2,i}(LTD/TA)_i + \theta_{3,i}(DDER/TA)_i + v_i : i = 1, \dots, N \quad (16)$$

$$\hat{\beta}_{4,i} = \lambda_{1,i} + \lambda_{2,i}(TI/TS)_i + \lambda_{3,i}(CDER/TA)_i + \mu_i : i = 1, \dots, N \quad (17)$$

with $f(v_i, \mu_i) = \frac{1}{2\pi\sigma_v\sigma_\mu\sqrt{1-\rho^2}} e^{-\frac{1}{2(1-\rho^2)}[v_i^2 + \mu_i^2 - 2\rho v_i\mu_i]}$ again using the bivariate normal

density function. ρ is the correlation between v and μ . The parameters for all bivariate regressions are estimated by maximizing the log-likelihood function with the Berndt-Hull-Hull-Hausman (BHHH) algorithm, as in Greene (1997).

The relationship between the foreign exchange index and foreign currency exposure has been considered in previous empirical studies by examining the impact on cash flows (Shapiro (1975), and Levi (1994)). The works predict that the cash flow sensitivity to foreign currency exposure depends on the firm's activities, the extent to which it exports and imports, the extent of its foreign operations, the currency of denomination of its competitors, the competitiveness of its input and output markets, and the extent of its risk management (Shapiro (1975), Levi (1994), Bodnar (2002), Allayannis and Ofek (2001). Consider the motivations for hedging foreign exchange exposures with currency derivatives. An increase (decrease) in revenues from foreign operations would increase (decrease) foreign currency exposure. The explanation is as follows. A U.S. exporter (importer) of agricultural goods relies on customer revenues denominated in foreign (dollar) currency. A foreign currency index that is denominated in dollars per unit of foreign currency (\$/FC) decreases (increases) when

the dollar appreciates (depreciates) in value. The exporter is hurt when the dollar index drops since more foreign currency units are now needed to pay for the same dollar sales.²⁹ Similarly, the U.S. importer benefits from a decrease in the foreign currency index, since foreign sales expenses improve when the index declines. Thus, it is expected that for a given non-dollar currency exposure, an increase in revenues from foreign operations increases cash flow in foreign currency and foreign currency exposure. Foreign currency derivatives used to hedge foreign currency exposure should decrease exposures for firms with positive exposure (the importer) and increase exposures for firms with negative exposure (the exporter). The relevant measure as Allayannis and Ofek (2001) suggest is to measure foreign currency derivatives use in absolute terms since we are examining net long and short currency exposures. Thus the use of foreign currency derivatives is expected to decrease this exposure.

The motivations for hedging interest rate exposure with derivatives are also examined in this study. To the extent that a firm's assets and liabilities have greater maturity mismatches, then the firm is more sensitive to interest rate exposure. Consider the firm whose cash flow and earnings are exposed to a single hedgeable source of interest rate risk. If all debt in the firm's capital structure is variable and gross nominal assets are mostly fixed in terms of maturity, then the firm is exposed to interest rate risk. Unexpected increases (decreases) in interest rates increase (decrease) a firm's interest expense, reducing (increasing) cash flow and earnings and

²⁹ This assumes that the exporter does not adjust its product margin to compensate for the dollar appreciation.

increasing volatility. For the given example, interest rate derivatives as a hedge mitigate the effect of interest rate risk on earnings volatility by reducing nominal net asset gaps and by converting variable debt to fixed rate debt through the exchange of periodic settlement payments arising from the interest rate swap. For another firm that has only fixed debt payments in its capital structure, but assets that are variably priced, an interest rate swap to convert fixed rate to variable rate debt would allow that firm to reduce earnings and cash flow variability as well. We measure the net nominal asset sensitivity using long-term debt as a proxy since many non-financial firms do not report gap or interest rate sensitivity information. Firms with more long-term debt in their capital structure are expected to have a greater need to use derivatives. Thus it is expected that there is a positive relationship to debt. And analogous to currency derivatives, interest rate derivatives used to hedge debt exposure should reduce this exposure in absolute terms.

For a given exposure, an increase in revenues from commodity operations as measured by inventory levels should increase exposure. According to Strong (1991), oil price risk is largely unanticipated, based on an oil price series that follows a martingale. As with currencies and interest rates, commodity price risk is largely unanticipated. To the extent that derivatives can hedge against the unanticipated commodity price risk, then the firm's cash flow and earnings are improved. The hypothesis suggests that commodity exposure should be positively related to the ratio of total inventory to total assets. Further, if firms use commodity derivatives to hedge

these commodity movements, then the use of derivatives should reduce commodity exposure in absolute terms. As with other derivatives use, the use of commodity derivatives should decrease commodity exposure for firms with positive exposure and increase (decrease in absolute value) commodity exposure for firms with negative exposures. The presence of a positive relationship between the values of commodity derivatives used and the absolute values of commodity exposures, however, would suggest that firms are speculating in the use of derivatives.

3.4 Identification of Firms to be Included in the Study and Derivatives Reporting

The motivation for this study is to consider an expanded approach to derivatives use for all firm's exposure, using time series data. The sample was constructed based on a Compustat search of firms with three and four-digit SIC codes for metals mining (SIC 1000-1040), food processing (2000), pharmaceutical and large biotechnology (2384) and primary metals processing (3310-3390) for 1995 to 1998. The industries were chosen based upon the a priori belief that they would be more likely to use commodities derivatives for hedging commodity exposure, or that they would find derivatives necessary to smooth volatility to finance projects for research and development, production and exploration, or advertising. This is supported in Mian's (1996) study of hedging policy for 3000 firms, which finds that these four

groups had the largest proportion of hedging in commodities. The current study also considers commodity derivatives where prior studies have not generally integrated commodity exposures.

Not only does the current study considers time series and continuous derivatives data, but also considers firms of all sizes. To study nonusers and limit size bias in these categories, firm size was not restricted to Fortune 500 or 1,000 largest asset values. The smallest non-user is \$16.5mm in total assets and \$20.6mm for users for 1998 (see Table V).

The reporting of derivatives information is difficult and time-consuming to collect as it is contained in notes to financial statements and not directly on the balance sheet. The derivatives data are available online in a firm's 10-K filing and annual report.³⁰ However, the published derivatives information and reporting requirements did improve under SFAS 119. Effective for large firms after fiscal years ended June 15, 1994 and for all other firms one year later, SFAS 119 required disclosures about the amounts, nature and terms of derivatives that were expanded from the predecessor SFAS 105. Companies were also urged, but not required under the new ruling to report quantitative information about the risks associated with these derivatives. Also required were more adequate disclosures of information of off-balance sheet risk, especially disaggregation of data. Firms were required to segregate hedging activities from trading account reporting. This study eliminates any amounts reported as trading

³⁰ See Chapter 3.4.1 for a detailed discussion with regard to 10-K information.

activity to minimize the possibility of speculation in hedging. While it is possible that a firm misclassified speculative trading into hedging accounts, the overall size of the hedging positions and the small trading positions reported would suggest that speculation was not a misspecified variable in the database. In sum, notional disclosure content during 1995-1998 is more thorough than in research using data previous to SFAS 119 as in Hentschels and Kothari (2001) and Howton and Perfect (1998). Better data were an important motivation for the research of the current study.

Fair value of derivatives instruments was also a reporting requirement under SFAS 119. However, fair value amounts were not consistently reported during 1995-1998. Barton (2000) finds that for Fortune 500 firms that used derivatives during 1994-1996, 53% had reported fair value amounts. Some firms report about fair values in an indirect manner by stating in their 10-K reports that there was no material affect on the firm as a result of derivatives use during the period. While fair value would more closely reflect delta hedging, the missing data variables could lead to large regression misspecifications. Further, notional values have been important in other studies such as Allayannis and Ofek (2001), Barton (2000), Hentschels and Kothari (2001) and Guay and Kothari (2001).^{31 32} Thus, this study uses notional values.

³¹ This project was completed prior to the implementation of SFAS 133, which further changed the reporting requirements for derivatives and other risk measures for a firm. The effective date for SFAS was June 15, 2000, with most companies complying with account reporting beginning in the first quarter, 2001. Currently under SFAS 133 firms are required to report all derivatives instruments at fair value, except in certain cases. The goal of the current accounting standard is to reflect the impact of derivative use in a firm's financial statements instead of off-balance sheet in footnote categories. SFAS 133 reporting provides detail that would not be comparable to the current study. In certain cases there

3.4.1 The Data Set

While the objective of SFAS 119 was to improve the quality of a firm's disclosures about derivatives, the information was not contained directly on financial statements, but as a variety of possible footnote items. Firms did not uniformly report this information by category. Even within a single firm the location of derivatives information may change from year to year. Using Edgar 10-K online filings, the framework of this study was to utilize a keyword search of derivatives words.³³ However, this did not always produce a complete profile of derivatives usage. All firms' financial statements including footnotes and the Management Discussion and Analysis in the firm's Annual Report or 10-K filings were read completely to confirm that no derivatives use was reported. Further, derivatives hedging information was

is now less detailed category information, as many firms mark derivatives positions directly into their financial statement to reflect fair values.

³² In 1997 and 1998, after the implementation of SFAS 119 and prior to the implementation of SFAS 133, the SEC required more detailed quantitative and qualitative information about the market risks associated with derivatives and other financial instruments. As shown in Blankley, Lamb, and Schroeder (2000), the disclosures by the majority of non-financial firms met the basic SEC requirements. However, a minority of firms was not as forthcoming in the first reporting period of implementation. The study suggests that this was due in part to a learning curve effect, as firms required clarification of what and how to report. Further, this disclosure was not as effective due to the proposed implementation of SFAS 133 and the reluctance of some firms to provide detailed hedging positions to competitors.

³³ The keyword search words were derivatives, hedging, risk (management), forwards, futures, swaps, interest rate (swaps), caps, collars, floors, puts, calls, foreign (exchange) (currency) and options.

compared each year for consistency of reporting. Information was collected on notional amounts for each firm by category using gross notional principal as this is the most consistently reported hedging information. While this may overstate hedging positions, derivatives gains and losses are not published and the use of notional values has been standard in other studies.³⁴ If notional amounts were not reported, a firm was removed from the sample. For commodity derivatives some firms reported only contract quantity and notional values were calculated by multiplying quantities by fiscal year-end closing cash commodity prices. All Canadian firms data were expressed in U.S. dollar terms using closing year-end Canadian to U.S. Dollar spot exchange rates.

³⁴See Haushalter (2000), Barton (2001), Allayannis and Ofek (2001), Hentschels and Kothari (2001), Guay and Kothari (2001), Carter, Pantzalis, and Simkins (2001), and Guay (1999).

3.4.2 Discriminator Criteria and Data Sources

The initial sample was reduced through the use of three discriminator criteria.

These criteria are:

Discriminator 1. Only those firms with publicly traded stock in the United States and Canada are included in the study. This study is primarily concerned with evaluating stock returns and derivatives exposure risks for published, replicable data. Non-traded firms returns information would be inappropriate.

Discriminator 2. The sample was restricted to the four industry classifications with these SIC codes: 1000-1040 (gold and silver mining), 2000 (food processing), 2834 (pharmaceuticals) and 3300-3390 (primary metals processing). As noted earlier, these choices reflect prior research suggesting that these would be most likely to have exposure to the categories of risk under investigation in the current study.

Discriminator 3. Firm disclosures for annual reports use data for the fiscal years ending between January 1, 1995 and December 31, 1998. This uses a consistent data set containing only SFAS 119 data. Returns are holding period returns calculated directly by the CRSP database and include dividends. For the CRSP database, firms that were missing five or more returns data were excluded from the study. This is to avoid the potential bias of beta estimates for shares that are infrequently traded as shown in Dimson (1979). Compustat data were used for calculating operating ratios and to normalize derivatives data to reflect size. As noted earlier, Compustat

geographic segment data were utilized for foreign sales data and all items were verified by manual searches of a firm's online Annual Report, including associated footnotes and Management Discussion and Analysis, or 10-K SEC filings available online through Edgar or through a company's website.³⁵ Electronic online financial statements from the firm or Edgar were also collected for derivatives data.

The current study considers time series data. Time series data are important to a consistent study as positions and hedging philosophies for a firm change over time. Industry needs to hedge also change over time. For example, firms in the gold extraction industry might be less willing to hedge with derivatives when prices are low to avoid maintaining in low gold prices.

After considering these discriminators, the final database of firms studied in this research met the following criteria:

1. the firm had monthly and daily returns data available in CRSP;
2. the firm had electronic SEC 10-K or annual report information available to review for derivatives hedging, either on Edgar (online) or online at the company's website;
3. and, the firm had financial data available on Compustat.³⁶

³⁵ The geographic segment data were missing items in some cases and had incorrect information in other cases; thus the need to verify geographic information.

³⁶ Four firms with zero total inventory values were removed from the study. These zero values reflected the individual circumstances of either exploration firms with no production, firms that were reorganized with sales in a different SIC, i.e. computer software, or biotechnology firms that were pure research, with only discovery research in phases I-III clinical trials.

A summary of firm characteristics for the final database is listed in Table V.

There were 71 firms that used a combination of either interest rate or currency derivatives in 1998, 66 firms in 1997, 68 firms in 1996 and 58 firms in 1995. The number of nonuser firms was 86, 96, 94, and 96 for the years 1998, 1997, 1996, and 1995, respectively. For firms that used currency and commodity derivatives we find 75, 66, 66, and 54 for the years 1998, 1997, 1996, and 1995, respectively. For firms that use interest rate and commodity derivatives there are 75, 71, 66, and 54 for 1998, 1997, 1996, and 1995, respectively.

Mean asset size for users is larger than non-users, as shown in Table V. For example, firms that use interest rate and currency derivatives had mean assets of \$4.635 billion in 1998 compared with \$1.0 billion for non-users in that year. The mean percent of foreign sales to total sales was 28.35% for users compared with 10.5% for non-users in 1998. Most non-users had minimum to no foreign sales, although 8 firms had over 50% of their sales as foreign. There is not a significant difference in the real operations ratio for interest rates for user firms compared with non-user firms. LTD/TA is 0.226 for users in 1998 vs. 0.216 for non-users. Interest rate ratios for users are less in 1996 and 1995.

3.4.3 Classification of Derivatives Data

This section expands the discussion on the classification of derivatives categories used in the study. Table III-Panel A describes the types of derivatives found in each category of use for commodities, foreign exchange, interest rates, and other derivatives. Included in commodity derivatives are futures, options, forward sales or purchases, and swaps for commodity use. These are all components of commodities risk management. Foreign exchange derivatives include futures, forwards, swaps, and options for currency use to hedge currency translation, transaction, and financing exposures.³⁷ Interest rate derivatives are dollar denominated swaps, forwards, forward rate agreements (FRA's), caps, collars, floors, swaptions and exotic derivatives. Other derivatives category is a total of three components. The first is foreign debt that can substitute for foreign exchange derivatives, which is important as another form of risk management. This has not been explicitly modeled in currency derivatives studies. The second component is energy derivatives, such as oil futures and swaps, used to hedge production costs in

³⁷ Pringle (1991) and Frazer and Pantzalis (2002) examine the three major categories that explain foreign currency exposure. These are translation or accounting exposure, transaction exposure, and operating exposure. In the first instance, firms use the balance sheet to hedge exchange rate fluctuations from the accounting translation effects of foreign operations into domestic U.S. dollars. For example, currency swaps or foreign loans can be used to adjust balance sheet financing needs. The second effect, transaction exposure, arises from the timing difference from the sale of a product to the receipt of payment using the future exchange rate. This effect is efficiently hedgeable when timing of receipts and amounts are known. The third, operating exposure, occurs when a firm's goods become more or less competitive in the marketplace. This is the most difficult to hedge with derivatives. Pringle (1991) suggests revenue and expense matching by location, which may be costly.

heavy manufacturing. The third is equity derivatives to hedge a firm's equity exposures.

CHAPTER FOUR

4.1 Analysis and Interpretation of Research Results

In this Chapter, organization and detail of the analysis performed in the study are discussed. Also provided is commentary on the results of the statistical tests. As indicated in Chapter Three, the study encompassed several primary research tasks. These tasks were the development of measures for risk exposures, real operations, and derivatives use; construction of the appropriate models and hypotheses to be tested; and the choice of firms in the study. The collection of data items and the development of derivatives items were previously discussed in Chapter Three.

A summary of the variables used in this study to measure risk exposures is listed below. Acronyms used to identify these variables are shown in capital letters.

1st Stage Regression Input for Independent Variables for

Currency Exposure:

Monthly or daily change in FRB-BBI from time t to $t-1$	FX
---	-----------

Interest Rate Exposure:

Monthly or daily change in 3 month LIBOR from time t to $t-1$	IR
---	-----------

Commodity Exposure:

Monthly or daily change in CRB EWI for spot commodity prices

from time t to $t-1$

CM

For the Dependent Variable for

Returns:

Monthly or daily change in a firm's holding period returns, including

dividends from time t to $t-1$

R

Second Stage Regression Input for the Independent Variables for

Real Operations:

(Foreign Sales/Total Sales) for firm i using Compustat

geographic data and 10-K filings for foreign sales

and Compustat Industrial item # 12

FS/TS

(Long-Term Debt/Total Asset) for firm i using Compustat

Industrial data set items # 9 and #6 and 10-K Reports

LTD/TA

(Total Inventory/Total Sales) for firm i using Compustat

Industrial data set items #3, #12 and 10-K Reports

TI/TS

Derivatives:

(Foreign Currency Derivatives/Total Assets) for firm i from

10-K, and Edgar for derivatives and Compustat Industrials

item # 6

FDER/TA

(Interest Rate Derivative/Total Assets) for firm i from 10-K,

and Edgar for derivatives and Compustat Industrial

data set item # 6

DDER/TA

(Commodity Derivatives/Total Assets) for firm *i* from 10-K,

and Edgar for derivatives and Compustat Industrial data set

item # 6.

CDER/TA

for the Dependent Variables in the Multiple Regressions

Estimated Firm Currency Exposure from 1st Stage Regression $\hat{\beta}_{2,i}$

Estimated Interest Rate Exposure from 1st Stage Regression $\hat{\beta}_{3,i}$

Estimated Commodity Exposure from 1st Stage Regression $\hat{\beta}_{4,i}$

These variables provide a basis for testing the hypotheses about the relationships between firm exposures and derivatives use and real operations.

The likelihood of using each category of derivatives is measured by a firm's real operations. The higher the ratio, the more likely a firm is to use derivatives as a hedge to reduce its risk exposure. For currency exposures the measure is the ratio of foreign sales to total sales as in Levi (1994), Jorion (1990), and Allayannis and Ofek (2001).³⁸ The dollar interest rate exposure is measured by the ratio of long-term debt to total assets as in Haushalter (2000), Barton (2000), and Fama (1993). For

³⁸ The best proxy to measure the need to hedge currency exposure is foreign profits, which are not consistently available for all firms. (See Jorion 1990).

commodity exposure, this is the ratio of total inventory to total sales from the works of Geczy, Minton, and Schrand (1999), Haushalter, Heron, and Lie (2000), and Fama and French (1987). The data reflecting real operating hedging characteristics were obtained as described in Chapter 3.

Derivatives measures using notional principal reflect the size of the individual exposures, if only as an approximation according to Hentschels and Kothari (2001), Allayannis and Ofek (2001), Guay and Kothari (2001), and Barton (2000). First, the data considers gross notional principal outstanding and not net long and short hedging position. But the latter information is not publicly available. Second, consider two call options with identical maturities, but with different strikes: one in-the-money, the other deep out-of-the money. The in-the-money position will have a much higher exposure than the deep out-of-the money position. Additionally, consider two identical swaps, or futures, or other linear hedging vehicle with the same notional principal amounts and different maturity dates. Those derivatives with longer maturities will have higher exposures than the identical hedge vehicle with a shorter maturity. Accordingly, these examples suggest that the use of gross notional amounts has some potential data problems. Overall, however, the use of notional principal provides a rough approximation of the magnitude of a firm's exposures if a firm is generally hedging and not speculating.

4.2 Data Collection and Measurement of Derivatives Use

An important part of the analysis for this project was collection of the data. As discussed in Chapter 3, the firms were identified using an SIC search of Edgar on-line by the four SIC categories 1000 (all), 2000 (all), 2834, and 3000 (all). The firms that were studied in this research met the three criteria: 1. the firm had monthly and daily returns data available in CRSP, 2. the firm had electronic SEC 10-K or annual report information available to review for derivatives hedging, either on Edgar (online) or online at the company's website; 3. and, the firm had financial data available on Compustat. For these firms, each derivatives category was measured by notional principal and normalized for size using total assets. Derivatives data were collected through searches of the firm's financial statements, including associated footnotes and the Management Discussion and Analysis in the firm's Annual Report or 10-K available online or through Edgar. Compustat geographic segment data were utilized for foreign sales data and all items were verified by manual searches of a firm's online Annual Report (including associated footnotes and Management Discussion and Analysis) or 10-K SEC filings available online through Edgar or through a company's website. For each remaining independent variable, Compustat Industrial Annual data were used. The list of firms that met all the criteria for which all independent and dependent variables were available are discussed in Chapter 3.

4.3 Two-Stage Regression Analysis (TSRA)-Models of Exposure Risks

TSRA was the primary model used to test for combinations of exposures as describe in Chapter 3. The models are shown again below grouped to represent the four and three-factor forms and combinations of risk exposures.

For the four-factor model:

$$R_{i,t} = \beta_{1,i} + \beta_{2,i}FX_t + \beta_{3,i}IR_t + \beta_{4,i}CM_t + \beta_{5,i}R_{m,t} + \varepsilon_{i,t} : t = 1, \dots, T \quad (12)$$

Individually for exchange rate exposure:

$$\hat{\beta}_{2,i} = \gamma_{1,i} + \gamma_{2,i}(FS/TS)_i + \gamma_{3,i}(FDER/TA)_i + \xi_i : i = 1, \dots, N \quad (13)$$

Individually for interest rate exposure:

$$\hat{\beta}_{3,i} = \theta_{1,i} + \theta_{2,i}(LTD/TA)_i + \theta_{3,i}(DDER/TA)_i + \nu_i : i = 1, \dots, N \quad (14)$$

Individually for commodity exposure:

$$\hat{\beta}_{4,i} = \lambda_{1,i} + \lambda_{2,i}(TI/TS)_i + \lambda_{3,i}(CDER/TA)_i + \mu_i : i = 1, \dots, N \quad (15)$$

The equations for the three-factor two-stage regressions are:

For foreign currencies and interest rates:

$$R_{i,t} = \beta_{1,i} + \beta_{2,i}FX_t + \beta_{3,i}IR_t + \beta_{4,i}R_{m,t} + \varepsilon_{i,t} : t = 1, \dots, T \quad (12a)$$

$$\hat{\beta}_{2,i} = \gamma_{1,i} + \gamma_{2,i}(FS/TS)_i + \gamma_{3,i}(FDER/TA)_i + \xi_i : i = 1, \dots, N \quad (13)$$

$$\hat{\beta}_{3,i} = \theta_{1,i} + \theta_{2,i}(LTD/TA)_i + \theta_{3,i}(DDER/TA)_i + \nu_i : i = 1, \dots, N \quad (14)$$

For foreign currencies and commodities:

$$R_{i,t} = \beta_{1,i} + \beta_{2,i}FX_t + \beta_{4,i}CM_t + \beta_{5,i}R_{m,t} + \varepsilon_{i,t} : t = 1, \dots, T \quad (12b)$$

$$\hat{\beta}_{2,i} = \gamma_{1,i} + \gamma_{2,i}(FS/TS)_i + \gamma_{3,i}(FDER/TA)_i + \xi_i : i = 1, \dots, N \quad (13)$$

$$\hat{\beta}_{4,i} = \lambda_{1,i} + \lambda_{2,i}(TI/TS)_i + \lambda_{3,i}(CDER/TA)_i + \mu_i : i = 1, \dots, N \quad (15)$$

For interest rates and commodities:

$$R_{i,t} = \beta_{1,i} + \beta_{3,i}IR + \beta_{4,i}CM_t + \beta_{5,i}R_{m,t} + \varepsilon_{i,t} : t = 1, \dots, T \quad (12c)$$

$$\hat{\beta}_{3,i} = \theta_{1,i} + \theta_{2,i}(LTD/TA)_i + \theta_{3,i}(DDER/TA)_i + \nu_i : i = 1, \dots, N \quad (14)$$

$$\hat{\beta}_{4,i} = \lambda_{1,i} + \lambda_{2,i}(TI/TS)_i + \lambda_{3,i}(CDER/TA)_i + \mu_i : i = 1, \dots, N \quad (15)$$

The MLE procedure is used to estimate the time-varying covariance of future returns.

It is assumed that the variables for the returns $r_{i,t}$ and $r_{j,t}$ are drawn from bivariate normal distributions, and they are referred to as joint normally distributed random variables, if and only if their joint probability densities are given by:

For foreign currencies and interest rates:

$$f(\xi_i, \nu_i) = \frac{1}{2\pi\sigma_\xi\sigma_\nu\sqrt{1-\rho^2}} e^{-\frac{1}{2(1-\rho^2)}[\xi_i^2 + \nu_i^2 - 2\rho\xi_i\nu_i]}$$

For foreign currencies and commodities:

$$f(\xi_i, \mu_i) = \frac{1}{2\pi\sigma_\xi\sigma_\mu\sqrt{1-\rho^2}} e^{-\frac{1}{2(1-\rho^2)}[\xi_i^2 + \mu_i^2 - 2\rho\xi_i\mu_i]}$$

For interest rates and commodities:

$$f(v_i, \mu_i) = \frac{1}{2\pi\sigma_v\sigma_\mu\sqrt{1-\rho^2}} e^{-\frac{1}{2(1-\rho^2)}[v_i^2 + \mu_i^2 - 2\rho v_i\mu_i]}$$

where $\xi_i, v_i, \mu_i, \sigma_\xi, \sigma_v, \sigma_\mu, \rho$ are the means, standard deviations, and correlations of the studied combinations of the two random variables r_i, r_j . The procedure in maximum likelihood estimation is to select the distribution parameters that maximize the log-likelihood function.

Table VI presents two-stage regression results from daily data using OLS for the four-factor model, which includes the CRB index. The two-stage regression model for estimating currency exposures is specified by the following:

$$R_{i,t} = \beta_{1,i} + \beta_{2,i}FX_t + \beta_{3,i}IR_t + \beta_{4,i}CM_t + \beta_{5,i}R_{m,t} + \varepsilon_{i,t} : t = 1, \dots, T \quad (12)$$

$$\hat{Abs}(\beta_{2,i}) = \gamma_{1,i} + \gamma_{2,i}(FS/TS)_i + \gamma_{3,i}(FDER/TA)_i + \xi_i : i = 1, \dots, N \quad (13)$$

The coefficient estimates in (13) link a firm's currency exposure estimates using the absolute exposure estimates from equation (12) with its determinants. For currency exposure these determinants are foreign sales and foreign currency derivatives used. There is no significant relationship between the absolute value of exchange-rate exposure and the ratio of foreign sales to total sales during any of the four years

studied using daily data. In one year there is an unexplained significant and negative ratio. We also examine the relationship between the absolute value of currency exposure and currency derivative use. There is little support that the use of currency derivatives reduces currency exposure, except for 1996, when adjusted for heteroskedasticity. The data are heteroskedastic for 1995, and 1996. The signs of the association are consistent with the hypothesis. The model shows that both real operations and currency derivatives use are not determinants of exposure when daily data are used.

Table VI also examines the coefficient estimates for the absolute interest rate exposure with daily data using OLS. The two-stage regression model for estimating interest rate exposure is:

$$R_{i,t} = \beta_{1,t} + \beta_{2,t}FX_t + \beta_{3,t}IR_t + \beta_{4,t}CM_t + \beta_{5,t}R_{m,t} + \varepsilon_{i,t} : t = 1, \dots, T \quad (12)$$

$$Abs(\hat{\beta}_{3i}) = \theta_{1,i} + \theta_{2,i}(LTD/TA)_i + \theta_{3,i}(DDER/TA)_i + \nu_i : i = 1, \dots, N \quad (14)$$

The coefficients link the exposure estimates from equation (12) with its determinants, the ratio of long-term debt to total assets and dollar derivatives used in equation (14). There are no years when there is a positive significant relationship between absolute interest rate exposure and the real operations ratio, when adjusted for heteroskedasticity. We also examine the relationship between the absolute value of interest rate exposure and dollar derivatives use. There is little support for a firm's hedging motives for interest rate derivatives, except in 1998. For that year only, we find a negative and significant association between the absolute value of the exposure

value of the exposure and the percentage of dollar derivatives use. The signs of the regression are as expected. The empirical evidence from daily data suggests that interest rate derivatives use determines exposure for only one year, while real operations is not a determinant of interest rate exposure.

Finally, Table VI also examines the coefficient estimates for the absolute commodity exposure with daily data using OLS. The two-stage regression model for estimating the absolute commodity exposure is:

$$R_{i,t} = \beta_{1,i} + \beta_{2,i}FX_t + \beta_{3,i}IR_t + \beta_{4,i}CM_t + \beta_{5,i}R_{m,t} + \varepsilon_{i,t} : t = 1, \dots, T \quad (12)$$

$$\hat{Abs}(\beta_{4,i}) = \lambda_{1,i} + \lambda_{2,i}(TI/TS)_i + \lambda_{3,i}(CDER/TA)_i + \mu_i : i = 1, \dots, N \quad (15)$$

We examine the coefficients which link the absolute value of exposure estimates from equation (12) with its determinants in equation (15), the ratio of total inventory relative to total sales and commodity derivatives used, adjusted for size effects. There is some support that real operations determine currency exposure for there are significant positive relationships between the two variables for 1998 and 1995. When we examine the motivation for a firm's hedging with commodity derivatives, we find a significant but positive association between the absolute value of the exposure and the percentage of commodity derivatives used. The signs of the regressions are not as expected and because they are positive in value this suggests that the use of commodity derivatives increases exposure for the firms studied. Additionally, the monthly data for all regressions-currency, interest rate and commodity- suggest heteroskedasticity for most years.

After examining daily data, the study considered monthly data. Monthly data have been empirically shown to result in less biased beta estimates with respect to returns according to Scholes and Williams (1977), Dimson (1979), as corrected by Fowler and Rorke (1983), and Tufano (1996). Table VII presents OLS two-stage regression results using monthly variables with White's correction for heteroskedasticity (1980) for all firms. The first stage regressions were run with all of the three exposure indices, which is the four-factor model. The regressions were also run excluding the commodity index, the CRB, which is the three-factor model, to isolate the effects of using an index that is based on general price levels. For example, in the four-factor model, the first stage regression to measure currency hedging would be run with the three indices FX, IR, and CM. The second stage would then be run with $\hat{\beta}_{2,i}$ on the proxy for foreign real operations, FS/TS and the proxy for currency derivatives use FDER/TA. This is shown in Table VII as BFX with CRB, which represents the use of the CM index in the 1st Stage Regression. It was also necessary to run the exposure estimates $\hat{\beta}_{2,i}$, $\hat{\beta}_{3,i}$, and $\hat{\beta}_{4,i}$ with and without absolute values, as previously explained in Chapter 3 as the former is an important measure for derivatives use and the later is important for real operations.

In Table VII we examine the four-factor model from monthly data using OLS, with White adjustments (1980). The two-stage regression model for estimating currency exposures is:

Four-factor model (with CRB):

$$R_{i,t} = \beta_{1,i} + \beta_{2,i}FX_t + \beta_{3,i}IR_t + \beta_{4,i}CM_t + \beta_{5,i}R_{m,t} + \varepsilon_{i,t} : t = 1, \dots, T \quad (12)$$

$$\hat{\beta}_{2,i} = \gamma_{1,i} + \gamma_{2,i}(FS/TS)_i + \gamma_{3,i}(FDER/TA)_i + \xi_i : i = 1, \dots, N \quad (13)$$

The coefficient estimates in (13) link a firm's currency exposure estimates with its determinants from equation (12) to real operations, measured by the ratio of foreign sales to total sales, and derivatives used, the ratio of foreign currency derivatives used to total assets. There is only one year, 1997, where a significant relationship exists between the value of currency exposure and foreign sales. However, the sign is negative, which is not predicted. We also consider the relationship between the value of currency exposure and currency derivative use. There are no significant relationships during the four-year period to explain a firm's motivations for the use of currency derivatives. When we consider the absolute value estimates for equation (13), there are no significant relationships to real operations. We find some support for a firm's currency hedging motivations in one year, 1997. In that year we find a negative, statistically significant association between the absolute value of currency exposures and currency derivatives used. The sign of the association is consistent with predictions.

Table VII also examines two-stage regressions with the following three-factor model for currency exposures that excludes the effect of commodity price levels:

Three-factor model (without CRB):

$$R_{i,t} = \beta_{1,i} + \beta_{2,i}FX_t + \beta_{3,i}IR_t + \beta_{5,i}R_{m,t} + \varepsilon_{i,t} : t = 1, \dots, T \quad (12a)$$

$$\hat{\beta}_{2,i} = \gamma_{1,i} + \gamma_{2,i}(FS/TS)_i + \gamma_{3,i}(FDER/TA)_i + \xi_i : i = 1, \dots, N \quad (13)$$

There is no significant positive relationship between currency exposure and the real operations ratio of foreign sales to total sales. In one year, 1997, the relationship is significantly negative, which is not predicted. Further, there is no significant relationship to explain the use of currency derivatives and currency exposure during any of the four years studied. When the model uses the absolute value of currency exposure, there are again no significant positive relationship between currency exposure and the real operations ratio. There is one year, 1996, when the relationship is significantly negative, an unpredicted result. However, there is some support that currency derivatives use reduces absolute exposure with significant negative results for 1997 and 1995; the negative sign is as predicted.

In Table VII, we examine the OLS White consistent (1980) relationship between interest rate exposure and its determinants with monthly data, again using four and three-factor models. The two-stage regression models are:

Four-factor model (with CRB):

$$R_{i,t} = \beta_{1,t} + \beta_{2,t}FX_t + \beta_{3,t}IR_t + \beta_{4,t}CM_t + \beta_{5,t}R_{m,t} + \varepsilon_{i,t} : t = 1, \dots, T \quad (12)$$

$$\hat{\beta}_{3,i} = \theta_{1,i} + \theta_{2,i}(LTD/TA)_i + \theta_{3,i}(DDER/TA)_i + v_i : i = 1, \dots, N \quad (14)$$

Three-factor model (without CRB):

$$R_{i,t} = \beta_{1,t} + \beta_{2,t}FX_t + \beta_{3,t}IR_t + \beta_{5,t}R_{m,t} + \varepsilon_{i,t} : t = 1, \dots, T \quad (12a)$$

$$\hat{\beta}_{3,i} = \theta_{1,i} + \theta_{2,i}(LTD/TA)_i + \theta_{3,i}(DDER/TA)_i + v_i : i = 1, \dots, N \quad (14)$$

There is no significant relationship between real operations and interest rate exposure using either the four-factor and three-factor models, or when using absolute exposure coefficients. There is some support that interest rate derivatives use reduces absolute

interest rate exposure, in both the four and three-factor models, for one year, 1995.

The significant relationships have the predicted correct negative signs for both models in that year.

Table VII also shows the results of the OLS regressions (White consistent, (1980)), for commodity derivatives using four-factor models with monthly data as follows:

$$R_{i,t} = \beta_{1,i} + \beta_{2,i}FX_t + \beta_{3,i}IR_t + \beta_{4,i}CM_t + \beta_{5,i}R_{m,t} + \varepsilon_{i,t} : t = 1, \dots, T \quad (12)$$

$$\hat{\beta}_{4,i} = \lambda_{1,i} + \lambda_{2,i}(TI/TS)_i + \lambda_{3,i}(CDER/TA)_i + \mu_i : i = 1, \dots, N \quad (15)$$

There is no need to consider the three-factor case because we are examining commodity exposure and need to include this variable. There is some evidence of significant positive association with commodity exposure and the real operations ratio of total inventory to total sales for 1997 and 1995. And there is also significant positive association for absolute exposure for one year, 1995. However, there is no significant relationship between commodity exposures and derivatives use for all firms. This result, no significant relationship, is also observed for absolute commodity exposure and derivatives use.

Tables VIII, IX, and X consider only derivatives user firms and exposure determinants to study the user group separately. In Table VIII, the two-stage regression models for currency exposures is the combination of pairs of derivatives users according to the following equations:

Three-factor model for FX and CM derivatives users:

$$R_{i,t} = \beta_{1,i} + \beta_{2,i}FX_t + \beta_{4,i}CM_t + \beta_{5,i}R_{m,t} + \varepsilon_{i,t} : t = 1, \dots, T \quad (12)$$

$$\hat{\beta}_{2,i} = \gamma_{1,i} + \gamma_{2,i}(FS/TS)_i + \gamma_{3,i}(FDER/TA)_i + \xi_i : i = 1, \dots, N \quad (13)$$

Three-factor model for IR and FX derivatives users:

$$R_{i,t} = \beta_{1,i} + \beta_{2,i}FX_t + \beta_{3,i}IR_t + \beta_{5,i}R_{m,t} + \varepsilon_{i,t} : t = 1, \dots, T \quad (12a)$$

$$\hat{\beta}_{2,i} = \gamma_{1,i} + \gamma_{2,i}(FS/TS)_i + \gamma_{3,i}(FDER/TA)_i + \xi_i : i = 1, \dots, N \quad (13)$$

For equations (12) and (13), the coefficient estimates link a firm's currency exposures with its determinants for those firms that use currency and commodity derivatives. For equations (12a) and (13), the coefficient estimates link currency exposures with its determinants for those firms that use currency and interest rate derivatives. In the currency and commodity user group, only one year shows a significant and positive relationship between the absolute value of currency exposure and the ratio of foreign sales to total sales, which is chosen to proxy for the need to use derivatives. However, for real operations determinants we make no predictions about absolute value relationships, but are only able to examine predictions regarding positive relationships between the value of currency exposures and real operations ratios. There is an unexpected negative relationship between currency exposure and the real operations ratio for 1997.³⁹ We also examine the relationship between the absolute value of currency exposure and derivatives use and do not find any

³⁹ This result is different from previous studies that considered foreign sales only. Jorion (1990), Allayannis and Ofek, (2001), and Carter, Pantzalis and Simkins (2001) use a different regression methodology that surrounds the hedging data for monthly returns data while examining only large firms. This compares with the current study that uses monthly returns preceding the derivatives hedging period.

significant negative relationship for the four years. We can only make predictions regarding absolute exposures and derivatives use since we are examining gross long and short derivatives positions.

For currency exposure estimates, we also examine those firms that use currency and interest rate derivatives in Table VIII. Using equations (12a) and (13), the coefficient estimates link currency exposures with its determinants for those users. For the real operations ratio, the only significant sign is negative in 1997, which is not predicted. While the years 1998 and 1997 show significant positive association for real operations, this is only for absolute exposures, for which we do not make a prediction. As for derivatives use, there is no significant negative relationship that determines absolute currency exposure for the four years of the study.

We also examine derivatives use and interest rate exposure in Table VIII, using monthly data. The regression models for estimating interest rate exposures, using White consistent standard errors (1980), are:

Three-factor model for IR and CM derivatives users:

$$R_{i,t} = \beta_{1,i} + \beta_{2,i}IR_t + \beta_{4,i}CM_t + \beta_{5,i}R_{m,t} + \varepsilon_{i,t} : t = 1, \dots, T \quad (12c)$$

$$\hat{\beta}_{3,i} = \theta_{1,i} + \theta_{2,i}(LTD/TA)_i + \theta_{3,i}(DDER/TA)_i + v_i : i = 1, \dots, N \quad (14)$$

Three-factor model for IR and FX derivatives users:

$$R_{i,t} = \beta_{1,i} + \beta_{2,i}FX_t + \beta_{3,i}IR_t + \beta_{5,i}R_{m,t} + \varepsilon_{i,t} : t = 1, \dots, T \quad (12a)$$

$$\hat{\beta}_{3,i} = \theta_{1,i} + \theta_{2,i}(LTD/TA)_i + \theta_{3,i}(DDER/TA)_i + v_i : i = 1, \dots, N \quad (14)$$

The three-factor model using Equations (12a) and (14) link a firm's interest rate exposures with its determinants for those firms that use interest rate and commodity derivatives. Equations (12c) and (14) link interest rate exposures with its determinants for those firms that use interest rate and currency derivatives. When we examine interest rate and commodity users, there is no support that the proxy for real operations, the ratio of long-term debt to total assets, determines interest rate exposure.⁴⁰ For derivatives use, we find some support that interest rate derivatives use reduces absolute exposure in one year, 1998. For those firms that use interest rate and currency derivatives, there is no significant positive relationship between the real operations ratio and interest rate exposure using equations (12c) and (14).⁴¹ Moreover, we do not find support that derivatives use reduces absolute interest rate exposure.

The last panel of Table VIII examines the relationship between commodity derivatives use and exposure determinants using the following three-factor two-stage OLS regression models:

Three-factor model for IR and CM users:

$$R_{i,t} = \beta_{1,i} + \beta_{3,i}IR_t + \beta_{4,i}CM_t + \beta_{5,i}R_{m,t} + \varepsilon_{i,t} : t = 1, \dots, T \quad (12c)$$

$$\hat{\beta}_{4,i} = \lambda_{1,i} + \lambda_{2,i}(TI/TS)_i + \lambda_{3,i}(CDER/TA)_i + \mu_i : i = 1, \dots, N \quad (15)$$

⁴⁰ We do find some support that the debt ratio determines the absolute value of interest rate exposure for 1995, but our model does not consider the absolute value of exposures and real operations.

⁴¹ Again, we do find a positive relationship between real operations and the absolute value of exposure for 1995 for interest rate and currency derivatives users, but we are not making predictions regarding absolute exposure.

Three-factor model for FX and CM users:

$$R_{i,t} = \beta_{1,i} + \beta_{2,i}FX_t + \beta_{4,i}CM_t + \varepsilon_{i,t} : t = 1, \dots, T \quad (12b)$$

$$\hat{\beta}_{4,i} = \lambda_{1,i} + \lambda_{2,i}(TI/TS)_i + \lambda_{3,i}(CDER/TA)_i + \mu_i : i = 1, \dots, N \quad (15)$$

Equations (12c) and (15) consider interest rate and commodity derivatives users, while equations (12b) and (15) study currency and commodity users. Our focus is on commodity exposure and its determinants. First, we study interest rate and commodity derivatives users using equations (12c) and (15), and find mixed outcomes for the relationship between commodity exposures and the real operations ratio of total inventory to total sales: Commodity exposure is significant and positively related to the inventory ratio for one year, 1998, as predicted. However, there are two years when the exposures are negatively related to real operations (1996 and 1995), an unexpected result. Further the absolute values of commodity exposures show a significant positive relationship with real operations for 1995; while the sign is as expected, we generally are not able to make a prediction regarding absolute exposures and commodity real operations. Next, we examine derivatives use to determine if it reduces absolute commodity exposure. There is no evidence that commodity derivatives use reduces the absolute level of commodity exposure. There is support, however, that commodity derivatives use increases absolute exposure for 1995, which occurs for both combinations of user groups studied. This suggests that commodity derivatives users may not always be hedging. We also note that there are significant

and positive associations between commodity exposure and derivatives use, although we are not making predictions about these associations, as already noted.

Table VIII also examines derivatives users using equations (12b) and (15) to further understand the determinants of commodity exposures. Again, commodity exposure is significantly related to the inventory ratio for one year, 1998, as predicted. However, again there is one year when the ratio is unexpectedly negative. With respect to derivatives use and absolute commodity exposure, there is no significant predicted negative relationship. There is support that commodity derivatives use increases absolute exposure for two years, 1997 and 1995. Again this lends support to the evidence that derivatives use maybe increasing risk for firms in some years.

The study considers estimation models that have not been previously used in other studies. In Table IX, we consider derivatives users and exposure determinants using MLE with univariate distributions, based on monthly data for the first stage regressions. MLE tests should produce results similar to OLS regressions. We show the similar lack of association between exposures and determinants as in OLS regressions, although the MLE tests do not correct for heteroskedasticity. The significant results that are predicted are discussed below. For currency and interest rate derivatives users, there is no significant positive relationship between currency exposure and the real operations ratio of foreign sales to total sales for any of the years in the study. For the real operations ratio of long-term debt to total assets, there is also no significant positive association, except for 1997. Moreover, derivatives use does

not significantly reduce absolute currency exposure, except in 1998. For interest rate and commodity derivatives users, there is little support that interest rate or commodity exposure is related to real operations ratios. In only one year (1998) is commodity exposure related to the real operations ratio of total inventory to total sales. There are no years that show a significant commodity exposure relationship to the real operations ratio of long-term debt to total assets. Further, commodity derivatives use increases absolute commodity exposure for 1995. For currency and commodity derivatives users, there are no significantly positive associations between their exposures and real operations ratios (for foreign sales to total sales and for total inventory to total sales) for any of the years studied. Commodity and currency derivatives use reduces absolute exposure for only one year, 1998, during the study period. In fact commodity and currency derivatives use significantly increases absolute commodity exposure in 1995.

To integrate the use of derivatives in an overall approach that reflects enterprise risk, this study considers the simultaneous use of combinations of exposures using MLE with bivariate distributions as discussed in Chapter 3. This has not been examined in any study regarding exposures and derivatives use. Once again only user firms are examined since user and nonuser firms may have different exposure characteristics. The benefit of this methodology is that we are able to capture the relationship of combinations of derivatives hedging and real operations to determine the importance of hedging to a firm. Further, using the bivariate MLE procedure

provides insight into the interaction of the combinations jointly with simultaneous equations. In particular, we are interested in determining whether bivariate combinations of exposures interact in such a way that makes the use of OLS and MLE regressions with univariate distributions inappropriate econometric methods. For example, we are interested in the interaction of the dependent variables for interest rate exposure and currency exposure, $\hat{\beta}_{2,i}$ and $\hat{\beta}_{3,i}$ and their standard errors for equations (13) and (14). Let the standard error of (13) and (14) be defined as D_0 and E_0 respectively and F_0 as the covariance of the residual of the bivariate regression. In our bivariate MLE regressions, we will reject the use of OLS type econometric tests if the correlation of the bivariate residuals is significant. We determine this based on the relationship between the covariance of the residual and the correlation, where ρ , is the correlation defined as $\frac{\text{cov}}{\sqrt{\text{var}}\sqrt{\text{var}}}$, or $\frac{F_0}{\sqrt{D_0}\sqrt{E_0}}$. If the covariance is significant, then the correlation will also be significant and bivariate MLE is more appropriate.

The bivariate regressions are:

Three-factor model for currency and interest rate exposures:

$$R_{i,t} = \beta_{1,i} + \beta_{2,i}FX_t + \beta_{3,i}IR_t + \beta_{5,i}R_{m,t} + \varepsilon_{i,t} : t = 1, \dots, T \quad (12a)$$

$$\hat{\beta}_{2,i} = \gamma_{1,i} + \gamma_{2,i}(FS/TS)_i + \gamma_{3,i}(FDER/TA)_i + \xi_i : i = 1, \dots, N \quad (13) \text{ and}$$

$$\hat{\beta}_{3,i} = \theta_{1,i} + \theta_{2,i}(LTD/TA)_i + \theta_{3,i}(DDER/TA)_i + \xi_i : i = 1, \dots, N \quad (14)$$

Three-factor model for currency and commodity exposure:

$$R_{i,t} = \beta_{1,i} + \beta_{2,i}FX_t + \beta_{4,i}CM_t + \beta_{5,i}R_{m,t} + \varepsilon_{i,t} : t = 1, \dots, T \quad (12b)$$

$$\hat{\beta}_{2,i} = \gamma_{1,i} + \gamma_{2,i}(FS/TS)_i + \gamma_{3,i}(FDER/TA)_i + \xi_{i,t} : i = 1, \dots, N \quad (13) \text{ and}$$

$$\hat{\beta}_{4,i} = \lambda_{1,i} + \lambda_{2,i}(TI/TS)_i + \lambda_{3,i}(CDER/TA)_i + \mu_{i,t} : i = 1, \dots, N \quad (14)$$

Three-factor model for interest rate and commodity exposures:

$$R_{i,t} = \beta_{1,i} + \beta_{3,i}IR_t + \beta_{4,i}CM_t + \beta_{5,i}R_{m,t} + \varepsilon_{i,t} : t = 1, \dots, T \quad (12c)$$

$$\hat{\beta}_{3,i} = \theta_{1,i} + \theta_{2,i}(LTD/TA)_i + \theta_{3,i}(DDER/TA)_i + \nu_i : i = 1, \dots, N \quad (14) \text{ and}$$

$$\hat{\beta}_{4,i} = \lambda_{1,i} + \lambda_{2,i}(TI/TS)_i + \lambda_{3,i}(CDER/TA)_i + \mu_i : i = 1, \dots, N \quad (15)$$

Table X shows that several of the bivariate covariances are significant. This occurs for the absolute exposures for interest rate and currencies in 1997, the absolute exposures for currencies and commodities in 1997 and 1996, and the absolute exposures for interest rates and commodities in 1996. This means that using OLS is not always appropriate as an econometric method in the analysis of the bivariate combinations of firms exposures and derivatives use. This also suggests that considering an OLS framework for single exposures may also be inappropriate in some cases due to the omission of the other exposure variables.

To isolate the effects of individual components for all categories and to replicate other studies on foreign currency, univariate exposure regressions also were considered. The univariate regressions in the two-stage process are:

For foreign currencies:

$$R_{i,t} = \beta_{1,i} + \beta_{2,i}FX_t + \beta_{3,i}R_{m,t} + \varepsilon_{i,t} : t = 1, \dots, T \quad (11)$$

$$\beta_{2,i} = \gamma_{1,i} + \gamma_{2,i}(FS/TS)_i + \gamma_{3,i}(FDER/TA)_i + \xi_i : i = 1, \dots, N$$

$$\hat{\beta}_{2,i} = \gamma_{1,i} + \gamma_{2,i}(FS/TS)_i + \gamma_{3,i}(FDER/TA)_i + \xi_i : i = 1, \dots, N \quad (13)$$

For interest rates:

$$R_{i,t} = \beta_{1,i} + \beta_{2,i}IR_t + \beta_{3,i}R_{m,t} + \varepsilon_{i,t} : t = 1, \dots, T \quad (16)$$

$$\hat{\beta}_{2,i} = \theta_{1,i} + \theta_{2,i}(LTD/TA)_i + \theta_{3,i}(DDER/TA)_i + \nu_i : i = 1, \dots, N \quad (14)$$

For commodities

$$R_{i,t} = \beta_{1,i} + \beta_{2,i}CM_t + \beta_{3,i}R_{m,t} + \varepsilon_{i,t} : t = 1, \dots, T \quad (17)$$

$$\hat{\beta}_{2,i} = \lambda_{1,i} + \lambda_{2,i}(TI/TS)_i + \lambda_{3,i}(CDER/TA)_i + \mu_i : i = 1, \dots, N \quad (15)$$

Table XI presents results for second stage regressions for user firms only with monthly data and using univariate OLS equations and a two-factor model, with White (1980) corrections, to specify each exposure. Derivatives use reduces absolute exposure in only one year and for only one type of exposure: interest rates in 1995. Interest rate derivatives use reduces absolute exposure for 1995 only. Commodity derivatives use increases absolute exposure in 1996, suggesting that user firms are speculating during that time period. Unlike prior studies, currency derivatives use doesn't significantly reduce the absolute value of this exposure in most years in this study. Currency derivatives use only reduces the actual value of currency exposure in 1995, interest rate derivatives use reduces actual exposure in 1996 and commodity derivatives use reduces the actual value of commodity exposure, but actual values are

not a prediction for this study. Only absolute values of exposures are important to derivatives use in the current model since we are examining gross long and short derivatives positions. In light of the fact that most univariate OLS results are insignificant, this suggests that derivatives use is not important to the individual economic exposures of the firms studied.

Also examined in Table XI are real operating factors and exposures using univariate OLS regressions with a two-factor model corrected for heteroskedasticity. For currency exposure, the foreign sales ratio is negatively associated with currency exposures with significance in 1997; this negative relationship is not predicted as an outcome. For interest rate exposure, the long-term debt to total assets ratio is significantly positive in 1998 and 1997, as predicted. For commodity exposure, the ratio of total inventory to total sales is significant and positive for 1998, as expected, but negative and significant for 1995 and 1996, a relationship not expected. The implication is that real operational factors are also not usually important to a firm's exposures and returns, except in some years for interest rate exposures. In sum, this study does not establish significant relationships between real operations and a firm's categories of exposures except in certain cases for interest rates, nor does it establish a significant relationship between financial hedging and those categories of exposures.

Since derivatives use for the firms in the study does not reduce each exposure for most years, the study separates user and nonuser firms to see if exposure levels are different. Table XII shows equality of means between users and nonusers, using two

tailed t-tests. If exposures are different, this suggests that other risk management factors not tested maybe responsible for reducing exposure levels. Using the betas from OLS bivariate regressions, user means for foreign currency regressions are significantly different than nonuser means for all years in the study. This suggests that factors other than derivatives use make currency exposure significantly different from the nonuser group. The means for interest rate derivatives as well as commodities derivatives users are also significantly different than the nonuser group in some years. In particular, users means are significantly different than nonusers for all three types of derivatives categories in 1998, 1996 and 1995. This suggests that factors other than derivatives use are important to currency, interest rate and commodity exposures.

4.4 Robustness Tests

The results from bivariate and univariate regression results using different data sets, daily and monthly returns, are a good measure of robustness. Further, the analysis and consideration of different firm categories (all, user and nonusers groups) also contributes to the analyses of robustness. After reviewing these tests, the lack of significant exposure results suggest that the level of derivatives used by the firms studied is not significant to exposures. Moreover, there are years when derivatives use increases risk exposure, which is not a neutral hedging outcome. None of the real operations variables is significantly related to exposures, contrary to past studies. This is especially significant for foreign currency hedging. This may reflect the composition of foreign currency derivatives used in other studies.⁴⁰

⁴⁰For example, Allayannis and Ofek (2001) define currency derivatives as forward contracts and options but currency swaps are not considered.

CHAPTER FIVE

5.1 Conclusions, Limitations, and Future Research Issues

This chapter presents discussion of the conclusions to be drawn from the research findings presented in Chapter 4. Potential limitations of the methods and design employed in the study are discussed in the context of the study. This chapter is organized into sections, which relate to the models specified and tests performed in the study. Each section includes a brief summary of the related findings. The discussion of conclusions and limitations is followed with suggestions for future research to extend the pursuit of this type of scholarly work. The chapter ends with a discussion of the implications for corporate policy and derivatives hedging.

5.2 The Models For Exposures

Although multifactor market models have been used in past studies of derivatives hedging, this is the first use of a simultaneous approach using different econometric models to measure risk management in a broad context. The use of OLS tests and MLE univariate and bivariate regressions provides an econometric testing

methodology that has not been used. These tests are appropriate because they allow us to study the interaction of exposures with derivatives use and real operations. Some of the variables have appeared in the literature individually, but not in the context of an overall framework. Although the initial specifications of the model were based upon daily returns, the majority of the model tests were conducted using monthly data, which provided more firm specific data points than higher frequency data. Further, monthly returns data were less volatile for smaller firms, which are sometimes infrequently traded, and provided a better match to the use of annual derivatives data.

The set of variables selected for the models was consistent with evidence developed in past studies for individual risk exposures, with appropriate changes made to make reflect a firm's total exposures. The new specifications also incorporated substitutes for derivatives hedging, by the inclusion of a firm's real operations, extending the works of Allayannis and Ofek (2001) and Jorion (1990).

5.3 Multivariable Two-Stage Regression Analysis

5.3.1 The Full Model

This study was initiated to consider the proposition that both the usage of derivatives and the real operations are related to a firm's risk exposures. Examples of ways in which derivatives transactions affect the risk profile of a firm were provided. Also provided were examples of non-derivatives transactions and an understanding of the changing nature of risk management for a firm today. It was argued that a firm that is not speculating sees a reduction in its relevant risk exposures from derivatives use. And a firm will be more likely to hedge if it has the identified real operating characteristics. The measure of notional principle amounts in this study serves as a proxy for the quantitative value of a firm's derivatives positions since net hedging positions or derivatives gains and losses are not available. Multifactor two-stage regressions tests of derivatives hedging did not confirm the hypothesized relationships with economic exposures. Also not explained in the regression tests were the associations between a firm's real operations and risk exposures. These results were surprising given that recent research for foreign currency hedging had shown the expected relationships for derivatives use, risk exposures and real operations as in Allayannis and Ofek (2001).

A variety of potential explanations can be advanced, or conclusions drawn, based on the insignificance of the multifactor two-stage regression models. The most obvious reason for the insignificance is that no relationship exists between a firm's exposure risks and the level of derivatives use and its real operations. This seems surprising given the size of the derivatives market and the prevalence of risk management use among corporation today. Another explanation is that the level of derivatives usage is just not large enough to be economically significant to a firm. This seems more likely in light of other research as well by Brown (2001), Bodnar et al (1995, 1996, 1998) and Guay and Kothari (2001). Several additional explanations for the insignificance include the following:

1. Other non-derivative factors not measured in real operations are more important to a firm's management of risk exposures. Factors such as global diversification, internal contracting, production management and product pricing have been shown in some research studies to be important motivations for derivatives use as in Brown (2001), and Carter, Pantzalis, and Simpkins (2001). Production management is also one motivation that is related to global diversification as a possible substitute for derivatives use that has not been extensively studied, probably due to the lack of standardized available public information on production.

2. Large, high-quality non-financial firms that are well diversified in terms of geographical locations and investor base, do not have a large economic justification for most derivatives hedging, as the market frictions for these firms are not sufficient to justify the transaction and operational costs. These firms have the diversity of international production, the diversity of a large investor base and the access to capital markets for the best possible financing alternatives to manage overall risk. The major reasons for hedging for these types of firms would be to facilitate internal contracting or to maintain a competitive advantage in product sales.
3. The firms in the study may have risk exposures, which are more homogeneous than those found in the general population, so that differences in risk exposures are difficult to detect statistically. This is not supported in currency exposures where there are statistically significant differences between user and non-user firms. It is surprising that given this mean difference for currency exposures in each of the years that derivatives use is not important to a firm's return. This suggests that either other forms of risk management are more important or that a user firm's currency exposures are inherently different for other reasons not identified.

4. The factors that determine risk exposures may be non-linear in addition to linear. Recently, literature has begun to investigate currency exposure to determine if the currency puzzle question can be explained by nonlinear functions, as in Bartram (2002). This suggests that is important to consider the nonlinear components and derivatives users in the three categories of exposure in future research.

Using three and four-factor models and alternative econometric tests, the study constructs a straightforward, but important overall approach to measuring the importance of derivatives use through exposure levels for four selected industries over time. Except for one year for interest rate exposure, there is little evidence that derivatives use reduces risk exposures for the firms studied. There is some evidence that user firms are speculating in the use of commodity derivatives. These results are also obtained using univariate models. Moreover, for some years, a bivariate MLE econometric test is more appropriate because of the interrelationship between exposures, which has not been considered in previous studies.

Further, this is no evidence from this study's regression results to suggest a positive association between any of the variables for real operations and related exposures. These results are robust to bivariate and univariate tests and are consistent over time. There is evidence that derivative user firm exposure coefficients for foreign currency are different than nonusers, suggesting that other forms of risk

management or other macroeconomic factors are significantly more important than derivatives. The implications of this study are that hedging with the level of derivatives used is not important to a firm's rate of return, as suggested in other studies (Bodnar, Hayt, and Marston (1998), Brown (2001), and Guay and Kothari (2001)).

5.4 Future Research Issues

The measurement of all of a firm's risk exposures to financial and real operations represents an expanded approach to the analysis of the importance of derivatives use for public non-financial firms. Its use is dependent upon the quality of disclosure, which reflects the forms of disclosure used by firms during the period under study. This has also been the case in all similar studies and the outcomes have been mixed in terms of finding a consistent relationship regarding exposures in the extant literature. As the exposure puzzle for currency, interest rate and commodity prices fails to explain the relationship to derivatives hedging, we are left to further investigate the following questions with research. First, if a firm hedges a minor portion of exposures that effectively are of little significance to returns, would larger exposures be more effective? A potentially promising approach would include examining the additional disclosure elements of those firms in the study with very

detailed information to determine through simulations what the potential impacts would be from a wide range of hedging possibilities. This would involve the range of the use of no derivatives to high levels of derivatives to test the sensitivity of a firm's cash flows, and impact on profitability. The findings of our study suggest that current hedging practices are not affecting a firm's returns.

A second consideration is the question of whether or not firms are speculating in the use of commodity derivatives. In general, the results of this study suggest that firms overall are hedging commodities with amounts that are usually not significant to returns, which would generally not suggest speculation. Further research however should consider why derivatives commodities and exposures are sometimes significantly positive with tests for specific commodities items.

Research may also further consider whether or not market imperfections are sufficient to encourage significant derivatives use by non-financial firms. This question can be framed in terms of whether firms believe that they should be using derivatives for true economic benefit unique to each individual firm, or to satisfy the general beliefs of stock analysts that hedging is essential for all Fortune 500 firms. The results of this current study would suggest that hedging is generally not value additive in terms of returns, which is contrary to those analysts' beliefs.

Lastly, are other non-derivative factors not directly considered in this study, substitutes to a firm's global risk management and important to risk exposures? These factors might include, but not be limited to, global diversification, production

management, internal conflicts, and product pricing with market position. Further, these factors should be examined in a model that considers linear and nonlinear exposures.

New constructs using behavioral models may further add to the understanding of the nature of hedging for non-financial firms. The behavioral constructs may help to explain the lack of significance in returns from derivatives hedging and better address the issue of these firms' exposure puzzles. However, it may turn out that, after further investigation very little of a firm's value is attributable to changes in interest rate, or currency, or commodity risk. If this is the case, then the firm should devote an appropriately small portion of managerial resources to managing its risk exposures.⁴¹ This is a consideration that a firm needs to periodically review as an element of its strategic plan. This review should consider not only the actual investigation of exposures, but also consider simulations of different hedging strategies with economic, accounting and tax implications of the effects on firm value. Such an investigation is attainable in today's financial environment that provides real-time access to financial markets with information regarding those markets and state-of-the-art risk management software packages and models.

⁴¹ This is the policy implication suggested by Levi (1994) for the management of foreign currency rates and by extension is also appropriate as a general policy guideline for all derivatives hedging and risk management.

Table I
Derivatives Industry

NUMBER OF OPTIONS CONTRACTS TRADED ON U.S. EXCHANGES, 1995-1998
(Millions)

<u>Year</u>	<u>Equity</u>	<u>Stock Index</u>	<u>Foreign Currency</u>	<u>Interest Rate</u>
1995	174.4	107.9	5	0.1
1996	198.6	92.4	3.2	0.1
1997	269.6	78.2	2.6	0.1
1998	325.8	74.8	1.8	0.1

Sources: Options Clearing Corporation; Futures Industry Association; Securities Industry Association.

NUMBER OF FUTURES CONTRACTS TRADED ON U.S EXCHANGES, 1995-1998
(Millions)

<u>Year</u>	<u>Interest Rate</u>	<u>Agricultural Commodities</u>	<u>Energy Products</u>	<u>Foreign Currency</u>	<u>Other</u>	<u>Total</u>
1995	223.6	63.5	47.2	23.2	0.5	395.3
1996	212.5	74.9	47.2	22.6	0.8	397.4
1997	244.6	74.9	52.9	26.6	1.1	443.7
1998	279.2	73.3	63.8	27	1.2	503.2

Source: Futures Industry Association; Securities Industry Association

GLOBAL DERIVATIVES MARKET, 1995-1998 (1)
(\$ Billions, end of year)

<u>Year</u>	<u>Exchange- Traded</u>	<u>Over-the- Counter (OTC)</u>	<u>Total</u>
1995	9,283	17,713	26,996
1996	10,018	25,453	35,471
1997	12,403	29,035	41,438
1998	13,932	80,318	94,250

(1) Notional principal value outstanding

Source: Bank for International Settlements

Table II
World Gold Supply / Demand Balance
(In Metric Tonnes)

	<u>1995</u>	<u>1996</u>	<u>1997</u>	<u>1998</u>
SUPPLY				
Mine Production	2,269	2,346	2,464	2,545
Old Gold Scrap	625	644	611	1,093
Total World Supply	2,894	2,990	3,075	3,638
DEMAND				
Fabrication				
Jewelry	2,767	2,807	3,328	3,156
Electronics	205	207	237	240
Other	210	213	226	220
Total Fabrication	3,182	3,227	3,791	3,616
 Mine & Scrap Supply / Fabrication Demand "Gap"	 -288	 -237	 -716	 22
INVESTMENT DEMAND				
Official Coins	84	63	99	124
Bar Hoarding	306	182	337	112
Implied Investment	33	-163	-260	292
Total Investment Demand	423	82	176	528
 TOTAL DEMAND	 3,605	 3,309	 3,967	 4,144
 TOTAL BALANCE "GAP"	 -711	 -319	 -892	 -506
 CREATING THE TOTAL "GAP"				
Net Official Sector Sales	182	239	406	398
Net Forward Sales	466	-14	329	60
Gold Loans/Option Hedging	64	94	157	48

Sources: Gold Fields Mineral Services and Lehman Brothers estimates

Table III – Panel A Hedging Category Descriptions

Commodity -

- Futures are traded on exchanges and used to hedge commodities.
- Options are OTC and exchange-traded options and may include compound options, Asian options, collars (some are no-cost where the premium received on the option sold offsets the cost of the option bought), straddles, floors, and ceilings. Options are recorded at the notional value where available, or the quantity of product hedged multiplied by either the average option price hedged, or if not available, at the futures or spot price at the fiscal year-end.
- Forward Sales include forward sales and forward purchase contracts, fixed price agreements with firm or indexed prices, and spot deferred sales.
- Swaps are private agreements to exchange payments based upon a commodity index or other index to hedge commodity positions.

Foreign Currency –

- FX Forwards are currency forwards bought and sold and may include foreign currency forwards used to hedge metals production that has currency risk.
- FX Swaps are cross-currency and non-dollar denominated swaps that may be fixed vs. variable.
- FX Options are exchange-traded options to buy or sell foreign currency.
- FX Futures are exchange-traded futures contracts on foreign currencies.

Interest Rate -

- \$ Swaps are dollar denominated interest rate swaps including forward dated and FRA agreements, caps, collars and floors, and swap options. These swaps are mainly used to change the interest rate sensitivity on debt, or in a few instances, on a firm's investment portfolio.

Other –

- Foreign Debt is the long-term non-dollar denominated debt, including any current portion.
- Energy Hedging is the use of swaps, options, caps, collars, or floors to hedge energy production requirements.
- Loans are gold, silver, and other commodity loans outstanding used in a hedging program by a producer at fiscal year-end and generally for metals hedging.
- Options on Interest Rate Instruments such as Treasury Bonds are used to hedge the investment portfolio.
- Equity Collars and Puts are used to hedge a firm's investment portfolio.

Table III – Panel B
Expected Coefficients of Variables

Exposures And The Use Of Derivatives:

	<u>Expected Sign Dependent Variable</u>	
	<u>β</u>	<u>Abs (β)</u>
<u>Independent Variables:</u>		
Foreign Currencies –		
Foreign Sales / Total Sales (FS/TS)	+	None
FX Derivatives/ Total Assets (FDER/TA)	None	-
Interest Rates –		
Long-Term Debt / Total Assets (LTD/TA)	+	None
IR Derivatives / Total Assets (DDER/TA)	None	-
Commodities –		
Total Inventories / Total Sales (TI/TS)	+	None
CM Derivatives / Total Assets (CDER/TA)	None	-

Table IV
Test of Equality of Means for Betas for Users and Nonusers
1998-1995

	1998		1997		1996		1995	
	MEAN	PROB	MEAN	PROB	MEAN	PROB	MEAN	PROB
FX, IR:								
BFX, NONUSERS	-0.1155	0.7966	0.0431	0.8387	0.0414	0.9690	-0.0837	0.9523
BFX, USERS	-0.0560		0.0786		0.0483		-0.0726	
ABS(BFX, NONUSERS)	1.2225	0.0154**	0.8732	0.0368**	0.9084	0.0479**	0.9366	0.0029***
ABS(BFX, USERS)	0.8489		0.6168		0.6652		0.5507	
BLIBOR, NONUSERS	-0.3537	0.1894	-0.2768	0.6279	-0.0099	0.1291	-0.0019	0.7497
BLIBOR, USERS	-0.6406		-0.3532		-0.0993		-0.0233	
ABS(BLIBOR, NONUSERS)	0.9997	0.7687	0.8170	0.1934	0.2928	0.0922*	0.3557	0.0000***
ABS(BLIBOR, USERS)	0.9495		0.6721		0.2224		0.1693	
Number Nonusers	84		95		93		95	
Number Users	71		67		68		58	

FX, CM:								
BCRB, NONUSERS	0.1516	0.8061	-0.1468	0.4459	0.1965	0.004***	0.5002	0.0858*
BCRB, USERS	0.1138		-0.2540		-0.3290		0.0727	
ABS(BCRB, NONUSERS)	0.8325	0.0406**	0.7048	0.3967	0.8629	0.0773*	1.2431	0.0134*
ABS(BCRB, USERS)	0.6285		0.6244		0.6207		0.8047	
BFX, NONUSERS	0.2835	0.0018**	0.1363	0.1948	0.0943	0.3345	-0.1905	0.4747
BFX, USERS	-0.4156		-0.0908		-0.0792		-0.0511	
ABS(BFX, NONUSERS)	1.1302	0.1850	0.8558	0.0712*	0.8752	0.0529*	0.8906	0.0268**
ABS(BFX, USERS)	0.9255		0.6309		0.6253		0.5700	
Number Nonusers	80		96		95		99	
Number Users	75		66		66		55	

IR, CM:								
BCRB, NONUSERS	0.1062	0.7370	-0.2015	0.8566	0.0301	0.5174	0.4270	0.3864
BCRB, USERS	0.1579		-0.1763		-0.0895		0.2088	
ABS(BCRB, NONUSERS)	0.8339	0.0297**	0.6910	0.6462	0.8882	0.0263**	1.1787	0.1788
ABS(BCRB, USERS)	0.6180		0.6478		0.5843		0.9372	
BLIBOR, NONUSERS	-0.1559	0.0004**	-0.2173	0.0897*	-0.0291	0.4622	0.0244	0.7136
BLIBOR, USERS	-0.9010		-0.4835		-0.0830		-0.0157	
ABS(BLIBOR, NONUSERS)	0.6589	0.0004**	0.7519	0.8139	0.3562	0.0959*	0.4537	0.0766*
ABS(BLIBOR, USERS)	1.2633		0.7785		0.2689		0.3031	
Number Nonusers	80		91		95		99	
Number Users	75		71		66		54	

*, **, *** denote significance in mean value between user and nonuser groups at the 10%, 5%, and 1% levels, respectively, based on two-tailed tests.

This table contains the mean values of exposures and absolute exposures for users and nonusers of derivatives. The two variable combinations of derivative users are shown as currency and interest rates (FX, IR), currencies and commodities (FX, CM), and interest rates and commodities (IR, CM). BFX and ABS(BFX) are currency exposure coefficients obtained with the three-factor model using the FRB nominal major currency index, the equally-weighted CRSP market index, and either the FRB 3-month LIBOR rate or the CRB commodity index, depending on which user category is being examined.

BLIBOR and ABS(BLIBOR) are interest rate exposure coefficients obtained with the three-factor model using the FRB 3-month LIBOR rate, the equally-weighted CRSP market index, and either the FRB nominal major currency index or the CRB commodity index, depending on which user category is being examined.

BCRB and ABS(BCRB) are commodity exposure coefficients obtained with the three-factor model using the FRB commodity index, the equally-weighted CRSP market index, and either the FRB nominal major currency index or the FRB 3-month LIBOR rate, depending on which user category is being examined.

Table V
Firm Characteristics
Bivariate Combinations: IR and FX for Users and Nonusers
1995-1998

**BIVARIATE: IR
AND FX**

	#	Mean	Median	Max.	Min.	Std. Dev.	Mean	Median	Max.	Min.	Std. Dev.
	% of total										
Users		TA (\$MM)					FS/TS				
1998	71 45.2%	4,635	1,699	31,853	21	6,197	0.283	0.258	1.000	0.000	0.250
1997	66 40.7%	4,495	2,175	25,812	87	5,423	0.284	0.267	1.000	0.000	0.254
1996	68 42.0%	4,458	2,174	24,293	87	5,359	0.303	0.268	1.000	0.000	0.274
1995	58 37.7%	4,760	2,433	23,832	53	5,545	0.322	0.294	0.936	0.000	0.253
Non-Users		TA (\$MM)					FS/TS				
1998	86 54.8%	1,003	378	13,834	17	1,894	0.105	0.000	0.988	0.000	0.237
1997	96 59.3%	745	285	11,354	19	1,416	0.096	0.000	0.996	0.000	0.208
1996	94 58.0%	715	264	11,277	14	1,622	0.092	0.000	1.000	0.000	0.198
1995	96 62.3%	708	258	11,197	10	1,548	0.085	0.000	1.000	0.000	0.205
Users		LTD/TA					TI (\$MM)				
1998		0.226	0.199	0.674	0.008	0.137	522	197	3,640	3	752
1997		0.207	0.200	0.556	0.007	0.114	523	199	3,523	5	718
1996		0.195	0.179	0.601	0.003	0.122	487	245	2,807	1	615
1995		0.187	0.178	0.414	0.014	0.109	517	282	2,830	4	621
Non-Users		LTD/TA					TI (\$MM)				
1998		0.216	0.199	0.861	0.000	0.175	163	61	2,563	1	326
1997		0.203	0.166	0.678	0.000	0.173	122	50	2,094	1	240
1996		0.204	0.203	0.591	0.000	0.159	137	45	3,343	1	382
1995		0.206	0.190	0.655	0.000	0.168	130	44	3,573	1	371

This table contains descriptive statistics for all bivariate combinations of user and nonuser non-financial firms by year, by number and % of total. The two variable combinations (bivariate) of users are shown as currency and interest rates (FX, IR), currencies and commodities (FX, CM) and interest rates and commodities (IR, CM). For each firm, TA is total assets (Compustat item #6), FS/TS is the ratio of foreign sales to total sales (Compustat geographic data and 10-K filings, Compustat item #12), LTD/TA is the ratio of long-term debt to total assets (Compustat items #9, #6 and 10-K filings and Annual Reports), TI/TS is the ratio of total inventory to total sales (Compustat items #3,

#12 and 10-K filings, Annual Reports), TI is total inventory, FS is foreign sales, TS is total sales which are components of ratios as previously defined.

Table V
Firm Characteristics for
IR and FX Users and Nonusers
1995-1998

**BIVARIATE: IR
AND FX**

	# % of total	Mean	Median	Max.	Min.	Std. Dev.	Mean	Median	Max.	Min.	Std. Dev.
Users		LTD (\$MM)					FS (\$MM)				
1998		895	370	6,259	1	1,164	1,311	223	9,575	0	2,290
1997		801	357	5,032	5	967	1,316	278	8,162	0	2,049
1996		784	375	6,021	0	1,077	1,342	356	8,237	0	2,030
1995		870	313	7,809	10	1,322	1,512	436	7,372	0	2,022
Non-Users		LTD (\$MM)					FS (\$MM)				
1998		227	50	2,847	0	467	190	0	2,949	0	432
1997		166	37	2,345	0	320	143	0	2,295	0	255
1996		151	45	2,356	0	333	103	0	2,075	0	227
1995		141	49	2,263	0	314	84	0	1,917	0	212
Users		TS (\$MM)									
1998		4,376	1,472	29,218	36	6,329					
1997		4,529	1,754	23,841	53	5,765					
1996		4,004	1,681	19,829	1	4,975					
1995		4,303	2,253	18,624	70	4,841					
Non-Users		TS (\$MM)									
1998		1,078	394	18,510	1	2,298					
1997		819	337	16,109	1	1,777					
1996		962	290	24,002	1	2,783					
1995		941	320	24,822	1	2,704					

Table V
Firm Characteristics for
IR and CM Users and Nonusers
1995-1998

**BIVARIATE: IR
AND CM**

	# % of total	Mean	Median	Max.	Min.	Std. Dev.	Mean	Median	Max.	Min.	Std. Dev.
Users		TA (\$MM)					TI/TS				
1998	75 47.8%	2,954	1,219	18,302	41	4,091	0.168	0.148	1.073	0.030	0.134
1997	71 43.6%	3,851	1,437	25,812	64	5,216	0.136	0.124	0.336	0.020	0.064
1996	66 40.7%	3,923	1,488	24,293	47	5,254	0.161	0.140	0.902	0.020	0.126
1995	54 35.1%	4,566	2,503	23,832	45	5,482	0.140	0.113	0.623	0.023	0.093
Non-Users		TA (\$MM)					TI/TS				
1998	82 52.2%	2,024	441	31,853	17	4,952	0.163	0.151	0.560	0.000	0.109
1997	92 56.4%	1,004	299	14,977	19	2,175	0.172	0.165	0.443	0.000	0.096
1996	96 59.3%	1,028	303	14,685	7	2,286	0.182	0.158	1.492	0.000	0.168
1995	100 64.9%	839	274	13,929	3	1,980	0.179	0.141	2.125	0.000	0.218
Users		LTD/TA					TI (\$MM)				
1998		0.233	0.207	0.674	0.000	0.141	332	131	2,882	3	501
1997		0.212	0.200	0.556	0.000	0.122	457	166	3,523	5	690
1996		0.211	0.197	0.601	0.028	0.119	434	146	2,807	3	597
1995		0.198	0.181	0.655	0.014	0.129	496	260	2,830	1	613
Non-Users		LTD/TA					TI (\$MM)				
1998		0.218	0.187	0.861	0.000	0.180	238	67	2,624	0	474
1997		0.196	0.166	0.677	0.000	0.169	144	61	1,799	0	265
1996		0.194	0.184	0.591	0.000	0.160	166	56	3,343	0	404
1995		0.207	0.195	0.585	0.000	0.160	143	53	3,573	0	385

Table V
Firm Characteristics
IR and CM Users and Nonusers
1995-1998

**BIVARIATE: IR
AND CM**

	#	Mean	Median	Max.	Min.	Std. Dev.	Mean	Median	Max.	Min.	Std. Dev.
	% of total										
Users		LTD (\$MM)					FS (\$MM)				
1998		599	248	3,619	0	804	847	129	9,575	0	1,860
1997		726	311	5,032	0	980	1,048	135	8,162	0	1,914
1996		724	274	6,021	2	1,081	1,192	127	8,237	0	2,020
1995		849	269	7,809	2	1,356	1,500	387	7,372	0	2,034
Non-Users		LTD (\$MM)					FS (\$MM)				
1998		377	73	6,259	0	913	591	0	9,018	0	1,611
1997		179	45	1,979	0	345	296	0	5,687	0	966
1996		183	47	2,356	0	368	271	0	5,404	0	903
1995		157	56	2,263	0	309	168	0	5,105	0	700
Users		TS (\$MM)									
1998		2,778	909	23,231	35	4,363					
1997		3,904	1,209	23,841	29	5,522					
1996		3,598	1,126	19,829	5	4,858					
1995		4,226	2,475	18,624	9	4,774					
Non-Users		TS (\$MM)									
1998		1,888	556	29,218	1	4,313					
1997		1,040	346	16,701	1	2,177					
1996		1,211	335	24,002	1	3,018					
1995		1,016	335	24,822	1	2,776					

Table V
Firm Characteristics for
FX and CM Users and Nonusers
1995-1998

**BIVARIATE: FX
AND CM**

	#	Mean	Median	Max.	Min.	Std. Dev.	Mean	Median	Max.	Min.	Std. Dev.
	% of total										
Users		TA (\$MM)					FS/TS				
1998	75 47.8%	4,190	1,699	31,853	21	6,006	0.274	0.241	1.000	0.000	0.275
1997	66 40.5%	4,441	2,481	25,812	64	5,521	0.307	0.279	1.000	0.000	0.281
1996	66 40.7%	4,409	2,128	24,293	47	5,389	0.312	0.278	1.000	0.000	0.275
1995	54 35.5%	4,839	2,574	23,832	45	5,569	0.308	0.266	0.936	0.000	0.252
Non-Users		TA (\$MM)					FS/TS				
1998	82 52.2%	1,030	418	14,992	17	1,981	0.111	0.000	0.927	0.000	0.216
1997	97 59.5%	818	291	11,703	19	1,562	0.070	0.000	0.718	-0.752	0.178
1996	96 59.3%	710	267	11,277	14	1,476	0.088	0.000	1.000	0.000	0.193
1995	100 64.5%	760	273	11,197	10	1,664	0.100	0.000	1.000	0.000	0.216
Users		TI/TS					TI (\$MM)				
1998		0.153	0.143	0.425	0.030	0.083	490	185	3,640	3	739
1997		0.135	0.119	0.336	0.029	0.066	478	169	2,973	5	636
1996		0.169	0.137	0.902	0.000	0.138	486	249	2,807	0	615
1995		0.152	0.114	0.623	0.024	0.100	529	304	2,830	1	620
Non-Users		TI/TS					TI (\$MM)				
1998		0.169	0.155	0.560	0.000	0.106	139	66	1,232	0	196
1997		0.170	0.164	0.443	0.000	0.094	147	59	3,523	0	375
1996		0.177	0.156	1.492	0.000	0.163	132	50	3,343	0	357
1995		0.175	0.140	2.125	0.000	0.217	137	45	3,573	0	380

Table V
Firm Characteristics for
FX and CM Users and Nonusers
1995-1998

**BIVARIATE: FX
AND CM**

	# % of total	Mean	Median	Max.	Min.	Std. Dev.	Mean	Median	Max.	Min.	Std. Dev.
Users		LTD (\$MM)					FS (\$MM)				
1998		809	286	6,259	0	1,154	1,216	183	9,575	0	2,210
1997		782	283	5,032	0	1,014	1,386	311	8,162	0	2,091
1996		761	310	6,021	0	1,081	1,465	394	8,237	0	2,112
1995		858	285	7,809	2	1,338	1,646	525	7,372	0	2,085
Non-Users		LTD (\$MM)					FS (\$MM)				
1998		216	76	1,859	0	350	213	0	6,590	0	854
1997		179	48	2,487	0	340	94	0	2,295	0	338
1996		159	49	2,356	0	328	72	0	2,075	0	274
1995		164	55	2,263	0	354	105	0	3,581	0	430
Users		TS (\$MM)									
1998		4,023	1,279	29,218	35	6,138					
1997		4,189	1,505	23,637	29	5,419					
1996		4,004	1,793	19,829	4	5,021					
1995		4,429	2,565	18,624	9	4,873					
Non-Users		TS (\$MM)									
1998		1,031	532	13,439	1	1,929					
1997		997	346	23,841	1	2,570					
1996		946	327	24,002	1	2,569					
1995		1,008	328	24,822	1	2,763					

Table VI
Relationship Between Currency Exposures and Derivatives Use

Four-factor model using daily data, all firms, $\text{Abs}(\hat{\beta}_{2,i})$				
	1998	1997	1996	1995
Foreign Exchange Exposures				
$\gamma_{2,i}$ (FS/TS)	0.1797	-0.0826	0.7673	-.3528
(Prob)	(0.7266)	(0.7581)	(0.0605)*	(0.0125)**
(White Adj Prob)	(0.6638)	(0.7403)	(0.3806)	(0.0385)**
$\gamma_{3,i}$ (FDER/TA)	1.0346	0.9298	-2.1802	0.2665
(Prob)	(.6383)	(.6050)	(.0967)*	(.0372)**
(White Adj Prob)	(0.3156)	(0.2522)	(0.1417)	(0.3822)
Heteroskedasticity Test				
Chi-Sq	0.8978	1.0049	4.6725	6.582
(Prob)	(.6383)	(.6050)	(.0967)*	(.0372)**
n (firms)	139	149	150	146

*, **, *** denote significance at the 10%, 5%, and 1% levels, respectively, based on two-tailed tests.

This table reports estimates of the determinants of the absolute currency exposures, using OLS regressions unadjusted and adjusted for heteroskedasticity using White (1980). The regression models for estimating currency exposures are specified by two-stage regression equations:

$$R_{i,t} = \beta_{1,i} + \beta_{2,i}FX_t + \beta_{3,i}IR_t + \beta_{4,i}CM_t + \beta_{5,i}R_{m,t} + \varepsilon_{i,t} : t = 1, \dots, T \quad (12)$$

$$\text{Abs}(\hat{\beta}_{2,i}) = \gamma_{1,i} + \gamma_{2,i}(FS/TS)_i + \gamma_{3,i}(FDER/TA)_i + \xi_i : i = 1, \dots, N \quad (13)$$

where the dependent variable in (13) is estimated using the coefficient $\hat{\beta}_{2,i}$ in equation (12). $R_{i,t}$ is the return on the i th firm's common stock (including dividends), FX_t is the daily percent change in the FRB nominal major currency index, IR_t is the daily percent change in the FRB three-month London Interbank Offered Rate for dollar deposits, CM_t is the daily percent change in the CRB commodity index, and $R_{m,t}$ is the daily percent change in the return on the equally-weighted CRSP market portfolio (NYSE, AMEX, and Nasdaq firms). We use daily data for the year previous to the derivatives date to calculate equation (18) for the one-year period.

The independent variables for currency exposures are: $(FS/TS)_i$ is the i th firm's ratio of foreign sales to total sales, $(FDER/TA)_i$ is the i th firm's ratio of foreign currency derivatives to total assets. We present the estimates (top) and the associated probabilities (bottom) for the coefficient of FS/TS , $\gamma_{2,i}$, and $FDER/TA$, $\gamma_{3,i}$.

Table VI
Relationship Between Interest Rate Exposures and Derivatives Use

Four-factor model using daily data, all firms, $Abs(\hat{\beta}_{3,i})$				
	1998	1997	1996	1995
Interest Rate Exposures				
$\theta_{2,i}$ (LTD/TA)	1.6019	-0.2102	0.6511	0.5061
(Prob)	(0.0860)*	(0.4681)	(0.4453)	(0.0805)*
(White Adj Prob)	(0.1846)	(0.3603)	(0.5460)	(0.1580)
$\theta_{3,i}$ (DDER/TA)	-6.4993	-0.6966	0.9600	-0.4819
(Prob)	(0.0230)**	(0.4295)	(0.6561)	(0.5972)
(White Adj Prob)	(0.0010)***	(0.3064)	(0.5874)	(0.3694)
Heteroskedasticity Test				
Chi-Sq	6.9651	1.2456	0.7950	3.5057
(Prob)	(.0307)**	(.5364)	(.6720)	(.1733)
n (firms)	139	149	150	146

*, **, *** denote significance at the 10%, 5%, and 1% levels, respectively, based on two-tailed tests.

This table reports estimates of the determinants of the absolute interest rate exposures, using OLS regressions unadjusted and adjusted for heteroskedasticity using White (1980). The regression models for estimating interest rate exposures are specified by two-stage regression equations:

$$R_{i,t} = \beta_{1,i} + \beta_{2,i}FX_t + \beta_{3,i}IR_t + \beta_{4,i}CM_t + \beta_{5,i}R_{m,t} + \varepsilon_{i,t} : t = 1, \dots, T \quad (12)$$

$$Abs(\hat{\beta}_{3,i}) = \theta_{1,i} + \theta_{2,i}(LTD/TA)_i + \theta_{3,i}(DDER/TA)_i + v_i : i = 1, \dots, N \quad (14)$$

where the dependent variable in (14) is estimated using the coefficient $\beta_{3,i}$ in equation

(12). $R_{i,t}$ is the rate of return on the i th firm's common stock (including dividends),

FX_t is the daily percent change in the FRB nominal major currency index, IR_t is the daily percent change in the FRB three-month London Interbank Offered Rate for dollar deposits, CM_t is the daily percent change in the CRB commodity index, and $R_{m,t}$ is the daily percent change in the return on the equally-weighted CRSP market portfolio (NYSE, AMEX, and Nasdaq firms). We use daily data for the year previous to the derivatives date to calculate equation (12) for the one-year period.

The independent variables for interest rate exposures are: $(LTD/TA)_i$ is the i th firm's ratio of long-term debt to total assets, $(DDER/TA)_i$ is the i th firm's ratio of dollar derivatives to total assets. We present the estimates (top) and the associated probabilities (bottom) for the coefficient of LTD/TA , $\theta_{2,i}$, and $DDER/TA$, $\theta_{3,i}$.

Table VI
Relationship Between Commodity Exposures and Derivatives Use

Four-factor model using daily data, all firms, $\text{Abs}(\hat{\beta}_{4i})$				
	1998	1997	1996	1995
Commodity Exposures				
$\lambda_{2,i}$ (TI/TA)	0.5054	0.3861	0.2275	1.0045
(Prob)	(0.0317)**	(0.1774)	(0.2445)	(0.0025)***
(White Adj Prob)	(0.0501)*	(0.2323)	(0.2445)	(0.0228)**
$\lambda_{3,i}$ (CDER/TA)	1.3148	0.7579	0.9025	1.0840
(Prob)	(0.0000)***	(0.0000)***	(0.0000)***	(0.0000)***
(White Adj Prob)	(0.0009)***	(0.0000)***	(0.0000)***	(0.0005)***
Heteroskedasticity Test				
Chi-Sq	71.0348	24.5327	47.5089	32.2539
(Prob)	(.0000)***	(.0000)***	(.0000)***	(.0000)***
n (firms)	139	149	150	146

*, **, *** denote significance at the 10%, 5%, and 1% levels, respectively, based on two-tailed tests.

This table reports estimates of the determinants of the absolute commodity exposures, using OLS regressions unadjusted and adjusted for heteroskedasticity using White (1980). The regression models for estimating commodity exposures are specified by two-stage regression equations:

$$R_{i,t} = \beta_{1,i} + \beta_{2,i}FX_t + \beta_{3,i}IR_t + \beta_{4,i}CM_t + \beta_{5,i}R_{m,t} + \varepsilon_{i,t} : t = 1, \dots, T \quad (12)$$

$$\text{Abs}(\hat{\beta}_{4,i}) = \lambda_{1,i} + \lambda_{2,i}(TI/TS)_i + \lambda_{3,i}(CDER/TA)_i + \mu_i : i = 1, \dots, N \quad (15)$$

where the dependent variable in (15) is estimated using the coefficient $\beta_{4,i}$ in equation (12). $R_{i,t}$ is the rate of return on the i th firm's common stock (including dividends),

FX_t is the daily percent change in the FRB nominal major currency index, IR_t is the daily percent change in the FRB three-month London Interbank Offered Rate for dollar deposits, CM_t is the daily percent change in the CRB commodity index, and $R_{m,t}$ is the daily percent change in the equally-weighted CRSP market portfolio (NYSE, AMEX, and Nasdaq firms). We use daily data for the year previous to the derivatives date to calculate equation (12) for the one-year period.

The independent variables for commodity exposures are: $(TI/TS)_i$ is the i th firm's ratio of total inventory to total sales, $(CDER/TA)_i$ is the i th firm's ratio of commodity derivatives to total assets. We present the estimates (top) and the associated probabilities (bottom) for the coefficient of TI/TS , $\lambda_{2,i}$, and $CDER/TA$, $\lambda_{3,i}$.

Table VII
Relationship Between Currency Exposures and Derivatives Use

Three and four-factor models using monthly data, all firms

	1998		1997		1996		1995	
	COEFF	PROB	COEFF	PROB	COEFF	PROB	COEFF	PROB
Four-factor model (with CRB)								
BFX								
FS/TS	-0.4748	0.3321	-0.9792	0.0074**	-0.4891	0.2133	-0.0867	0.8434
FDER/TA	-0.6553	0.7381	1.1030	0.1505	-0.0987	0.9361	-0.5289	0.6870
Abs(BFX)								
FS/TS	0.0788	0.8322	0.3934	0.1218	-0.0827	0.7684	-0.1623	0.6199
FDER/TA	-1.4074	0.4199	-1.0555	0.0389**	-0.4252	0.6301	-0.8642	0.2354
Three-factor model (without CRB)								
BFX								
FS/TS	-0.5730	0.2603	-0.9693	0.0066	-0.5908	0.0552*	-0.5043	0.2983
FDER/TA	-0.2207	0.9137	1.0660	0.1502	-0.2332	0.7244	-0.2424	0.7755
Abs(BFX)								
FS/TS	-0.0928	0.7883	0.3086	0.2242	-0.1193	0.6535	0.1646	0.5787
FDER/TA	-0.6079	0.6609	-0.9177	0.0653*	-0.5841	0.4843	-1.3508	0.0779*
n (firms)	145		161		161		152	

*, **, *** denote significance at the 10%, 5%, and 1% levels, respectively, based on two-tailed tests.

This table reports estimates of the determinants of currency exposures, using OLS regressions adjusted for heteroskedasticity using White (1980). The regression models for estimating currency exposures are specified by two-stage regression equations:

Four-factor model (with CRB):

$$R_{i,t} = \beta_{1,i} + \beta_{2,i}FX_t + \beta_{3,i}IR_t + \beta_{4,i}CM_t + \beta_{5,i}R_{m,t} + \varepsilon_{i,t} : t = 1, \dots, T \quad (12)$$

$$\hat{\beta}_{2,i} = \gamma_{1,i} + \gamma_{2,i}(FS/TS)_i + \gamma_{3,i}(FDER/TA)_i + \xi_i : i = 1, \dots, N \quad (13)$$

Three-factor model (without CRB):

$$R_{i,t} = \beta_{1,i} + \beta_{2,i}FX_t + \beta_{3,i}IR_t + \beta_{5,i}R_{m,t} + \varepsilon_{i,t} : t = 1, \dots, T \quad (12a)$$

$$\hat{\beta}_{2,i} = \gamma_{1,i} + \gamma_{2,i}(FS/TS)_i + \gamma_{3,i}(FDER/TA)_i + \xi_i : i = 1, \dots, N \quad (13)$$

where the dependent variable for the four and three-factor models in (13) are estimated using the coefficient $\hat{\beta}_{2,i}$ in equation (12). $R_{i,t}$ is the return on the i th firm's common stock (including dividends), FX_t is the monthly percent change in the FRB nominal major currency index, IR_t is the monthly percent change in the FRB three-month London

Interbank Offered Rate for dollar deposits, CM_t is the monthly percent change in the return on the CRB commodity index, and $R_{m,t}$ is the monthly percent change in the return on the equally-weighted CRSP market portfolio (NYSE, AMEX, and Nasdaq firms). We also estimate equation (13) for the four and three-factor models with Abs ($\hat{\beta}_{2,i}$) for the dependent variable. We use monthly data for the three years preceding the derivatives date to calculate equations (12) and (12a) for the three-year period.

The independent variables for currency exposures are: $(FS/TS)_i$ is the i^{th} firm's ratio of foreign sales to total sales, $(FDER/TA)_i$ is the i^{th} firm's ratio of foreign currency derivatives to total assets.

We present the estimates (top) and the associated probabilities (bottom) for the coefficients of FS/TS , $\gamma_{2,i}$, and $FDER/TA$, $\gamma_{3,i}$.

Table VII
Relationship Between Interest Rate Exposures and Derivatives Use

Four and three-factor models using monthly data, all firms

	1998		1997		1996		1995	
	COEFF	PROB	COEFF	PROB	COEFF	PROB	COEFF	PROB
Four-factor Model (with CRB)								
BLIBOR								
LTD/TA	0.6279	0.3625	0.0740	0.8874	-0.0130	0.9597	-0.3383	0.4674
DDER/TA	0.6897	0.7268	-0.7435	0.6161	0.1074	0.8635	-0.4342	0.3007
Abs(BLIBOR)								
LTD/TA	-0.3664	0.5100	0.1773	0.6378	0.0763	0.6788	0.6024	0.1043
DDER/TA	-0.5807	0.7155	-0.0743	0.9445	-0.0603	0.8929	-0.6767	0.0258**
Three-factor Model (without CRB)								
BLIBOR								
LTD/TA	0.4971	0.4877	0.3424	0.5089	0.0212	0.9191	-0.3459	0.1640
DDER/TA	0.3645	0.8574	-0.8728	0.5525	-0.6066	0.0945*	0.2625	0.7125
Abs(BLIBOR)								
LTD/TA	-0.2464	0.6525	0.1309	0.7229	-0.1189	0.4295	0.0477	0.8095
DDER/TA	-0.7166	0.6478	-0.0172	0.9869	-0.2106	0.5631	-0.6747	0.0028***
n (firms)	145		161		161		152	

*, **, *** denote significance at the 10%, 5%, and 1% levels, respectively, based on two-tailed tests.

This table reports estimates of the determinants of interest rate exposures, using OLS regressions adjusted for heteroskedasticity using White (1980). The regression models for estimating interest rate exposures are specified by two-stage regression equations:

Four-factor model (with CRB):

$$R_{i,t} = \beta_{1,i} + \beta_{2,i}FX_t + \beta_{3,i}IR_t + \beta_{4,i}CM_t + \beta_{5,i}R_{m,t} + \varepsilon_{i,t} : t = 1, \dots, T \quad (12)$$

$$\hat{\beta}_{3,i} = \theta_{1,i} + \theta_{2,i}(LTD/TA)_i + \theta_{3,i}(DDER/TA)_i + v_i : i = 1, \dots, N \quad (14)$$

Three-factor model (without CRB):

$$R_{i,t} = \beta_{1,i} + \beta_{2,i}FX_t + \beta_{3,i}IR_t + \beta_{5,i}R_{m,t} + \varepsilon_{i,t} : t = 1, \dots, T \quad (12a)$$

$$\hat{\beta}_{3,i} = \theta_{1,i} + \theta_{2,i}(LTD/TA)_i + \theta_{3,i}(DDER/TA)_i + v_i : i = 1, \dots, N \quad (14)$$

where the dependent variable for the four and three-factor models in (14) is estimated using the coefficient $\beta_{3,i}$ in equation (12). $R_{i,t}$ is the return on the i th firm's common stock (including dividends), FX_t is the monthly percent change in the FRB nominal major currency index, IR_t is the monthly percent change in the FRB three-month London

Interbank Offered Rate for dollar deposits, CM_t , is the monthly percent change in the CRB commodity index, and $R_{m,t}$ is the monthly percent change in the rate of return on the equally-weighted CRSP market portfolio (NYSE, AMEX, and Nasdaq firms). We also estimate equation (14) for the four and three-factor models with Abs ($\hat{\beta}_{3,i}$) for the dependent variable. We use monthly data for the three years preceding the derivatives date to calculate equations (12) and (12a) for the three-year period.

The independent variables for interest rate exposures are: $(LTD/TA)_i$ is the i^{th} firm's ratio of long-term debt to total assets, $(DDER/TA)_i$ is the i^{th} firm's ratio of dollar derivatives to total assets.

We present the estimates (top) and the associated probabilities (bottom) for the coefficients of LTD/TA , $\theta_{2,i}$, and $FDER/TA$, $\theta_{3,i}$.

Table VII
Relationship Between Commodity Exposures and Derivatives Use

Four-factor model using monthly data, all firms

	1998		1997		1996		1995	
	COEFF	PROB	COEFF	PROB	COEFF	PROB	COEFF	PROB
BCRB								
TI/TS	0.7068	0.4053	0.2729	0.0445**	0.8272	0.1317	1.4783	0.003***
CDER/TA	0.6272	.0705*	0.4167	0.3090	-0.5590	0.3377	-1.3478	0.0929*
Abs(BCRB)								
TI/TS	0.2731	0.6073	-0.0807	0.4229	0.2625	0.5578	1.5489	0.0012***
CDER/TA	0.0646	0.7873	0.2512	0.2180	-0.1580	0.7247	0.5694	0.2716
n (firms)	145		161		161		152	

*, **, *** denote significance at the 10%, 5%, and 1% levels, respectively, based on two-tailed tests.

This table reports estimates of the determinants of commodity exposures, using OLS regressions adjusted for heteroskedasticity using White (1980). The regression models for estimating commodity exposures are specified by two-stage regression equations:

$$R_{i,t} = \beta_{1,i} + \beta_{2,i}FX_t + \beta_{3,i}IR_t + \beta_{4,i}CM_t + \beta_{5,i}R_{m,t} + \varepsilon_{i,t} : t = 1, \dots, T \quad (12)$$

$$\hat{\beta}_{4,i} = \lambda_{1,i} + \lambda_{2,i}(TI/TS)_i + \lambda_{3,i}(CDER/TA)_i + \mu_i : i = 1, \dots, N \quad (15)$$

where the dependent variable for the four and three-factor models in (15) is estimated using the coefficient $\beta_{4,i}$ in equation (12). $R_{i,t}$ is the return on the i th firm's common stock (including dividends), FX_t is the monthly percent change in the FRB nominal major currency index, IR_t is the monthly percent change in the FRB three-month London Interbank Offered Rate for dollar deposits, CM_t is the monthly percent change in the return on the CRB commodity index, and $R_{m,t}$ is the monthly percent change in the rate of return on the equally-weighted CRSP market portfolio (NYSE, AMEX, and Nasdaq firms). We also estimate equation (15) for the four and three-factor models with Abs ($\hat{\beta}_{4,i}$) for the dependent variable. We use monthly data for the three years preceding the derivatives date to calculate equations (12) and for the three-year period.

The independent variables for commodity exposures are: $(TI/TS)_i$ is the i^{th} firm's ratio of total inventory to total sales, $(CDER/TA)_i$ is the i^{th} firm's ratio of commodity derivatives to total assets.

We present the estimates (top) and the associated probabilities (bottom) for the coefficients of TI/TS , $\lambda_{2,i}$, and $CDER/TA$, $\lambda_{3,i}$.

Table VIII
Relationship Between Currency Exposures and Derivatives Use

Three-factor models using monthly data, user firms only

DERIVATIVES USERS	White BFX	Abs Std Err	Abs (BFX)	White Std Err	White BFX	Abs Std Err	Abs (BFX)	White Std Err
Currency Exposure:								
FX,CM	1998				1997			
FS/TS	-0.3588	-0.3588	0.4324	0.4324	-1.4265	-1.4265	0.8109	0.8109
(Prob)	0.5425	0.6183	0.3123	0.4052	0.0005***	0.0005***	0.0045***	0.0071***
FDER/TA	1.3170	1.3170	-1.6948	-1.6948	1.5403	1.5403	-0.8245	-0.8245
(Prob)	0.4794	0.5607	0.2109	0.3409	0.084*	0.045**	0.1918	0.1073
n (firms)	76				66			
IR,FX								
FS/TS	-0.8200	-0.8200	1.6686	1.6686	-1.4322	-1.4322	0.6194	0.6194
(Prob)	0.1924	0.1733	0.0001***	0.0001***	0.0014***	0.0028***	0.0394**	0.0719*
FDER/TA	-0.5987	-0.5987	0.2011	0.2011	0.9229	0.9229	-0.5978	-0.5978
(Prob)	0.7339	0.7499	0.8898	0.8898	0.2962	0.2359	0.3244	0.2715
n (firms)	71				67			
FX,CM	1996				1995			
FS/TS	-0.5562	-0.5562	0.3299	0.3299	-0.0395	-0.0395	-0.0099	-0.0099
(Prob)	0.2157	0.2035	0.3229	0.2866	0.9336	0.9306	0.9768	0.9745
FDER/TA	-0.1531	-0.1531	-0.1459	-0.1459	-0.4453	-0.4453	-0.3798	-0.3798
(Prob)	0.8898	0.8405	0.8593	0.6986	0.5061	0.3782	0.4288	0.2559
n (firms)	66				55			
IR,FX								
FS/TS	-0.6309	-0.6309	0.0318	0.0318	0.1433	0.1433	0.2128	0.2128
(Prob)	0.1491	0.1328	0.9144	0.9144	0.7585	0.767	0.5241	0.505
FDER/TA	-0.8260	-0.8260	-0.2243	-0.2243	-0.8633	-0.8633	-0.4234	-0.4234
(Prob)	0.4431	0.1737	0.7593	0.7593	0.3615	0.1768	0.5308	0.474
n (firms)	67				56			

*, **, *** denote significance at the 10%, 5%, and 1% levels, respectively, based on two-tailed tests.

This table reports estimates of the determinants of currency exposures for users only, using OLS regressions unadjusted and adjusted for heteroskedasticity (White, 1980). Regression models for estimating currency exposures are specified by two-stage regression equations as follows:

Three-factor model for FX, CM:

$$R_{i,t} = \beta_{1,t} + \beta_{2,t}FX_t + \beta_{4,t}CM_t + \beta_{5,t}R_{m,t} + \varepsilon_{i,t} : t = 1, \dots, T \quad (12)$$

$$\hat{\beta}_{2,i} = \gamma_{1,i} + \gamma_{2,i}(FS/TS)_i + \gamma_{3,i}(FDER/TA)_i + \xi_i : i = 1, \dots, N \quad (13)$$

Three-factor model for IR, FX:

$$R_{i,t} = \beta_{1,i} + \beta_{2,i}FX_t + \beta_{3,i}IR_t + \beta_{5,i}R_{m,t} + \varepsilon_{i,t} : t = 1, \dots, T \quad (12a)$$

$$\hat{\beta}_{2,i} = \gamma_{1,i} + \gamma_{2,i}(FS/TS)_i + \gamma_{3,i}(FDER/TA)_i + \xi_i : i = 1, \dots, N \quad (13)$$

where the dependent variable for the three-factor model in (13) is estimated using the coefficient $\hat{\beta}_{2,i}$ in equation (12) or (12a). $R_{i,t}$ is the return on the i th firm's common stock (including dividends), FX_t is the monthly percent change in the FRB nominal major currency index, IR_t is the monthly percent change in the FRB three-month London Interbank Offered Rate for dollar deposits, CM_t is the monthly percent change in the CRB commodity index, and $R_{m,t}$ is the monthly percent change in the return on the equally-weighted CRSP market portfolio (NYSE, AMEX, and Nasdaq firms). We also estimate equation (13) with $Abs(\hat{\beta})$ for the dependent variable. We use monthly data for the three years preceding the derivatives date to calculate equations (12) and (12a) for the three-year period.

The independent variables for currency exposures are: $(FS/TS)_i$ is the i th firm's ratio of foreign sales to total sales, $(FDER/TA)_i$ is the i th firm's ratio of foreign currency derivatives to total assets.

We present the estimates (top) and the associated probabilities (bottom) for the coefficients of FS/TS , $\lambda_{2,i}$ and $\gamma_{2,i}$, and $FDER/TA$, $\lambda_{3,i}$ and $\gamma_{3,i}$.

Table VIII
Relationship Between Interest Rate Exposures and Derivatives Use

Three-factor models using monthly data, user firms only

DERIVATIVES USERS	BLIBOR	White	Abs	White	BLIBOR	White	Abs	White	
		Std Err	(BLIBOR)	Std Err		Std Err	(BLIBOR)	Std Err	
Interest Rate Exposure:									
IR,CM		1998				1997			
LTD/TA		1.0665	1.0665	-0.1079	-0.1079	0.3327	0.3327	0.1710	0.1710
(Prob)		0.4275	0.5057	0.923	0.9331	0.7364	0.7581	0.8261	0.8402
DDER/TA		4.7329	4.7329	-4.4923	-4.4923	0.6392	0.6392	-0.4897	-0.4897
(Prob)		0.0803*	0.036**	0.0468**	0.0074***	0.7119	0.7468	0.7195	0.7611
n (firms)		75				71			
IR,FX									
LTD/TA		0.2364	0.2364	0.5941	0.5941	1.2191	1.2191	-0.6588	-0.6588
(Prob)		0.83	0.8888	0.5031	0.6689	0.2012	0.347	0.3485	0.5035
DDER/TA		2.1511	2.1511	-1.2012	-1.2012	-1.1408	-1.1408	1.1070	1.1070
(Prob)		0.3058	0.2592	0.4763	0.4551	0.4528	0.5583	0.3249	0.489
n (firms)		71				67			
IR,CM		1996				1995			
LTD/TA		0.5137	0.5137	0.3141	0.3141	-0.4082	-0.4082	0.5032	0.5032
(Prob)		0.2085	0.2388	0.3084	0.3554	0.4027	0.2448	0.16	0.0381**
DDER/TA		0.5135	0.5135	0.4021	0.4021	-0.2348	-0.2348	-0.1738	-0.1738
(Prob)		0.3957	0.3783	0.3796	0.3682	0.7004	0.5654	0.6962	0.5687
n (firms)		66				54			
IR,FX									
LTD/TA		0.1080	0.1080	0.1555	0.1555	0.1112	0.1112	0.3355	0.3355
(Prob)		0.7134	0.7566	0.4653	0.5461	0.6859	0.7104	0.0559*	0.0825*
DDER/TA		-0.3838	-0.3838	0.1814	0.1814	0.3013	0.3013	-0.0985	-0.0985
(Prob)		0.3974	0.2316	0.5795	0.5242	0.312	0.2669	0.597	0.4256
n (firms)		68				57			

*, **, *** denote significance at the 10%, 5%, and 1% levels, respectively, based on two-tailed tests.

This table reports estimates of the determinants of interest rate exposures for users only, using OLS regressions unadjusted and adjusted for heteroskedasticity (White, 1980). Regression models for estimating interest rate exposures are specified by two-stage regression equations as follows:

Three-factor model for IR, FX:

$$R_{i,t} = \beta_{1,t} + \beta_{2,t}FX_t + \beta_{3,t}IR_t + \beta_{5,t}R_{m,t} + \varepsilon_{i,t} : t = 1, \dots, T \quad (12a)$$

$$\hat{\beta}_{3,i} = \theta_{1,i} + \theta_{2,i}(LTD/TA)_i + \theta_{3,i}(DDER/TA)_i + v_i : i = 1, \dots, N \quad (14)$$

Three-factor model for IR, CM:

$$R_{i,t} = \beta_{1,i} + \beta_{2,i}IR_t + \beta_{4,i}CM_t + \beta_{5,i}R_{m,t} + \varepsilon_{i,t} : t = 1, \dots, T \quad (12c)$$

$$\hat{\beta}_{3,i} = \theta_{1,i} + \theta_{2,i}(LTD/TA)_i + \theta_{3,i}(DDER/TA)_i + \nu_i : i = 1, \dots, N \quad (14)$$

where the dependent variable for the three-factor model in (20) is estimated using the coefficient $\beta_{3,i}$ in equations (12a) or (12c). $R_{i,t}$ is the return on the i th firm's common stock (including dividends), FX_t is the monthly change in the FRB nominal major currency index, IR_t is the monthly percent change in the FRB three-month London Interbank Offered Rate for dollar deposits, CM_t is the monthly percent change in the CRB commodity index, and $R_{m,t}$ is the monthly percent change in the return on the equally-weighted CRSP market portfolio (NYSE, AMEX, and Nasdaq firms). We also estimate equation (14) with $Abs(\hat{\beta})$ for the dependent variable. We use monthly data for the three years preceding the derivatives date to calculate equations (12a) and (12c) for the three-year period.

The independent variables for interest rate exposures are: $(LTD/TA)_i$ is the i^{th} firm's ratio of long-term debt to total assets, $(DDER/TA)_i$ is the i firm's ratio of dollar derivatives to total assets.

We present the estimates (top) and the associated probabilities (bottom) for the coefficients of LTD/TA , $\theta_{2,p}$ and $FDER/TA$, $\theta_{3,i}$.

Table VIII
Relationship Between Commodity Exposures and Derivatives Use

Three-factor models using monthly data, user firms only

DERIVATIVES USERS	BCRB	White Std Err	Abs (CRB)	White Std Err	BCRB	White Std Err	Abs (CRB)	White Std Err
Commodity Exposure:								
IR, CM	1998				1997			
TI/TS	3.5386	3.5386	0.0426	0.0426	0.7340	0.7340	0.4661	0.4661
(Prob)	0.0015***	0.0053***	0.9583	0.9672	0.6388	0.5775	0.6574	0.5243
CDER/TA	0.5043	0.5043	0.2129	0.2129	0.4324	0.4324	0.3257	0.3257
(Prob)	0.1398	0.1209	0.4071	0.4129	0.2523	0.3146	0.1999	0.1395
n (firms)	75				71			
FX, CM								
TI/TS	2.5489	2.5489	-0.0060	-0.0060	0.2191	0.2191	1.1136	1.1136
(Prob)	0.0254**	0.0323**	0.9941	0.9952	0.882	0.8802	0.2717	0.1632
CDER/TA	0.5786	0.5786	0.2051	0.2051	0.5682	0.5682	0.3755	0.3755
(Prob)	0.1055	0.0857*	0.4244	0.4303	0.1087	0.19	0.1206	0.0831*
n (firms)	76				66			
IR, CM	1996				1995			
TI/TS	-1.6313	-1.6313	0.6245	0.6245	-3.6394	-3.6394	3.0371	3.0371
(Prob)	0.0428**	0.0517*	0.2239	0.3127	0.0354**	0.0479**	0.007***	0.0057***
CDER/TA	0.0969	0.0969	0.1173	0.1173	-1.1594	-1.1594	0.8032	0.8032
(Prob)	0.8237	0.8159	0.6755	0.4352	0.0455**	0.1165	0.0315**	0.1563
n (firms)	66				54			
FX, CM								
TI/TS	0.1224	0.1224	-0.3339	-0.3339	-3.4029	-3.4029	2.8863	2.8863
(Prob)	0.9135	0.927	0.7386	0.7709	0.0175**	0.0293**	0.0018***	0.0032***
CDER/TA	0.1546	0.1546	0.2673	0.2673	-1.0099	-1.0099	1.0788	1.0788
(Prob)	0.8192	0.7405	0.6564	0.0987*	0.0516*	0.1625	0.0015***	0.0606*
n (firms)	66				55			

*, **, *** denote significance at the 10%, 5%, and 1% levels, respectively, based on two-tailed tests.

This table reports estimates of the determinants of the absolute commodity exposures, for users only, using OLS regressions unadjusted and adjusted for heteroskedasticity (White, 1980). The regression models for estimating commodity exposures are specified by two-stage regression equations as follows:

Three-factor model for IR, CM:

$$R_{i,t} = \beta_{1,i} + \beta_{3,i}IR_t + \beta_{4,i}CM_t + \beta_{5,i}R_{m,t} + \varepsilon_{i,t} : t = 1, \dots, T \quad (12c)$$

$$\hat{\beta}_{4,i} = \lambda_{1,i} + \lambda_{2,i}(TI/TS)_i + \lambda_{3,i}(CDER/TA)_i + \mu_i : i = 1, \dots, N \quad (15)$$

Three-factor model for FX, CM:

$$R_{i,t} = \beta_{1,i} + \beta_{2,i}FX_t + \beta_{4,i}CM_t + \varepsilon_{i,t} : t = 1, \dots, T \quad (12b)$$

$$\hat{\beta}_{4,i} = \lambda_{1,i} + \lambda_{2,i}(TI/TS)_i + \lambda_{3,i}(CDER/TA)_i + \mu_i : i = 1, \dots, N \quad (15)$$

where the dependent variable for the three-factor model in (15) is estimated by the coefficient $\hat{\beta}_{4,i}$ in equation (12b) or (12c). $R_{i,t}$ is the return on the i th firm's common stock (including dividends), FX_t is the monthly percent change in the FRB nominal major currency index, IR_t is the monthly percent change in the FRB three-month London Interbank Offered Rate for dollar deposits, CM_t is the monthly percent change in the CRB commodity index, and $R_{m,t}$ is the monthly percent change in the return on the equally-weighted CRSP market portfolio (NYSE, AMEX, and Nasdaq firms). We also estimate equation (14) with $\hat{Abs}(\beta)$ for the dependent variable. We use monthly data for the three years preceding the derivatives date to calculate equations (12c) and (12b) for the three-year period.

The independent variables for commodity exposures are: $(TI/TS)_i$ is the i th firm's ratio of total inventory to total sales, $(CDER/TA)_i$ is the i th firm's ratio of commodity derivatives to total assets.

We present the estimates (top) and the associated probabilities (bottom) for the coefficients of TI/TS , $\lambda_{2,i}$ and $\gamma_{2,i}$, and $CDER/TA$, $\lambda_{3,i}$ and $\gamma_{3,i}$.

Table IX
Relationship Between Interest Rate and Currency Exposures for
Derivative Users

Three-factor MLE models using monthly data, user firms only

	1998		1997		1996		1995	
	COEF	PROB	COEF	PROB	COEF	PROB	COEF	PROB
BFX								
FS/TS	-1.0931	0.1327	-1.4157	0.0010***	-0.5925	0.2490	0.3231	0.4869
FDER/TA	-0.1099	0.9483	0.9025	0.4184	-0.8897	0.6711	-1.0262	0.6559
Abs (FX)								
FS/TS	0.0786	0.8562	0.6441	0.0170**	0.0662	0.8838	0.2623	0.4707
FDER/TA	0.0000	0.9999	-0.6284	0.4125	-0.2434	0.8861	-0.4596	0.5632
BLIBOR								
LTD/TA	0.1336	0.8587	1.9323	0.0184**	0.1239	0.6728	0.1675	0.5603
DDER/TA	2.1998	0.4915	-1.4406	0.2713	-0.3861	0.5616	0.2956	0.3520
Abs (LIBOR)								
LTD/TA	0.8782	0.1472	-1.0976	0.1038	0.1707	0.3628	0.3287	0.1198
DDER/TA	-1.3360	0.5520	1.2914	0.1779	0.1792	0.6727	-0.0983	0.7687

*, **, *** denote significance at the 10%, 5%, and 1% levels, respectively, based on two-tailed tests.

This table reports estimates of the determinants of currency and interest rate exposures for users only, using MLE with univariate distributions. Regression models for estimating exposures are specified by two-stage regression equations:

Three-factor model

$$R_{i,t} = \beta_{1,i} + \beta_{2,i}FX_t + \beta_{3,i}IR_t + \beta_{5,i}R_{m,t} + \varepsilon_{i,t} : t = 1, \dots, T \quad (12a)$$

$$\hat{\beta}_{2,i} = \gamma_{1,i} + \gamma_{2,i}(FS/TS)_i + \gamma_{3,i}(FDER/TA)_i + \xi_i : i = 1, \dots, N \quad (13) \text{ for FX or}$$

$$\hat{\beta}_{3,i} = \theta_{1,i} + \theta_{2,i}(LTD/TA)_i + \theta_{3,i}(DDER/TA)_i + \mu_i : i = 1, \dots, N \quad (14) \text{ for IR}$$

where the dependent variables in (13) or (14) are estimated using the coefficient $\beta_{2,i}$ in equation (12a). $R_{i,t}$ is the return on the i th firm's common stock (including dividends), FX_t is the monthly percent change in the FRB nominal major currency index, IR_t is the monthly percent change in the FRB three-month London Interbank Offered Rate for dollar deposits, CM_t is the monthly percent change in the CRB commodity index, and $R_{m,t}$ is the monthly percent change in the return on the equally-weighted CRSP market portfolio (NYSE, AMEX, and Nasdaq firms). We also estimate equations (13) and (14)

with $\hat{Abs}(\beta)$ for the dependent variable. We use monthly data for the three years preceding the derivatives date to calculate equations (12a) for the three-year period.

The independent variables for currency and interest rate exposures are: $(FS/TS)_i$ is the i^{th} firm's ratio of foreign sales to total sales, $(FDER/TA)_i$ is the i^{th} firm's ratio of foreign currency derivatives to total assets, $(LTD/TA)_i$ is the i^{th} firm's ratio of long-term debt to total assets, and $(DDER/TA)_i$ is the i firm's ratio of dollar derivatives to total assets.

We present the estimates and the associated probabilities for the coefficients of FS/TS , $\gamma_{2,i}$, $FDER/TA$, $\gamma_{3,i}$, LTD/TA , $\theta_{2,i}$, and $DDER/TA$, $\theta_{3,i}$.

Table IX
Relationship Between Interest Rate and Commodity Exposures and
Derivative Users

Three-factor MLE models using monthly data, user firms only

	1998		1997		1996		1995	
	COEF	PROB	COEF	PROB	COEF	PROB	COEF	PROB
BCRB								
TI/TS	3.5627	0.0002***	0.8011	0.6598	-1.5588	0.0415**	-3.6181	0.0197**
CDER/TA	0.5281	0.1405	0.4682	0.1848	0.1015	0.8209	-1.2022	0.0099***
Abs (BCRB)								
TI/TS	-0.0103	0.9871	0.3699	0.8150	0.5710	0.3963	2.9877	0.0063***
CDER/TA	0.2100	0.4096	0.2994	0.3283	0.1086	0.8497	0.7664	0.0074***
BLIBOR								
LTD/TA	0.9831	0.3935	0.6280	0.5802	0.4636	0.3794	-0.3667	0.6243
DDER/TA	4.6368	0.2619	0.3906	0.8153	0.4611	0.5165	-0.2317	0.8573
Abs (LIBOR)								
LTD/TA	0.1470	0.8859	0.0543	0.9539	0.4196	0.1505	0.5473	0.3517
DDER/TA	-4.4585	0.3253	-0.2978	0.8191	0.4537	0.4119	-0.1705	0.8080

*, **, *** denote significance at the 10%, 5%, and 1% levels, respectively, based on two-tailed tests.

This table reports estimates of the determinants of the interest rate and commodity exposures, for users only, using MLE with univariate distributions. The regression models for estimating exposures are specified by two-stage regression equations:

Three-factor model:

$$R_{i,t} = \beta_{1,i} + \beta_{3,i}IR_t + \beta_{4,i}CM_t + \beta_{5,i}R_{m,t} + \varepsilon_{i,t} : t = 1, \dots, T \quad (12c)$$

$$\hat{\beta}_{3,i} = \theta_{1,i} + \theta_{2,i}(LTD/TA)_i + \theta_{3,i}(DDER/TA)_i + v_i : i = 1, \dots, N \quad (14) \text{ for IR or}$$

$$\hat{\beta}_{4,i} = \lambda_{1,i} + \lambda_{2,i}(TI/TS)_i + \lambda_{3,i}(CDER/TA)_i + v_i : i = 1, \dots, N \quad (15) \text{ for CM}$$

where the dependent variables in (14) and (15) are estimated using the coefficient $\beta_{3,i}$ or $\beta_{4,i}$ in equation (12c). $R_{i,t}$ is the return on the i th firm's common stock (including dividends), FX_t is the monthly percent change in the FRB nominal major currency index, IR_t is the monthly percent change in the FRB three-month London Interbank Offered Rate for dollar deposits, CM_t is the monthly percent change in the return on the CRB commodity index, and $R_{m,t}$ is the monthly percent change in the return on the equally-weighted CRSP market portfolio (NYSE, AMEX, and Nasdaq firms). We also estimate equations (14) and (15) with $Abs(\hat{\beta})$ for the dependent variable. We use monthly data

for the three years preceding the derivatives date to calculate equations (12c) for the three-year period.

The independent variables for interest rate exposures are: $(LTD/TA)_i$ is the i^{th} firm's ratio of long-term debt to total assets, $(DDER/TA)_i$ is the i firm's ratio of dollar derivatives to total assets, $(TI/TS)_i$ is the i^{th} firm's ratio of total inventory to total sales, $(CDER/TA)_i$ is the i^{th} firm's ratio of commodity derivatives to total assets.

We present the estimates and the associated probabilities for the coefficients of LTD/TA , $\theta_{2,i}$, $DDER/TA$, $\theta_{3,i}$, TI/TS , $\lambda_{2,i}$, and $CDER/TA$, $\lambda_{3,i}$.

Table IX
Relationship Between Currency and Commodity Exposures and
Derivative Users

Three-factor models using monthly data, user firms only

	1998		1997		1996		1995	
	COEF	PROB	COEF	PROB	COEF	PROB	COEF	PROB
BFX								
FS/TS	0.0290	0.9531	-1.4511	0.0002***	-0.5595	0.3295	0.0290	0.9531
FDER/TA	-0.4910	0.5901	1.5657	0.1386	-0.0834	0.9599	-0.4910	0.5901
Abs (FX)								
FS/TS	0.5860	0.1132	0.8594	0.0012***	0.4083	0.4928	0.0627	0.8754
FDER/TA	-2.0738	0.0460**	-0.8906	0.3030	-0.3095	0.8680	-0.4282	0.5712
BCRB								
TI/TS	-3.4449	0.0069***	0.2760	0.8516	0.1740	0.9100	-3.4449	0.0069***
CDER/TA	-1.0492	0.0115**	0.6100	0.0447**	0.1649	0.8652	-1.0492	0.0115**
Abs (BCRB)								
TI/TS	0.1277	0.8479	1.0146	0.4640	-0.3783	0.8947	2.7919	0.0007***
CDER/TA	0.1873	0.4721	0.3473	0.2021	0.2557	0.9188	1.0438	0.0000***

*, **, *** denote significance at the 10%, 5%, and 1% levels, respectively, based on two-tailed tests.

This table reports estimates of the determinants of commodity and currency exposures, for users only, using MLE with univariate distributions. The regression models for estimating exposures are specified by two-stage regression equations:

$$R_{i,t} = \beta_{1,i} + \beta_{2,i}FX_t + \beta_{4,i}CM_t + \beta_{5,i}R_{m,t} + \varepsilon_{i,t} : t = 1, \dots, T \quad (12b)$$

$$\hat{\beta}_{2,i} = \gamma_{1,i} + \gamma_{2,i}(FS/TS)_i + \gamma_{3,i}(FDER/TA)_i + \xi_i : i = 1, \dots, N \quad (13) \text{ for FX or}$$

$$\hat{\beta}_{4,i} = \lambda_{1,i} + \lambda_{2,i}(TI/TS)_i + \lambda_{3,i}(CDER/TA)_i + \mu_i : i = 1, \dots, N \quad (15) \text{ for CM}$$

where the dependent variables in (13) and (15) are estimated by the coefficient $\beta_{2,i}$ or $\beta_{4,i}$ in equation (12b). $R_{i,t}$ is the return on the i th firm's common stock (including dividends), FX_t is the monthly percent change in the FRB nominal major currency index, IR_t is the monthly percent change in the FRB three-month London Interbank Offered Rate for dollar deposits, CM_t is the monthly percent change in the CRB commodity index, and $R_{m,t}$ is the monthly percent change in the return on the equally-weighted CRSP market portfolio (NYSE, AMEX, and Nasdaq firms). We also estimate equations (13) and (15) with $Abs(\hat{\beta})$ for the dependent variable. We use monthly data for the three years preceding the derivatives date to calculate equation (12b) for the three-year period.

The independent variables for currency and commodity exposures are: $(FS/TS)_i$ is the i^{th} firm's ratio of foreign sales to total sales, $(FDER/TA)_i$ is the i^{th} firm's ratio of foreign currency to total assets, $(TI/TS)_i$ is the i^{th} firm's ratio of total inventory to total sales, and $(CDER/TA)_i$ is the i^{th} firm's ratio of commodity derivatives to total assets.

We present the estimates and the associated probabilities for the coefficients of FS/TS , $\gamma_{2,i}$, $FDER/TA$, $\gamma_{3,i}$, TI/TS , $\lambda_{2,i}$, and $CDER/TA$, $\lambda_{3,i}$.

Table X
Bivariate Relationship Between Interest Rate and Currency Exposures
for Derivatives Users

Three-factor MLE models using monthly data, user firms only

IR, FX	Coeff 1998	Std Error	Signif	Coeff Abs (1998)	Std Error	Prob
CONSTANT	0.1947	0.2062	0.3451	0.8827	0.1442	0.0000 ***
FS/TS	-0.9183	0.7625	0.2285	-0.0999	0.4174	0.8108
FDER/TA	-0.1737	1.7950	0.9229	-0.0667	0.9470	0.9439
CONSTANT	-0.7511	0.3589	0.0363 **	0.8752	0.2397	0.0003 ***
LTD/TA	-0.1447	0.7939	0.8553	0.7484	0.5610	0.1822
DDER/TA	2.4553	3.4923	0.4820	-1.4800	2.0794	0.4766
STD ERR of REG for IR	1.1351	0.2203	0.0000 ***	0.4875	0.1032	0.0000 ***
STD ERR of REG for FX	1.3601	0.2699	0.0000 ***	0.8676	0.2193	0.0001 ***
COVAR OF RES	0.1621	0.1626	0.3187	0.1896	0.1269	0.1351

	1997			Abs (1997)		
CONSTANT	0.4346	0.1647	0.0083 ***	0.5428	0.1127	0.0000 ***
FS/TS	-1.4440	0.4479	0.0013 ***	0.3508	0.2765	0.2046
FDER/TA	0.9109	1.2292	0.4587	-0.4176	0.8542	0.6249
CONSTANT	-0.6324	0.2742	0.0211 **	0.7822	0.2191	0.0004 ***
LTD/TA	1.9269	0.8849	0.0294 **	-0.8330	0.7126	0.2424
DDER/TA	-1.4971	1.5687	0.3399	0.7771	0.9597	0.4181
STD ERR of REG for IR	0.5607	0.1117	0.0000 ***	0.2681	0.0641	0.0000 ***
STD ERR of REG for FX	0.6716	0.1121	0.0000 ***	0.3737	0.0650	0.0000 ***
COVAR OF RES	-0.0201	0.0868	0.8170	0.1213	0.0610	0.0465 **

	1996			Abs (1996)		
CONSTANT	0.3048	0.1874	0.1038	0.6686	0.1775	0.0002 ***
FS/TS	-0.6171	0.5357	0.2493	0.0330	0.4361	0.9397
FDER/TA	-1.0277	2.1726	0.6362	-0.1093	1.8028	0.9516
CONSTANT	-0.0740	0.0853	0.3851	0.1590	0.0808	0.0492 **
LTD/TA	0.0006	0.3162	0.9985	0.2334	0.2380	0.3267
DDER/TA	-0.4209	0.7936	0.5958	0.2324	0.4191	0.5792
STD ERR of REG for IR	0.7398	0.1239	0.0000 ***	0.3484	0.0507	0.0000 ***
STD ERR of REG for FX	0.0833	0.0101	0.0000 ***	0.0417	0.0062	0.0000 ***
COVAR OF RES	-0.0626	0.0450	0.1639	0.0192	0.0251	0.4448

	1995			Abs (1995)		
CONSTANT	-0.1495	0.2526	0.5540	0.5023	0.1664	0.0025 ***
FS/TS	0.6021	0.6546	0.3577	0.2618	0.3993	0.5121
FDER/TA	-1.4836	2.3029	0.5194	-0.4586	0.8179	0.5750
CONSTANT	-0.0526	0.0726	0.4687	0.1134	0.0529	0.0319 **
LTD/TA	0.0753	0.2904	0.7954	0.3283	0.2235	0.1419
DDER/TA	0.2993	0.3228	0.3538	-0.0981	0.3510	0.7798
STD ERR of REG for IR	0.6039	0.0859	0.0000 ***	0.3089	0.0677	0.0000 ***
STD ERR of REG for FX	0.0467	0.0077	0.0000 ***	0.0187	0.0029	0.0000 ***
COVAR OF RES	-0.0474	0.0369	0.1992	0.0001	0.0135	0.9949

*, **, *** denote significance at the 10%, 5%, and 1% levels, respectively, based on two-tailed tests.

This table reports estimates of the determinants of interest rate and currency exposures for users only, using MLE with bivariate distributions that maximize the log-likelihood function using the Berndt-Hull-Hull-Hausman algorithm. Regression models for estimating exposures are specified by two-stage regression equations:

Three-factor model

$$R_{i,t} = \beta_{1,i} + \beta_{2,i}FX_t + \beta_{3,i}IR_t + \beta_{5,i}R_{m,t} + \varepsilon_{i,t} : t = 1, \dots, T \quad (12a)$$

$$\hat{\beta}_{2,i} = \gamma_{1,i} + \gamma_{2,i}(FS/TS)_i + \gamma_{3,i}(FDER/TA)_i + \xi_i : i = 1, \dots, N \quad (13) \text{ and}$$

$$\hat{\beta}_{3,i} = \theta_{1,i} + \theta_{2,i}(LTD/TA)_i + \theta_{3,i}(DDER/TA)_i + \xi_i : i = 1, \dots, N \quad (14)$$

where the dependent variables in (13) and (14) are estimated using the $\beta_{2,i}$ and $\beta_{3,i}$ in equation (12a). $R_{i,t}$ is the return on the i th firm's common stock (including dividends), FX_t is the monthly percent change in the FRB nominal major currency index, IR_t is the monthly percent change in the FRB three-month London Interbank Offered Rate for dollar deposits, and $R_{m,t}$ is the monthly percent change in the equally-weighted CRSP market portfolio (NYSE, AMEX, and Nasdaq firms). We also estimate equations (13) and (14) with $Abs(\hat{\beta})$ for the dependent variable. We use monthly data for the three years preceding the derivatives date to calculate equations (12a) for the three-year period.

The independent variables for interest rate and currency exposures are: $(FS/TS)_i$ is the i^{th} firm's ratio of foreign sales to total sales, $(FDER/TA)_i$ is the i^{th} firm's ratio of foreign currency derivatives to total assets, $(LTD/TA)_i$ is the i^{th} firm's ratio of long-term debt to total assets, and $(DDER/TA)_i$ is the i^{th} firm's ratio of dollar derivatives to total assets.

We present the estimates and the associated probabilities for the coefficients of FS/TS , $\gamma_{2,i}$, $FDER/TA$, $\gamma_{3,i}$, LTD/TA , $\theta_{2,i}$, and $DDER/TA$, $\theta_{3,i}$.

Table X
Bivariate Relationship Between Currency and Commodity Exposures
for Derivatives Users

Three-factor MLE models using monthly data, user firms only

FX, CM	Coeff 1998	Std Error	Signif	Coeff Abs (1998)	Std Error	Prob
CONSTANT	-0.3369	0.2254	0.1349	0.8868	0.2000	0.0000 ***
FS/TS	-0.7398	0.5659	0.1911	0.6376	0.4263	0.1347
FDER/TA	1.7625	1.6987	0.2995	-2.3509	1.0947	0.0317 **
CONSTANT	-0.3948	0.1952	0.0432 **	0.6136	0.1658	0.0002 ***
TI/TS	2.7125	1.0973	0.0135 **	0.0707	0.7146	0.9212
CDER/TA	0.7119	0.4637	0.1248	0.0133	0.3418	0.9689
STD ERR of REG for FX	1.4070	0.2607	0.0000 ***	0.7413	0.1415	0.0000 ***
STD ERR of REG for CM	0.6343	0.0899	0.0000 ***	0.3286	0.0643	0.0000 ***
COVAR OF RES	0.1327	0.1207	0.2714	0.1010	0.0762	0.1848

	1997			Abs (1997)		
CONSTANT	0.2135	0.1496	0.1535	0.4191	0.1455	0.0040 ***
FS/TS	-1.3416	0.3735	0.0003 ***	0.8801	0.2846	0.0020 ***
FDER/TA	1.5111	1.1611	0.1931	-0.7632	0.8872	0.3897
CONSTANT	-0.4739	0.2408	0.0491 **	0.5345	0.2202	0.0152 **
TI/TS	0.5767	1.5495	0.7097	0.5244	1.5815	0.7402
CDER/TA	1.0060	0.3728	0.0070 *	0.1715	0.3335	0.6070
STD ERR of REG for FX	0.6162	0.1204	0.0000 ***	0.3096	0.0713	0.0000 ***
STD ERR of REG for CM	0.5912	0.1058	0.0000 ***	0.2732	0.0420	0.0000 ***
COVAR OF RES	0.2311	0.0861	0.0073 ***	0.1020	0.0573	0.0751 *

	1996			Abs (1996)		
CONSTANT	0.0246	0.2640	0.9259	0.4462	0.2703	0.0988 *
FS/TS	-0.3467	0.4396	0.4303	0.6101	0.3692	0.0985 *
FDER/TA	0.0989	1.3161	0.9401	-0.0393	0.9340	0.9664
CONSTANT	-0.3508	0.3669	0.3390	0.5604	0.4598	0.2230
TI/TS	0.4716	1.2456	0.7050	0.2970	1.2100	0.8061
CDER/TA	-0.4440	0.7090	0.5311	0.0252	1.0225	0.9803
STD ERR of REG for FX	0.8178	0.2149	0.0001 ***	0.4424	0.1802	0.0141 **
STD ERR of REG for CM	1.3160	0.1645	0.0000 ***	1.0296	0.2339	0.0000 ***
COVAR OF RES	-0.6312	0.1848	0.0006 ***	0.4357	0.1433	0.0024 ***

	1995			Abs (1995)		
CONSTANT	-0.0088	0.2001	0.9649	0.6024	0.1690	0.0004 ***
FS/TS	0.0270	0.5088	0.9577	0.0425	0.4047	0.9164
FDER/TA	-0.5026	0.9238	0.5864	-0.4433	0.7603	0.5598
CONSTANT	0.7359	0.3136	0.0190 **	0.2567	0.2409	0.2866
TI/TS	-3.4600	1.3252	0.0090 ***	2.7972	0.8439	0.0009 ***
CDER/TA	-1.0380	0.4249	0.0146 **	1.0467	0.2658	0.0001 ***
STD ERR of REG for FX	0.6659	0.0996	0.0000 ***	0.3396	0.1009	0.0008 ***
STD ERR of REG for CM	0.9990	0.2298	0.0000 ***	0.4034	0.0860	0.0000 ***
COVAR OF RES	0.0193	0.1396	0.8899	-0.0189	0.1073	0.8604

*, **, *** denote significance at the 10%, 5%, and 1% levels, respectively, based on two-tailed tests.

This table reports estimates of the determinants of the currency and commodity exposures, for users only, using MLE with bivariate distributions that maximize the log-likelihood function using the Berndt-Hull-Hull-Hausman algorithm. The regression models for estimating exposures are specified by two-stage regression equations:

Three-factor model:

$$R_{i,t} = \beta_{1,i} + \beta_{2,i}FX_t + \beta_{4,i}CM_t + \beta_{5,i}R_{m,t} + \varepsilon_{i,t} : t = 1, \dots, T \quad (12b)$$

$$\hat{\beta}_{2,i} = \gamma_{1,i} + \gamma_{2,i}(FS/TS)_i + \gamma_{3,i}(FDER/TA)_i + \xi_{i,t} : i = 1, \dots, N \quad (13) \text{ and}$$

$$\hat{\beta}_{4,i} = \lambda_{1,i} + \lambda_{2,i}(TI/TS)_i + \lambda_{3,i}(CDER/TA)_i + \mu_{i,t} : i = 1, \dots, N \quad (14)$$

where the dependent variables in (13) and (14) are estimated using the coefficients $\beta_{2,i}$ and $\beta_{4,i}$ in equation (12b). $R_{i,t}$ is the return on the i th firm's common stock (including dividends), FX_t is the monthly percent change in the FRB nominal major currency index, CM_t is the monthly percent change in the CRB commodity index, and $R_{m,t}$ is the monthly percent change in the equally-weighted CRSP market portfolio (NYSE, AMEX, and Nasdaq firms). We also estimate equations (13) and (14) with $Abs(\hat{\beta})$ for the dependent variable. We use monthly data for the three years preceding the derivatives date to calculate equations (12b) for the three-year period.

The independent variables for currency and commodity exposures are: $(FS/TS)_i$ is the i th firm's ratio of foreign sales to total sales, $(FDER/TA)_i$ is the i th firm's ratio of foreign currency derivatives to total assets, $(TI/TS)_i$ is the i th firm's ratio of total inventory to total sales, and $(CDER/TA)_i$ is the i th firm's ratio of commodity derivatives to total assets.

We present the estimates and the associated probabilities for the coefficients of FS/TS , $\gamma_{2,i}$, $FDER/TA$, $\gamma_{3,i}$, TI/TS , $\lambda_{2,i}$, and $CDER/TA$, $\lambda_{3,i}$.

Table X
Relationship Between Interest Rate and Commodity Exposures for
Derivative Users

Three-factor MLE models using monthly data, user firms only

IR, CM	Coeff 1998	Std Error	Signif	Coeff Abs (1998)	Std Error	Prob
CONSTANT	-1.2801	0.3804	0.0008 ***	1.4763	0.3567	0.0000 ***
LTD/TA	0.5638	1.2356	0.6482	0.1493	1.0674	0.8887
DDER/TA	4.6179	4.5901	0.3144	-4.4477	4.9816	0.3720
CONSTANT	-0.4372	0.1963	0.0259 **	0.5912	0.1557	0.0001 ***
TI/TS	3.4411	1.0130	0.0007 ***	-0.0167	0.6647	0.9799
CDER/TA	0.4059	0.3861	0.2932	0.1993	0.2877	0.4885
STD ERR of REG for IR	2.3705	0.4059	0.0000 ***	1.6183	0.2734	0.0000 ***
STD ERR of REG for CM	0.5744	0.1061	0.0000 ***	0.3261	0.0729	0.0000 ***
COVAR OF RES	-0.1794	0.1626	0.2699	0.0133	0.0921	0.8852

	1997			Abs (1997)		
CONSTANT	-0.5732	0.3245	0.0773 *	0.7825	0.3231	0.0155 **
LTD/TA	0.2833	1.0961	0.7961	0.0079	1.0015	0.9937
DDER/TA	0.7617	1.6179	0.6378	-0.2391	1.4765	0.8714
CONSTANT	-0.2275	0.2945	0.4398	0.5821	0.2185	0.0077 ***
TI/TS	0.1218	1.7871	0.9456	0.2852	1.6017	0.8587
CDER/TA	0.2167	0.4003	0.5883	0.2503	0.4521	0.5798
STD ERR of REG for IR	0.9633	0.1736	0.0000 ***	0.5957	0.1284	0.0000 ***
STD ERR of REG for CM	0.6897	0.1097	0.0000 ***	0.3048	0.0448	0.0000 ***
COVAR OF RES	-0.1923	0.1242	0.1217	0.0324	0.0722	0.6537

	1996			Abs (1996)		
CONSTANT	-0.1875	0.1638	0.2523	0.1822	0.1065	0.0871 *
LTD/TA	0.4077	0.5718	0.4758	0.4013	0.2957	0.1747
DDER/TA	0.3027	0.9147	0.7407	0.1178	0.4363	0.7872
CONSTANT	0.1866	0.1746	0.2851	0.4422	0.1058	0.0000 ***
TI/TS	-1.6941	0.8165	0.0380 **	0.7721	0.4533	0.0885 *
CDER/TA	0.1134	0.4321	0.7930	0.0975	0.3609	0.7869
STD ERR of REG for IR	0.1465	0.0289	0.0000 ***	0.0801	0.0170	0.0000 ***
STD ERR of REG for CM	0.5023	0.1125	0.0000 ***	0.2041	0.0428	0.0000 ***
COVAR OF RES	-0.0525	0.0344	0.1269	0.0558	0.0162	0.0006 ***

	1995			Abs (1995)		
CONSTANT	0.1300	0.1629	0.4251	0.2081	0.1532	0.1745
LTD/TA	-0.5811	0.5976	0.3308	0.5527	0.5903	0.3491
DDER/TA	-0.4166	0.9946	0.6753	-0.1679	0.7090	0.8128
CONSTANT	0.8506	0.3308	0.0101 **	0.4290	0.2319	0.0643 *
TI/TS	-3.2309	1.4838	0.0294 **	2.9659	1.1502	0.0099 ***
CDER/TA	-1.4226	0.4152	0.0006 ***	0.8099	0.3052	0.0080 ***
STD ERR of REG for IR	0.2003	0.0389	0.0000 ***	0.1036	0.0173	0.0000 ***
STD ERR of REG for CM	1.2182	0.3660	0.0009 ***	0.4971	0.0997	0.0000 ***
COVAR OF RES	-0.2060	0.1285	0.1089	0.0265	0.0657	0.6870

*, **, *** denote significance at the 10%, 5%, and 1% levels, respectively, based on two-tailed tests.

This table reports estimates of the determinants of the interest rate and commodity exposures, for users only, using MLE with bivariate distributions that maximize the log-likelihood function using the Berndt-Hull-Hull-Hausman algorithm. The regression models for estimating interest rate and commodity exposures are specified by two-stage regression equations:

Three-factor model:

$$R_{i,t} = \beta_{1,i} + \beta_{3,i}IR_t + \beta_{4,i}CM_t + \beta_{5,i}R_{m,t} + \varepsilon_{i,t} : t = 1, \dots, T \quad (12c)$$

$$\hat{\beta}_{3,i} = \theta_{1,i} + \theta_{2,i}(LTD/TA)_i + \theta_{3,i}(DDER/TA)_i + v_i : i = 1, \dots, N \quad (14) \text{ and}$$

$$\hat{\beta}_{4,i} = \lambda_{1,i} + \lambda_{2,i}(TI/TS)_i + \lambda_{3,i}(CDER/TA)_i + \mu_i : i = 1, \dots, N \quad (15)$$

where the dependent variables in (14) and (15) are estimated using the coefficients $\beta_{3,i}$ and $\beta_{4,i}$ in equation (12c). $R_{i,t}$ is the return on the i th firm's common stock (including dividends), IR_t is the monthly percent change in the FRB three-month London Interbank Offered Rate for dollar deposits, CM_t is the monthly percent change in the CRB commodity index, and $R_{m,t}$ is the monthly percent change in the equally-weighted CRSP market portfolio (NYSE, AMEX, and Nasdaq firms). We also estimate equations (14) and (15) with $Abs(\hat{\beta})$ for the dependent variable. We use monthly data for the three years preceding the derivatives date to calculate equations (12c) and for the three-year period.

The independent variables for interest rate and commodity exposures are: $(LTD/TA)_i$ is the i th firm's ratio of long-term debt to total assets, and $(DDER/TA)_i$ is the i th firm's ratio of dollar derivatives to total assets, $(TI/TS)_i$ is the i th firm's ratio of total inventory to total sales, and $(CDER/TA)_i$ is the i th firm's ratio of commodity derivatives to total assets.

We present the estimates and the associated probabilities for the coefficients of LTD/TA , $\theta_{2,i}$, $DDER/TA$, $\theta_{3,i}$, TI/TS , $\lambda_{2,i}$ and $CDER/TA$, $\lambda_{3,i}$.

Table XI
Univariate Relationship Between Currency Exposures and Derivatives Use

Two-factor OLS model using monthly data, user firms only

	BFX	White Std Err	Abs (BFX)	White Std Err	BFX	White Std Err	Abs (BFX)	White Std Err
Currency Exposure:								
	1998				1997			
FS/TS	-1.3000	-1.3000	0.8923	0.8923	-1.4833	-1.4833	0.7305	0.7305
(Prob)	0.1230	0.1444	0.1271	0.1099	0.0039***	0.009***	0.043**	0.0643*
FDER/TA	-1.5897	-1.5897	0.4233	0.4233	0.8333	0.8333	-0.2766	-0.2766
(Prob)	0.4562	0.5322	0.7744	0.8268	0.3370	0.2865	0.6575	0.6625
n (firms)	48				43			
	1996				1995			
FS/TS	-0.5914	-0.5914	0.2269	0.2269	0.4428	0.4428	-0.1709	-0.1709
(Prob)	0.2652	0.2685	0.5586	0.5681	0.4822	0.3986	0.7067	0.6002
FDER/TA	-0.7700	-0.7700	-0.2728	-0.2728	-1.4293	-1.4293	-0.4058	-0.4058
(Prob)	0.5207	0.2553	0.7563	0.4516	0.1916	0.0187**	0.6043	0.4902
n (firms)	48				40			

*, **, *** denote significance at the 10%, 5%, and 1% levels, respectively, based on two-tailed tests.

This table reports estimates of the determinants of currency exposures for users only, using OLS regressions adjusted for heteroskedasticity using White (1980). Regression models for estimating currency exposures are specified by two-stage regression equations:

Two-factor model:

$$R_{i,t} = \beta_{1,t} + \beta_{2,t}FX_t + \beta_{3,t}R_{m,t} + \varepsilon_{i,t} : t = 1, \dots, T \quad (11)$$

$$\hat{\beta}_{2,i} = \gamma_{1,i} + \gamma_{2,i}(FS/TS)_i + \gamma_{3,i}(FDER/TA)_i + \xi_i : i = 1, \dots, N \quad (13)$$

where the dependent variable in (13) is estimated by the coefficient $\beta_{2,i}$ in equation (11).

$R_{i,t}$ is the return on the i th firm's common stock (including dividends), FX_t is the monthly percent change in the FRB nominal major currency index, and $R_{m,t}$ is the monthly percent change in the return on the equally-weighted CRSP market portfolio (NYSE, AMEX, and Nasdaq firms). We also estimate equation (11) with $Abs(\hat{\beta}_{2,i})$ for the dependent variable. We use monthly data for the three years preceding the derivatives date to calculate equation (13) for the three-year period.

The independent variables for currency exposures are: $(FS/TS)_i$ is the i^{th} firm's ratio of foreign sales to total sales, and $(FDER/TA)_i$ is the i^{th} firm's ratio of foreign currency derivatives to total assets.

We present the estimates (top) and the associated probabilities (bottom) for the coefficient of FS/TS , $\gamma_{2,i}$, and $FDER/TA$, $\gamma_{3,i}$.

Table XI
Univariate Relationship Between Interest Rate Exposures and
Derivatives Use

Two-factor OLS model using monthly data, user firms only

	BLIBOR	White Std Err	Abs (BLIBOR)	White Std Err	BLIBOR	White Std Err	Abs (BLIBOR)	White Std Err
Interest Rate Exposure:								
	1998				1997			
LTD/TA	3.1533	3.1533	-1.6536	-1.6536	2.3531	2.3531	-1.6509	-1.6509
(Prob)	0.035**	0.0246**	0.1588	0.1259	0.0465**	0.1423	0.0732*	0.1966
DDER/TA	1.1143	1.1143	-1.0456	-1.0456	-1.8541	-1.8541	2.3157	2.3157
(Prob)	0.6830	0.5400	0.6306	0.4437	0.3273	0.4057	0.1213	0.2353
n (firms)	45				46			
	1996				1995			
LTD/TA	0.4569	0.4569	0.4086	0.4086	0.3302	0.3302	0.4059	0.4059
(Prob)	0.3080	0.3864	0.2243	0.2929	0.3765	0.4426	0.1038	0.1719
DDER/TA	-0.5021	-0.5021	0.2426	0.2426	-0.0195	-0.0195	-0.1816	-0.1816
(Prob)	0.3986	0.0814*	0.5847	0.4120	0.9576	0.9263	0.4560	0.0918*
n (firms)	43				38			

*, **, *** denote significance at the 10%, 5%, and 1% levels, respectively, based on two-tailed tests.

This table reports estimates of the determinants of the interest rate exposures, for users only, using OLS regressions adjusted for heteroskedasticity using White (1980). The regression models for estimating interest rate exposures are specified by two-stage regression equations:

Two-factor model:

$$R_{i,t} = \beta_{1,t} + \beta_{3,t}IR_t + \beta_{5,t}R_{m,t} + \varepsilon_{i,t} : t = 1, \dots, T \quad (16)$$

$$\hat{\beta}_{3,i} = \theta_{1,i} + \theta_{2,i}(LTD/TA)_i + \theta_{3,i}(DDER/TA)_i + v_i : i = 1, \dots, N \quad (14)$$

where the dependent variable in (14) is estimated by the coefficient $\beta_{3,i}$ in equation (16).

$R_{i,t}$ is the return on the i th firm's common stock (including dividends), IR_t is the percent change in the FRB three-month London Interbank Offered Rate for dollar deposits, and $R_{m,t}$ is the percent change in the return on the equally-weighted CRSP market portfolio

(NYSE, AMEX, and Nasdaq firms). We also estimate equation (14) with $Abs(\hat{\beta}_{3,i})$ for the dependent variable. We use monthly data for the three years preceding the derivatives date to calculate equation (16) for the three-year period.

The independent variables for interest rate exposures are: $(LTD/TA)_i$ is the i^{th} firm's ratio of long-term debt to total assets, $(DDER/TA)_i$ is the i^{th} firm's ratio of dollar derivatives to total assets.

We present the estimates (top) and the associated probabilities (bottom) for the coefficient of LTD/TA , $\theta_{2,i}$ and $DDER/TA$, $\theta_{3,i}$.

Table XI
Univariate Relationship Between Commodity Exposures and
Derivatives Use

Two factor OLS model using monthly data, user firms only

	BCRB	White Std Err	Abs (BCRB)	White Std Err	BCRB	White Std Err	Abs (BCRB)	White Std Err
Commodity Exposure:								
	1998				1997			
TI/TS	1.3551	1.3551	0.3914	0.3914	-0.3405	-0.34053	0.0166	0.0166
(Prob)	0.0346**	0.0001***	0.3748	0.3009	0.8422	0.7935	0.9893	0.9846
CDER/TA	0.7279	0.7279	0.4102	0.4102	0.4047	0.40472	0.3243	0.3243
(Prob)	0.0262**	0.0489**	0.0716*	0.2051	0.3085	0.3702	0.2602	0.1479
n (firms)	48				42			
	1996				1995			
TI/TS	-2.0157	-2.0157	1.0465	1.0465	-3.3676	-3.3676	2.5669	2.5669
(Prob)	0.005***	0.0134**	0.0179**	0.0956*	0.1088	0.0758*	0.0597*	0.0223**
CDER/TA	0.1353	0.1353	0.3377	0.3377	-1.8124	-1.8124	0.6374	0.6374
(Prob)	0.7193	0.7624	0.1596	0.04**	0.0167**	0.0285**	0.1728	0.3272
n (firms)	34				28			

*, **, *** denote significance at the 10%, 5%, and 1% levels, respectively, based on two-tailed tests.

This table reports estimates of the determinants of the commodity exposures, for users only, using OLS regressions adjusted for heteroskedasticity using White (1980). The regression models for estimating commodity exposures are specified by two-stage regression equations:

Two-factor model:

$$R_{i,t} = \beta_{1,i} + \beta_{4,i}CM_t + \beta_{5,i}R_{m,t} + \varepsilon_{i,t} : t = 1, \dots, T \quad (17)$$

$$\hat{\beta}_{4,i} = \lambda_{1,i} + \lambda_{2,i}(TI/TS)_i + \lambda_{3,i}(CDER/TA)_i + \mu_i : i = 1, \dots, N \quad (15)$$

where the dependent variable in (15) is estimated by the coefficient $\hat{\beta}_{4,i}$ in equation (17). $R_{i,t}$ is return on the i th firm's common stock (including dividends), CM_t is the monthly percent change in the CRB commodity index, and $R_{m,t}$ is the monthly percent change in the return on the equally-weighted CRSP market portfolio (NYSE, AMEX, and Nasdaq firms). We also estimate equation (15) with $Abs(\hat{\beta}_{4,i})$ for the dependent variable. We use monthly data for the three years preceding the derivatives date to calculate equation (17) and for the three-year period.

The independent variables for commodity exposures are: $(TI/TS)_i$ is the i^{th} firm's ratio of total inventory to total sales, and $(CDER/TA)_i$ is the i^{th} firm's ratio of commodity derivatives to total assets.

We present the estimates (top) and the associated probabilities (bottom) for the coefficient of TI/TS , $\lambda_{2,i}$, and $CDER/TA$, $\lambda_{3,i}$.

Table XII
Probabilities from Test of Equality of Means for Betas
For Users and Nonusers
1998-1995

	1998 PROB	1997 PROB	1996 PROB	1995 PROB
FX, IR:				
BFX	0.8296	0.8569	0.9322	0.9588
ABS(BFX)	0.0134**	0.0258**	0.0485**	0.0012***
BLIBOR	0.1612	0.6606	0.095*	0.6112
ABS(BLIBOR)	0.7738	0.1306	0.067*	.000000***
FX, CM:				
BCRB	0.7407	0.4371	0.0031***	0.1096
ABS(BCRB)	0.0423**	0.4402	0.0673*	0.0113**
BFX	0.0015***	0.1864	0.3625	0.5657
ABS(BFX)	0.2025	0.0753*	0.0514*	0.0211**
IR, CM:				
BCRB	0.8034	0.8683	0.4609	0.4491
ABS(BCRB)	0.0309**	0.7040	0.0223**	0.1600
BLIBOR	0.0003***	0.099*	0.3986	0.6221
ABS(BLIBOR)	0.0003***	0.8309	0.0808*	0.0611*

*, **, *** denote significance in mean value at the 10%, 5%, and 1% levels, respectively, based on two-tailed tests.

This table contains the probabilities of exposures and absolute exposures for user and nonusers of derivatives. The two variable combinations of derivative users are shown as currency and interest rates (FX, IR), currencies and commodities (FX, CM), and interest rates and commodities (IR, CM). BFX and ABS(BFX) are currency exposure coefficients obtained with the three-factor model using the FRB nominal major currency index, the equally-weighted CRSP market index, and either the FRB 3-month LIBOR rate or the CRB commodity index, depending on which user category is being examined.

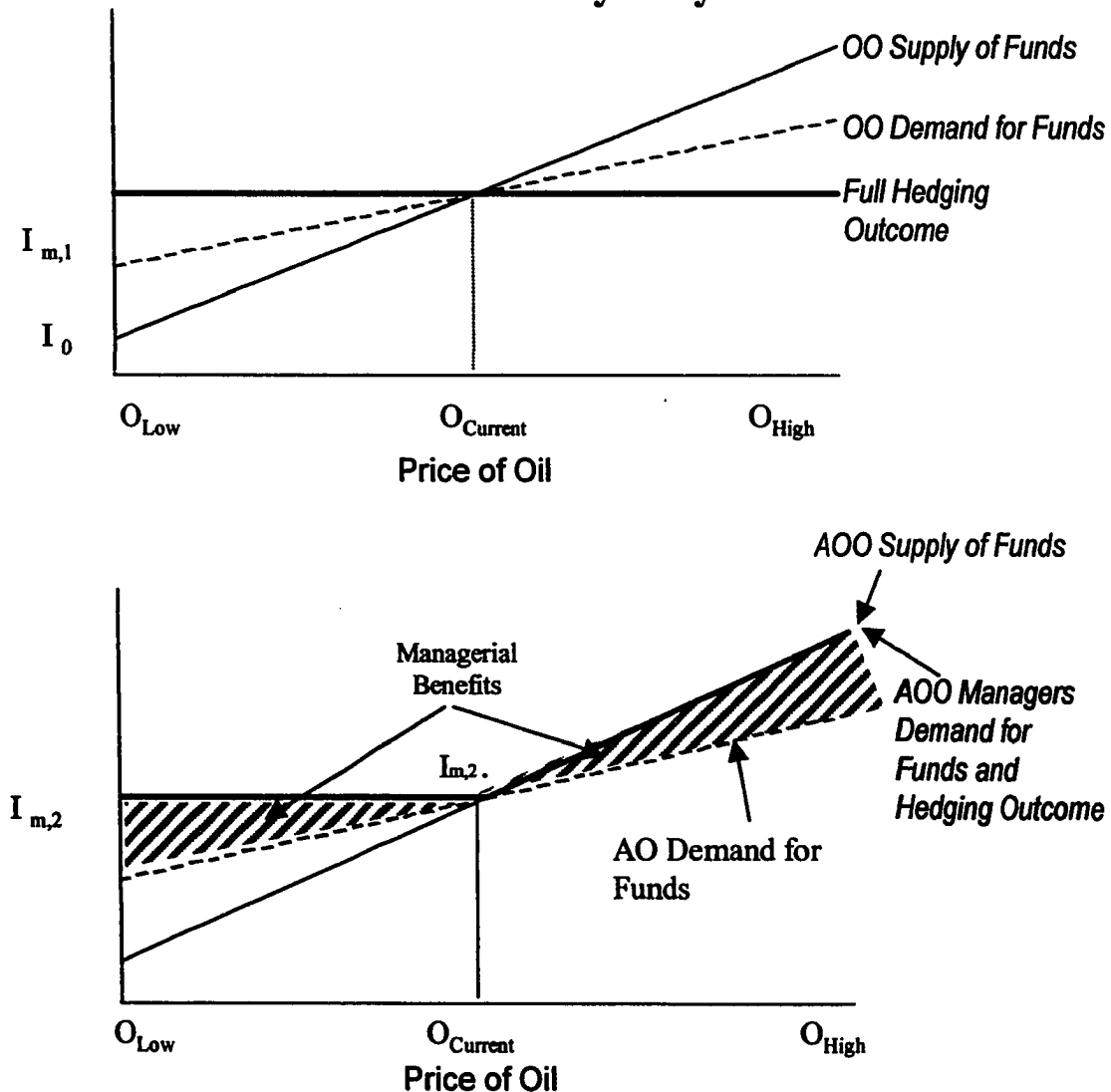
BLIBOR and ABS(BLIBOR) are interest rate exposure coefficients obtained with the three-factor model using the FRB 3-month LIBOR rate, the equally-weighted CRSP market index, and either the FRB nominal major currency index or the CRB commodity index, depending on which user category is being examined.

BCRB and ABS(BCRB) are commodity exposure coefficients obtained with the three-factor model using the FRB commodity index, the equally-weighted CRSP market index,

and either the FRB nominal major currency index or the FRB 3-month LIBOR rate, depending on which user category is being examined.

Figure 1

Hedging and the Effects of Agency Costs and Informational Asymmetry



Both firms are faced with the same initial supply of funds and investment needs under low, current and high oil prices.

For OO, information asymmetry and agency costs are not severe and capital markets exist to finance projects. Hedging outcome is line $I_{m,1}$.

For AOO, information asymmetry and agency costs are severe. Hedging allows managers to shift demand for funds up in high price states and capture private benefits. Under low price states managers can fund investment projects that the capital markets would reject. Hedging outcome is line $I_{m,2}$.

* Adapted from Froot, Scharstein and Stein (1994, p. 8) and Tufano (1998, p. 69).

REFERENCES

- Adam, Tim R., 1999, Do firms use derivatives to reduce their dependence on external capital markets? Working paper, Hong Kong University of Science & Technology.
- Adler, Michael, and Bernard Dumas, 1984, Exposure to currency risk: definition and measurement. *Financial Management*, 13: 41-50.
- Agrawal, Anup, and Gershon Mandelker, 1987, Managerial incentives and corporate investment and financing decisions. *Journal of Finance*, 42: 823-837.
- Alchian, A. A., and R. Kessel, September, 1959, Redistribution of wealth through inflation. *Science*, 30: 535-539.
- Allayannis, George, and Eli Ofek, 2001, Exchange rate exposure, hedging, and the use of foreign currency derivatives. *Journal of International Money and Finance*, 20: 273-296.
- _____ and J. Weston, 2001, The use of foreign currency derivatives and firm market value, forthcoming, *The Review of Financial Studies*.
- Amihud, Yakov, and Baruch Lev, 1981, Risk reduction as managerial motive for conglomerate mergers. *Bell Journal of Economics*, 12: 605-617.
- Association for Financial Professionals, May 21, 2001, The impact of FAS 133 on the risk management practices of end users of derivatives, survey results. n.p.
- Banz, Rolf W., 1981, The relationship between return and market value of common stocks. *Journal of Financial Economics*, 9: 3-18.
- Barton, Jan, January, 2000, Does the use of financial derivatives affect earnings management decisions? *Emory University Working Paper*.
- Bartram, Sohnke M., 2002, Linear and non-linear foreign exchange rate exposures of German nonfinancial corporations, *Lancaster University Working Paper*.
- Bartov, Eli, and Gordon Bodnar, 1994, Firm valuation, earnings expectations, and the exchange rate exposure effect. *Journal of Finance*, 44: 1755-1785.
- Basu, Sanjoy, 1983, The relationship between earnings yield, market value, and return for NYSE common stocks: further evidence. *Journal of Financial Economics*, 12: 129-156.

- Beatty, Anne, 1999, Assessing the use of derivatives as part of a risk-management strategy. *Journal of Accounting and Economics*, 26: 353-357.
- Bicksler, James and Andrew H. Chen, 1986, An economic analysis of interest rate swaps. *Journal of Finance*, 41, 645-655.
- Black, F., and M. Scholes, 1973, The pricing of options and corporate liabilities. *Journal of Political Economy*, 81: 637-659.
- Blankley, Alan, Reinhold Lamb, and Richard Schroeder, Spring, 2000, Compliance with SEC disclosure requirements about market risk. *The Journal of Derivatives*, 39-50.
- Block, S. B. and T. J. Gallagher, 1986, The use of interest rate futures and options by corporate financial managers. *Financial Management*, 15: 73-78.
- Blose, Laurence E., and Joseph C. P. Shieh, 1995, The impact of gold price on the value of gold mining stock. *Review of Financial Economics*, 42: 125-139.
- Bodnar, Gordon M, Fall, 2002, Estimating exchange rate exposures: issues in model structure. *University of Pennsylvania Working Paper*.
- _____, Gregory S. Hayt, and Richard C. Marston, 1998, 1998 Wharton survey of financial risk management by US non-financial firms. *Financial Management*, 27: 70-91.
- _____, Wharton School and The Chase Manhattan Bank, N.A, 1996, 1995 survey of derivatives- usage among non-financial firms. *Financial Management*.
- _____, Wharton School and The Chase Manhattan Bank, N.A, 1995, 1994 survey of derivatives- usage among non-financial firms. *Financial Management*.
- _____, and M. H. Franco Wong, January, 2000, Estimating exchange rate exposures: some weighty issues. *National Bureau of Economic Research Working Paper*.
- Bolster, Paul, Don Chance, and Don Rich, 1996, Executive equity swaps and corporate insider holdings. *Financial Management*, 25: 14-24.
- Booth, J.R., R.L. Smith, and Rene W. Stulz, 1986, The use of interest rate futures by financial institutions. *Journal of Bank Research*, 15: 15-20.
- Breeden, D. and S. Viswanathan, 1996, Why do firms hedge? An asymmetric information model. *Duke University Working Paper*.

- Brown, Gregory W., May, 2001, Managing foreign exchange risk with derivatives. *Journal of Financial Economics*, 60, 401-448..
- Carter, David A., Christos Pantzalis, and Betty J. Simkins, 2001, Firm wide risk management of foreign exchange exposure by U.S. multinational corporations. *Oklahoma State University Working Paper*.
- Chacko, George, Peter Tufano, and Geoffrey Verter, February, 2000, Cephalon, Inc. taking risk management seriously. *Harvard University Working Paper*.
- Chang, C., 1997, Does hedging aggravate or alleviate agency problems? A managerial theory of risk management. *University of Minnesota Working Paper*.
- Dadalt, Peter, Gerald D. Gay, and Jouahn Nam, 2002, Asymmetric information and corporate derivatives use. *The Journal of Futures Markets*, 22: 241-267.
- DeBondt, Werner F.M. and Thaler, Richard M., 1985, Does the stock market overreact? *Journal of Finance*, 40: 793-805.
- DeMarzo, Peter, and Darrell Duffie, 1995, Corporate incentives for hedging and hedge accounting. *Review of Financial Studies*, 8: 743-772.
- Dimson, Elroy, 1979, Risk measurement when shares are subject to infrequent trading. *Journal of Financial Economics*, 7: 197-226.
- Dolde, Walter., 1995, Hedging, leverage, and primitive risk. *The Journal of Financial Engineering* 4: 187-216.
- Duffie, Darrell, and Jun Pan, Spring, 1997, An overview of value at risk. *The Journal of Derivatives*, 4: 7-47.
- Dumas, Bernard, June, 1978, The theory of the trading firm revisited. *Journal of Finance*, 33: 1019-1029.
- _____, and Bruno Solnik, 1995, The world price of foreign exchange risk. *The Journal of Finance*, 50: 445-479.
- Eccher, Elizabeth A., K. Ramesh and S. Ramu Thiagarajan, 1996, Fair value disclosures by bank holding companies. *Journal of Accounting and Economics*, 22: 79-117.
- Fama, Eugene F, 1988, Business cycles and the behavior of metals prices. *The Journal of Finance*, 43: 1075-1093.

- _____, June, 1975, Short-term interest rates as predictors of inflation. *American Economic Review*, 269-282.
- _____, and Kenneth R. French, 1987, Commodity futures price: some evidence on forecast power, premiums, and the theory of storage. *Journal of Business*, 60: 55-73.
- _____, and Kenneth R. French, 1993, Common risk factors in the returns on stock and bonds. *Journal of Financial Economics*, 33: 3-56.
- _____, and Kenneth R. French, 1996, Multifactor explanations of asset pricing anomalies. *Journal of Finance*, 51: 55-84.
- _____, and Michael Gibbons, May, 1982, Inflation, real returns and capital investment. *Journal of Monetary Economics*.
- _____, and Merton H. Miller, 1972, *The Theory Of Finance*. (New York: Holt, Rinehart, and Winston).
- _____, and William G. Schwert, November, 1977, Asset returns and inflation. *Journal of Financial Economics*, 6: 115-146.
- Financial Accounting Standards Board, 1994, *Statement of Financial Accounting Standards No. 119: Disclosure about derivative financial instruments and fair value of financial instruments*. (FASB, Stamford, Conn.).
- _____, 1998, *Statement of Financial Accounting Standards No. 133: Accounting for derivative instruments and hedging activities*. (FASB, Stamford, Conn.).
- Flannery, Mark J., and Christopher M. James, 1984, The effect of interest rate changes on the common stock returns of financial institutions. *Journal of Financial Economics*, 39: 1141-1153
- Folger, H. Russel, Kose John, and James Tipton, May, 1981, Three factors, interest rate differentials and stock groups. *Journal of Finance*, 36: 323-335.
- Fowler, David J. and C. Harvey Rorke, 1983, Risk measurement when shares are subject to infrequent trading. *Journal of Financial Economics*, 12: 279-283.
- Fraser, Steve P. and Christos Pantzalis, October, 2002, Foreign exchange rate exposure of U.S. multinational corporations: a firm specific approach. *University of South Florida Working Paper*.

- French, Kenneth R., Richard S. Ruback, and G. William Schwert, 1983, Effects of nominal contracting on stock returns. *Journal of Political Economy*, 91: 70-96.
- Friend, Irwin and Larry H.P. Lang, 1988, An empirical test of the impact of managerial self-interest on corporate capital structure. *The Journal of Finance*, 43: 271-281.
- Froot, Kenneth, David Scharfstein and Jeremy Stein, 1993, Risk management: coordinating investment and financing policies. *The Journal of Finance*, 48: 425-458.
- Gale, Douglas, and Martin Hellwig, 1985, Incentive-compatible debt contracts: the one-period problem. *Review of Economic Studies*, 52: 647-664.
- Gay, Gerald G., and Jouahn Nam, 1998, The underinvestment problem and corporate derivatives use. *Financial Management*, 27: 53-69.
- Geczy, Christopher, Bernadette A. Minton and Catherine Schrand, 1997, Why firms use currency derivatives. *The Journal of Finance*, 52: 1323-1354.
- _____, November, 1999, Choices among alternative risk management strategies: evidence from the natural gas industry. *University of Pennsylvania Working Paper*.
- Graham, John R. and Clifford W. Smith, Jr., 1999, Tax incentives to hedge. *The Journal of Finance*, 54: 2241-2262.
- Greene, William H, 1997, *Econometric Analysis*. (Upper Saddle River, Prentice Hall).
- Grossman, Sanford, and Oliver Hart, 1986, The costs and benefits of ownership: a theory of vertical and lateral ownership. *Journal of Political Economy*, 94: 691-719.
- Guay, Wayne, 1999, The impact of derivatives on firm risk: an empirical examination of new derivatives users. *Journal of Accounting and Economics*, 26: 319-351.
- _____, and S. P. Kothari, March, 2001, How much do firms hedge with derivatives? *University of Pennsylvania Working Paper*.
- Haushalter, David G., 2000, Financing policy, basis risk, and corporate hedging: evidence from oil and gas producers. *The Journal of Finance*, 55: 107-152.
- _____, Randall A. Heron, and Erik Lie, January, 2000, Price uncertainty and corporate value. *University of Oregon Working Paper*
- Hentschel, Ludger, and S.P. Kothari, 2001, Are corporations reducing or taking risks with derivatives? *Journal of Financial and Quantitative Analysis*, 36: 93-118.

- Hodder, J., November, 1982, Exposure to exchange rate movements. *Journal of International Economics*, 13: 375-386.
- Hong, Harrison, 2000, A model of returns and trading in futures markets. *The Journal of Finance*, 55: 959-988.
- _____, and Jeremy Stein, 1999, A unified theory of under reaction, momentum trading, and overreaction in asset markets. *The Journal of Finance*, 54: 2143-2183.
- Howton, Shawn D., and Steven B. Perfect, Winter, 1998, Currency and interest-rate derivatives use in U.S. firms. *Financial Management*, 27: 111-121.
- Jareka, Danuta, 1998, Perils of the Hedge Highwire, *Business Week*, October 26, 1998, 72-75.
- Jegadeesh, Narasimhan, and Sheridan Titman, 1993, Returns to buying winners and selling losers: implications for stock market efficiency. *Journal of Finance*, 48: 65-91.
- Jensen, Michael C., and William H. Meckling, 1976, Theory of the firm: managerial behavior, agency costs, and ownership structure. *Journal of Financial Economics*, 3: 305-360.
- _____, and R. Ruback, 1983, The market for corporate control: the scientific evidence. *Journal of Financial Economics*, 11: 5-50.
- Jorion, Philippe, 1990, The exchange-rate exposure of U.S. multinationals. *Journal of Business*, 63: 331-345.
- Koski, Jennifer Lynch and Jeffrey Pontiff, 1999, How are derivatives used? Evidence from the mutual fund industry. *The Journal of Finance*, 54: 791-816.
- Lakonishok, Josef, Andrei Shleifer and Robert W. Vishny, 1994, Contrarian investment, extrapolation, and risk. *Journal of Finance*, 50: 1541-1578.
- Leahy, Michael P., October, 1998, New summary measures of the foreign exchange value of the dollar. *Federal Reserve Bulletin*, 811-818.
- Lei, Ugur, Fall, 2002, Corporate hedging policy around the world. *University of Indiana Working Paper*.
- Leland, M. and D. Pyle, 1977, Information asymmetries, financial structure, and financial intermediation. *Journal of Finance*, 32: 371-387.

- Levi, Maurice D., 1994, Exchange rates and the valuation of firms. *Exchange Rates and the Valuation of Equity Shares*, Y. Amihud and R. Levich, Eds. Irwin Publishing.
- Litner, John, 1965, The valuation of risk assets and the selection of risky investments in stock portfolios and capital budgets. *Review of Economics and Statistics*, 47: 13-37.
- Marshall, Chris, and Michael Siegel, Spring, 1997, Value at risk: implementing a risk management standard. *Journal of Derivatives*, 91-111.
- May, Don O., 1995, Do managerial motives influence firm risk reduction strategies? *Journal of Finance*, 48: 1275-1290.
- Mayers, David and Clifford W. Smith, Jr., 1982, On the corporate demand for insurance. *Journal of Business*, 55: 281-296.
- _____, 1987, Corporate insurance and the underinvestment problem. *Journal of Risk and Insurance*, 54: 45-54.
- _____, 1990, On the corporate demand for insurance: evidence from the reinsurance market. *Journal of Business*, 63: 19-40.
- McConnell, John J. and Henri Servaes, 1990, Additional evidence on equity ownership and corporate value. *Journal of Financial Economics*, 27: 595- 612.
- McDonald, John G., and Bruno Solnick, 1977, Valuation and strategy for gold stocks. *Journal of Portfolio Management*, 3: 29-33.
- Merton, Robert C., 1973, An intertemporal capital asset pricing model. *Econometrica*, 41: 867-887.
- _____, and Merton H. Miller, 1972, *The theory of finance* (New York:Holt, Rinehart, and Winston).
- Mian, Shehzard L., 1996, Evidence on corporate hedging policy. *Journal of Financial and Quantitative Analysis*, 31: 419-439.
- Modigliani, F. and M.H. Miller, June, 1958, The cost of capital, corporate finance and the theory of investment. *American Economic Review*, 261-297.
- Morek, Randall, Andrei Shleifer and Robert W. Vishny, 1988, Management ownership and market valuation, an empirical analysis. *Journal of Financial Economics*, 20: 293-315.

- Mozumdar, Abon, 2001, Corporate hedging and speculative incentives: implications for swap market default risk. *Journal of Financial and Quantitative Analysis*, 36: 221-250.
- Myers, Stewart C., November, 1977, Determinants of corporate borrowing. *Journal of Financial Economics*, 24: 147-176.
- _____, 1984, The capital structure puzzle. *Journal of Finance*, 39: 575-592.
- Nance, Deana R., Clifford W. Smith, Jr. and Charles W. Smithson, 1993, On the determinants of corporate hedging. *The Journal of Finance*, 48: 267-284.
- Nelson, Charles R., and G. William Schwert, June, 1977, On testing the hypothesis that the real rate of interest is constant. *American Economic Review*, 478-486.
- Oertmann, Peter, Christel Rendu, and Heinz Zimmermann, 2000, Interest rate risk of European financial corporations. *European Financial Management*, 6: 459-478.
- Opler, Tim C. and Sheridan Titman, July, 1994, Financial distress and corporate performance. *The Journal of Finance*, 49: 1015-1040.
- Pennings, Joost M. E. and Raymond M. Leuthold, 2000, The motivation for hedging revisited. *The Journal of Futures Markets*, 20: 865-885.
- Petersen, Mitchell A. and S. Ramu Thiagarajan, Winter, 2000, Risk measurement and hedging: with and without derivatives. *Financial Management*, 29: 5-30.
- Pringle, John J., 1991, Managing foreign exchange exposure. *Journal of Applied Corporate Finance*, 73-82.
- Rajgopal, Shivaram, and Morton Pincus, July, 1999, The interaction of accounting policy choice and hedging: evidence from oil and gas firms. *University of Washington Working Paper*.
- _____, and Mohan Venkatachalam, December, 1998, The association between earnings sensitivity measures and market determined risk exposures: the case of oil price risk for petroleum refiners. *Stanford University Working Paper*.
- Ross, Stephen A., 1976, The arbitrage theory of capital asset pricing. *Journal of Economic Theory*, 13: 341-360.
- Samant, Ajay, David Burnie and James D'Mello, 1995, Has the interest rate swap age made a difference? *International Review of Financial Analysis*, 4: 155-167.

- Saunders, Kent T., 1999, The interest rate swap: theory and evidence. *Journal of Corporate Finance*, 5: 55-78.
- Scholes, Myron and Joseph Williams, 1977, Estimating betas from non-synchronous data. *Journal of Financial Economics*, 5: 309-328.
- Schrand, Catherine and Haluk Unal, 1998, Hedging and coordinated risk management: evidence from thrift conversions. *The Journal of Finance*, 53: 979-1013.
- Shapiro, A.C., 1975, Exchange rate changes, inflation and the value of the multinational corporation. *Journal of Finance*, 30: 485-502.
- Sharpe, William F., 1964, Capital asset prices: a theory of market equilibrium under conditions of risk. *Journal of Finance*, 19: 425-442.
- Shin, Hyun-Han and Rene M. Stulz, December, 2000, Shareholder wealth and firm risk. *Ohio State Working Paper*.
- Shleifer, Andrei and Robert W. Vishy, 1986, Large shareholders and corporate control. *Journal of Political Economy*, 94: 461-488.
- Simon, Herbert, 1951, A formal theory model of the employment relationship. *Econometrica* 19: 293-305.
- _____, and J. Warner, 1979, On financial contracting: an analysis of bond covenants. *Journal of Financial Economics*, 7: 117-161.
- Skinner, Douglas J., 1996, Are disclosures about bank derivatives and employee stock options 'value-relevant'? *Journal of Accounting and Economics*, 22: 393-405.
- Smith, Clifford W., Summer, 1995, Corporate risk management: theory and practice. *Journal of Derivatives*, 22: 21-30.
- _____, and Rene Stulz, December, 1985, The determinants of a firm's hedging policies. *Journal of Financial and Quantitative Analysis*, 20: 391-406.
- Smithson, Charles. W. (Ed.), 1996, *Managing financial risk 1996 Yearbook*. New York, NY, CIBC Wood Gundy.
- Strong, John S., Spring, 1991, Using oil share portfolios to hedge oil price. *Quarterly Review of Economics and Finance*, 31.1: 48-63.
- Stulz, Rene M., 1990, Managerial discretion and optimal financing policies. *Journal of Financial Economics*, 26: 3-28.

- _____, June, 1984, Optimal hedging policies. *Journal of Financial and Quantitative Analysis*, 127-140.
- Sweeney, Richard J., and Arthur D. Warga, 1986, The pricing of interest-rate risk: evidence from the stock market. *The Journal of Finance*, 41: 393-410.
- Titman, Sheridan, 1992, Interest rate swaps and corporate financing decisions. *The Journal of Finance*, 47: 1503-1516.
- _____, and Roberto Wessels, 1988, The determinants of capital structure choice. *The Journal of Finance*, 43: 1-19.
- Townsend, Robert M., 1979, Optimal contracts and competitive markets with costly state verification. *Journal of Economic Theory*, 21: 265-293.
- Tufano, Peter, 1996, Who manages risk? An empirical examination of risk management practices in the gold mining industry. *The Journal of Finance*, 51: 1097-1137.
- _____, 1998, The determinants of stock price exposure: financial engineering and the gold mining industry. *The Journal of Finance*, 53: 1015-1052.
- _____, Spring, 1998, Agency costs of corporate risk management. *Financial Management*, 27: 67-77.
- Wall, Larry D. and J. J. Pringle, 1989, Alternative explanations of interest rate swaps: an empirical analysis. *Financial Management*, 18: 119-149.
- Warner, Jerold B., 1977, Bankruptcy costs: some evidence. *The Journal of Finance*, 32: 337-348.
- White, Halbert, 1980, A heteroskedasticity-consistent covariance matrix and a direct test for heteroskedasticity. *Econometrica*, 48: 817-838.
- Williams, J.C., 1986, *The Economic Function of Futures Markets*. Cambridge University Press, Cambridge.